Eating like there is a tomorrow

A design science research project on developing a technology that supports individuals in following a more sustainable diet

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Programme: MSc Business Administration and E-Business

Course: Master Thesis

Place, Date: Copenhagen, 14.11.2019

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Pages/Characters: 80/174.407

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Abstract

Our diet has not only an impact on our personal health, but poses great challenges to the environment and society as a whole. About 40% of livable land is used for agriculture. Food production alone is accountable for about 70% water use and up to 30% of global CO2e emissions [1], [2], [3], [4], [5]. This is more than double the CO2 emissions of the global transportation sector, which is responsible for about 14% of global CO2e emissions [6].

At the same time, current solutions that address this challenge often rely on the producer side or on information provision to the consumer in the form of labels [7]. The latter has proven to be of little effect or even impeding the confused and skeptical consumer who can not see through the jungle of claims and labels [8], [9], [10]. A possible hint for the existence of this paradox is the gap between research and practice. Determinants of a sustainable diet are well researched but lack practical implementation and testing [11], [12]. Hitherto, current consumer solutions are often not grounded in theory and thus fail to support a change in dietary habit.

Thus, this design science thesis supports overcoming this gap by developing and testing a technical solution that supports individuals in adapting a more sustainable diet. Hence, the research question *„How can influencing factors of sustainable diets be leveraged by technology in order to support sustainable dietary change?“* will be addressed.

For this, a total of five iterations have been followed in close collaboration with a target user group, going from user needs development to solution ideation and testing. Grounding the project in kernel theory on dietary habits and primary studies on the determinants of sustainable food consumption, continuous user insights added to the design and development of the final artifact: a sustainable recipe app. The app was tested over a course of 3 weeks with a total of 15 users. The final evaluation compromised a thematic analysis of the semi-structured interviews conducted.

Evaluation shows that the application supported users in changing their diet and creating a higher consciousness of food sustainability in general. Notably, intriguing content such as nice photos and inspiring ingredients, as well as supporting the user in setting achievable goals for his or her dietary change turned out to be most supportive.

Hence, this thesis supports sustainable dietary researchers in taking the step from theory to practice, it supports institutions in supporting dietary change more meaningfully and it brings research into current practices of sustainable dietary change technologies. With this, this thesis addresses a global challenge by supporting individuals to eat, like there is a tomorrow.

1. Introduction

„Food in the Anthropocene represents one of the greatest health and environmental challenges of the 21st century.“ [13, p. 449]

Our food consumption has not only an impact on our personal health and well-being, but poses great challenges on the environment and society as a whole. What we eat impacts heavily on greenhouse gas emissions, land and water use, soil pollution, diseases occurrence, and food security for a growing population [14]. To be more concrete, about 40% of livable land is used for agriculture. Food production alone is accountable for about 70% water use and up to 30% of global CO2e emissions [1], [2], [3], [4], [5]. This is more than double the CO2 emissions of the transportation sector world wide, which is responsible for about 14% of global CO2e emissions [6]. On top of that, unhealthy diets represent a greater risk for early death than alcohol, drugs, tobacco and sexually transmitted diseases combined [13]. A sustainable diet is hence not only for personal benefit but for planetary health too. Linking this to global agendas such as the EAT-Lancet Commission, the Intergovernmental Panel on Climate Change or the UN Sustainable Development Goals 2 and 12, this project aims to develop a solution that supports sustainable food consumption for human and planetary sustainability [15].

Motivation

The impact of our diet on health and environment is more than obvious. Still, people tend to stick to their unsustainable diets. Why do people not simply change their dietary behavior? First, behavioral change is not an easy task since routinized behaviors manifest over years and are likely to form habits, resulting in a mostly unconscious process of cues and actions [16]. Hence, changing ones habit requires active involvement of the habit keeper and mental re-programming [17].

Secondly, current practices to get people to consume more sustainably include mostly the provision of information such as labels like FairTrade and Organic or creating institutions of experts such as the ones named above [7]. However, no direct positive effect of these aspirations can be observed so far. In fact, meat consumption, one of the major CO2 contributor, increases globally [18]. Besides, recent studies conclude that consumers are skeptical about the labels, don’t trust them or don’t understand them and hence labels do not support or even impede sustainable consumption [8], [9], [10].

A possible answer to these unsuccessful interventions is that they are not of core importance to people’s dietary choice. As extensive research indicates, factors motivating people to consume more sustainable food are not in fact provision of information or labels. Factors supporting and hindering people to consume

more sustainably are visible in theory - they just have not been translated into practice let alone been tested [11], [12]. Hence, research and practice seem to pursue differing paths, adding to the paradox of sustainable food consumption.

Lastly, a lot of current interventions deal with the producer side of the food system such as innovations in alternative protein sources, blockchain in food safety, emerging technologies for agriculture and the pursuit to regulate farming practices to a higher degree [19]. Hitherto, the consumer is mostly left out and acts only as the receiver of these new inventions. Overall, the paradox of environmental need and awareness in the light of current practices and successful dietary change is clearly visible. It is time for re-inventing the way we eat and it is time for empowering the consumer to reinvent his and her own diet.

Objective & Research Question

The objective of this research is thus to assess how and which factors impede sustainable dietary change. On top of that, this thesis aims to explore the most important impeding factors of a defined target user group in order to develop a solution that addresses these factors, easing the dietary shift of the target users. Hence, this research seeks to add theoretical and practical value to both practitioners and researchers in the field of food technology, habit formation and change and sustainability studies by addressing the given paradox and discrepancy between research on changing individual habits towards a more sustainable diet and current practices. By applying a design science research (DSR) approach, this thesis does not only add theoretical but also practical value to the field. Thus, in accordance with objectives of DSR, a functioning artifact will be designed and built that addresses the given research question and objective. The artifact will be tested and its behavior investigated and lastly, design themes based on the given analysis will be prescribed. For this, the following research question can be derived:

„How can influencing factors of sustainable diets be leveraged by technology in order to support sustainable dietary change?“

Furthermore, three major subquestions arise:

Subquestion 1: What are impeding and supporting factors of following a sustainable diet?

Subquestion 2: What are the influencing factors of the target users in following a sustainable diet?

Subquestion 3: What technical functionalities are needed to address those factors meaningfully?

Research Scope

This paper contributes to the current research on supporting and impeding factors for dietary change, here especially towards sustainable dietary change.

Additionally, in accordance with the followed DSR, a specific target group has been identified. This thesis addresses hence the needs and requirements of the identified target group of potential greens (PG), who represent an attractive target for sustainable dietary change.

As will be explained in chapter 2, the term sustainability within the topic of food and diet can be defined in a variety of ways. One could possibly include ecological, social or animal welfare, health, economical and many other factors. For this thesis, focus will be put on the environmental aspect of food sustainability, more precisely CO2 emissions. CO2 emissions in the food system do not only pose a significant challenge to the world, but they are of core importance to the chosen target group of this thesis. Besides, unlike the other food sustainability factors, the food system's CO2 emissions are relatively accessible and hence assessable within the scope of this thesis [20].

Signposting

The following chapters will focus on the elaboration of the theoretical foundations and the DSR process. A conceptual and theoretical overview will be given in chapter 2, beginning with the discussion of a sustainable diet. Besides, supporting and impeding factors for following or changing towards a sustainable diet will be outlined. In chapter 3, a discussion on the research philosophy and methodology is presented. This will be followed by a closer look into DSR and the approach followed for this thesis. In chapter 4, the project's perspective on habitual change will be introduced and the design and development process elaborated. The evaluation in chapter 5 presents insights gathered on the final artifact's utility. For this, the final interviews will be analyzed in the light of the artifact developed. Besides, the outcomes will be interrelated with the theoretical background of chapter 2. The thesis concludes with chapter 7 and with this, will address limitations and future outlooks of the paper.

2. Literature Review

This thesis aims to develop a solution to support individuals in following a more sustainable diet. As mentioned in the introduction, a paradox exists not only between the unambiguous need of humans to follow a more sustainable diet and the individual actions in terms of diet, but also the current means of changing human diet and the results. Thus, the need to identify novel ways of motivating people to follow a more sustainable diet is apparent. In order to do so, it is crucial to identify current impediments as well as motivators that keep or support individuals from following a sustainable diet. Therefore, the following chapter conceptualizes current notions of the independent variable, sustainable diet, in the light of the dependent variable, factors influencing sustainable diets. In order to do so, it is first and foremost important to understand the meaning of sustainable diet for this thesis. Hence, a brief introduction of the term will be

given before mapping the current state of knowledge in the field of influencing factors of a sustainable diet. A detailed overview of the existing theory in relation and context of the given variables is provided as a concept matrix. An overview on how the concepts are related towards each other is described in a conceptual model.

Review Strategy

The major part of the literature review was conducted between March and July 2019. However, due to the iterative nature of this research, the literature review was revised and updated continuously as needed when new insights were gained throughout the project. The literature review was done by the author. In terms of search strategy, focus was put on English literature, whereas Danish literature was taken into account in order to better understand Danish food habits and include studies on Danish food consumption done by Danish institutions such as DTU. Also, only primary studies on factors were considered to ensure scientific quality of the factors [21]. All of these studies were required to evaluate the factors influencing the purchase or consumption of sustainable food. Databases such as Emerald Insights, Elsevier and Scopus were used since these are especially relevant for topics within diet and dietary change. Besides, references of relevant articles were screened to cross-reference other related and relevant studies**.** Keywords for search included „habit sustainable eating/diet“, „environment food consumer“, „consumer patterns diet“.

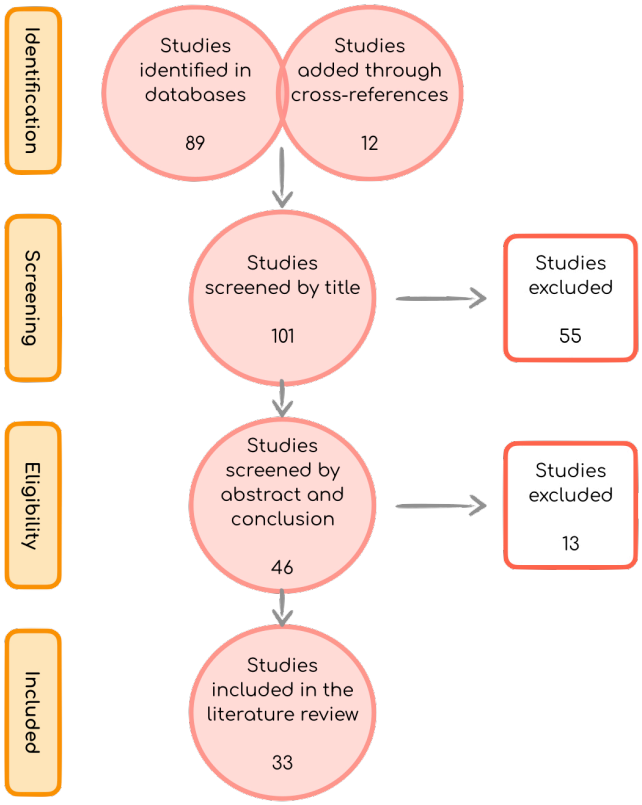


Image 1: Flow Diagram of Studies Included in the Review

Over the whole course of literature reviewing, a total of 101 articles were initially found due to their fit of title or cross-reference in relevant articles. Of these, only 46 were identified as relevant after having examined the abstract and conclusion of the articles. Relevance was assessed based on the criteria above, especially being a primary study assessing factors that influence sustainable food consumption. For example, [22] was excluded at this point since the research conducted is rather a meta-analysis of factors determining food choice and not a primary study on these. The remaining 46 primary studies were assessed more closely. Finally, 33 primary studies were selected as

relevant in terms of the selection criteria and relevance to the thesis. In this last step, studies such as [23] were excluded since it misses the focus on assessing factors influencing sustainable food consumption but instead focusses on determining the optimal pricing strategy for sustainable food. The remaining 33 studies were used as a basis for the concept matrix below. The process of reviewing the literature can be seen in the flow diagram above.

Sustainable Diet

In order to address sustainable food consumption, it first has to be clear what sustainable food consumption is. The original definition of sustainable development as defined by the Brundtland report is *„to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs“* [24]. In economics, sustainability is often seen within the definition of the triple bottom line, focussing on profit, people and planet [25]. But how does all this apply to food?

Looking at studies on sustainable food consumption, interest is put on a variety of aspects and perspectives. Some address organic food, for example [26], plant-based food, for example [27] or local food, for example [28]. Others again focus on specific factors such as the personal health to sustain oneself [29]. It is obvious that the term sustainability in diet and food enjoys no consensus.

One of the most recent and discussed contributions to the topic comes from the EAT-Lancet Commission. Over the past years, the commission has made it their duty and goal to define a so called planetary health diet that is both sustainable to the human in terms of nutritional intake and health, as well as to the planet in terms of climate stability, ecosystem resilience and environmental health [13]. Building on a large base of research on global diets, agriculture, human health and environmental sustainability, the commission finally defined the diet below that is both sustainable for humans and the planet. For this study, the EAT Lancet definition of a planetary health diet will be used as a working definition for a sustainable diet. Hence, a sustainable diet is one that has *„[…] an optimal caloric intake and consist largely of a diversity of plant-based foods, low amounts of animal source foods, contain unsaturated rather than saturated fats, and limited amounts of refined grains, highly processed foods and added sugars.“* [30].

With this diet, a large step towards both human as well as planetary health can be achieved. Thus, focus is primarily on environmental and human sustainability and not on other aspects such as animal- or social welfare. Thus, definitions of sustainability that embrace the environmental aspect will be regarded such as organic, local, seasonal and plant-based food.

A Concept Matrix: Influencing Factors of a Sustainable Diet

Factors influencing the purchase and consumption of sustainable foods are highly researched. Both supporting as well as impeding factors have been studied extensively within recent years. As noted before, studies do not use a coherent definition of sustainability. Instead, sustainability is often seen under the concept of organic food or plant-based food**.** A concept matrix combining the variables of food consumption and influencing factors based on relevant primary studies has been created. Table 1 below summarizes the most important concepts. 22 concepts have been found in total. However, concepts that have been named only once or twice will be given less regard due their relative unimportance. In the following, each concept will be described briefly according to its effect on sustainable food consumption. Concepts will be addressed in order of their relative importance within the studies reviewed. In the end, a conceptual model is formed, highlighting the importance of factors and their respective relationships among each other.

In general it can be observed that there is a clear tendency towards certain factors. Health (27), environment (20) price (15) and taste (11) are most discussed whereas the other factors have less than 10 mentions. Important to notice here is however that some of the studies address the four mentioned factors in particular due to their popularity. Hence, importance of those factors might be biased.

Besides, the 33 primary studies are not only addressing the target user of the PG but also sustainable consumers and potential sustainable consumers in general. Most studies focus on European consumers whereas [31], [28] focus on the USA and [32] on Australia. Since those studies did not interfere with the other studies, they were taken into account. It also has to be noted that studies often do not make a difference between the purchase intention and actual purchase or consumption of the food. However, as multiple studies show, factors influencing both intention and actual behavior are the same while differing only in intensity and hence both will be regarded [33], [34]. Factors in the concept matrix represent both impeding, motivating or indifferent influence. The „+“ stands for a positive influence, the „-„ for a negative, „+/-„ for both and „/„ for indifference. In the following, concepts will be discussed in terms of all their influences found.

	Health Consciouness	Environmental Concern	Price Sensitivity	Taste	Availability	Skills and Knowledge	Animal Welfare Concern	Convenience of Shopping	Purity of the Food	Nutrient Intake	Quality of Food
[26]	+	+									+
[27]					+			-			
[28]	+	+	-	+	-	-				+	+
[29]	+										
[31]		+	-					-	+		
[32]	+					-					
[33]	+		-					-	+		
[34]	+	+	-					-	+		+
[35]	+	+		+			+		+		
[36]	+	/	-								
[37]	+	+									
[38]	+	+					+		+		
[39]	+	/	/	+	-						
[40]	+	+					+				
[41]	+	+	-	+	-	-					-
[42]	+	+	-	+	-	-					
[43]	+		-	+	-						

	Health Consciouness	Environmental Concern	Price Sensitivity	Taste	Availability	Skills and Knowledge	Animal Welfare Concern	Convenience of Shopping	Purity of the Food	Nutrient Intake	Quality of Food
[44]	+	+	/			+					+
[45]	+		-								
[46]	+		-	+/-			+				
[47]	+					-				+/-	
[48]	+	+		+			/				
[49]	+				-			-			
[50]	+	+		+							
[51]	+										
[52]	/		/	+			+		+		
[53]	/								+		
[54]	/	+	-		-		+			+	
[55]	/	/		+/-	/	+/-				+/-	
[56]		+					+				
[57]		+									
[58]		/	-					-			
[59]						-		-			

	Enjoyment of Eating	Social Environment	Locality of Producers	Social Impact of Purchase	Identity	Trust	Weight	Holistic Sustainable Mindset	Political Support	Curiosity	Brand loyalty
[26]				+				+			
[27]					-						
[28]						-					
[29]											
[31]											
[32]											
[33]		+					+				
[34]	+		+								
[35]											
[36]		+									
[37]											
[38]											
[39]											
[40]											
[41]			+	+		-					
[42]											

	Enjoyment of Eating	Social Environment	Locality of Producers	Social Impact of Purchase	Identity	Trust	Weight	Holistic Sustainable Mindset	Political Support	Curiosity	Brand loyalty
[43]	+										
[44]											
[45]	-										
[46]			-								
[47]											
[48]		/					/				
[49]											
[50]											
[51]					+						+
[52]											
[53]								+			
[54]				+							
[55]											
[56]									+		
[57]										+	
[58]											
[59]	-										

Table 1: Concept Matrix - Influencing Factors for a Sustainable Diet

Factor 1: Health Consciousness

Health is the most mentioned factor affecting dietary choice. Out of the 27 studies that address health, 23 conclude a supporting effect on change towards or following a sustainable diet. Most of the studies view food sustainability within organic**,** some within plant-based and one considers fair-trade**.** Even though health is the most mentioned factor, its relative importance compared to other factors is changing.

For the majority, health is seen as the most important supporting factor for a sustainable diet [32],[35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46], [47], [48], [49] but it is also mentioned as being of secondary importance [26], [28], [33], [50]. In general, health is often referred to as an „individualistic" or „egoistic" factor since peoples' concern lies within their own and not the planet's or others wellbeing [35], [36]. However, [40] also notes that health is of core importance to purchasing and wanting to purchase more organic food for the family's health in the UK.

As several studies indicate, the health factor for dietary choice has a variety of underlying motivations such as health due to the food's purity and less strong use of pesticides [35], personal illness and allergies [41], or prevention of diseases [47]. Besides, the higher the health consciousness of an individual, the more likely (s)he is to buy organic food and vice versa [28], [37], [49]. This is additionally supported by [29] who note that Spanish consumers perceive organic food as being healthier and by [51], who state that health consciousness supports the attitude towards purchasing organic food. This seems to be especially true for females who are more likely to purchase organic food for personal and family health reasons [35], [36].

As mentioned, studies often focus on either actual purchase [28], [33], [39], [42] or attitude towards purchase [32], [33], [44], [47]. However, [33], [34], [43], [45] reveal that for both, people who already eat environmentally friendly and those who want to change, health is a motivating factor to do so. Nevertheless, it appears that the more experienced a consumer is in his or her sustainable food consumption, the more likely they are to focus on other factors apart from health [38].

While most studies discover health as being a supporting factor for a sustainable diet, four studies reveal little to no effect [52], [53], [54], [55]. As observed by others, the factor health is for example not of primary importance in Germany for organic purchase [52], [54] and [55] even note that respondents are unaware of the connection of plant-based food and health.

In total however, health has been and still is a highly researched factor that positively influences sustainable food consumption. Health consciousness if mostly related to personal concerns and the more health conscious an individual is, the more likely (s)he is to consume sustainable food, especially organic and plant-based food. Lastly, it might be true that health consciousness is a factor that is especially relevant for

irregular sustainable food consumers, since other factors such as environmental concern grow stronger the more experience a consumer has with sustainable foods.

Factor 2: Environmental Concern

Environmental concern is the second most mentioned factor affecting sustainable dietary choice. Out of the 20 studies that address environmental concern, 16 conclude a supporting effect on change to or following a sustainable diet. Most of the studies view sustainability within food as organic, four within plant-based**.**

Similar to health, the relative importance of the factor differs. Most studies view environmental concern as the most motivating factor to change to or follow a sustainable diet [26], [28], [34], [35], [38], [54], [56], [57], especially for those who already consume organic food regularly [26], [28], [34], [35], [38], [54], [56], [57]. For some however, environmental concern is of secondary importance [37], [40], [42], [44], [48].

Opposing to the „egoistic" health consciousness factor, environmental concern is described as a more „altruistic" factor since respondents are more concerned about the planet and the environment and less about the personal wellbeing [26], [36]. Even though most studies do not make a difference between purchase and purchase intention, [34], [54] note that overall motives are the same.

Interestingly, a pattern seems to emerge: While [38] state that the environmental consciousness within food is missing completely in the UK, [40] expresses the opposite and [41] add that environmental concern is only valid in regard to regular organic buyers, not occasional ones. [28] note something similar when declaring that the more frequent organic food products are purchased, the higher is the individual concern for environment over health.

Adding to this, people with an a holistic environmental concern, meaning not only related to food but also for example energy usage, are more likely to purchase organic food [31], [50]. Besides, even though the overall relevance of environmental concern in organic purchase might not be of primary importance to consumers, the intensity of buying organic food over conventional food increases noticeably with higher environmental concern [31], [44], [50].

On the other hand, [36] state that environmental concern has no effect on purchase of organic foods in Denmark and Greece [39], while [55] detects an unawareness of the positive environmental impact of plant-based food and [58] even state that people, especially men, disbelief in the environmental impact of food.

Overall, the tendency as observed within the health consciousness factor can be supported. Environmental concern seems to have a positive impact on purchasing organic and plant-based foods but seems to be of higher importance for people who are already regular consumers. While it is not stated whether concern

impacts purchase or the other way around, environmental concern is higher for the regular buyers. Additionally, the environmental impact of plant-based food seems to be less visible than of organic food.

Factor 3: Price Sensitivity

As the third most mentioned factor, price is the first with an overall negative influence on sustainable food consumption. 12 out of 15 studies identify a strong negative influence while only the remaining three note little to no influence on sustainable food consumption. Again, most studies refer to organic food while two address plant-based food.

Most studies state that for those consuming only meat and for those wanting to change to a more plant-based diet, price acts as a major impediment [33], [41], [42], [43], [45], [46]. Nevertheless, one prior study found that price is only a perceived barrier, whereas the effect on actual purchase of organic food is little [58]. This is confirmed by [44] who notes that price effects the amount purchased but not the act of purchase in itself. [31], [34] oppose to this by stating that price is a challenge in overcoming the attitude-behavior gap of organic food purchase and that price acts as demotivation for both regular and occasional organic buyers [28], [43], [54].

Lastly, [39], [52] identify price as a weak demotivator in sustainable food purchase.

In total, price sensitivity resembles the strongest demotivator in sustainable food consumption but assumably only affects the amount purchased and not the purchase in itself.

Factor 4: Taste

Among the 11 mentions, all identify better taste as a motivator towards purchasing organic or plant-based foods**.** Among those, two however also identify taste as a barrier.

Most see better taste as a weak motivator [28], [35], [41], [43], [46], [48], [55] and only a few see it as one of the most important drivers for organic food purchase [39], [42] or even as a sensory experience [52].

On the other hand, [46] even see taste as a barrier for those consuming a lot of conventional meat compared to organic meat and [55] as a barrier towards eating more plant-based when meat and dairy consume is high.

Even though evidence is small, a tendency can be seen towards a positive attitude towards taste of organic foods while plant-based foods are considered less tasty by heavy meat eaters.

Factor 5: Availability

A second major impediment for sustainable food consumption is availability. Out of the nine mentions, seven identify availability of sustainable alternatives as a barrier, one as a motivator and one as indifferent.

Similar to price, availability is often described as the most important obstacle in organic food purchase [39], [41], [42], [43], [54]. However, this seems to be especially true for regular sustainable consumers, who see the small availability of sustainable alternatives as less convenient and associate this with more effort they have to spend in order to achieve a regular activity as grocery shopping [28], [54].

Studies on plant-based food paint a similar picture: once availability of plant-based food is leveraged, people consume it more frequently [27]. If however only few plant-based alternatives are available, more people stick to animal-based foods [27]. This lets assume that availability is not only linked to the actual accessibility of the foods, but also to its diversity [27].

On the other side, people who already consume a high amount of plant-based food have a positive attitude towards the availably of plant-based foods in Denmark [55].

Hence, availability seems to be linked to knowledge and convenience since it doesn't effect the actual purchase of organic or plant-based foods for regular buyers and only has annoyance factors, whereas for irregular consumers, especially plant-based, foods are perceived as less available.

Factor 6: Skills and Knowledge

Another strong impeding factor is skills and knowledge about sustainable foods and dishes. Seven out of eight studies consider this factor as a barrier. For the first time, the focus is more on plant-based foods compared to organic.

In terms of skills and knowledge as a barrier, studies identify the lack of cooking skills [41] and the lack of information on organic products and their benefits as crucial determinants [42]. Especially the latter is even true for regular organic shoppers [28].

Within plant-based foods, those who consume little animal products like the ease of cooking plant-based dishes [55], whereas the ones consuming animal products to a high degree have negative attitudes towards their plant-based cooking skills as well as the nutritional information of plant-based foods [32], [47], [55], [59]. Rephrased, this means that those who know more about sustainable food and have more experience, consume more [44].

Overall, skills and knowledge are only a perceived barrier that is broken once experience in especially plant-based food is gained.

Factor 7: Animal Welfare

With a total of eight mentions, animal welfare is mostly seen as a motivating factor for an organic and plant-based diet.

This factor is especially important for those who already consume organic food products heavily [35], [52], [54], [56]. For few, animal welfare is also important with little actual organic consumption [56].

Similar to the environmental concern, more experienced organic food consumers place a higher value on animal welfare when purchasing organic food compared to other factors such as health [38]. This however is not true for organic meat, for which animal welfare is a high motivating factor for purchase [40], [46].

On the other side, [48] identify only little importance for animal welfare when viewed within the consumption of plant-based food.

Hence, similar to environmental concern, animal welfare seems to be an important factor for more experienced sustainable food consumers.

Factor 8: Convenience of Shopping

Of the total seven mentions, all consider convenience as a barrier towards buying plant-based or organic foods.

Convenience is heavily related to the fact that people eat what they know and what they know tastes good [27], [31], [33], [34], [49] [59]. This seems to be especially true for males who are considering eating more plant-based foods [58]. Simply put: people are satisfied with their known conventional food and do not see the need to change their behavior [31], [34], [49]. Thus, similar to the availability factor, convenience poses a challenge for people in having to put more effort into a regular activity they do not see the need to put effort into.

It is obvious that convenience has a higher negative effect on plant-based foods since the change from conventional to organic food is less related to having to choose completely different products [58]. For a plant-based diet, people have to adjust their consumption patterns towards for example new sources of protein.

Hence, convenience is especial related to plant-based foods and the change from an animal-based diet towards a plant-based one. In general, convenience has a strong habitual aspect and reveals that people simply eat what they know and are less willing to experiment with something unknown.

Factor 9: Purity of the Food

Six out of seven mentions of purity of the food refer to organic food whereas one to plant-based food. All studies see purity as a motivator.

Purity of the food is mostly seen under the personal health aspect since organic products contain less pesticides and are hence better for personal health [35], [38], [53]. Only one study found purity to be related to the health of the environment [31]. Others describe organic and plant-based food as being more natural [34], [52] which serves as a motivator for both regular buyers and those who desire to purchase more plant-based [33].

Overall, purity has a strong link to the health consciousness of individuals who wish to have less harmful residues in their food. Even though an environmental effect is seen, it is less impactful than the personal benefit.

Factor 10: Nutrient Intake

Having already addressed nutrients of organic and plant-based foods under the skills and knowledge factor, both nutritional superiority and concern about nutrient intake are mentioned in studies concerning this factor.

For heavy organic shoppers, the nutritional superiority of organic food compared to conventional is highlighted [28]. Individuals interested in nutrition are more likely to purchase organic foods [54]. Similarly, individuals who consume high amounts of plant-based food have positive attitudes towards the nutritional value of their diets [47], [55].

On the other hand, people who consume high amounts of animal-based products have a negative perception on especially protein intake and hence satiety of plant-based foods [47], [55].

Similar to skills and knowledge, this factor seems to be mostly related to experience with sustainable foods. The more experience an individual has with the respective food, the more satisfied (s)he is with the nutritional intake.

Factor 11: Quality of Food

The quality factor is only mentioned under the organic aspect and is represented in five studies.

All studies reveal that quality is of secondary importance in terms of motivation for organic consumers [26], [28], [34], [44]. Quality refers to the both the freshness and taste of the food product [28], [44] as well as the enjoyment of treating oneself with something delicate and extraordinary [34].

[41] are the only ones who identify the quality of organic food as a barrier of consumption in the UK. Here respondents note the poor in-store presentation of organic food and hence a mistrust in irregular organic consumers towards value for money of organic products.

Thus, quality of food can be related to a variety of other factors such as taste and price perception. In general, organic food is perceived as of higher quality by both regular and irregular consumers but poor presentation of the food can put irregular consumers off quickly.

Factor 12: Enjoyment of Eating

Enjoyment is mentioned **three** times, once as a barrier and twice as a motivator for both organic, and plant-based food.

Enjoyment is mentioned as a pleasurable experience to consume organic food; however, only of secondary importance [34], [43].

For heavy meat consumers, enjoyment of consuming animal products, especially meat, serves as barrier towards consuming less animal and more plant-based products [59]. These consumers do not want to miss out on their sensory experience of eating meat.

Besides, people who value indulgence of food have a negative attitude towards organic food, which is likely related to the lacking diversity and excitement but at the same time higher price for these products [45].

Hence, enjoyment of eating is a fuzzy factor that both contributes and impedes people to consume more organic and plant-based foods. Especially the enjoyment of eating what one is used to and valuing diversity and low prices impedes people to eat more sustainable.

Factor 13: Social Environment

The social environment factor is mentioned three times of which two refer to plant-based diets. This factor is seen slightly positive whereas its influence on sustainable food consumption is majorly indifferent.

Studies generally note that the social environment, namely the family and the family's food habits, influence on what is being consumed [36], [48]. This however goes for all foods. Hence, if people are used to having organic, conventional or plant-based food within their family, they will likely consume those foods respectively [36], [48]. This effect however is often seen as not very impactful [48].

On the other side, it has been found that sociability and an improved social image work as motivating factors for those who want to change to a more plant-based diet [33]. Hence, trend-related food and what the majority of the social environment thinks is fashionable has a positive impact on what is being consumed.

In total, people seem to be less influenced by their family in regards to food consumption. However, familiarity to food does steer food choice and especially an improved social image can be noted as a driver for food change. This however is not necessarily related to sustainable food but can be true for any food that is valued by the society or is familiar to the consumer.

Factor 14: Locality of Producers

The locality factor was mentioned three times and is exclusive for organic food. This factor is especially important to consumers who value support of their local farmers.

Hence, this factor goes both ways: in favor and against organic food. For those who consume organic food from local farmers, locality serves as a motivator to consume organic over conventional food [34], [41].

On the other hand, consumers who value locality and who see organic food as mostly imported from other countries choose to purchase more conventional but local food [46].

Thus, similar to the social environment factor, locality per se is not a motivating or impeding factor for consuming sustainable food. Instead, the origin of the food product is more important guiding consumer who favor locality towards the food that is sourced locally.

Factor 15: Social Impact of Purchase

The social impact factor is related to both organic and fair trade food and serves as motivator to purchase these.

Similar to the previous factor, people who value support of local farmers are driven towards purchasing local organic food if available [26], [41]. However, different to the prior factor, the social impact factor spans local boundaries and serves additionally as a motivator to purchase fair trade food that supports farmers in third world countries [54].

Hence, the driving force for this factor is the individual's value for social sustainability. This counts for both for local as well as global farmers.

Remaining Factors

The following factors have only been mentioned once or twice throughout all studies and have hence been clustered.

Identity has been mentioned twice of which one refers to identity as a motivating factor to consume organic food in terms of self-identifying as a green consumer [51]. The other study reveals a negative influence related to plant-based food and states that especially males identify themselves with meat-eating which impedes them from trying out plant-based foods [27].

In terms of trust, two studies name that missing trust in food labels works as an impediment for both frequent as well as occasional organic consumers [28], [41].

Regarding weight, consumers who already eat plant-based foods like the weight improvement [33] while [48] finds little to effect of this factor on consumption of plant-based foods.

Moreover, two studies both note an increased consumption of organic foods in individuals who have a broader sustainable mindset, including for example concern for the environment, society and animal welfare and who follow sustainable practices also outside of food-related actives such as regarding waste sorting, electricity and water usage [26], [53]. This is called a holistic sustainable mindset.

One study observes a positive impact of political influence on the consumption of organic foods in Norway, suggesting that political statements on and support for organic food increases the positive perception of the population towards organic foods [56].

Another study mentions that consumer curiosity in trying out new wines supports the consumption of organic wines [57].

Lastly, under the light of routine and familiarity ones study discovers that consumers who show brand loyalty towards organic brands purchase those more [51].

Conceptual Model

Having reviewed factors that impede or support the intention and consumption of sustainable food, including organic, plant-based, and climate-friendly food, a few key points can be noted.

Firstly, studies analyzing influencing factors on sustainable food consumption are very diverse and focus on a set of different factors as well as aspects of sustainability in food. Most studies focus on organic food followed by plant-based food and lastly climate-friendly food. A holistic view on sustainable food is missing.

Secondly, studies often do not make a difference between purchase intention, actual consumption or attitude towards the respective food. However, as noted by a few researchers, while the intensity of factors might differ between these stages, the factors in itself stay the same.

Lastly, influencing factors are clearly diverse and prove difficult to be generalized. This adds to the challenge of developing meaningful solutions to support people in changing towards a more sustainable diet.

Nevertheless, certain meaningful patterns emerge. Hitherto, a variety of influencing factors could be determined, the most researched being health, environment, price and taste. For these factors, the outcome is rather clear: health and environment serve mostly as supporting factors towards a sustainable diet including organic and to a lesser degree plant-based foods. A tendency towards a factor-hierarchy can be observed: Health as the most crucial supporting factor is valued by both regular as well as occasional sustainable food consumers. Health and to a lesser degree environmental concern are linked directly to the purity of the food. However the more frequent the consumption of such products is, the more important becomes environmental concern, which is hence more important to regular sustainable food consumers. To a lesser degree, animal welfare follows the same pattern.

Price consciousness is the most pressing barrier and is connected to a few other factors. High prices of sustainable food impede price conscious consumers who feel a diminished value for price in terms of quality and enjoyment. Nevertheless, enjoyment seems to switch once more experience is gained with the respective food. Also, price does not effect the sustainable purchase in itself but only the amount of food being purchased.

Most factors are very much reliant on experience and knowledge about the respective food product. For example, perception on taste, availability, enjoyment and nutritional knowledge have a positive influence the more sustainable products are consumed. However, the less frequent sustainable foods are consumed, the more negative is also the perception on these factors.

Lastly, a few factors seem to be short cuts to either consuming conventional or sustainable food. These factors are locality, social environment, social impact and convenience. For the former, the origin of the product is more important than its sustainability or conventionality. If the product that is most local happens to be sustainable, then this is what is being consumed. Social environment and convenience can be seen under the light of routine and habit since people note that they rather consume what they are used to without having to put much effort into changing food habits. Hence, familiarity functions as a short cut towards either conventional or sustainable food.

Having these dynamics in mind, a transitional model from following a conventional diet to following a more sustainable diet can be drafted. The image 3 illustrates these relationships among the factors.

As can be seen in image 3, the path from following a conventional diet towards a more sustainable diet starts with developing a consciousness for health, which stand in relation to purity. By consuming more and more sustainable food, factors such as knowledge and skills, enjoyment, taste, nutrition and availability perception gain more positive momentum towards sustainable food. The more sustainable food is

consumed, the more the individual starts to care about the environmental effects of food and to a lesser degree animal welfare.

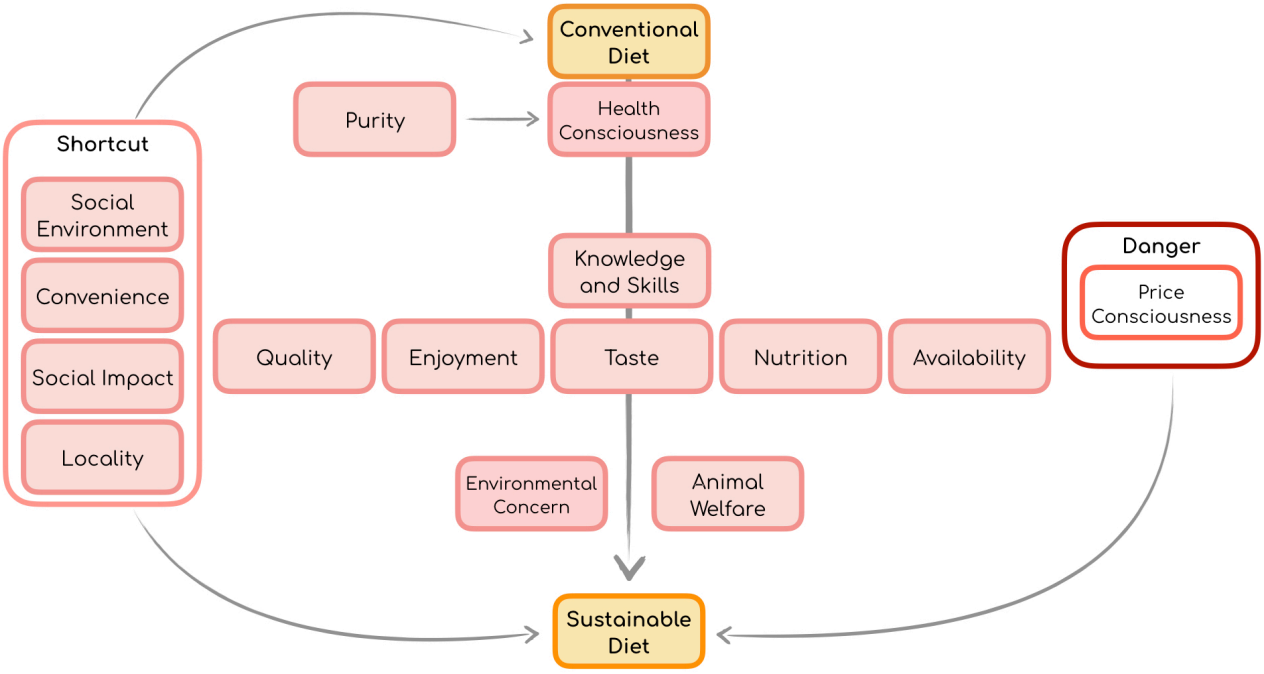


Image 2: Conceptual Model: Factors Influencing Change to a More Sustainable Diet

Along this journey, influences of the social environment, convenience, social impact and locality can act as a short cut towards either conventional or sustainable food, depending on the respective meaning of the factor.

Lastly, price consciousness can act as a challenge along the whole way, impeding the degree of sustainable food products purchased, however not the purchase in itself. Perceived value for price stands in close relation to price.

The factors that have only been mentioned once or twice in the relevant primary studies have not been included. However, identity, holistic sustainable mindset, political influence, curiosity and brand loyalty could be added to the shortcut, whereas trust to the danger section. However, there is not enough research on these factors to actually map a strong influence or relation to any other factor. Hence, these factors are ignored within this conceptual model of influencing factors of a sustainable diet.

3. Design Science Methodology

Having outlined the motivation, the research question as well as the theoretical and conceptual foundations with their core concepts, a next step is to address the DSR methodology in order to understand the general philosophical basis of the paper and to make the single steps taken transparent and reproducible.

Design Science Research

The aim of DSR is to *„design artifacts that serve human purposes“* [21 p. v]. Hence, it is about solving problems in the real world while contributing to the scientific and practical community. Even though DSR fails to describe and follow a standardized process, various DS researchers tried to map a common process of DSR. As one of the major contributors to aligning a common DSR process, [60] proposes the model as can be see below. However it has to be noted, that [60] as well another researchers do not mean to cage the process of DSR since its iterative and exploratory nature will likely differ from DSR project to project.

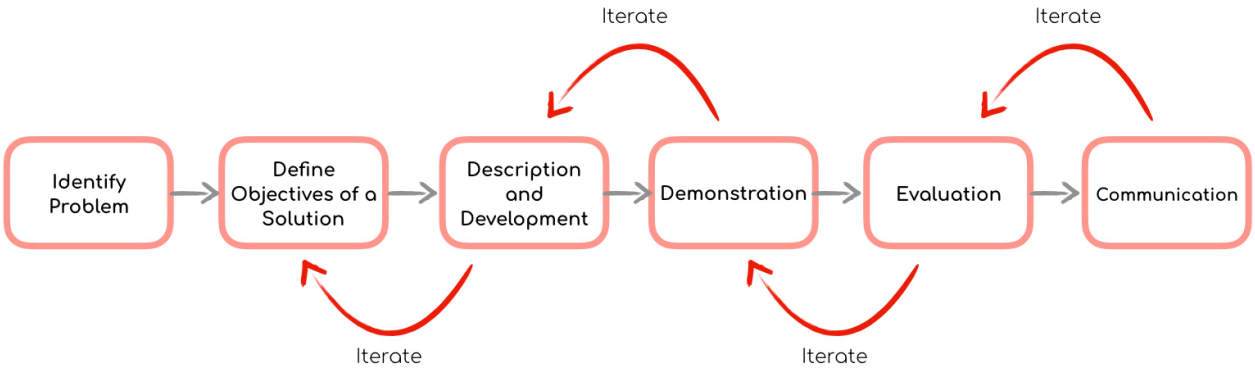


Image 3: Design Science Research Process [60]

Hence, for this project iterations align with the general thought of DSR: firstly mapping the situation as-is by identifying a problem and showing its importance, secondly iterating between defining normative values and goals of the situation and the solution-to-be, designing and developing artifacts and lastly testing and evaluating its utility and meaningfulness. Once a satisfactory solution has been found, developed and tested, the results will be communicated within the scope of this thesis that will be made publicly available.

The process is characterized by constantly tapping into the two important knowledge sources of known theories and methods, referred to as the rigor cycle, and the given context, referred to as the relevance

cycle [61]. This at the same time represents the shifting between induction and deduction. At the heart of the whole process is the design cycle characterized by designing and evaluating artifacts and processes [61]. Lastly, as depicted by [62], the DSR process is characterized by a series of evaluation activities. Criticizing the majority of DSR process models like the one above, [62] highlight the importance of evaluating designs, artifacts or specific characteristics throughout the whole DSR process and not solely at the end. Hence, for the process of this project, a variety of evaluation activities were included as described within each iteration in the next chapter. Thus, a variety of ex ante evaluations take place before the final ex post evaluation of the final artifact. The research process followed within this project will be described in more detail in the next chapter.

Design Science Research for this Project

DSR is, among others, suitable for topics for which traditional research has already contributed to the general knowledge base while actual application of that knowledge is missing [63]. As visible in chapter 2, research on factors influencing a sustainable diet has been conducted extensively and shows a clear tendency towards certain factors. However, actual application and testing of these factors is missing [11]. Besides, current practices that address sustainable dietary change are often unsuccessful or do not have the desired effect. Hence, prescriptive knowledge for factors influencing sustainable food consumption is lacking but needed which validates the meaningfulness of conducting DSR within this field [64].

Generally, DSR projects tend to either be more process- or more product-centric [63]. Since the aim of this thesis is to develop and test a solution that supports sustainable food consumption, a product-centric approach was chosen. Besides, focusing on the utility of the final developed artifact with a clearly defined target group, focus is put on instantiated artifact utility over contribution of theoretical characteristics [63]. As mentioned, the latter has already been addressed extensively in given studies. With this, inductive and abductive inquiry of knowledge is favored over deduction to ensure problem-solution fit with the given target users needs and requirements. Nevertheless, inclusion and relation to relevant prior studies is of core importance due to the extensive research already produced within this field of study. Ultimately, this project contributes in form of an improvement since a new solution is being develop for an already known problem [64].

Research Philosophy

Understanding world views in DSR is an art yet to be agreed upon. Most researchers within DSR skip the step of referring to their ontological and epistemological assumptions [65]. While acknowledging the

difference of DSR to traditional research and their respective world views, most DS researchers choose to view their research under pragmatist assumptions [65]. Without going into much detail of why DSR is in need of a direction in scientific foundations, this research acknowledges that traditional ontologies and epistemologies might not suit DSR. Nevertheless, taking into the account the contribution made by [65], this research can be said to follow a more interpretive world view characterized by a more relativist ontology and subjectivist epistemology.

This is reasonable in the sense that the literature review shows that factors influencing sustainable dietary choice can be quite individual. At the same time, research is based on the insights gathered by a specific target group and the solution is meant to be designed for this specific target group and their needs. In terms of epistemology, a subjective view favors a „knowing-via-participating“ approach while DSR relies more on a „knowing-via-making“ nature [65]. However, in order to make, participation with the target users is key to develop a meaningful artifact.

Besides, realties are seen as subjective and as a changing phenomenon. Changes are accounted through the interaction of the users with the solution. This however might also imply that outcomes are not generalizable and instead unique to this project. However, relying on a profound theoretical basis and reliable research process, this study can act as a blueprint for future research.

The basis of DSR is an identified problematic situation which is sought to be improved [66]. Improvement is done via a knowledge inquiry process that starts by evaluating the situation as-is and works its way through building and evaluating relevant artifacts to not only imagine, but realize a desirable situation-to-be [66], [61]. This entails that core concern for DSR is utility and meaningful contribution to practice through describing means-to-ends and building artifacts that solve the initially identified problem [66], [61].

Epistemologically, this results in a different types of knowledge needed and acquired throughout the DSR process. From evaluative knowledge of the problem situation as-is, to prospective and normative knowledge about the desirable and imaginable situation and artifact to-be up until prescriptive knowledge that helps clarifying the use values of the solution. The ultimate goal of knowledge in DSR is to enhance a given situation through active improvement [66].

For the given research, this indicates that the sources of knowledge need to come from a variety of sources such as the given knowledge base of known theories, the given situation and its analysis and evaluation as well as from the author’s own experience and reasoning [61]. Besides, methods used have to be meaningful for the identified problem and the desired outcome and hence need to be entangled in a for the research purpose relevant means-to-ends description. Since the purpose of this research is to explore and identify factors of changing to a more sustainable diet with the ultimate goal of changing people’s dietary habits, chosen methods need to reflect upon this by either assessing the individual impeding factors or by contributing to evaluation of the effectiveness of the (possible) solution. Due to its knowledge inquiry

through practice nature, this research is characterized by an iterative cycle of knowledge gathering, building and evaluating artifacts. The process, its methods and means-to-end description will been elaborated in chapter 4.

To link this to the thesis logic of inquiry, a mix of an inductive, deductive and abductive process is followed by firstly studying related literature, observing and analyzing a phenomenon and then proposing a best guess by the author for explaining it. Different to a deductive or inductive process, the outcome is neither solely explained by previous work, nor grounded purely in the given data. Instead, input is taken from both previous studies and the given phenomenon as well as the authors experience and common sense to draw final conclusions for the given research question. As explained, the DSR process occurs rather iteratively than linearly and represents hence a constant change between deduction from previous literature, induction from given data and processing of what is known.

4. Design and Development Approach

Following a product-centric DSR approach within this thesis, focus is on developing an artifact that is meaningful for the given context. For this, the design and development process has to be made transparent. Therefore, the target group will be defined and the sampling strategy elaborated. First and foremost though, the research will be put into its perspective of habitual change of diets. Besides, the concepts of validity and reliability will be explained in the light of this thesis.

Habits

Day in and day out an individual is faced by many decisions to make. As it turns out, most of the decisions are not at all conscious but rely to more than 40% on habits [16]. Due to habits, our brains are highly efficient since decision making processes are energy intensive [67]. When a habit is performed however, the brain runs on auto-pilot without putting in a lot of effort [16].

Regarding the habit formation process, most theories agree that habits form through repeated goal-oriented actions in a stable context, eventually switching from goal-directed to habitual behavior [68]. Within this process, the brain is looking for stimuli in the environment that have rewarded it in the past [69]. This makes it close to fail proof for a habit to be performed with the correct cue given. A cue can be anything from time, location, sound or alike [70]. However, this also means that people have a harder time resisting the habit once the cue has gained attention [71]. One of the most prevalent models of how habits work is the habit loop [72]. It consists of three stages:

1) A **cue** which functions as a trigger to the brain that a certain action is needed.

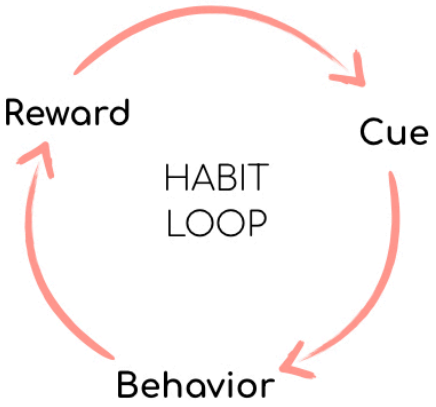


Image 4: The Habit Loop

2) A **behavior** that fits the cue. It can be of physical, mental or emotional nature and it has been performed countless times so that the brain can act without needing to decide.

3) A **reward** can be physical or emotional and rewards *Image* the brain to continue this habit.

Changing Habits

Changing habits has been proven hard in a stable context cueing [73]. Besides, even if habits have been changed successfully, old habits are still present [74]. Since habits represent an energy-efficient alternative compared to having to make active decisions, people often favor habitual responses for reduced effort and speed of execution [68]. Studies on habitual change often focus on either undermining the cue that activates a habit or on forming new habits by repeated action [68]. Since this study is not about avoiding undesired habits but more about changing existing habits, focus will be put on the latter.

Literature looking at changing habits often relies on behavioral change interventions [12], [70]. Interventions are *„[…] coordinated sets of activities designed to change specified behavior patterns.“* [75, p. 1]. A common framework for this is the Behavior Change Wheel [75]. This framework is based on a variety of interventions used in practice and consists of 19 interventions and policies for behavioral change.

Interventions	Definition	Examples
Education	Increasing knowledge or understanding	Providing information to promote healthy eating
Persuasion	Using communication to induce positive or negative feelings or stimulate action	Using imagery to motivate increases in physical activity
Incentivisation	Creating expectation of reward	Using prize draws to induce attempts to stop smoking
Coercion	Creating expectation of punishment or cost	Raising the financial cost to reduce excessive alcohol consumption
Training	Imparting skills	Advanced driver training to increase safe driving
Restriction	Using rules to reduce the opportunity to engage in the target behaviour (or to increase the target behaviour by reducing the opportunity to engage in competing behaviours)	Prohibiting sales of solvents to people under 18 to reduce use for intoxication
Environmental restructuring	Changing the physical or social context	Providing on-screen prompts for GPs to ask about smoking behaviour
Modelling	Providing an example for people to aspire to or imitate	Using TV drama scenes involving safe-sex practices to increase condom use
Enablement	Increasing means/reducing barriers to increase capability or opportunity[1]	Behavioural support for smoking cessation, medication for cognitive deficits, surgery to reduce obesity, prostheses to promote physical activity

Table 2: Interventions [75]

These interventions have been proven highly successful for changing health and transportation related habits and are suggested to be used for eating and sustainability behavior as well [12]. For example, environmental restructuring such as placing a bowl of fruit in a prominent location to be continuously reminded to eat a piece fo fruit has proven successful in a prior study [73]. Hence, the Behavior Change Wheel and especially the suggested interventions will be taken into account for this study.

For a habit to change, repeating the new behavior is key. This however takes time and researchers have not come to a common ground on how much time it takes for a habit to change. One of the most cited publications states that in order to reach a 95% automation of a new behavior, anything from between 18-254 days is needed [17]. This study however deals with the creation of new habits - not with changing existing habits. A study on changing eating habits found that the peak of automaticity was already reached after two weeks [76]. Hence, it can be assumed that changing dietary habits might already occur between two to three weeks, taking both studies into account.

However, repetition alone does not do the job. For example, interventions containing reminders showed high rates of activity repetition but low rates of actual habit formation [70]. This is likely related to the active decision making process that impedes habits. However, reminders set using a context aware technology such as sensors might be successful but has not been tested yet [77]. Still, reminders in the beginning of a change process can be beneficial to spur repetition initially [70].

Lastly, habitual change has proven most successful during life changing events such as giving birth or moving [78]. Due to the missing contextual cues that would usually start the habit loop, habits are not being performed.

Dietary Habits and Change

Today's food consumption is however not solely based on habits but is influenced by a variety of other factors [79]. Factors can range from socio-demographic factors, to biological factors or socio-psychological factors to name a few [80], [81]. Thus, changing lifestyle habits such as diets have been shown to be very unsuccessful [82]. One study however in particular yielded great success in changing food habits in families using the habit loop as a basis [76]. Conclusions on successful dietary habit change of this study are:

1) *Habitual change requires individuals to be motivated for change,*
2) *Goals should be set including time and location of habit performed,*
3) *Specifying the frequency of the desired behavior supports habit formation.*

This aligns with other research-based results. Even though [12] note that studies on technology enabled behavioral change interventions are scarce and often lack the description of the effect of the intervention,

they conclude that goal-setting and the use of multiple interventions such as suggested by the Behavior Change Wheel could prove fruitful for habitual change.

In terms of technology mediated change, [70] conclude their study with a few design guidelines. Firstly, a trigger event should be set. This is in form of a goal and should include the action and context. Secondly, a reminder should be set to support repetition initially. Since reminders are however proven to support repetition and hinder automaticity, caution should be kept [70].

Overall, studies regarding habitual dietary change are scarce but come to similar conclusions: goal-setting, initial user motivation and initial reminders could serve fruitful when changing technology mediated sustainable food behavior. Other interventions lack scientific proof and but can serve useful and should be combined to provide greater success.

The Target Group: Potential Greens

Defining a target group for this research means thus working with a target group who is not yet following a sustainable diet but is motivated for change. This target group is often described as the PG [79]. Studies describing the PG are however rather diverse and it seems as if the PG is very heterogenous in terms of intention, goal, and knowledge [79].

[39] for example describe the PG as a person who says to follow a well-balanced diet and to care for low amounts of chemicals in food. Others discover that the PG has high intentions to consume environmentally friendly food, but is hindered by price [83] or skepticism towards food labels [84]. Hence, it can be stated that the a PG is concerned with health and the environmental effects of food, is motivated to purchase sustainable foods but is hindered by price and mistrust.

For Denmark, an interesting group that aligns with the characteristics of a PG while at the same time has a high environmental food impact are males just below the age of 30. This group constitutes one of the greatest meat eaters in Denmark while also being the most likely to be responsive and motivated for dietary change [48], [33]. Adding to this, meat is considered a food with high habit formation likelihood [85]. Hence, even though focus of this study is not necessarily promotion of plant-based foods, a reduction in meat consumption is necessary to align with a sustainable diet as introduced before. Hence for this study, focus is put on this target group.

Sampling

Non-probability sampling was chosen for this study since no statistical inference from the total population is needed. Instead, working with a defined target group favors non-probability sampling [86]. To follow a DSR

approach, key users were integrated into the research process from the beginning on [61]. For this, five key users fitting the persona were recruited. As a rule of thumb, five users are recommended as a minimum for reaching saturation [87].

Users have been chosen based on purposive sampling. This sampling technique is suitable for small sample sizes and can easily be aligned with the given research question and defined target group [86]. Moreover, due to the author's knowledge about the sampled users' food consumption and attitude towards food and sustainable foods, relevance for finding a meaningful solution to the given research question is higher.

One could now argue that the social closeness could have an effect on the outcome but several studies suggest that this does not have an effect on sustainable consumption intention [88]. Besides, since the author has already been in a friendly relationship with the users prior to this project, an actual influence on sustainable food consumption should have already been present prior to this study given the author's high interest in sustainable food. However, in order to minimize this bias, a user group of five users fitting the target group was used to develop and ideate the solution initially. For final testing and evaluating, 10 further individuals who have not been involved in the process have been recruited to eliminate the bias.

Of the additional testers, five fit the identified target group whereas five represent the female counterpart of the target group. The female group has been chosen for the sake of external validity in order to test if the developed solution is also of value to females interested in changing their diet towards a more sustainable one. The additional testers were screened for their food consumption motives and needs as were the five key users to ensure fit with the core user needs identified as will be described specifically in iteration 2.

All users have been granted anonymity. Therefore, users have been given a number from 1-16, of which 1-5 are the key users. When addressing users throughout this project, the gender-neutral pronouns he, him, his and himself will be used.

Design and Development Process

In alignment with DSR, the research methods used were not predetermined but chosen throughout the design process. This is due to the high dependence of the research process on previous outcomes of method and purpose. Consequently, a variety of methods have been chosen to suit the methodological approach as explained in chapter 3. For this project, qualitative methods were chosen to be useful due to the subjective nature of this thesis. Occasionally**,** collection and analysis of the qualitative data have been done simultaneously in order to maximize the relevance and value of the data collected and ease into the next phase [89]. The research process as well as crucial methods used can be seen in image below. In the following, the research process will be explained by touching upon the data collection, design, and data

measurement methods used within the respective iterations. Outcomes are summarized to better understand the transition and meaningfulness from one iteration to the next.

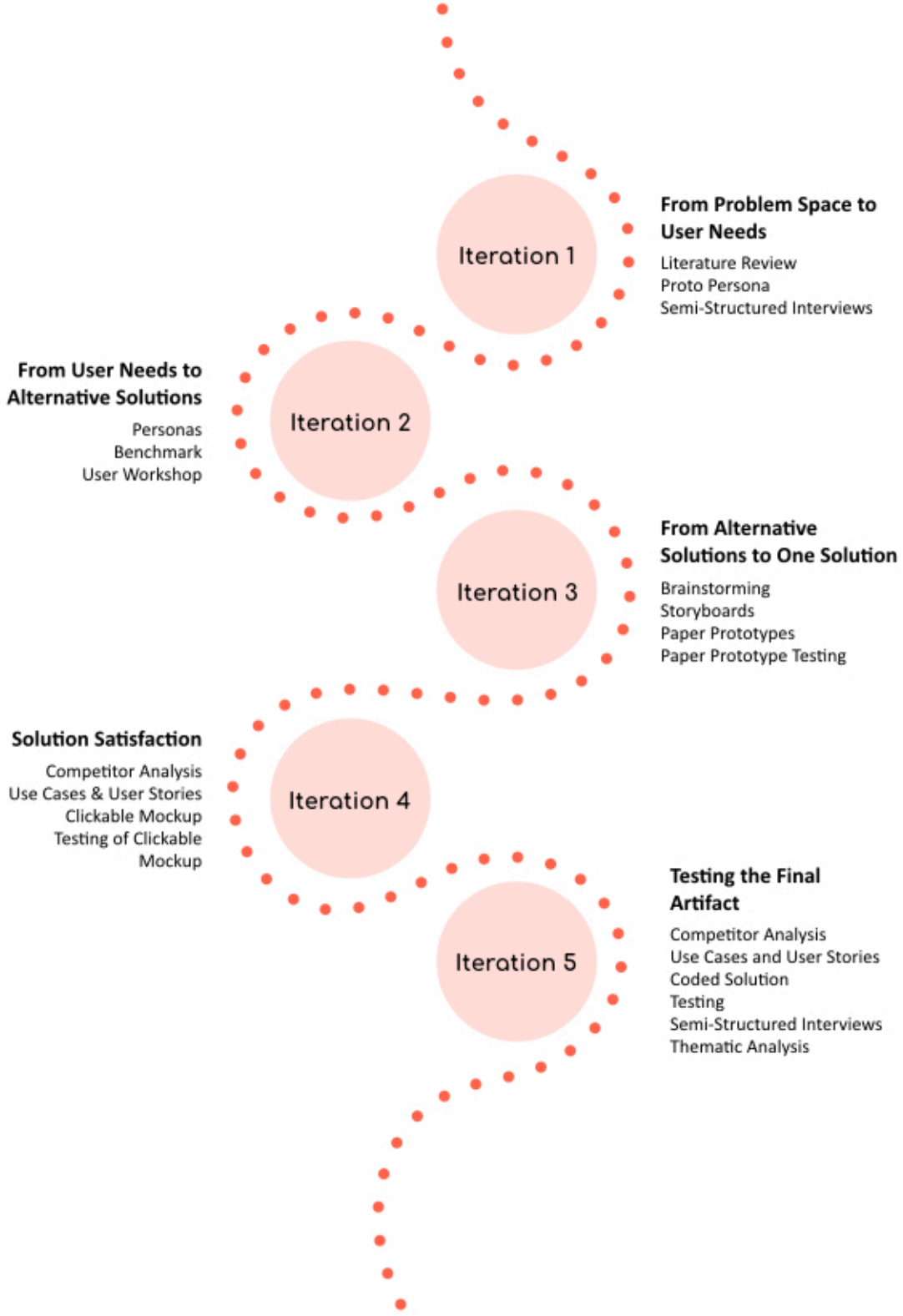


Image 5: Design Process Iterations

Methods

A variety of data collection methods have been used throughout the research. On top of primary data, the knowledge base has been continuously referenced to ensure rigor. The base consists of prior research in form of a continuous literature review already existing solutions that have been benchmarked throughout the process, and field experts who have been approached on relevant events such as the Food Day 2019 from the University of Copenhagen, the Techfestival 2019 and TechBBQ, which all had food technology and sustainability as core topics.

As the core of DSR, a variety of prototypes and artifacts were designed and tested throughout the process. Artifacts include paper prototypes, storyboards and a final coded solution.

Insights were analyzed continuously, adding to the further development of the prototype. While finishing with a thematic analysis of semi-structured interviews, most methods are linked to the analysis of feedback given by participants during workshops in the form of quotes (both written or transcribed from recordings).

Iteration 1 - From Problem Space to User Needs

The goal of this iteration is to ensure that the identified problem is relevant for research, practice and the chosen user group. Hence, core focus was on conducting an initial literature review in the field of factors influencing sustainable food consumption, current practices and interviewing users who fit the target persona.

Methods

Apart from conducting an extensive literature review and brief practice check as can be revised in chapter 1 and 2, a proto persona has been designed based on these insights. Lastly, semi-structured interviews with the five key users have been conducted.

Proto Persona

Creating a proto persona is meaningful in the very early stage of a design project. The proto persona, different to the persona, is based solely on secondary research and heuristics [90]. Its goal is to align the stakeholders of a project in terms of needs, behaviors and goals of a potential user [90]. A proto persona should however in a later stage be tested against real users to validate assumptions and create a realistic picture of the actual user [90].

Hence, based on the literature review in chapter 2, the proto persona John was created. He is around 30 years of age and mostly concerned about his health. He is currently not following a sustainable diet but sees the connection of his diet to his health and would thus like to change his diet to be even more healthy.

Besides, he is unaware of the connection of the environment to his diet and sees knowledge and cooking skills generally as a problem. Most important though is his high price-sensitivity that keeps him from purchasing expensive food such as organic. His core goal in using the to-be-developed solution is to improve his health. The image below illustrates John.

<table>
<tr>
<td>John Nielsen

„I want to live a healthy and fun life and I see that diet could play an important role here.“

  </td>
<td>Physical, social and technical environment

* Does not see how a sustainable diet is related to the environment
* Values health
* Unaware of how to prepare plant-based food
* Concerns about nutrient (protein) intake with plant-based food
* Eating not sustainable most of the time but interested and positive attitude towards it
* Price-sensitive</td>
</tr>
<tr>
<td>Demographics

Age: 18-30
Family status: Unmarried, no children
Education: University degree (Master)
Income level: Above average
Job: Private sector</td>
<td>Goals & needs using the proposed solution

* Goal: is to consume more food that addresses personal needs such as health
* Need: is a solution that overcomes the impeding factors for a sustainable diet and/or supports the motivating ones in order to bridge the attitude-behavior gap</td>
</tr>
</table>

Image 6: Proto Persona John

Semi-Structured Interviews

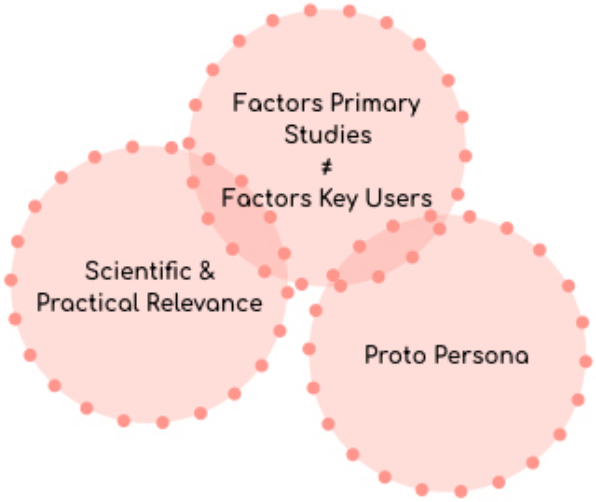
In order to not only validate the problem in research, semi-structured interviews were held with the five key users fitting the target group of the PG. Important to note here is that the proto persona was not yet used as a selection criteria for the users since, in alignment with the philosophical bases of this thesis, the author wanted to create the exact user needs, values and goals based on the actual users fitting the PG and not based on what theory says. Hence, the proto persona represents a theory-based image of the actual user that has to be cross-validated with actual users.

Semi-structured interviews are a suitable method for the interpretive nature of this thesis and make it possible to gain personal insights from the interviewees on a given phenomenon - here, their understanding of factors that influence their (sustainable) food consumption [86].

A total of five interviews have been conducted in person and over phone in order to better understand the motives and goals of the users in terms of their (sustainable) food consumption. Besides, first gain and pain points in their sustainable food consumption were uncovered. The interviews were scheduled in advance and were recorded and transcribed. Transcription was seen useful since this phase is characterized by an exploratory nature of identifying initial user needs and opinions [86]. Rules for transcription and the actual transcriptions can be found in the appendix. Each interview took about 30 minutes. An interview guide has been designed which, as the name indicates, serves more as a guide rather than a script. Hence, the guide consists of prompt and probe questions that have been designed in an open-answer style [86], [91]. Prompt questions address the main point of inquiry whereas probe questions serve as possibilities for the interviewee to elaborate further [86], [91]. The latter don't have to asked if not necessary. Besides, depending on the answers of the interviewee, questions have been asked in differing orders and importance while always asking the prompt questions. Closed-questions have been avoided so that interviewees have space to elaborate their answers [86], [92]. The interview guide and the transcribed interviews can be found in the appendix.

Insights

Two core insights can be noted down for this iteration. Firstly, the practical and scientific relevance is given based on the high theoretical maturity of the matter but the low practical translation of these insights. Besides, dietary change is needed for both human as well as planetary health.



Secondly however, the insights from the literature review do not conform completely with the needs identified throughout the interviews. While literature focuses on personal health concerns as the core factor for wanting to change to a more sustainable diet, the key users addressed a variety of other factors. Importance was put for example a lot on the environment but also animal welfare reasons:

„Recently I think about consuming less meat because I think that's what I heard and also what I read partly that you, or meat production, produces a lot of CO2 emissions.“ (Interview 5A).

Besides, core impediments were identified as convenience, knowledge and trust whereas literature suggests that price consciousness in conjunction with quality are major challenges to change to a more sustainable diet.

„I think the easiest thing to do would be to know more recipes because I don't. The reason why I sometimes buy these things that I would consider them unsustainable is because they're quite easy to make really delicious food out of.“ (Interview 1A)

In total, the proto persona has to be revised and user needs have to be translated into requirements for the solution-to-be-designed.

Iteration 2 - From User Needs to Alternative Solutions

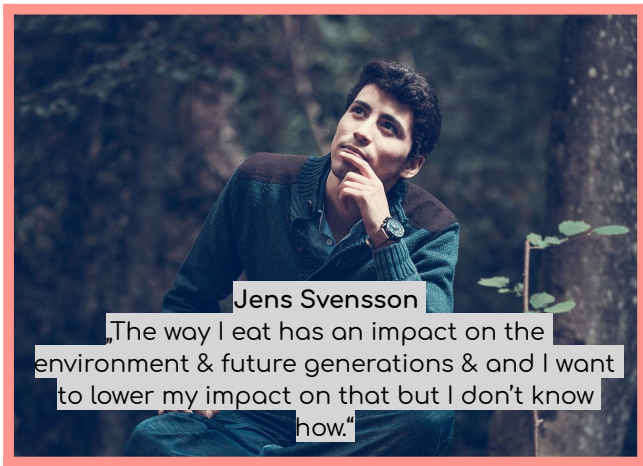
The goal of the second iteration is to understand the users and their needs in order to establish non-functional requirements and ideate possible alternative solutions that incorporate these needs and requirements.

Methods

For this, the persona was updated according to the interviews in iteration 1 and an initial brief benchmark of current solutions helped to understand the possible value proposition of the solution-to-be-designed. Besides, a user workshop was held in which user gains and pains were established and possible solutions ideated.

Personas

As noticed in iteration 1, the initial proto persona had to be updated to better suit the target users. Containing the same elements as the proto persona, the purpose of the persona is to represent a realistic image of the actual user in terms of needs, goals, behaviors and demographics [93]. The interviews in iteration 1 made clear that the proto persona needed update and they made even finer details visible. Hence, two personas were ultimately designed, whereas focus for the to-be-designed-solution is on the persona Jens, who is at the very start of wanting to change his dietary behavior. The persona Chris was identified as already being a step ahead and embracing sustainable food to a higher degree. However, availability and ease of cooking are major bottlenecks for this persona. Since these are also needs of Jens, a solution could possibly be suitable for both. Of the key users, three resemble Jens (1, 4 and 5) and two resemble Chris (2 and 3).



Values & Believes

Value: Taste & ease of food
Belief: Diet has an impact on the environment but I don't know the best way to contribute since I don't know & don't trust the sustainable food system

Demographics

Age: 25-30
Nationality: European
Family status: Not married, no children
Education: University degree (Master)
Income Level: Above average
Job: Private Sector

Goals & tasks using the proposed solution

Goals: Easy, tasty food that I can trust
Needs: Ease of use, taste, guidance on cooking, knowledge about sustainability to elevate trust
Tasks: Learning more about sustainability, eating, learning more about cooking & finding sustainable alternatives

Image 7: Persona Jens

Values & Believes

Value: Ease of finding food
Belief: I feel responsible towards the environmental sustainability. I trust in the sustainable food system as so far, that the more I buy sustainable, it will have some sort of effect

Demographics

Age: 25-30
Nationality: European
Family status: Not married, no children
Education: University degree (Master)
Income Level: Above average
Job: Private Sector

Goals & tasks using the proposed solution

Goals: Eating environmentally sustainable without too much effort
Needs: Easy access to sustainable alternatives
Tasks: Buying, cooking, eating

Image 8: Persona Chris

Most adjustments for the personas have been made in terms of their core values and goals whereas demographics have stayed the same. As noted, the health factor is not as relevant to the key users as assumed by previous research. Instead, core importance is put on the environmental effects of diets and the effortless preparation and finding of sustainable alternatives. Besides, a strong lack of trust is visible in the beginner. For the environmentalist, trust is not so important but gets exchanged with availability of sustainable products.

Benchmark of Existing Solutions

A benchmark is meaningful in order to understand how others are already solving the identified problem to better frame a unique value proposition [86]. Besides, for DSR it is important to know about the artifacts that already exist to solve the given class of problems [64]. Hence, an initial review of current solutions that support individuals in following a more sustainable diet has been undertaken. Here, focus was put on technological solutions whereas others exist such as information provision through food labels, reports or documentaries or the influence of people such as politicians or life-style influencers**.** While this is only for exploratory reasons, a full competitor analysis has not been undertaken at this point in time. Instead, online research has been conducted by searching with keywords such as „sustainable“, „diet“, „technology“, „support“, „help“, „food“ were used to search the internet for available solutions.

Current technical solutions addressing sustainable dietary change of individuals are often in the form of smartphone applications. Solutions span a variety of aspects such as

- **recipe apps** like **Seasonal Food Guide** that recommends recipes based on seasonal fruits and vegetables in accordance with the users region
- **bar code apps**, like **CodeCheck or EWG's food score & Healthy Living** which the user can use to scan bar codes of products to gain information on the products sustainability according to a variety of aspects such as nutritional value or certifications
- **restaurant guides** like **Happy Cow** that guide the user towards vegetarian and vegan friendly restaurants
- **blockchain technology** for food security such as **ripe.io, Te-Food, Provenance, IBM Food Trust** that track food from farm to table to ensure food confidence and leverage transparency to the consumer
- **delivery of food** and even cooked meals such as **SunBasket** and **SimpleFeast** who deliver ready-made meals to the doorstep
- **applications for meal planning & grocery lists** like **platejoy** who support the user in creating grocery shopping lists that suit the users needs
- **support for personalized nutrition** such as **habit** who create a personalized meal plan based on self-reported indicators

- **databases** such as **How Good** that rank food items according to certain sustainability parameters such as social impact and health (**GoodGuide)** or **Certified Humane** which lists humanly slaughtered meat, or **Seafood Watch** who list fish and alternatives that are fished in minimal impact to environment and avoid overfishing, or **What's on my food** that lists the pesticides used for certain vegetables and fruits

In total, it is clear that currently available solutions address mostly the knowledge gap of users by providing information and transparency on food sustainability. Some address the personal health factor, others identity and some environmental aspects of food. No technology was found that consciously addresses behavioral change towards a sustainable diet. This aligns with research on technology supported habitual change. Most applications are not grounded in theories on habitual change **[70].**

User Workshop

The user workshop was conducted with four of the five key users in the role of the target personas. Only four key users could participate since one had to cancel last minute. He was, however, debriefed by having received the agenda of the workshop and the mutually agreed upon key findings. The workshop was held at BitLab in Copenhagen Business School before dinner time to get users in the „food mood" but in an unbiased location away from there usual food routines [86].

A user workshop is meaningful to better understand the key users opinions about the subject matter, their gains, pains and needs [94]. The goal was to describe the differing and common understandings and meanings of the key users impeding and supporting factors for sustainable food consumption. A user journey and emotional journey were created to understand the core pain points and a value proposition canvas was used to spark ideas about possible gain creators and pain relievers of solutions to-be ideated. With this, first common requirements

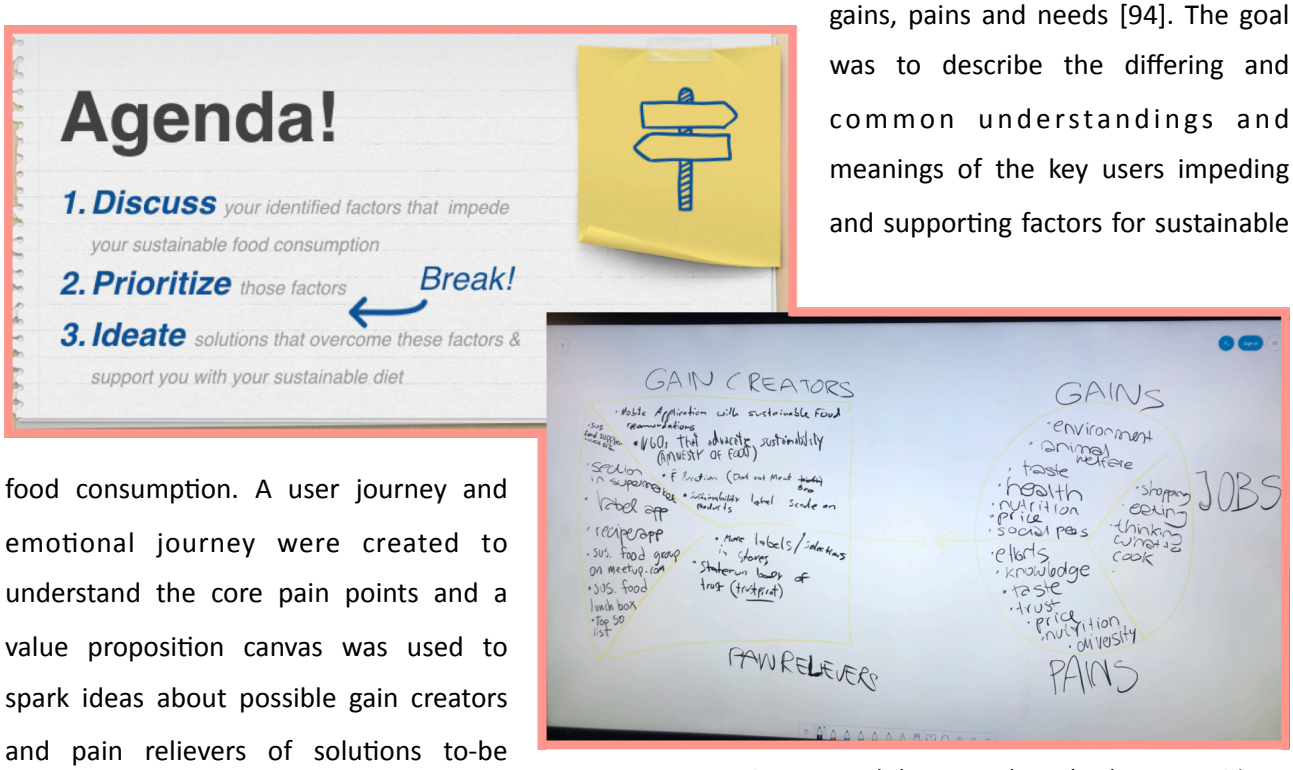
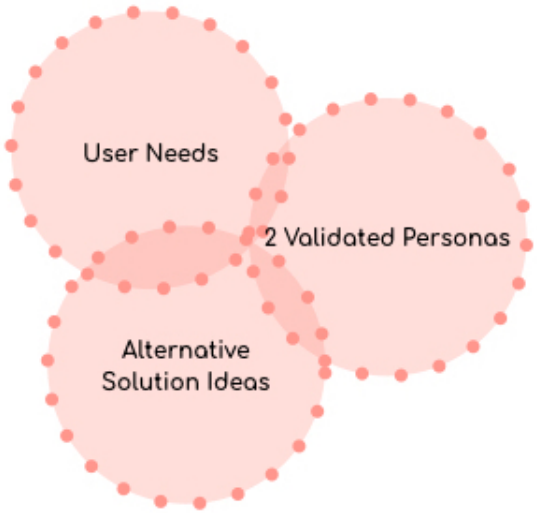


Image 9: User Workshop Agenda and Value Propositions

and needs for the solution-to-be were identified and a common understanding of the term „sustainable food“ was explored. Lastly, pain and gain creators were translated into first possible alternative solutions that could solve the users problems while addressing their needs. The needs were translated into user stories and a conceptual model of the influencing factor of sustainable dietary change could be developed.

Insights

As a first core outcome, the personas were created which, as already indicated in iteration 1, are fairly different to what literature says the persona should be like. As a core focus of the following iterations, the environmental concern, and here especially the CO2 footprint of food, has to be addressed by the solution to-be-designed. In the following iterations, food sustainability as well environmental sustainability was understood in the light of CO2 emissions of food. Besides, the brief benchmark showed that there is currently no solution available that addresses user needs within the light of foods environmental sustainability or habitual change. Lastly, the user needs have been defined together with the users. The following statement has been written in collaboration with the users during the workshop:



"To eat more environmentally sustainable, I need:

- *to know what sustainable products & recipes are,*
- *sustainable alternatives to be easily available,*
- *tasty & easily cookable sustainable alternatives,*
- *trustworthy information about the sustainability of the products.“*

Hence, this represent the self-reported core user pains and gains in order to eat more environmentally sustainable. As can be seen, these differ somewhat from the primary studies evaluated within the literature review. Whereas factors such as health and price score high in the literature, knowledge about sustainable recipes and products comes sixth, availability fifth, taste forth and trust only seventeen with solely two mentions in literature. Also, health and price as core concepts within current literature are not important to key users. This validates the subjectivist nature of this paper since influencing factors proof to be very diverse among people. The user needs resemble the users influencing factors on following a more sustainable diet. Throughout the user interviews as well as the workshop, a conceptual model of these factors could be created.

As can be seen in the image to right, users journey from a conventional diet to a more sustainable diet starts with gaining more and more knowledge about and experience with sustainable products. With this, skills regarding preparation of food, taste perception and perceived availability are supported. Once these are strong enough, environmental concern could unfold its potential and guide the user towards a more sustainable diet. As a danger especially in the beginning of this process, mistrust towards the claims made about sustainable foods can hinder transition.

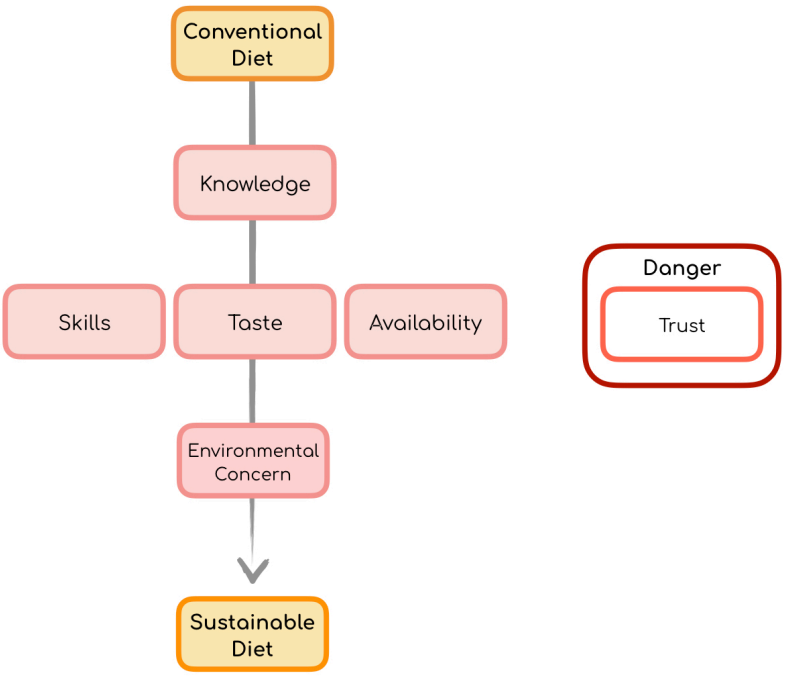


Image 10: Conceptual Model Key Users

Lastly, a variety of ideas have been brainstormed in the user workshop that could address the user needs. Solutions were for example:

* a **canteen delivery app** that would serve sustainable food for lunch at work
* a **recipe app** that would, based on your available ingredients, suggest sustainable recipes
* a **sensor attached to the shopping trolley** in the supermarket that would indicate the sustainability of the products put into the trolley
* a **payback system** that would reward people buying sustainable food products in the supermarket
* an **audio-guided supermarket tour** that would show consumers where to find sustainable products
* a **meet up** of like-minded people

These ideas are however not very specific and need further detail and thought.

Iteration 3 - From Alternative Solutions to One Solution

The purpose of this iteration is to agree on a final solution to be developed. For this, alternative solutions need to be presented to the users to evaluate the utility of these solutions.

Methods

In order to find a final solution, alternatives have to be ideated first. Based on the insights gathered throughout the former iterations, a variety of brainstorming techniques helped the author developing a range of feasible and meaningful ideas for the users. Based on the outcome of ideation, three alternatives were storyboarded and lastly paper prototyped. The paper prototypes were evaluated by the users in a testing session in order to find the solution to-be-developed.

Brainstorming

A variety of brainstorming techniques such as SCAMPER [95] and the six thinking hats [96] were used by the author to further ideate and elaborate possible solutions that address the user needs [97]. The purpose of SCAMPER is ideating new solutions based on what is already known. The acronym stands for substitute, combine, adapt, modify, put to another use, eliminate and reverse [95]. Questions such as „What technologies could be used to substitute the existing?“ can be asked to spur creativity. The solutions found were gathered in a mind map for easing the overview.

Image 11: Mindmap Possible Solutions

The six thinking hats method comes in at a later stage to test ideas for a variety of parameters such as values, critiques, emotions and facts [96]. Based on the outcomes of brainstorming, six of the solutions were elaborated as proof-of-concepts and assessed for feasibility by creating short scenarios, single user tasks and a goal to be achieved [98].

These solutions were in brief:

1. a **workplace delivery app** that would allow users to order sustainable lunches straight to their workplace, addressing trust, ease of preparing, ease of finding and taste.
2. a **nudging app** that would remind him throughout the day to think about his diet and suggest more sustainable alternatives, addressing mainly trust and ease of finding
3. a **scanner app** based on blockchain that would track the CO2 footprint of food from farm to table for individual use, addressing mainly trust and ease of finding
4. A **workplace food computer** that could grow vegetables and fruits for employees based on their input and needs, addressing mainly trust, ease of finding and taste
5. A **3D printer** that could print out sustainable food, addressing trust, ease of preparing, ease of finding and taste
6. A **recipe app** that guides you step by step through easy and sustainable recipes, addressing ease of preparing, ease of finding and taste

Most solution focus on either workplace or dinner settings since these, according to the users, are their most frequent touchpoint with food. At their workplace however, food is usually not home cooked so dinner is the only option to support change in purchase and cooking. Out of the six ideas, solution 3-5 were eliminated quickly since they were not seen feasible within a short period of time. For solution 1, 2 and 6, the journey continued.

Storyboards

Storyboards were created for the remaining three solutions. The three solutions were chosen out of six possibilities after an extensive ideation phase of the author. The three selected solutions address the identified user needs and requirements and the research question and were evaluated most feasible and effective using an innovation matrix.

Storyboards were used to support ideation and empathy with the user [99], [100]. Like this, storyboards help visualize the solution in action and what the user could need and in which sequence in order to successfully use the solution [99], [100].

The storyboards contain three major parts: a scenario that is based on the target persona and the main goal, visuals that visualize each part of the storyboard, and a caption that describes the user actions and other relevant contextual informations [99]. The three full storyboards can be found in the appendix.

Image 12: Storyboard Example of Nudging Solution

Paper Prototypes

Based on the insights from the storyboards, three paper prototypes were designed as a proof of concept for the respective solution [101]. To support the paper prototypes, short scenarios were written to enable immersion into the context of the paper prototype [102]. Since paper prototypes are easy, quick and cheap to develop, they serve as a good prototype in earlier stages to verify design assumptions before investing time and resources into developing a high-fidelity solution [102]. The prototypes were designed to support the user needs as identified in iteration 2. For example, information about the CO2 emissions of dishes were added for both the catering as well as the recipe app to support knowledge about what sustainable products and recipes are. The aper prototypes contained various features such as clickable buttons, a pop-up and a scrollable page as can be seen in the example below. Paper prototypes can be found in the appendix.

The short scenarios are not fully elaborated. Instead, they address a goal, tasks and necessary contextual information for the prototype. The three scenarios for the alternative solutions are:

- **Catering app:** You know that your diet has an impact on the environment so you want to eat more sustainably. At the same time, you do not want to put a lot of effort into your diet and cooking and you do not know a lot about the trustworthiness of sustainability labels. Luckily, your workplace offers Spice as a sustainable lunch delivery application. With Spice, you can simply choose between sustainable lunch

offers of the day, receive a readily cooked meal at work and can save the recipe, ingredient list and sustainability explanation for later.

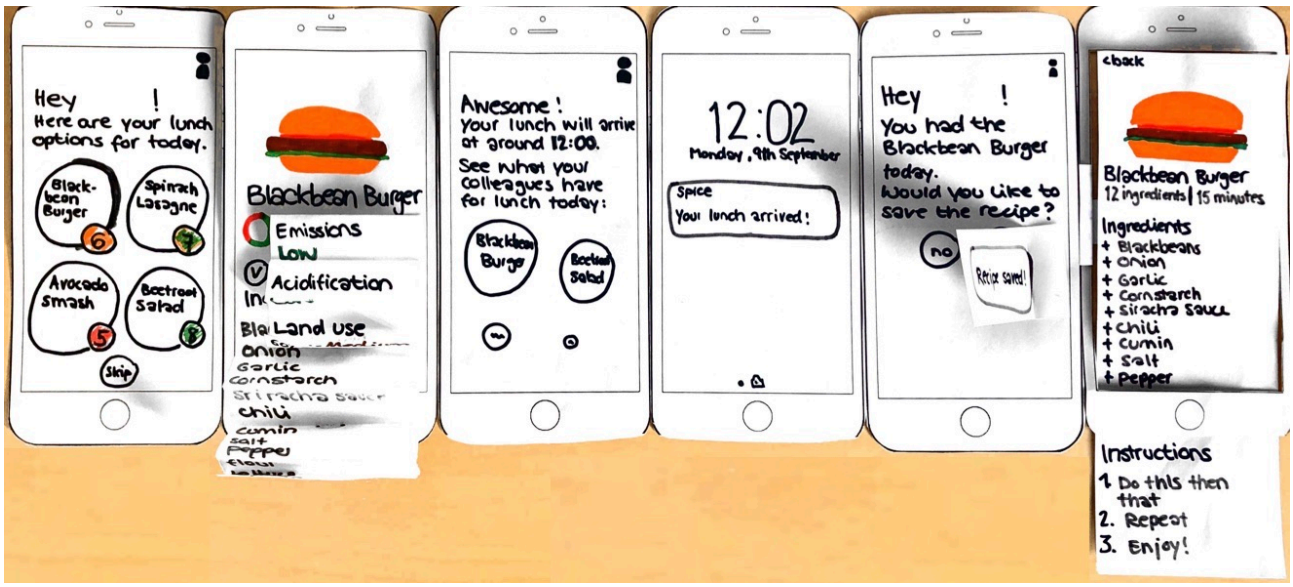


Image 13: Paper Prototype Example of Recipe Solution

- **Nudging app:** You know that your diet has an impact on the environment so you want to eat more sustainably. However, you eat what you eat out of convenience & do not really now how to cook differently or what sustainable is at all. But now you have Tasty – a personalized food app that continuously asks you for your daily meals and suggests more sustainable alternatives with shopping lists and recipes that suit your taste. Like this you can easily adopt to a more sustainable diet step by step.
- **Recipe app:** You know that your diet has an impact on the environment so you want to eat more sustainably. At the same time, you do not want to put a lot of effort into your diet and cooking and don‘t really know about sustainable recipes or food. Luckily, you just downloaded MasterMe - your new cooking assistant app. MasterMe suggests you sustainable recipes based on your personal taste & diet. It adds ingredients to your shopping list & guides you as a voice assistant through the cooking steps. Like this, you can be sure that whatever you cook tastes amazing.

Paper Prototype Testing

In order to test the paper prototypes in terms of proof of concept, a testing workshop had been arranged with the users. For this testing workshop, only two users were able to make it due to the summer holiday season. Since there was not the possibility to get more than two users for a period of time, it was decided to conduct the testing anyway and have one-on-one Skype meetings with the remaining three users. This was decided since this testing was concerned with scenario and paper prototype testing, which is also

possible over distance [103]. In this testing, users were shown the three alternative solutions in the form of both short scenarios and interactive paper prototypes.

The goal was to decide on a solution to be designed and tested further. The users were first presented the scenario corresponding to the given paper prototype to get into the context and setting of the solution. They were then asked to click through the paper prototype while thinking out loud. Apart from the author, who was in the role of the facilitator, a second person was briefed to support in the role of a human computer, changing the interfaces of the paper prototype once the users had clicked on a button [101].

After each paper prototype testing, users were asked to evaluate the personal utility of each prototype and in the end, a discussion about all three paper prototypes was held.

Image 14: Testing Workshop

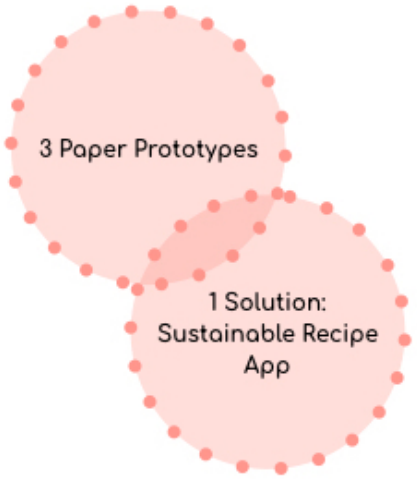
The three remaining users were contacted via Skype and enjoyed the same procedure while not being able to physically click on the prototype but having to explain where they would like to click and for the human computer to do the rest.

Insights

As a result of this iteration, three possible solutions could be ideated and prototyped. The nudging paper prototype was eliminated straight away as, according to the users, it takes too much effort using the app on a continuous basis. The remaining two solutions were voted similarly and users were in disagreement about a final winner. Since users could not be gathered all together, the author decided to make a reasoned choice for one of the solutions.

With reference to abductive thinking, the catering app was favored by the author since she already experienced in her personal social environment that when cooking new and tasty sustainable recipes for others, these actually tend to re-cook those recipes or are more interested in what they eat. However, testing this solution was considered difficult since it would have eventually included cooking for all testers

throughout the testing weeks to make the experience as real as possible. Hence, the recipe app was chosen for further development.



The chosen solution also matters practically since even though there are already a variety of recipe apps available, there is no evidence that they support, promote or enhance a sustainable diet. If the chosen features have an impact while leaving other features of the solution similar to current solutions, this thesis can serve as a basis for enhancing current recipe apps towards guiding people towards a more sustainable diet. This would also enlarge the possible market share and target group of the final solution tremendously.

Iteration 4 - Solution Satisfaction

Before going into developing a coded solution, a medium to high fidelity prototype is meaningful to assess functionalities and the user interface with users before spending too much time and resources on developing a solution without user feedback [100]. Hence, iteration 4 was meant to specify requirements and functionalities both from user insights and benchmarks and to finally test the high fidelity prototype for utility and satisfaction.

Methods

In order to do so, a more elaborate competitor analysis was undertaken for the chosen solution of a recipe app, resulting in value curves and a clearer picture of where value can be added by a new solution. These insights mixed with prior insights from users were used to specify requirements in the form of use cases and user stories. These were then translated into a clickable mockup which was shown to the users to be evaluated for features and utility.

Competitor Analysis

Having defined a solution to-be-developed, a competitor analysis is suitable to assess which other solutions are already available that solve the same problem and address the same or similar needs in order to benchmark, define best-practices and possible competitive advantages of a new solution [104]. The competitors were analyzed using value curves. Value curves are a suitable method to simply map and compare strategies and values of different players in the market to assess potentials in that market [105].

The value curves was created based on a mix of the identified user needs such as trustworthiness of sustainability information and competitive factors in the industry such as shopping list feature as can be seen in the image below. In total, nine relevant competitors were found and analyzed. Values range from 0-1 and are based on subjective assessment of the author based on insights gained from the respective competitors.

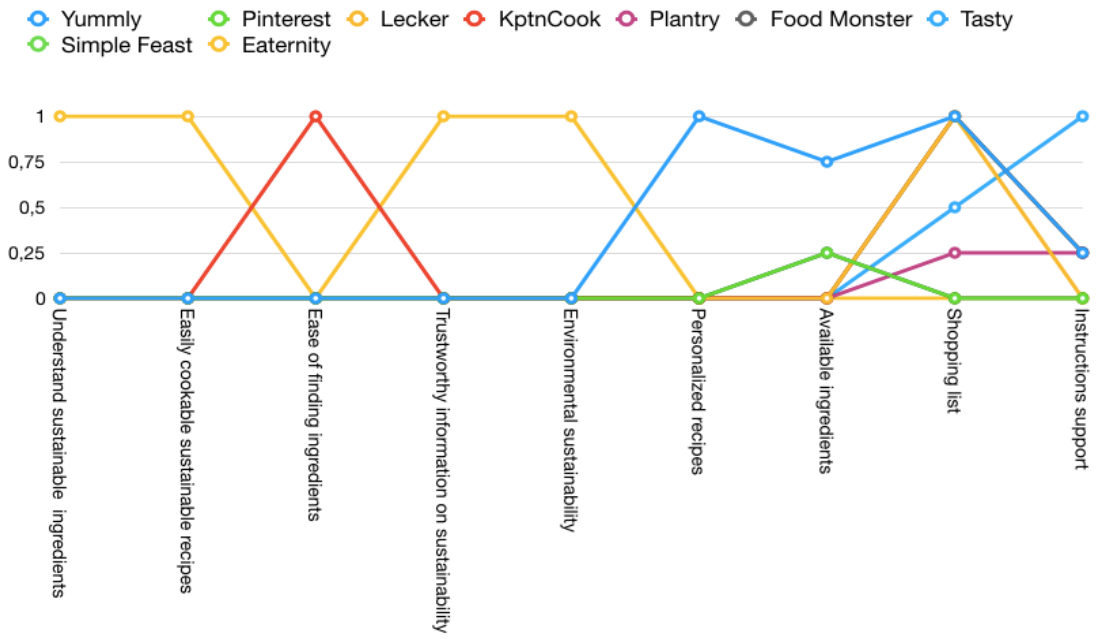


Image 15: Value Curve Recipe App

Looking at the value curves and identified user needs, a unique value proposition can be formed.

As can be see, most available solutions fail to the user needs identified for this project. In fact, only Eaternity addresses these aspects somewhat, but is therefore lacking in best practices such as shopping list, personalized recipes and instruction support. Besides, it is currently not suitable for individual users due to high costs and low availability of actual recipes.

Moreover, especially the personalization of recipes and instruction support are not well developed among competitors. These aspects combined can serve as unique value propositions of the solution-to-be-designed.

Use Cases and User Stories

With the insights gained before, use cases and user stories could be formed that represent the user needs and value propositions of the solution to-be-designed. Use cases are text-based stories of how a user interacts with the solution including the users major goals [106].

User stories are in the format „As a [user] I want to [action] so that [goal]“ [107]. Like this, they combine needs and goals of the user and are a descriptive add-on for use cases to make them easily understandable for different stakeholders and translatable into features [107]. The use cases as well as user stories are based on user comments gathered throughout the iterations, especially the user workshop and the paper prototype testing, as well as the competitor analysis above.

Clickable Mockup

A clickable mockup of the chosen solution was designed using the tool balsamique. The screens correspond with the user needs and user requirements that were put into use cases and translated into functionalities. A clickable mockup as a medium fidelity prototype is useful as a step in between low fidelity early stage prototyping and the final solution [100]. Due to their more finished look, clickable mockups covey to the user that design is more set and hence testing for utility and satisfaction with the design is more valuable [100].

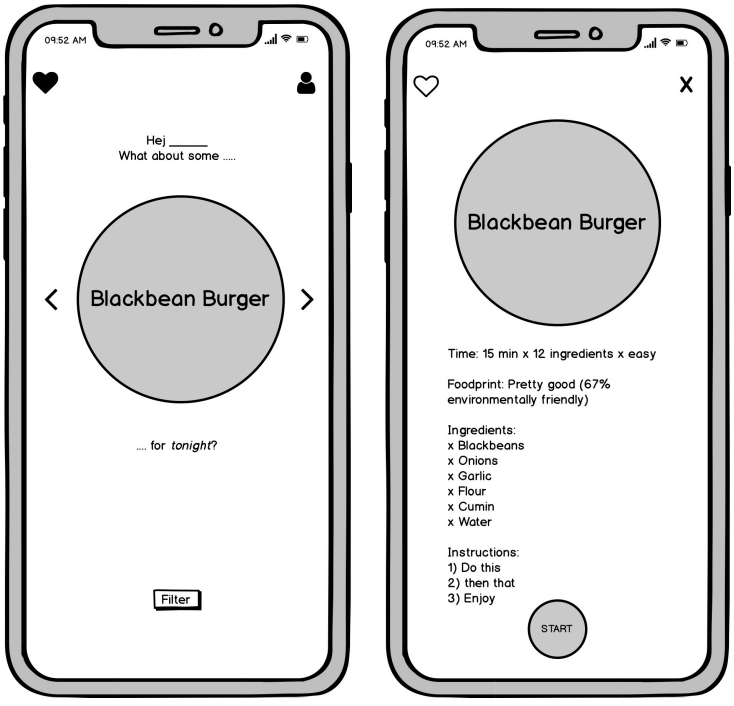


Image 16: Clickable Mockup Example Screens

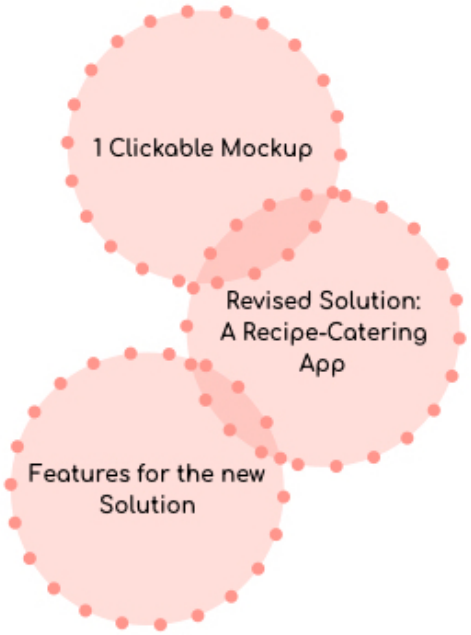
Testing the Clickable Mockup

The testing of the clickable mockup was done one-on-one with one user at a time. Testings were scheduled beforehand and conducted at BitLab at the Copenhagen Business School. Users were given the clickable mockup and were asked to use the mockup according to the use cases while talking out loud. User

comments were used to gain insights on the satisfaction with the user interface and functionalities. The full mockup can be found in the appendix.

Insights

Different than expected, the main insight is that users did not like the solution as expected. Instead, users repeatedly asked for features ideated for the catering app such as delivery and testing of recipes as well as a more minimalistic user interface and functionalities. *„I just want to know what is good and tastes good. That app has too many functions for me.“* [User 1 comment testing]. Working with a user-centered approach, this feedback was taken seriously and hence a decision was made to reverse the chosen solution and instead focus only on the most crucial features relevant to the users.



The final solution is hence a mix of a recipe app with a potential of being a delivery app since it both offers the ordering and re-cooking of meals by offering the recipe ingredients and instructions. Like this, the effort of the user to find tasty and easily cookable recipes is tried to be kept to a minimum while offering trustworthy information on the sustainability of the recipes. More precisely, users asked for the following features to be present:

1) A variety of changing tasty dishes to choose from
2) Trustworthy information on the CO2 emissions of the dish
3) Easy ingredients and instructions to re-cook the dish
4) Ordering a dish

As mentioned before, actually cooking and delivering a dish to all 15 testers was not considered feasible by the author and hence this functionality was seen with caution.

Iteration 5 - Testing the Final Artifact

The goal of this final iteration resembles the ultimate goal of the thesis: addressing the research question and assessing the utility and success of the final coded solution.

Methods

Due to time constraints, no new mockup was designed but instead functionalities for the final solution were briefly validated with the key users to start coding the solution. Requirements were translated into use cases and user stories and another competitor analysis was conducted. The insights were used to code the final solution and test it over a course of three weeks with the five key users as well as ten additional users. Finally, all users were interviewed using semi-structured interviews and the interviews were transcribed and lastly analyzed using thematic analysis.

Competitor Analysis and Use Cases

In alignment with the process for competitor analysis and use case creation, value curves as well as use cases and user stories were created for the final solution. In terms of competition, six additional solutions were identified in accordance with sustainable delivery applications. The solutions were analyzed among industry specific factors such as speed of delivery, and user needs factors such as trustworthiness of information. The value curve can be seen below.

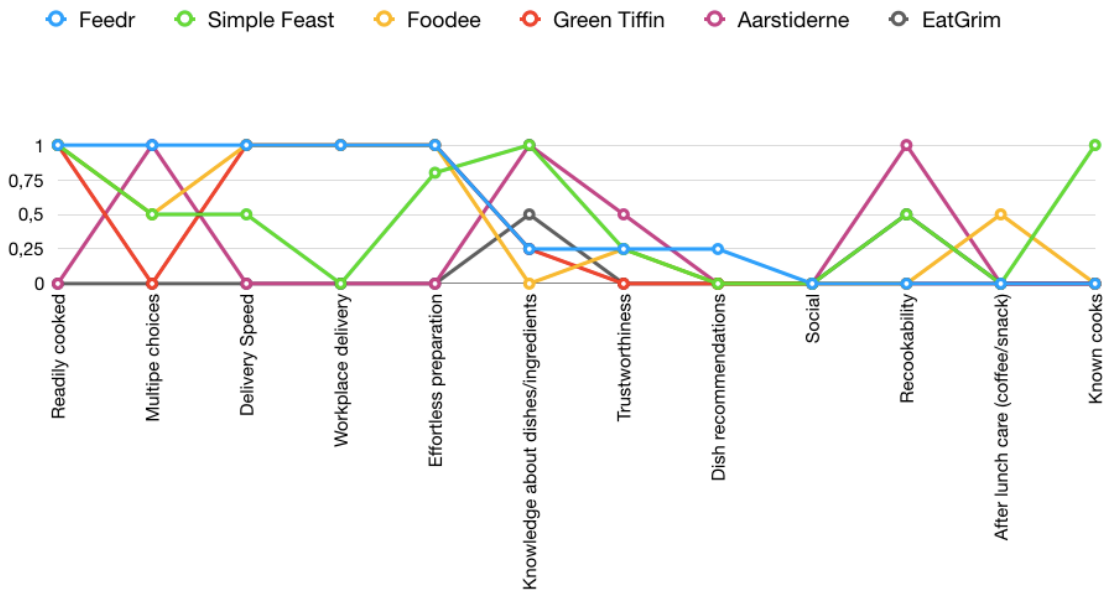


Image 17: Value Curve Catering App

In terms of use cases, four major use cases were formulated based on the user insights:

Use Case	User Story
Sign up new user	„As a user, I want to sign up so that I can use Spice and order my lunch at work.“
Log in known user	„As a user, I want to sign up so that I can save my profile and lunches on Spice.“
Select dinner	„As a user, I want to view different lunch option for today so that I can choose the one that suits me most.“ „As a user, I want to view the sustainability score of the lunch options so that I can make a considerate choice of my lunch.“ „As a user, I want to receive easily understandable information on the sustainability of my lunch options so that I understand the impact of my lunch option.“ „As a user, I want to see the ingredients of my lunch options so that I can select a lunch that suits my diet and taste.“
Save dinner	„As a user, I want to save lunches I liked so that I can re-cook them at home.“ „As a user, I want to see ingredients and instructions of my saved lunches so that I can easily re-cook them at home.“

Table 3: Use Cases and User Stories

The use cases and user stories are based on the user insights gained and the two competitor analysis. User stories were designed in collaboration with the five key users in order to ensure fit.

As noted by the users, most important is the trustworthy representation of the CO2 effect of the dishes. For this, the use case „select dinner“ contains the user story 2 and 3. Besides, in order to elevate the knowledge on sustainable recipes and ingredients, the app contains multiple sustainable recipes with scores and an overview of the ingredients and instructions of each dinner option (use case „select dinner“, user story 1 and 4). As noted, user want tasty and re-cookable dishes. Hence, the „select dinner“ use case with the order dish function as well as the „save dinner“ use case with the possibilities to save and review saved recipes is important. In order to account for user specific saved recipes, a sign up and log in is needed in order to connect the application to a database that can store and retrieve unique user specific data such as saved recipes (use case „sign up new user“ and „log in new user“).

As mentioned, a proper delivery function can not be tested. However, an „order now“ function can be integrated in order to give the appearance of a delivery app.

Coded Solution

Finally, the chosen solution was coded using the ionic framework. This framework was chosen since it enables cross-platform mobile app development**.** This is important since users are asked to test the application using their mobile devices which run on both iOS and Android. Without going into much detail on the architecture, design pattern, storage or connectivity of this application, Firebase's Firestore is used as the cloud database to enable authentication of users, storage capabilities and querying of the database based on for example user id.

The application was developed within two weeks in the end of September and addresses all use cases and corresponding user stories as developed throughout the research process.

Since the goal of DSR is to build meaningful artifacts, it was seen as vital to develop an artifact as close to a real solution as possible. Hence, the developed solution is a full-scale application with connection to the Firebase cloud service to enable database services to the user.

The final application is called Spice in order to resemble the tastiness of sustainable meals. For planning purposes, an excel sheet similar to a product backlog used in SCRUM was used. The sheet contains items, their priority according to their relevance to the use cases, a done indication and a notes section. Besides, a second sheet contains the same structure for bugs and possible improvements as found throughout the development process. The backlog has been used continuously throughout the development process and guided the author through the design of the use cases. The full product backlog as well as the code can be found in the appendix.

The final application is a progressive web app that can be used in the browser on any internet enabled device. It can be deployed on iOS as well as Android devices but since the author did not have a developer account for any of the systems, a progressive web app was seen suitable enough for testing. The final application has four main screens:

1) The sign up and log in screen on which users can either create a new account or use their existing account information to log in.
2) The home screen that contains the dishes of the week as well as button to view all dishes offered previously. Each dish contains an image, the title and the CO2 score called the climate score. The user interface resembles best practices of known catering apps. Additionally, a burger menu on the side offers links to the scientific foundation of the CO2 score as well as the health, nutritional and environmental values of the recipes**.** Every week, 7 dishes were presented to resemble a new dish per day. The dishes were chosen both based on articulated user preferences such as Mexican food, as well as user wishes of new and exciting dishes.

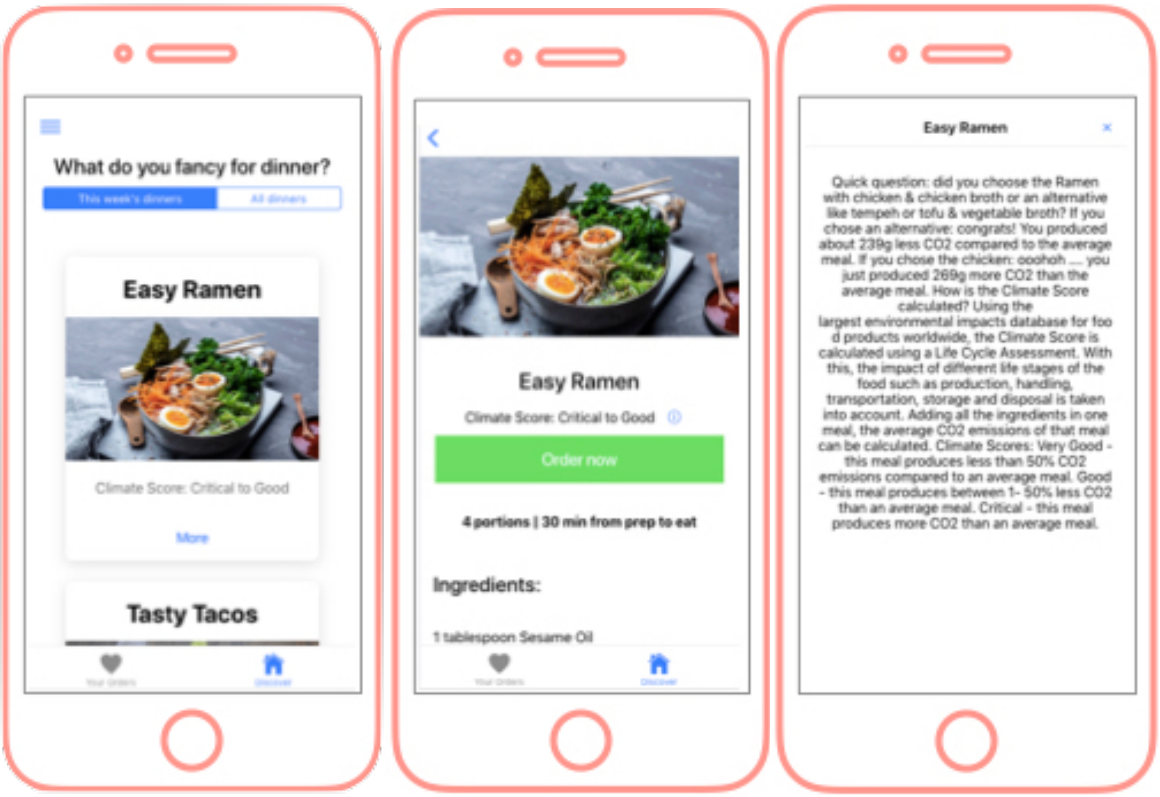


Image 18: Screenshots of the Final Application

3) When clicking on a dish, the dish can be viewed in detail. Here, the dish image, title, cooking time and portion size as well as ingredients and instructions are shown. This is based on the benchmark of existing recipe apps such as yummly. Besides, the climate score is shown and a more detailed description of the score and its calculation given once the user clicks on the score information icon. An order button is available for the user to order (and save) the dish**.** Since easy and fast preparation is important to the user, shorter recipes with maximum 30 minutes preparation and cooking time have been favored. Besides, instructions were written as clearly and simple as possible to inhibit perceived exclusion and demotivation by cooking-inexperienced users.
4) Lastly, the user can view his/her already ordered dishes on the „Your Orders“ tab on the home screen. This shows all previously ordered dishes in a table view and re-directs the user to the detail recipe view once clicked on a recipe.

Additionally, a push notification was added that reminded the users every evening just before their respective dinner times to check out the dishes of the week. This has been added in alignment with studies on behavioral change to imitate a cue triggering the action of using the application and re-cooking a dish. The application can be accessed via the link https://spice-94dcf.web.app.

The application contains a variety of features that are implemented to support the users in changing their dietary behavior. These features are partly translated from the identified influencing factors for sustainable dietary change of the user and the respective user stories created, and partly from research on dietary change. As identified in iteration 2 and hardened within the following iterations, the main factors for the target users are: Lacking knowledge about sustainable products and recipes, perceived lacking availability of sustainable products, perceived lack of tasty and easily cookable sustainable dishes, lack of trust in information about the sustainability of the products. Supporting interventions identified in literature on sustainable dietary change are: Goal setting, reminders, user motivation

Since the latter is assumed to be given due to the willingness to participate in the testing for dietary change, no feature for this factor was implemented. Reminders are seen twofold since they ease repetition but are said to hinder automaticity. However, they can prove fruitful in the beginning of a change and have hence been integrated [70].

The features and their purpose were not communicated to the users, however, a pop-up on sign-up explained the screens of the application for easier navigation.

The features, their purpose, intervention type accordion got the Behavior Change Wheel and source can be found in the table below. These features resemble at the same time the principles to be analyzed in the final interviews.

Feature	Purpose	Intervention	Source
Weekly Changing Dishes	To address factor 1 and 3	Educating and enabling	User insights
Climate Score	To address factor 1 and 4	Educating	User insights
Ingredients & Instructions	To address factor 1, 2 and 3	Educating and enabling	User insights
Saving Recipes	To address factor 3	Enabling	User insights
Reminders	To address factor 6	Environmental Restructuring	[70]
Goal Setting	To address factor 5	Incentivising	[12], [70], [76]

Table 4: Features of Spice

Testing

The final testing was done from weeks 42 to 44 2019 and included a total of 15 users. Three weeks was seen minimum suitable as proposed in literature on habitual change [17], [76]. The users consisted of the five key users and 10 additional male and female users fitting the respective persona. The users were given access to the application and were asked to use it as they felt useful.

In accordance with theory on behavioral change, users were asked to set a goal for themselves including frequency, time and location to support success of the testing and dietary change [12], [70], [76]. User goals were for example *„My goal is to make one sustainable homemade meal per week from the Recipe app.“* [User 3]. Additionally, a reminder was sent every day to the users just before their respective dinner times which simply asked „What do you fancy for dinner tonight?“. With this, the routine of searching for food should be guided towards using the application which would then suggest sustainable dinners.

The week prior to the testing week, all users were asked to note down their daily meals of the whole week. This was done in order to calculate the average CO2 produced per meal before testing and then after testing. However, due to a lack of time, the post testing scores could not be calculated and were hence regarded for analysis.

Semi-Structured Interviews

At the end of the three weeks testing, semi-structured interviews were conducted with 11 of the 15 user. Of the remaining four users, one could not test the application due to an extended holiday without internet access and three users could not be interviewed in time for analysis. The interviews were scheduled in advance and conducted at the Copenhagen Business School or via Skype. Each interview took about 15 minutes and was recorded. The interviews were transcribed using otter.ai and then checked manually for correct translation. The transcribed interviews were sent to the users for validation. Since the reasoning and method of semi-structured interviews was already described above, it will not be repeated here.

Nevertheless, the interview guide for these interviews is has unique aspects worth mentioning. Prompt questions are touching upon the general principles identified and featured in the final application. These principles are based on user insights and represent mechanisms that should, if user insights have been presented and analyzed correctly, prove successful in supporting the users dietary change. The ultimate goal of the interviews is to answer the research question and assess the utility of the artifact.

Since no overall rules for transcription exist, transcription can be loose [108]. Hence, focus was put on producing an orthographic transcript with only adding non-verbal cues such as chuckling if seen necessary by the author. The transcription as well as the full interview guide can be found in the appendix.

Thematic Analysis

Thematic analysis was chosen for the final analysis of the interviews. Thematic analysis is *„[…] a method for identifying, analyzing, and reporting patterns (themes) within data.“* [108, p. 6]. It is a qualitative analysis technique used in the majority of qualitative studies. With this, qualitative interviews that can not be compared as such become comparable by using a consistent framework for coding and analyzing. This supports the objectiveness of qualitative research methods [109], [110].

Before starting the analysis, a few questions have to be answered [110]. For example, it has to be clear what the material of analysis is. Here, all final interviews will be regarded in order to capture the widest range of possible answers to the research question. Due to the iterative process of insight gathering however, prior insights will be taken into account if relevant. In terms of what counts as a theme, it is clear that a theme has to be related to the research question - *„How can influencing factors of sustainable diets be leveraged by technology in order to support successful sustainable dietary change?“.* Hence, focus is on how and which influencing factors can be translated into meaningful technological features to support dietary change.

Even though a more inductive approach was followed throughout the whole research, themes for analysis were pre-set due to the nature of testing the features as described in the section on the final artifact above. However, space was given for additionally mentioned features by the users.

Superordinate theme	Sub-theme	Definition	Prime example	Further examples
Weekly Changing Meals	Intriguing Content	The interviewee indicates that the meal options served as inspiration for sustainable meals for either re-cooking or adapting the recipe.	6 - "So you get inspired what else is out there and different ways of eating sustainable." l. 67-68	15 - "I was just happy to see that there's more out there. So it's definitely yeah, it's like new inspiration and I did, in a way get sort of excited whenever, you know, you posted that the new recipes are out there. I was happy to go and check them out and see if there's something else that I can try." l. 105-108 8- „But that is still, then I thought, okay, it is not the app that the recipe that the app is telling me to do, but I'm sure that is even better, because it has a lot less ingredients." l. 75-77 10 - "I was more motivated to try out new recipes, like from scratch. Because I knew that it's going to come new and new." l. 78-79 1 - „Because I did thought in the beginning the selection was not very good. But I can see that they really put some effort into more content. Also I love the pictures." l. 200-201 15 - "I think the biggest help was the photos, was like a visual cue." l. 118

Image 19: Thematic Analysis Extract

The analysis has been done in a number of phases. Firstly, after having transcribed the interviews, the author immersed herself into the data by reading the whole data set, taking notes on possible themes. After

this, a first round of coding was used to identify interesting bits of data in each data item without filling in themes yet. Thirdly, the data set was re-read and this time included coding for themes. This was the followed by another round of reading and coding to eventually detail, collapse, re-group or eliminate themes. The themes are hence grouped according to the six main features of the application. Themes contain sub-themes that better describe the coded data and prescribe a design theme. Each sub-theme contains a description as well a prime example from the data set and further coded data that confirm the sub-themes. The final themes are analyzed and formulated in chapter 5.

Data Quality

In terms of data quality, common measures such as reliability and validity have been considered. Besides, credibility and research rigor are of core importance to DSR and will hence also be addressed.

Reliability has been ensured by the author by firstly triangulating methods to ensure corroboration of research findings [86]. Besides, during user interaction the author repeatedly asked for clarification and elaboration in order to ensure a more accurate interpretation of the users' thoughts Moreover, interviewees were asked to review their transcribed interviews and, if necessary, feedback to enhance credibility of the outcomes [111].

Nevertheless, ensuring reliability in a highly qualitative and interpretive study like this is difficult since it must be assumed that both the author as well as the testers create certain biases [86]. For example, since the author conducted and analyzed all data alone, probability for observer bias is given since the author's interpretation is the sole interpretation [86]. However, by making the research process, data and analysis highly transparent, this bias is sought to be kept at a minimum. Participant bias is another form of likely bias in this study [86]. This could be in the form of participants answering what they assume the author wants to hear. This bias is addressed by creating rapport with the interviewees and stating in participant interaction that there is no right or wrong answer and that it is solely about the interviewees perception.

Repeatability and credibility of the study has been ensured through the transparent description of the design process when describing each step in each iteration and how insights guided the way throughout the process. Also, using interim testing for validity and formative evaluation contribute to the overall credibility of this paper [64].

Focus was also put on validity. In order to ensure overall coherence of the research conducted and alignment of the methods and outcomes with the purpose of the research question, methods and outcomes have been reflected carefully [112]. As will be explained further below and in chapter 4, the research follows iterations of data gathering, data analysis, design and testing in order to ensure the internal and external validity of the outcomes and alignment with user needs.

Moreover, validity in DSR projects is established through the evaluation of the final artifact [113]. Here, focus is put on utility and the relation of the identified principles with the users and the dials identified within the primary studies on factors influencing sustainable diets.

Research rigor is one of the core concepts in DSR [64] and [114]. By using a thematic analysis of the final interviews, rigor is being supported.

5. Evaluation of the Final Artifact

In the following, the final evaluation and its outcomes will be presented and analyzed. As described above, a total of five iterations were followed that led to the development of the final application. Due to the product-centric research conducted within this study, focus will be put on the final thematic analysis of the semi-structured interviews conducted in iteration 5. The following will shorty describe and then analyze these findings.

Overview of Findings

As a final summative evaluation of the designed artifact, this analysis is based on the insights gathered throughout all prior formative evaluations. The six main themes analyzed below resemble the six main features implemented in the final artifact to ultimately support dietary change of the users. As described in chapter 4 above, these features are 1) Weekly Changing Dishes, 2) Climate Score, 3) Ingredients & Instructions, 4) Saving Recipes, 5) Reminders, 6) Goal Setting.

As can be seen in the thematic map below, each theme is constituted of a variety of sub-themes that better describe the given data. In fact, themes have been treated in a more descriptive manner since they represent the given app features, whereas sub-themes represent the prescriptive aspect of the theme, giving explicit recommendations based on the user insights.

The most controversial theme was the climate score and information, containing a total of five sub-themes. Most supportive for dietary change was the individually set goal which six out of 11 users followed and one user followed partially. Least influencing was the saving recipes feature, which however might be more due to the little overall amount of recipes and not because of the feature in itself. The most surprising feature was the weekly changing dishes and here especially the photos of the dishes: *„The pictures. I think, when we talk about food or in general looking at food, pictures are super important. And especially in this app, I thought about it a couple of times, the pictures are really good.“* (Interview 6 , l. 138-139). Since photos were not a feature that was designed for explicitly, the selection of pleasant photos was by pure chance.

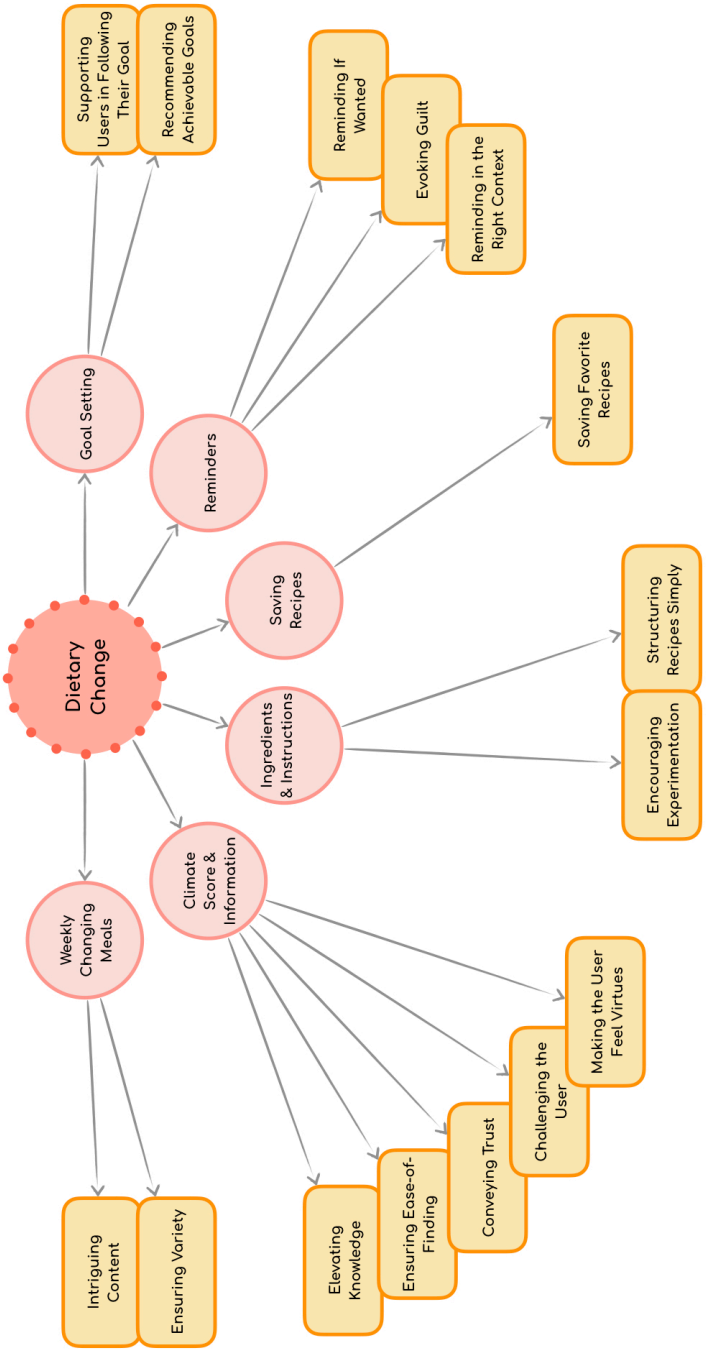


Image 20: Thematic Map

Overall, a change towards a more sustainable diet was reported by six out of the 11 testers, four noted an overall higher consciousness of sustainability in food and one even reported an integration of the application into normal life: *„I've been talking about it to people I have been sharing it, I have been looking up the recipes and kind of getting ideas of what should I eat tonight. Or, like, every time I was gonna go meet some friends and we're going to eat, I suggested, hey, let's use one of the recipes from the app.“* (Interview 3, l. 44-47).

Two testers reported no change, one because of his vegan girlfriend who already influences him in his eating behavior *„[…] I have a vegan girlfriend with who I cook similar recipes anyways.“* (Interview 1, l. 59-60) and the other due to a stressful time that did not allow him to really participate actively in the testing "*And for this one, I have to go change the shopping routine and the past weeks at least it was stressful for me. So I didn't really have the time or energy to actively change my shopping behavior.“* (Interview 5, l. 44-46). Since both users belong to the key users who have been part of the project from the beginning on, actively helping in developing the final artifact, hedonic decline is another possible reason for this. This entails that through repeated exposure and stimulation with the project and topic, the two user's hedonic response declined, resulting in less enjoyment or reflection of the project [115]. In total however, an overall change in perception and behavior can be observed.

Design Theme 1 - Weekly Changing Dishes

The weekly changing dishes feature was designed to support the users in their knowledge about sustainable products and recipes as well as their perceived ease of cooking tasty sustainable dishes. This theme is based on the user needs identified throughout the iterations and on best practice observed in state-of-the-art recipe apps. The intention is that by offering the users weekly changing sustainable dishes across a variety of cuisines, the users would be more tempted in re-cooking a dish that suits their taste preferences. Besides, showcasing a multitude of differing sustainable recipes should raise awareness for the diversity of tasty and easily cookable recipes. Hence, focus was put on selecting recipes that take less than 30 minutes to prepare while aligning with food preferences indicated by the users prior to the testing weeks (such as Mexican cuisine, Asian cuisine or unusual dishes see interview 2A, 4A, 5A and user workshop). Overall, this theme was designed as an educational and enabling intervention for habitual change. For this theme, analysis uncovered two sub themes: Intriguing Content and Ensuring Variety.

Sub-theme 1: Intriguing Content

This sub-theme was addressed once the interviewee indicated that the weekly changing meal options served as inspiration for sustainable meals for either re-cooking or adapting the recipe - or as the prime example puts it *"So you get inspired what else is out there and different ways of eating sustainable.“* (Interview 6, l. 67-68). In addition, users noted the excitement and even anticipation of receiving new and inspiring recipes the following weeks *„[...] in a way get sort of excited whenever, you know, you posted that the new recipes are out there. I was happy to go and check them out and see if there's something else that I can try.“* (Interview 15, l. 106-108).

The most intriguing aspect of the recipe was the photo that served as a visual cue for a tasty dish: *„The pictures. I think, when we talk about food or in general looking at food, pictures are super important. And especially in this app, I thought about it a couple of times, the pictures are really good.“* (Interview 6, l. 138-139). This was pointed out by six users repeatedly, underlining the relative importance of this aspect of the recipe. Since the author did not design intentionally for this aspect of the feature, the outcome is somewhat surprising. However, looking at best practices in recipe apps as well as the persuasion intervention named in theory on habitual change, the users response becomes explainable.

Overall, this feature motivated users to either re-cook (Interview 15) or adapt (Interview 8) a recipe and with this, eat more sustainably. Hence, this sub-theme supported the users actively in following a more sustainable diet. It thus suggests that sustainable dietary change in this context is supported by providing new and exciting recipes with, most importantly, eye-pleasing photos of the dishes.

Sub-theme 2: Ensuring Variety

However, one user also noted the difficulties he had in integrating the recipes into his daily eating routine due to cultural differences of eating light meals for dinner *„[…] and that sounds like that is a lot for dinner for me. So I just did like a different version.“* (Interview 8, l. 73-74). He further noted that he nevertheless used the recipes by adapting ingredients to his light dinner preferences *„But that is still, then I thought, okay, it is not the app that the recipe that the app is telling me to do, but I'm sure that is even better, because it has a lot less ingredients.“* (Interview 8, l. 75-77). Hence, even though the weekly changing recipes feature did not conform with his exact dinner needs, he still found a way to integrate the recipes into his eating routine.

Two more users added to this by stating that they would like to see different categories of foods in the future *„So if you're looking for maybe like Asian style cuisine or you're looking for salads, you know, fresh. Or meal based. So like I'm looking for breakfast options, that you have more filtering sort of things where you can get targeted at what you look for.“* (Interview 14, l. 143-145) and *„So bigger variety kind of covers more of your, you know, food areas that you would want to eat in a specific day.“* (Interview 2, l.72-73).

Thus, supporting dietary change also means supporting not only a single meal but offering sustainable alternatives for a variety of meal sizes, preferences and types. As suggested by users, these could include categories for breakfast, lunch, dinner, snacks, differing taste profiles.

Conclusion

As can be seen from the user input, this feature supported users as intended in their knowledge about sustainable products and recipes as well as their perceived ease of cooking tasty sustainable dishes. For the latter, the recipe photos were especially supportive since they conveyed a particularly tasty dish. This was surprising as it was not considered by the author beforehand and was hence also not designed for specifically. However, looking at currently available recipe apps, it is obvious that the quality of meal photos is rather high in popular recipe apps. Moreover, this aspect can be linked to habitual intervention with persuasion, since the photos invoke positive feelings towards the tastiness of the dish**.** Thus, intended to be more of an educational or enabling intervention, the recipe feature turns out to be persuasive too. Nevertheless, ensuring a variety of dishes across meals and tastes is necessary and also evident when looking at current successful recipe apps that support a variety of categories.

Design Theme 2 - Climate Score

The climate score was meant to support users in knowing about sustainable products and recipes and gaining trust in the sustainability of the products. As one fo the most crucial impediments for the Jens persona, trust in the sustainability of the product should be supported. Therefore, the climate score was calculated using the eaternity database, one of the largest global databases for food related metrics such as CO2 emissions produced**.** The source was clearly indicated in the application and a link to the database was given. The score was indicated below each recipe and ranged from very good to critical. When clicking on a recipe, the user could then click on the information icon on the score to gain more knowledge about the estimated grams of CO2e produced by that dish, what this meant in relation to, for example, energy usage, and how this dish stands in relation to the CO2 of an average meal. Hence, this feature was meant to be an educational intervention. As noted, this theme was most controversial and uncovered five sub-themes, indicating both supporting and hindering aspects of the feature.

Sub-theme 1: Elevating Knowledge

Two users referred to the climate score and information as conveying knowledge about the sustainability of the food. As the prime example indicates, *"Yeah, so I think it definitely, yeah, definitely helped by just knowing kind of how sustainable it [the dish] is.“* (Interview 3, l. 60). However, another user adds that *„I treated it more as a, like a fun fact, in a way, […]“* (Interview 15, l- 97-98). He and user 2 further noted the reason for this as being their overall trust in the application: *„[…] this app is meant to make me eat healthier. So literally anything I choose is going to be good enough.“* (Interview 15, l- 85-86).

Hence, the climate score in itself was not important to him since he assumed that the overall sustainability of any dish in the app was given. Hence, eating a sustainable dish is already good enough.

This aligns with user insights and research on habitual change. In terms of the former, users noted in prior iterations that they don't want to put much effort into cooking or food consumption but would simply like a tasty, and potentially sustainable, dish to be served to them. Research agrees that the human brain is seeking energy-efficiency and hence prefers to avoid any extra effort or decision making. Hence, reading about how sustainable a dish is that is assumed to be sustainable anyway could be seen as an extra unnecessary effort.

However, four users also felt like the climate score was lacking information or was not displayed nicely. As user 1 indicated: *„[…] I would make the climate score more transparent.“* (Interview 1, l. 275-276). Another user noted that, since he liked to alter the recipes with own ingredients, he couldn't really tell how sustainable his new version of the recipe was. He would have hence liked a score for each ingredient rather than the recipe *„Now I am just like okay, I think this could be. But I'm not sure.“* (Interview 8, l. 44). User 1, 3 and 12 all noted that they'd like a more descriptive score for easy comparison of different scores *"I would imagine it would be something like number based, you know, like maybe stars, or one to five or one to 100. Yeah. So, you know, what does very good mean compared to just good?“* (Interview 3, l. 114-116).

Interestingly, two of these three users who had difficulties with the score are key users who have been part of the project from the beginning on and who have hence been part of designing this solution. Adding to this, an initial explanation on where to find the climate score information in the app, the scientific basis of the score and where to find more information about it was given upon sign-up in form of a pop-up. When asking, none of these users could recall the pop-up nor where to find the information.

Hence, in total the information and the display of the information is important to most users. Therefore, it is important to give information to the users who want to know more but this information has to be displayed in a transparent way to ensure ease of understanding and comparing.

Sub-theme 2: Ensuring Ease-of-Finding

Adding to this, two users criticized the invisibility of the climate score information that was given once clicked on the icon in the respective recipe. For user 10, for who the climate score was important in deciding for a dish, the score information was important but he simply could not find it after having clicked on it once *„Because I basically I wanted to see it cause I remember for the feature, but I couldn't find it in the app.“* (Interview 10, l. 70-71). The other too noted that the information was interesting to him but hard to find. Besides, both suggested to have the information in a more visual representation rather than text *„So I*

would make the icon or something more visible.“ (Interview 10, l. 137-138) and having it more in the forefront rather than a hidden information *„I was thinking that maybe there's like the sustainable information about the co2 emission and such. Could be somehow put more in the forefront.“* (Interview 15, l. 182-183).

Hence, it is clear that the information was important to some of the users but they could not find it as quick as they would have liked to. Thus, ensuring high visibility of the information in a more visual way could support dietary change even more.

Sub-theme 3: Conveying Trust

As one of the intentions of the score feature, three users noted their trust in the correctness of the information based on the score *„[…] before in the paper testing, I don't know if I would trust all that stuff so much but if I go into the information icon then I can see a little bit more like the argument that's behind and I think that's something I like“* (Interview 4, l. 31-33). This, as one of the key users most in doubt about the trustworthiness of the information in prior rounds, resembles the value of the score. Another users added that he trusted the information but also needed to reflect upon it in order to make informed decisions *„However for me it is also a matter of reliability. So I know that you took those data from some institutions, right? So it’s serious data. However I didn't take the time to really read it so I mean yeah I didn't reflect too much on it.“* (Interview 5, l. 56-58). Even though this was only mentioned by three user, most seemed to be particularly critical towards the score at first and user 4 even referred to his uncertainty about the score during the paper prototype testing.

On the other hand, user 1 who already criticized the transparency of the score, even claimed that some of the information was not true *„I also didn't like that some of the explanation was a lie.“ (Interview 1, l. 97),* while adding later that he simply could not believe the example given for a specific dish in terms of the energy that can be used by what has been saved by eating one portion of that dish *„You know there was one explanation where it said I could make 14,000 smoothies? I don't believe that.“* (Interview 1, l.103-104). However, he also admitted that he did not check upon the information himself *„[…] I could probably put the work into it, but I just, I just want the link like right away.“* (Interview 1, l. 155).

Nevertheless, this is an important finding in terms of conveying trust to the user about the correctness of the information. This can be put together with the two prior sub-themes of presenting information transparently, visually and easy findable to support the mistrusting user. Since trust is a major impediment for the persona Jens, to which both user 1 and 4 belong, it is not surprising to receive a response from those users. However, it also shows that information has to be balanced carefully in order to create trust. Thus,

information on the sustainability of the food has to be grounded in science and easy to find and understand in order to convey trust and not impede the user in his efforts towards a more sustainable diet. This aligns well with the initial paradox identified, being that even though a lot of information on the sustainability of the food is provided, for example in the form of labels, people are rather confused or skeptical about the information and tend to hence mistrust the information that was meant to convey trustworthiness.

Sub-theme 4: Challenging the User

For some users the climate score was more than just information. Three users indicated that the score had an impact on which dish they chose since they preferred the superior one: *„This is one of the things that I it popped up to my eyes. […] So I was trying to choose between the ones that are one of the best ones, […]“* (Interview 10, l. 52-54). Here, it even seemed as if choosing the most sustainable dish served as a challenge since *„[…] I would prefer making food or a recipe that was very good rather than like medium.“* (Interview 1, l.81-82). One user even noted how he used the score to estimate how changing the recipe would make the score even better *„And even if I now that I'm thinking that I maybe, that I do like different versions of what it says, it might be even better. So that's good to know.“* (Interview 8, l. 85 - 86).

In total, these users saw the score as a challenge for themselves to eat the most sustainable dish or make it even more sustainable. Hence, supporting the user in challenging himself can support change. This can be linked to research on habitual change apps that suggests that features that support motivation, such as incentives or stats, support the initial stage of habitual change. Hence, even though not intentionally designed as an incentivizing feature, the climate score motivated some users to do the best they could. This could mean that re-designing the score to support motivation even more can support initial behavioral change to a higher degree.

Sub-theme 5: Making the User Feel Virtues

Lastly, the score served as a motivation or reward for one user on another level, as it made him feel as if he had done something good. He noted: *„Just afterwards, it's not really changing the way I eat before, it's just like a signal: you are doing something good here.“* (Interview 6, l. 59-60). As such, he referred to another application that he uses which has a similar feature.

Even though the insight is similar to the one from sub-theme 4, the user intention is different. Whereas sub-theme 4 addresses the individual motivation of being not only mediocre but best, this sub-theme reveals more altruistic intentions of doing something good. Nevertheless, the prescription is similar: design a

feature that supports users in self-motivation such as rewarding him with supportive messages of the good he has done by consuming a sustainable dish.

Conclusion

It is obvious that the climate score and information has a lot of potential to support dietary change. By providing the information in a transparent, visual and easily understandable way, users can make informed decisions about their dish. Besides, the source of information needs to be transparent, easily findable and trustworthy in order to support the skeptical user. Even though needing more research, the score could be even more beneficial if it was designed in a motivating way, for example addressing the self-optimizing or altruistic values of the users.

Design Theme 3 - Ingredients & Instructions

This principle is meant to support users in their knowledge on sustainable products and recipes, their perceived availability of these products and their perceived availability of tasty and easily cookable sustainable recipes. The ingredients and instructions appear once a user clicks on a recipe on the home screen. The format is aligned with best practices of current recipe apps, such as indicating the portions and time to prepare as well as a chronological listing of all ingredients and amounts followed by a step-by-step instruction of how to prepare the dish. As users noted their relative inexperience in cooking (sustainable) dishes during the user workshop, focus was put on making the steps as simple and short as possible and replacing cooking-lingo such as „sauté“ with lay-words such as „roast shortly“. In total, two sub-themes were found.

Sub-theme 1: Encouraging Experimentation

Seven users mentioned their adventurousness with the recipes by either altering the ingredients to suit their own taste or by getting inspiration form the ingredients to incorporate into their own dishes. As user 3 stated: *„And I feel also like the recipes in a way are easy to adapt.“* (Interview 3, l. 179).

Multiple reasons for recipe adjustments appear of which sole information about which ingredients can be seen as sustainable is the most prevalent. With this, users did not necessarily re-cook the dish but used the ingredients as inspiration to add to their own known recipes *„So even if I didn't cook them I saw the ingredients that they had. So that gave me an idea of what good sustainable ingredients are.“* (Interview 8, l. 93-95). Like this, the recipes did not only serve as dinner ideas but served as inspiration for any dish of the day *„[…] just to apply it in everyday not just for dinner or just in life to know.“* (Interview 8, l. 112).

Those who did cook an adapted dish from the app noted how they considered the sustainability of the substituted or added ingredients, for example *„So I added some ingredients, but I did consider whether that's like a sustainable or not sustainable choice. Like I wouldn't put beef in there, you know?“* (Interview 15, l- 134-135), or *„We did the spaghetti Bolognese, and instead of the lentils that the recipe said we just took some, we took some pea based meat like hakket meat. Used that instead, right, on it and it tasted pretty good“* (Interview 3, l. 181-183).

Also, another user noted his change strategy by starting with the dishes that resemble his usual dishes and adding some of his favored ingredients *„So I started with the things that I'm already eating like salad for example. And I tried the salad with adding the ingredients, I combine it with the ingredients that they're in the app, plus some ingredients that I must usually eat like cucumbers, for example.“* (Interview 10, l. 42 - 44).

Another user noted that he simply wanted to make use of the ingredients that he had at home without letting them go to waste *„[…] because I had a few things back home which I thought could make good fit in that recipe.“* (Interview 6, l. 92-93).

Overall, not a single user mentioned that he re-cooked the dish according to the recipe but instead added or substituted ingredients that suited his taste. Hence, the recipes were perceived as easily cookable as intended and even offered possibilities for tasty alteration. This theme further indicates that users wish to eat what they are used to, resembling user insights as well as research on routine-eating of whatever one is used to. This thus suggests that recipes should be designed in a way that easy adaptation to own taste preferences is given or even encourage to support smooth transition. Besides, user comments indicate that the ingredients were more important to them than the actual recipe and that the dishes serve more of an inspirational purpose than an actual action. Lastly, lacking cooking skills do not seem to be an impediment as such since most users enjoyed experimenting with the given ingredients. The underlying factor can rather be described as a lack of knowledge about sustainable ingredients, which leaves users uncertain about how to cook sustainable dishes.

Sub-theme 2: Structuring Recipes Simply

Supporting the re-cookability or adaptation of the recipes, users highlighted the ease of following the recipe ingredients and instruction lists: *„It helped me a lot. It was really clearly written. So it made it really easy to make the dish.“* (Interview 10, l. 85). As intended by the feature design, the simple listing and easy language of the recipe supported the user in re-coking a dish *"You have like steps 1234 and, and the instructions are quite small, so easy to kind of follow and create the recipe. So really good.“* (Interview 3, l. 186-187).

On top of that, two users relate to other recipe apps that have the same structure which eased their navigation *"I was really used to that kind of structure because I use other recipe apps. […] So that felt super familiar and I didn't have any struggle with that."* (Interview 6, l. 76 and 79-80). However, this familiarity also resulted in less excitement about the feature as such *„They are ok. Not exciting but easy to understand. Step 1,2,3, ingredients. I think for me it is just that those things are also easily accessible elsewhere, in other apps."* (Interview 12, l. 48-49).

In total, the intended design of the recipe proved successful. Hence, aligning with best-practice design from successful recipe apps supports users in navigating through the recipe and re-cooking it. Besides, easy language and structure motivate the user to cook a dish without being shied off.

Conclusion

Overall, the feature was successful in what it was designed for: supporting knowledge on sustainable recipes and ingredients as well as providing easily cookable and tasty recipes. Surprisingly however, users did not simply re-cook a given recipe but instead altered it to suit their taste or available ingredients. This makes sense when taking into account that people like to eat what they are used to. This however does not conform with prior user comments who state they would like new recipes that they haven't tried before. Conclusively, sustainable recipes should align with known dishes or at least give the freedom to substitute ingredients. This could mean that suggestions for substitution should be indicated in the list of ingredients as has been partially done by this application. In total, sustainable recipes should be designed for inspiration rather than exact re-cookability.

Design Theme 4 - Saving Recipes

Saving recipes was meant to support the users in perceiving sustainable dishes to be tasty and easily cookable. By saving their favorite recipes, users can easily come back and re-cook a recipe that suits their taste preferences. The feature is visible once a user clicks on the button while viewing the respective recipe. In the tab bar at the bottom, users can then navigate to their saved recipes. This feature was meant to support users in knowing about tasty and easily cookable recipes by giving them the possibility to save favorite recipes. Besides, this is a common feature in state-of-the-art recipe apps and was additionally mentioned by the users as a "must have" feature. This feature however did not attract much attention and contains only one straight forward sub-theme: Saving Favorite Recipes.

Sub-theme 1: Saving Favorite Recipes

As intended by the feature, two users used it to save recipes *„It's nice that you can save the different recipes so that you have like one place where you can find something. It's a little bit like Google Drive for your recipes.“* (Interview 4, l. 96-97) and user 10 noted the simplicity of the feature *„I knew that it's there so I can find it easily.“* (Interview 10, l. 105-106).

However, four users agreed that the amount of recipes on the app was fairly manageable and hence no such feature was needed as for now *"I actually didn't use that because there wasn't that much recipes to get lost.“* (Interview 6, l. 103). Nevertheless, these users generally saw the value of having such as feature once more recipes are available on the app *"So I would see the recipe and there's not so many recipes that I will get lost into it. So there was no reason for me to have to say recipes at this stage right. But of course, in the future, it will be super super useful, right?“* (Interview 3, l. 204-206).

This means that overall, the feature as for now did not support users to a high degree in changing their diet but that users see the potential value of the feature once more recipes are available. No inference can be made on this however since no more recipes have been added to the app. However, as being a common feature in most recipe app today, the feature appears to be useful.

Conclusion

Users didn’t really use this feature since the amount of recipes was manageable without loosing track of the recipes. However, in future, saving recipes could be valuable but more in the sense of expectations towards what a recipe app should do and less in terms of behavioral change.

Design Theme 5 - Reminders

Reminders were meant to ease the initial repetition of the new behavior of cooking with the app in mind. This feature is based on recommendations for food behavioral change applications and is said to support people in the beginning of the change process when high repetition of the new behavior is needed. Since it was not possible to send a reminder through the progressive web app, the author sent a reminder every evening to all users via Facebook messenger that simply stated: „Hungry? Then check the app for some delicious & quick dinner ideas.“. Since users would receive the message as a notification pop-up on their phones, resemblance to a an actual notification is given. In total, three sub-themes were uncovered with mixed outcomes.

Sub-theme 1: Reminding in the Right Context

As intended, four users reported the reminder working as a cue for them to check the app for dinner ideas *„When I was at home for dinner, and I received the link, the message from you I was checking it and I was thinking, what can I do now?“* (Interview 10, l. 113-114). As this user comment indicates however, the right moment in time and location, or simply the context, is important.

As user 1 stated: *„[…] it came at a time when I was not thinking of dinner.“* (Interview 1, l- 47). This however does not mean that the reminder was useless overall, it simply states that the reminder needs to appear in the right context, for example during lunch time or the weekends for user 4 *"But for me it would have helped me maybe a little bit more, if it would have been at the weekends in the morning or in the noon, because that's probably the time where I would have cooked.“* (Interview 4, l. 76-78). User 2 and 5 added the right location to the context of the reminder *„So if I would have push notification while doing shopping, then it would maybe influence more.“* (Interview 5, l. 97).

Due to technical difficulties in programming and displaying a reminder that can be set individually, the reminder was sent at around 6pm every evening to all users. However, a personalized or context aware reminder would have been more useful. This is supported by research on both habitual change as well as behavioral change applications that calls for context-aware reminders that can work as a contextual cue for the target behavior. Thus, it can be inferred that a reminder supports sustainable dietary change but only if it is set in the right context. What the right context is, is however up to the respective user.

Sub-theme 2: Evoking Guilt

The second sub-theme is another example of what can happen when the reminder is set in the wrong context. For example, as user 1 noted that the reminder was sent at the wrong time, he further elaborated *„But I liked the notification that I got every night. Made me feel guilty for not following it.“*(Interview 1, l. 40-41). Similarly, user 8 stated *„That made me feel bad that I wasn't using the app.“* (Interview 8, l. 119). Hence, both had a negative emotional reaction towards the reminder since neither of them followed the reminder’s instructions.

At this point it is unclear what the underlying reasons for guilt are. The author missed to ask probing questions and it is hence unclear if, for example, the users felt guilty for not putting more effort into their desired behavioral change, or if they felt guilty for not feeling they supported the author as indicated by user 8 *„I'm sorry, that I wasn't really involved. But I'll try to change that before you hand in your thesis […]“* (Interview 8, l. 226).

Nevertheless, linking to sub-theme 1, both users felt that the reminder was useful but simply appeared at the wrong point in time. This again stresses the importance for setting contextual reminders that support the users in their target behavior when needed and that don't make the user feel guilty.

Sub-theme 3: Reminding if Wanted

Lastly, two users noted that they did not have the need for the reminder since they used the application anyway. For example, user 15 stated *"The fact that I have the app alone was enough for me to keep trying."* (Interview 15, l. 153) and user 6 agreed by saying *„And if I don't have a specific plan, then I will check the app, no matter I get a reminder or not."* (Interview 6, l. 122). Neither of them described the reminder as intrusive or annoying but simply indifferent towards it.

Hence, no user had negative feelings, apart from guilt, towards the reminder but some did not need one in order to kick off the target behavior. This was expected to happen for some users since research indicates that reminders are only helpful in the beginning of the behavioral change. Since users 6 and 15 were part of the Chris persona, who is already a little further ahead in changing towards a more sustainable diet, these insights are conforming.

Thus, reminders are useful only for beginners whereas later-stage behavioral changers are no longer in need for a reminder to perform the target behavior. Hence, an option is necessary to discard the reminder if the user feels like it is no longer necessary.

Conclusion

In total, the reminder served its purpose of supporting users in starting their target behavior of a sustainable diet. However, the insights as well as prior research indicate that in order for a reminder to work successfully, the reminder has to occur in the right context and only as long as intrinsic cueing of the user to perform the target behavior is not yet developed.

Design Theme 6 - Goal Setting

Goal setting was supposed to support the motivated users in changing their dietary behavior towards their respective goal. Users were asked to set a goal on the day the testing started. The goal had to include a time, frequency and location of the behavior as noted by research on dietary change. Two sub-themes were uncovered.

Sub-theme 1: Recommending Achievable Goals

Seven users self-reported success in following their goal throughout the testing weeks. Without asking users to repeat their goal, all of them quoted their target and achievement. For example, user 10 stated *„[…] my goal was to eat plant based meal at once a day. […] And I'm doing that, since I set it. […] I am like more conscious that ok, this breakfast should be plant based.“* (Interview 10, l-.122-124).

Adding to this, user 6 and 3 noted a positive feeling they got from achieving their respective goal *„I really liked that idea to set a goal there because, yeah, if you have a specific goal, then you kind of make a rule for yourself and you get reminded when you do groceries, for example. And for example, yesterday evening, I did some groceries and in the supermarket I thought about this, this rule I made up and I stick to that, and it felt good.“* (Interview 6, l. 128-131) and *"And because it was doable, you know, I actually did it and now I'm happy like yeahy super cool I did my goal, right.“* (Interview 3, l. 238-239).

User 3 even referred to another aspect of setting doable goals. He noted that if he had set a goal that was not achievable for him, he would have been demotivated to follow it *"And then you know, like if I had said I was going to do two and then I only did one, and then the incentive would be backwards, right. I'll be like, ah, but I didn't make it last week, like, I already failed one time, like maybe forget about it.“* (Interview 3, 243-246). Reverse-supporting this statement, user 4 talked about his euphoria once he even over-reached his goal "*As I said, like the goal was related to eating at least once per week a vegetarian sustainable dish in the canteen and I even managed to do that more than I was setting the goal. So I think that worked pretty well.“* (Interview 4, l. 85-87).

Hence, even though it is unclear whether the time-frequency-location format of the goal helped the users as such, the goal in itself was already supportive. As noted by two users, setting achievable goals is important in order to be motivated to achieve it and feel good once it is accomplished. Hence, supporting users in setting manageable goals is recommended.

Sub-theme 2: Supporting Users in Following Their Goal

Nevertheless, four users had difficulties in following their goals. While user 1 simply noted that he is *„[...] not really the goal kind of person. I just mostly do whatever I feel like most of the time.“* (Interview 1, l. 240-241), he also added that it would have helped him to be reminded about his goal *"But I think it would have been better to be reminded about my goal.“* (Interview 1, l.241-242).

Even though user 8 partly achieved his goal of not eating meat, he noted difficulties when being in social situations *„I went to my friend's place and they cooked risotto with chicken so I had to eat it. So I wasn't gonna say no, but like for me, I don't buy for myself or if I buy here at the canteen I never eat and never get*

meat.“ (Interview 8, l. 142-144). Hence, the desire for achieving the goal was not strong enough to overcome the influence of social peers. Whether anything could have supported user 8 in that situation is unclear.

Even though user 2 and 12 achieved their goal, both stated that they would have liked to be supported in their goal, for example by tracking progress *„Showing the progress and something visual. And then maybe at the end of the week or month, I could get a total score of how well I did compared to the previous period.“* (Interview 12, l.86-88).

This supports the overall importance of setting achievable goals as mentioned above. For example, user 8’s goal could have been set without including social situations at first. Nevertheless, another important aspect is revealed: even though most users had no problems following and even recalling their set goals, one user would have liked a reminder to follow the goal. Unsurprisingly, this user belongs to the Jens persona who stands at the very beginning if his dietary change. Hence, more guidance might be needed. Thus, a more thorough guidance in setting and following goals might be necessary for those who are just starting their dietary change.

Conclusion:

Aligning with the suggestion for dietary change support, goal-setting has ben proven successful in supporting users in following a more sustainable diet. Having said that, it is unclear whether the goal in itself or the time-frequency-location format of the goal helped the users. Also, even though some users noted the wish to include the goal setting in the app or combine it with a reminder, most users remembered their goal by heart and followed it nevertheless. Another important note is that goals have to be set achievable for the user. Hence, support in setting a doable goal is recommended.

Conclusion

Hence, influencing factors of following a sustainable diet can be successfully translated into features of a technical solution. However, not every feature was equally successful in supporting the user in following a more sustainable diet. To sum up:

1) **Weekly Changing Dishes** supported users as intended in their knowledge about sustainable products and recipes as well as their perceived ease of cooking tasty sustainable dishes. For the latter, the recipe photos were especially supportive since they conveyed a particularly tasty dish. Also, focus has to be put on ensuring recipe variety in order to support all taste preferences as well as meals. Important to

note is that users preferred the recipes that are similar to the ones they already know for easy transition.

2) The **Climate Score & Information** supported users in their knowledge about the sustainability of the dishes and conveyed trust to most users. However, the source of information needs to be transparent, easily findable and trustworthy in order to support the skeptical user. Besides, the score could be even more beneficial if it was designed in a motivating way, for example addressing the self-optimizing or altruistic values of the users.
3) **Ingredients & Instructions** was successful in supporting knowledge on sustainable recipes and ingredients as well as providing easily cookable and tasty recipes. Users however altered recipes to suit their taste or available ingredients. Conclusively, sustainable recipes should align with known dishes or at least give the freedom to substitute ingredients. In total, sustainable recipes should be designed for inspiration rather than exact re-cookability.
4) As least influential, **Saving Recipes** was not used by most users and was only seen valuable once more recipes are available. No real inference can be made.
5) As a feature inspired by behavioral change research, **Reminders** supported users in starting their target behavior of a sustainable diet. However, the reminder has to occur in the right context and only as long as intrinsic cueing of the user to perform the target behavior is not yet developed.
6) Another behavior change feature, **Goal Setting**, proved also successful in supporting users in following a more sustainable diet. In order to work best, goals have to be set achievable for the user and support in setting a doable goal is recommended.

6. Discussion

Having analyzed the research outcomes, these will now be viewed in the light of the literature review to contrast current research and these findings. Besides, the practical and scientific contribution will be cleared.

From the literature review it got obvious that impeding factors for sustainable food consumption should be mainly convenience and price and the most motivating factors health and environmental concern. However in this study another picture is drawn.

Comparing the two conceptual models, both similarities and differences can be noted. Most present are the missing shortcuts in the model of this study. However, since the user group is fairly little and no particular focus has been put on discovering these kind of factors, it can not be assumed that they are not present.

A second interesting observation is the missing health consciousness. As one of the core motivating factors discovered in primary studies, users of this study seldom referred to the connection of health to eating more sustainably. Instead, the most motivating factor is environmental concern, which in primary studies is also important but mostly in later stages of dietary change.

Nevertheless, in this study too, a few other factors are influencing the commitment to a sustainable diet before environmental concern unfolds its full potential. First, users seem to highly mistrust the claims made about sustainable food. This aligns with the initial paradox discovered for this thesis, being the high use of labels in practice and the rising confusion and mistrust of consumers in these labels. Even though not tested specifically, it can be assumed that this mistrust adds to the leaping of the health consciousness factor in this study, since users do not believe in the superiority of sustainable food over conventional food (see initial interviews with key users). Trust as an impediment is not present in primary studies, instead, focus is on price and quality.

However, a slight similarity between the two models can be noted. As can be seen, by gaining knowledge about sustainable food over time, the perception on enjoyment, taste, nutrition and availability becomes more positive in the primary studies. Similarly, perception on skills, taste and availability rise for users in this study. Hence, an overall development through experience is evident in both models, paving the way to environmental concern and commitment to a sustainable diet.

Viewing this in the light of the final evaluation, another few points can be made:

1) As the final application was designed for the persona Jens, most focus was put on leaping the knowledge gap in the light of environmental sustainability. As expected, interventions addressing information provision were least successful or controversial. For some users, the climate score, its scientific basis and further information were important but display and visibility of this information was criticized. Thus, it is important to provide trustworthy information on the sustainability of the food, however care has to be taken in terms of easy and transparent display in order to not discourage skeptical users.
2) Both perceived taste as well as availability of sustainable dishes and foods were supported with the final application. However, skills did not seem to matter to the users since most even created new recipes without following the simple instructions of the given recipes. Most supporting was rather the provision of what ingredients are sustainable in order for the users to incorporate these into their diet. Hence, lacking cooking skills are not in fact an issue as described both by users in prior iterations and literature.
3) Other than expected, intriguing photos served most useful in motivating and inspiring the user for change. Even though visible as a best practice in current recipe apps and belonging to the persuasion

intervention as noted by habitual change research, this theme is more impactful than could have been assumed. In fact, it seems to be the most important aspect of the app for most users.

4) As indicated by research, both reminders and goal-setting proved successful in supporting dietary change. However, additional implications can be given. Reminders work best in a meaningful context such as location or time of food decision making. Also, reminders work best in the beginning of dietary change in order to spur repetition of the target behavior. Referring to goals, attention has to be put on supporting the user in creating achievable goals for the sake of motivation and reward. Also, reminding the user of the goal might be helpful.

Generalizability of the Outcomes

Since the outcomes stated above are contradictory to current research, a few notes have to be made on the generalizability of the outcomes. Overall, a self-reported dietary change towards a more sustainable diet or higher consciousness of sustainable food was noted by 9 out of 11 users. Of these, three were key users and all females were represented. Of the key users, one even noted an integration into his daily life. The two remaining key users did not note a change at all. The reasons for this being predominantly not having had time to cook sustainably (User 1 and 5). This might however also be explained with hedonic decline which states that indulgence minimizes with continuous exposure**.** Since these two users were part of the key users and the only ones reporting no change, hedonic decline is a likely explanation.

Another interesting aspect is the high positive response of female users towards the application and overall dietary change since the app has been designed with and for the persona Jens. Adding to this, no analytical difference could be made between the key users and the additional users apart from the overall behavioral change. These results together indicate the possible generalizability of the results since no social or gender bias can be observed.

Scientific and Practical Relevance

Hence, this thesis is relevant in a variety of ways. Firstly, it supports the paradox of current institutional practices and effect on the consumer in terms of labeling and knowledge provision of sustainable food. Users mistrust the information on sustainable food and leaping this gap has to be balanced wisely. Rather than providing more and more labels and information, users should be guided by elevating their experience with sustainable food. The more experience a user has, the more positive is his attitude and commitment towards sustainable food.

Moreover, for researchers on sustainable diet and influencing factors, this study adds not only theoretical by uncovering further factors, but it mostly adds by providing a practical implementation and testing of these factors. This is especially lacking in current research on factors influencing sustainable dietary change and has been criticized multiple times. Hence, this thesis adds relevance by providing practical insights and prescriptive knowledge to a given descriptive knowledge base.

Further, this thesis provides insights for developers of dietary change applications. As noted before, these kind of applications are in need of scientific basis and integration of behavioral change aspects. The presented application is both grounded in user insights, kernel theory on dietary change as well as influencing factor on sustainable dietary change. As a core insight, reminders and especially goal-setting have proven supportive on dietary change and should hence be incorporated in these kind of applications. Adding to this, another improvement of the developed application over currently available recipe apps is the sustainable aspect. No consumer application has been found that addresses the environmental sustainability of food. Two users underline this value proposition by stating *„Because I think there are a few other recipe apps out there but kind of the sustainable factor in it is makes it unique.“* (Interview 6, l.162 - 163), and *„You know, in all recipe apps out there, like you don't really know how good it is. […] While in this app, you know, the feature with the scores, the sustainability scores, and everything. Like that just gives you this extra stamp of assurance that it is worth the effort and that you are making a difference.“* (Interview 2, l. 151 -159).

7. Conclusion

This thesis addressed the question of how dietary change towards a more sustainable diet can be supported by technology by addressing influencing factors of a sustainable diet. In the following, a brief summary of the thesis and its main findings will be presented, followed by a concise discussion of the thesis's limitations. The thesis then concludes with future research perspectives based on the insights gathered herein.

Summary

This thesis aimed to improve the current food sustainability by developing a technology that supports people in changing towards a more sustainable diet. With this, not only a global problem of feeding the world population and ensuring sustainability over a variety of aspects is supported, but also personal wellbeing and health by providing a sustainable and healthy diet.

Using a product-centric DSR approach to address this challenge, a final artifact was designed and developed in a total of five iterations together with a defined target group, to address the needs of this group in a

meaningful and user-centered way. With this, key influencing factors for sustainable dietary change were identified and translated into a final application. The dietary change supporting features were:

1) Weekly Changing Dishes
2) Climate Score
3) Ingredients & Instructions
4) Saving Recipes
5) Reminders
6) Goal Setting

The application was tested with the target group and additional testers over a period of three weeks. Final evaluation showed that an overall dietary change and higher consciousness of food sustainability was self-reported by the testers. Most supporting aspects of the application were goal-setting as well as intriguing recipe photos and ingredients that sparked commitment and excitement in the users to change their diet. Most impeding was mistrust in the information on the sustainability of the food.

Limitations

Due to factors such as time and resource limits, this thesis is subject to limitations partly set by the author and partly evolved throughout the research.

First of all, as a single author, no researcher triangulation was possible and hence the sole interpretation of author might be biased. Triangulation would have been valuable for the systematic literature review, data gathering, design, as well as analysis.

Moreover, the short period of testing might be too little for changing dietary habits. Testing lasted only three weeks which can be seen as the minimum duration for habitual change. Adding to this, no long-term study that controls the lasting change in habit will be conducted. Thus, actual habitual change can not be testified.

Also, the testing was done with only 15 users, of which 11 completed the final interview. Hence, this amount of testers might be too little to infer meaningful and generalizable results. More research and more resources are needed to confirm the results.

Besides, no common analysis of habitual change has been made. Instead, self-reported dietary change as well factors that support change have been analyzed. Future studies could hence focus more on the actual behavioral change with the given solution.

In terms of the developed application, a few weaknesses can be pointed out. The developed application could not be deployed as an iOS or Android application due to the missing developer accounts of the author. Hence, the app had to be deployed as a progressive web app which hindered the direct integration

of the reminder feature. Besides, since the author had no prior knowledge with the ionic framework and the programming languages used, aspects such as the user interface are lacking a final touch. However, since the application is a minimum viable product, it is not meant to be perfect.

Moreover, the identified need of a global sustainable diet is generally not a core concern for people. This means that the problem that the application solves is not a pressing problem like supplying food to people who do not have access to food. Instead, it is solving a secondary problem of easing the way to sustainable food for would like to eat more sustainably. Hence, this thesis addresses a "nice to have" aspect of most people's diet but not a „need-to-have“ aspect.

Also, due to the broad definition of food sustainability for this thesis and research in general, especially the literature review is kept rather broad and includes research on organic, plant-based and climate friendly food. Slight differences can be noted in each of these aspects and hence insights might not be applicable to the broad term of food sustainability in general, but can only be seen within their respective definition. However, due lacking studies on specifically CO2 friendly food, studies addressing organic food as sustainable have been included.

Future Outlook

In terms of future research possibilities, a first interesting aspect has to be noted. A change in target group has been done early on in the project. Initially, focus was on pregnant women since research indicates that life changing events such as pregnancy serve as a window of opportunity for changing habits**.** Especially regarding change towards a more sustainable diet, available studies suggest that pregnant women are more likely and willing to adapt. Hence, supporting pregnant women in their pursuit of following a more sustainable diet suggests to be a promising research topics and should be regarded further.

In general, a range of prescriptive knowledge has been generated within this thesis, paving the way for researchers and practitioners in sustainable dietary change. This study hence serves as a blueprint for bringing practical evidence into the field of influencing factors of sustainable dietary change but more work has to be done. Especially, studies need to confirm actual habitual change with the developed solution and longitudinal studies could add value by testing habitual change over time.

Further, more studies need to include practical implementation and testing of factors influencing a sustainable diet. As noted by researchers, descriptive knowledge of this topic is widespread by prescriptions are lacking. By contributing with more prescriptive knowledge in this field, researchers could not only add value theoretically, but also practically to human kind and the world - making the planet a little more sustainable.

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Appendices

The appendices are enclosed and compromise the following in chronological order of their use or development:

1) Transcribed Interviews of the Key Users
2) Interview Guide Key Users
3) User Workshop Structure
4) User Workshop Slides
5) User Workshop Audio Recording
6) User Journeys created during User Workshop
7) Innovation Matrix
8) Proof of Concepts of Design Alternatives
9) Storyboards
10) Paper Prototypes
11) Value Curves
12) Clickable Mockup
13) Product Backlog Final Artifact
14) Code Final Artifact
15) Transcribed Final Interviews
16) Interview Guide Final
17) Thematic Analysis