Faculdade de Design,
Tecnologia e Comunicação
Universidade Europeia

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DOMESTIC KITCHEN DESIGN STRATEGIES TO REDUCE FOOD WASTE.

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Dissertação apresentada ao IADE - Faculdade de Design, Tecnologia e Comunicação da Universidade Europeia, para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Design do Produto e do Espaço realizada sob a orientação científica do Doutor *Eduardo Gonçalves*, *Professor Auxiliar* da *Faculdade de Design, Tecnologia e Comunicação da Universidade Europeia* e do Doutor *Cristóvão Valente Pereira*, *Professor Auxiliar* da *Faculdade de Belas-Artes da Universidade de Lisboa.*

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keywords

Sustainability: kitchen design; food waste; design for behaviour change; interior design; space design; product design.

abstract

This research aimed to understand how the domestic kitchen design can help the user to reduce their food waste. From this, we had the objective to define strategies and principles directed to professionals who develop domestic kitchen designs. To accomplish this goal, we approached the themes of sustainable development and design for sustainability as the basis for proposing solutions, focusing on the user phase, that create ruptures in the current system and instigate more responsible behaviours in terms of economy, environment and society. In this sense, we investigated the problem of food waste, mainly in the Portuguese scenario, to understand its dimension, what is actually wasted and what are the factors related to this behaviour. So we presented strategies and design projects to induce behavioural change, focusing both on sustainability and food waste. From that, we systematized those that can be transported to the kitchen scenario. About the kitchen space, we presented brief chronological evolution and the design rules and parameters existing in the literature, in order to define key moments in the design process for implementation of the selected strategies. Finally, we established a set of nine strategies and their principles, which were evaluated by a sample of professionals in the sector, through online survey. From all the data and information gathered in the research, we concluded this dissertation with the design of a kitchen model, in which we implemented the established guidelines, which meant a practical evaluation of our result.

Palavras-chave

Sustentabilidade; design de cozinhas; design para mudança de comportamento; design de interiores; design do espaço; design de produto.

resumo

Esta investigação buscou compreender como o desenho das cozinhas domésticas pode auxiliar o usuário a diminuir seu desperdício de alimentos. A partir disso tivemos o objetivo de definir estratégias e princípios direcionados a profissionais que desenvolvem desenhos de cozinhas domésticas. Para cumprir este objetivo, abordamos os temas do desenvolvimento sustentável e do design para a sustentabilidade como a base para a proposição de soluções, com foco na fase do usuário, que criem ruturas no sistema atual e que instiguem comportamentos mais responsáveis em termos de economia, meio ambiente e sociedade. Neste sentido, investigamos o problema do desperdício de alimentos, principalmente no cenário português, a fim de compreender qual a sua dimensão, o que é de fato desperdiçado e quais são os fatores relacionados a este comportamento.
Apresentamos, então, estratégias e projetos de design para induzir mudança de comportamento, com foco, tanto na sustentabilidade, quanto no desperdício de alimentos. A partir disso, sistematizamos aquelas que podem ser transportadas ao cenário da cozinha. Sobre o espaço da cozinha, apresentamos breve evolução cronológica e as regras e parâmetros de projeto existentes na literatura, a fim de definir momentos chave no processo de desenho para implementação das estratégias selecionadas. Por fim, estabelecemos um conjunto de nove estratégias e seus princípios, que foram avaliadas por uma amostra de profissionais do setor, por meio de inquérito online. A partir de todos os dados e informações colhidas na investigação, concluímos esta dissertação com a criação de uma proposta de projeto modelo de cozinha, no qual implementamos as *guidelines* estabelecidas, o que significou uma avaliação prática do nosso resultado.

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INTRODUCTION

Framework and general definition of the theme

It is notorious that sustainability is an issue that involves all sectors of society, being possibly the main concern of humanity in the 21st century. In this research we sought to understand how space design can be used as a strategic tool to combat food waste on a domestic scale, one of the problems directly related to the excessive use of natural resources.

The concept of *sustainable development*, arose from the search for a consensus between countries with different realities, which sought to structure global growth based on the balance between the environmental, social and economic sectors. Aware of the limits of the Earth, man sought to understand how it is possible to maintain development standards and, above all, guarantee access to resources and well-being parameters for future generations, while allowing the renewal of the planet's natural resources.

However, we have seen that the maintenance of consumption patterns is inconsistent with the search for the relief of pressure on natural resources. We already know that a sustainable project should not be one that only considers the use of more responsible resources and clean energy, but a combination that involves the different phases of the product, from its conception, its production, until its disposal. In this investigation we focus on the user phase, having the designer as an agent of culture change, in search of a more responsible behaviour from its users.

In this sense, we point out that design should act with the aim of creating ruptures, drawing strategies that break paradigms and create new quality criteria. Concepts such as *well-being*[1] and *quality of life*[2] are given new values, related to responsible production, the conscious use of resources and, especially, a decrease in consumption.

On the problem of food waste, we see compelling statistics that call attention to the need for action at the consumer scale. The UNEP (United Nations Environment Program) (2021) has estimated that in 2019, around 931 million tonnes of food was wasted, with

[1] The Oxford Learner's Dictionary defines *well-being* as "general health and happiness".
[2] The Oxford Learner's Dictionary defines *quality of life* as "the level of health, comfort and happiness that a particular person or group has".

61% of this number originates in the domestic environment. This means that approximately 17% of all the food that was produced in the world this year was wasted (of which 11% in the domestic environment). In Portugal, the same report estimated that around 84kg per person per year is wasted on the domestic scale.

Despite these alarming numbers, there is great difficulty in measuring data and understanding the dimensions of the problem. UNEP (2021) states that the amount of data currently available is low, and measurement methods vary, making it difficult to produce consistent results.

The factors that relate to food waste are very diverse, so that the difficulties are intertwined, and the result is a scenario of difficult action. They are related both to the internal context, which is the kitchen structure and the food storage conditions, and the external context, such as the existing commercial infrastructure, and socio-cultural factors that directly influence the families' eating routines.

We have found in the literature review some references to projects created to reduce food waste. They involve, above all, public policies of consumer awareness and education, in addition to the creation of equipment (mainly refrigerators) that help in the management and storage of food. In this research we sought to understand the strategies used in these projects and, based on this review, we propose alternatives to be applied in the domestic environment where food is located – the kitchen.

We consider that the space configuration is extremely important, since we spend most of our lives in indoor environments and these directly influence the activities, we perform in them. For Sommer (1969), the shape of the space should not only follow the function, but also support it in every possible way. In other words, it is necessary to create spaces that help and, at the same time, encourage habits.

Finally, we selected strategies and outlined principles that guide the creation of design projects for sustainable behaviour change. These strategies involve the provision of information to the consumer, encouraging responsible choices, directing behaviour by creating constraints and stimuli, using technology for innovation and intelligent design that steers the user.

General research question

Given the above, we present the general question of this research:

- H*ow can the design of domestic kitchens help the user to decrease his food waste?*

It is necessary to understand the factors that involve behaviours related to sustainability and food waste. There is a gap between the knowledge about sustainability and sustainable behaviour itself. Therefore, we sought, through literature analysis, to understand how it is possible to create projects that are more responsible and that encourage the user, beyond the awareness process.

In this sense, we tried to understand the concept of sustainability and what is the meaning of sustainable development from the designer's point of view. Besides emphasizing the responsibility of the professional's choices, we sought to guide him/her in the difficult task of putting into practice the knowledge acquired in the academy about the theme.

Furthermore, we intended to explore the difficulties that lead users to waste food, besides the socio-cultural factors that influence these habits. We had the need to define which of them are more relevant to the target audience of this research, which are the Portuguese people, and which of them can be improved, in the context of space design.

Finally, we sought to understand how the kitchen space is inserted in the users' everyday life and how its design can acquire new characteristics. During years of studying the space, rules and parameters have been established to guarantee the comfort and efficiency of the kitchen as a "laboratory" of domestic life. It is necessary to go further, to update these parameters considering the new dynamics of everyday life, using technology as a support tool integrated into a system that makes sense with more responsible food handling and consumption practices.

Objectives

Following the above, we present the *main objective* of this research:

- *Definition of guidelines addressed to professionals for domestic kitchen design, in order to decrease food waste.*

Therefore, we can establish the following *specific objectives*:

- *To comprehend how design can act in a more sustainable way, helping to combat the problem of food waste;*
- *To explore the existing solutions in the design field for the reduction of food waste.*
- *To understand which strategies from design for behaviour change and design for food waste reduction can be implemented in the context of kitchen design;*
- *To comprehend in which phases of the kitchen project it is possible to act, defining which parameters and design rules can be influenced by strategies that seek to reduce food waste;*
- *To understand the acceptance of professionals in the area, seeking to comprehend to what extent the strategies defined are applicable and constitute a gain in their daily lives;*
- *To make a design proposal as a possibility to apply the strategies and principles established during this investigation.*

Theoretical framework and methodological procedure

To answer the research question and achieve the objectives set out, we sought to establish the theoretical framework that grounded the main concepts studied and defined our research methodology.

To understand the concept of sustainability, considering its historical evolution and its scope for an analysis of the principles and premises in a broad sense and also in the scope of design, we resorted to authors such as Dresner (2012), McLennan (2004), Walker (2012), Manzini (2015), Manzini and Vezolli (2002).

In addition, we found in Papanek (1971) a basis for a critical view of design and its responsibility to society. Similarly, we saw in Walker (2012), Manzini (2015) and Manzini and Vezolli (2002) the search for new concepts in material culture, the search for a deconfiguration of consumer culture and the creation of new values and qualities for products.

Thinking about strategies aimed at professional practice, we consulted the work of Vicente (2012). We also consulted authors who work specifically with interior design, exploring the difficulties of applying sustainability concepts in everyday professional

practice, such as Stieg (2006), Maté (2006) Bacon (2011), Aktas (2013) and Hayles (2015),

We relied on reports prepared by the United Nations (UN) to understand the data related to the issue of sustainability, more specifically food waste. Moreover, we found in the Sustainable Development Goals to 2030 (SDG 2030) a demonstration of the need to study the issue of waste that is related both to fighting hunger and to the search for a better use of natural resources.

Regarding food waste, we consulted research that sought to systematize the multiplicity of influences related to it in the domestic environment. In addition, we looked for references that analysed existing solutions and proposed new ones. In this context, we highlight works such as that of Aschmann-Witzel, Giménez, and Ares (2019); Doberning and Schanes (2019); Bravi, Francioni, Murmura, and Savelli (2020); Davenport, Qi, and Roe (2019), de Waal, van Daalen, Luning, and Steenbekkers (2020); Farr-Wharton, Choi, and Foth (2014); Hebrok and Boks (2017); and Hebrok and Heidenstrøm (2019).

In Portugal, we found in the work of Baptista, Campos, Pires and Vaz (2012) extensive research regarding food waste numbers in the country. In addition to having a broader view of the problem, we were able to identify what type of food is most wasted and what are the main difficulties of consumers in this scenario.

On the study of design for behaviour change, we consulted the Theory of Planned Behaviour (TPB) model by Ajzen (1991) with the aim of structuring the antecedents of behavioural intentions. TPB was used as a theoretical framework basis in other works investigating sustainable choices, such as e Lee, Allen and Kim (2013) and Du Toit, Wagner and Fletcher (2017).

Another important reference used as a framework for the strategies of this research is the *nudging*, found in the work of Thaler and Sunstein (2008) and analysed by Lehner, Mont and Heinshkanen (2016). Likewise, in the work of Bhamra, Liley and Tang (2011), we highlighted strategies targeted at product design for sustainable behaviour.

For a characterization of the kitchen environment, seeking its historical evolution and the relationships of the space with the family's daily life we resorted to Baden-Powell (2006), Rybczynski (1987), Bell and Kaye (2002), Bech-Danielsen (2012), Shove, Watson, Hand and Ingram (2007), Freeman (2004) and Cieraad (2002).

Looking more specifically at kitchen design and its specificities, we investigated the work of Baden-Powell (2006), in addition to the works of Beamish, Parrott, Emmel and Peterson (2013); Schneiderman (2010); Panero, Slenik and Castán (1996); and Neufert and Neff (1999). Moreover, we found important definitions regarding the system of division and organization of space in Dynamic Space, developed by Blum.

Based on the above-mentioned theoretical framework, it was possible to systematize the strategies and principles that contribute to the problem of this research and that may be useful to professionals in the field of space design.

The next step was to evaluate these strategies by consulting experts in the field. This evaluation was done with the help of an online questionnaire, divided into three parts. The first one consisted in drawing the respondent's socio-demographic profile. The second part was structured based on the User Experience Questionnaire (UEQ), which uses a 7-point semantic differential scale to assess the qualities of each of the strategies as a product. Finally, the third was composed of questions that sought to evaluate the strategies as a set, seeking to understand how their applicability occurs in the professional environment.

Finally, we aimed to present our interpretation of the guidelines through the design of a kitchen model. We assumed as target audience a family composed of a young couple with one child[3]. This project symbolises our own evaluation of the outcome of this research, which could also serve as an as inspiration for new solutions and future investigations.

Themes and chapter contents

In *Chapter 1* we start by defining concepts related to sustainability and present the debate around the term sustainable development. We aim to understand how the problem of food waste fits into the context of overexploitation of natural resources and the consequent search for solutions that ensure the maintenance of development, within the current logic of the capitalist production system. In addition, we point out the

[3] We assume this family as target audience because, according to the INE (National Statistics Institute), in 2020 the most common type of household in the country were couples with children (35.2% of all families) and the Portuguese fertility rate was 1.41.

current state of the problem, what are the numbers that demonstrate its relevance and what are the challenges for action on a domestic scale.

In *Chapter 2* we address the existing strategies and principles in the literature on design for sustainable behaviour. We present strategies that assist the professional in product and space design, as well as principles that guide the thinking in search of solutions that address the problem in a broad and integrated way. We intend to understand sustainable design with a focus on the approach of social change and innovation through the creation of a new material culture. Furthermore, we investigate how the design for behaviour change literature provides tools for action by understanding the factors that are related to these behaviours, searching for key antecedents and defining strategies already tested in other scenarios.

In *Chapter 3* we present a brief history of the evolution of the kitchen space, in the Western scenario, with the aim of understanding how the space relates to everyday family life and how it can be the stage for changes in habits on the consumer scale. We systematize the rules and parameters found in the literature, in order to structure design strategies that corroborate with qualities already largely explored in this environment, such as comfort based on anthropomorphic measures, work efficiency and the systematization of the different zones of use.

In *Chapter 4* we present the main outcome of this research, the guidelines, structured from the result of the reading and interpretation of the literature review carried out and presented in the previous chapters. They are divided into strategies, which are the potential paths to be followed, and their principles, which are potential means of implementing these paths in the professional context. In this chapter we also present the evaluation of these guidelines, carried out with specialists in the sector, which sought to validate our proposal and at the same time establish future paths for research.

Finally, in *Chapter 5*, we present a design of a model kitchen. It signifies our practical evaluation of the established guidelines and represents a possibility of their implementation in a professional context.

CHAPTER 1: Sustainability and food waste

1.1. Sustainability

1.1.1. Defining concepts

According to John F. McLennan (2004) the terms *sustainability* and *sustainable design* have been misused, as they are mostly misunderstood. The author states that many architects and designers say that their projects are sustainable just because they have chosen more responsible materials or have adopted clean energy, for example, but without understanding the real holistic meaning of sustainable design. These designs may be 'green', they may have less impact, but they are not truly sustainable. It must be understood that the design for sustainability approach means an interdisciplinary approach, based primarily on the balance between maximum performance of the project, minimizing or eliminating its impact on the environment and also considering the social and economic factors that surround it.

For Veiga (2019), there is no simple, precise or definitive answer to the question "What is sustainability?". The author points out that until the late 1970s the term was used mainly by scientific communities to refer to the resilience of ecosystems. From the 1980s it began to be used to qualify development and today it has come to serve those who express vague future ambitions of continuity and perennity. In addition, Veiga (2019) states that the term has come to be commonly used as an adjective of the term development because of the need to make human aspirations compatible with the need to conserve the ecosystems necessary for their very existence.

Walker (2012) characterises sustainable development as the myth of the 21st century, born out of a culture of science, technology, and reason. It is a philosophical view of the situation, something that permeates our thoughts, but that seems to be in fact unattainable. Something that moves people, just like religions. According to the author, sustainable development meets the criteria of myth because “(i)t offers an idea of completeness, a total vision. It has a recognizable beginning, identifiable founders and key texts, and it is spawning a burgeoning collection of narratives, terminologies and scenarios” (Walker, 2012, p. 26).

It should be noted that, by becoming a myth, sustainability would be in the thoughts of people and their rulers. This indicates a discontent with the present moment, a discomfort and the search for something that can be done. Walker (2012) tells us that we should not ask ourselves if it is possible to achieve it, but rather understand what the creation of this myth implies in the daily life of contemporary society. That is, that we should understand how the system adapts, or not, to the challenge of the century.

In this sense, Dresner (2012) points out that "(i)n recent years, faith in human beings' capacity to successfully master nature or even to collectively control our own destiny has been diminished" (p. 4). In other words, awareness of the limits of the Earth and the limit of our technological development is increasingly present, causing us to worry more actively about the future that awaits us.

McLennan (2004), on the other hand, states that, despite printing a moral code of responsibility and a proposal to guide a change of behaviour, sustainability is not, and should not be, understood as a religion, but as a philosophy. In his words, "it is a way of seeing the world through a particular thought pattern or doctrine" (McLennan, 2004, p. 36).

In Manzini and Vezzolli (2002), sustainable development is defined as the systemic conditions, according to which human activities can be carried out so as not to interfere with the planet's resilience and, at the same time, without depleting its natural capital.

Dresner (2012) agrees that sustainable development goes beyond the common sense of being a matter of prudence so that we do not destroy the basis of human life, being, above all, a matter of equality. According to the well-known Brundtland report (1987), made by the World Commission on Environment and Development (WCED), sustainable development is based on "the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (p.6). In addition, it must ensure not only "a new era of economic growth for nations in which the majority are poor, but an assurance that those poor get their fair share of the resources required to sustain that growth" (p.6). This means that there must be equality between generations and equality within generations. (Dresner, 2012)

Furthermore, it is worth noting that the concept of sustainable development, defined by the Bruntland report in 1987, is based on three pillars, considered as the main

foundations that should guide actions, policies and projects: economic growth, ecological balance and social progress (Valente Pereira, 2012). In this sense, Valente Pereira (2012) points out that it is necessary to understand it not only as an environmental issue of attention to the needs of future generations, but many other aspects such as the limit of resources, industrial development, social injustices and debts of poor countries.

Even so, one should consider that sustainability should be understood as an objective, as an end and not as a direction to be followed (Manzini & Vezzolli, 2002). In other words, it should not be a tool for maintaining the *status quo*, but the purpose that encourages changes for the sake of life on Earth.

When we talk about sustainable development, it is relevant to question what these two words represent. Dresner (2012) discusses the meaning of development: "(i)s it about economic growth and industrialization, as it is commonly seen, or is it about non-material improvement in life?" (p. 69) The author points out that, as early as 1960, we began to realize that the material wealth of a country did not mean quality of life and well-being for all, on the contrary, it often meant the impoverishment of some classes. It was at this moment that we began to think of new measurement criteria, and that equality was necessary to achieve well-being because "(o)nly in countries that took deliberate steps to promote equality through land reform and investment in mass education and health care was the condition of the poor improving" (Dresner, 2012, p. 75).

On the other hand, the word sustainability comes from "sustain", that is, to maintain. Originating from economics, the word represents the relationship between the use and availability of resources. It was created to understand that the Earth, as well as a company, will only be healthy when we have a positive balance, that is, when its resources are used in a balanced way, so that it is possible to assure future generations the same access to them. It is worth pointing out that these resources are not only environmental, but also social and economic. However, for McLennan (2004), the term is problematic since it does not portray the change that we need to make but rather the maintenance of the "*status quo*".

According to Dresner (2012), the two words are perceived by many as contradictory and with vague meaning, however, for some environmentalists this combination was "a

necessary price to pay to get the idea of sustainability into the political mainstream at all" (Dresner, 2012, p. 2). This is because the idea of environmental protection was originally thought of as a "bourgeois luxury", as an obstacle to the development of poorer countries. Nevertheless, it is the result of the search for a set of principles that should be applicable to all countries and that encompassed not only environmental issues, but also social and economic ones. To this day, this issue is a source of great debate, given the complexity of decision making between countries that industrialized at the expense of the uncontrolled use of natural resources, both domestic and foreign, and those who did not have the same opportunity and are today fighting for their population to have the same comforts arising from this industrialization.

Also, according to Dresner (2012), despite the somewhat vague meaning, the main problem of sustainable development is not the definition itself, but the difficulty we have to operate it. This difficulty results from the imbalance between two words that are in tension and seem to go in opposite directions: the social and the environmental. Moreover, we see that the great challenge is the change of social values, of consumption patterns. Walker (2012) reaffirms what we mentioned at the beginning of this text, that 'green' products are created, but, for most, the intention is still on increasing sales and profits and "(w)hether or not the product is capable of making a meaningful and responsible contribution to material culture is often not even a consideration" (p. 33).

1.1.2. Brief chronology and evolution of the concept

When we think of the beginning of sustainable thinking, under its environmental aspect, we identify that one of the pioneers in the field is the publication of Thoreau Walden, in 1854, which criticized the expansion of technologies of his time (Walker, 2012). Besides him, in 1890, John Muir identified the natural beauties of California and had as a great achievement the establishment of two natural parks, defended by the foundation of the Sierra Club, created two years later. (Dresner, 2012).

In 1952, the metaphor of "*Spaceship earth*" was first launched, used in a speech by the American presidential candidate Adlai Stevenson (Dresner, 2012). According to Dresner (2012), this metaphor has two different meanings: the first is about the limits of human activity and the second about the need for human management over the environment. We also find the concept also in R. Buckminster Fuller's work*, Operating Manual for*

Spaceship Earth, released in 1969. The author makes a call for a revolution in the realm of design to guide the world to a more sustainable future. According to Walker (2012), Buckminster Fuller was one of the first to propose the valorisation of the use of renewable energy in the industrial era and his ideas were a great source of inspiration for the generation of young people in the late 1960s and early 1970s. It is in this period that we can identify an expansion of the green movement.

McLennan (2004) questions the first meaning of the metaphor, related to the role of human beings as managers of the environment, by stating that one of the principles of the philosophy of sustainable design is respect for the wisdom of nature, which means understanding that human beings are part of it, neither more nor less important. We note that in more Western approaches this connection is somewhat forgotten. According to the author, nature has the power to teach us everything we need. For McLennan (2004), this idea is not new, since man has always observed nature and based most of his inventions on it, especially in engineering and medicine. According to him: "(a)lmost all of our knowledge of natural medicines began with ancient local sources of knowledge - knowledge which is now disappearing" (p. 42).

In 1962, we highlight the launch of the work of Rachel Carson, *Silent Spring*, whose proposal was to denounce the damage of various toxic substances and pesticides, to the human body and especially to other species. According to Dresner (2012), Carson was the first who criticized the technology that was created to improve human living conditions, but that actually had unexpected consequences. Furthermore, "Carson's challenge to pesticides was implicitly a challenge to science and the idea of technological progress" (Dresner, S. 2012, p. 23).

In the context of Design, the launch of the book *Design for the real world: Human ecology and social change* by Victor Papanek in 1971, draws attention to the role of the designer as a professional who makes choices, and how it can be a tool for social and environmental change. At that time the author already stated that, although ecological problems had been somewhat recognized during the 1960s, the technologies that would solve them proved to be only responsible for their masking and, consequently, intensifying them.

Another important mark in the sustainable movement, a result of this awareness of the finitude of the Earth, was the report *The Limits to Growth*, in 1972. This report,

formulated based on the Malthusian concept, would be the solution that would ensure quality of life to the population, based on the reduction of consumption and containment of population growth (Dresner, 2012).

Still in this context, in 1973, we identify in E.F. Schumacker's work *Small is Beautiful* concerns about pollution, the indiscriminate use of natural resources and the inequalities in the industrialisation process. Despite not being specifically from the area of design, the work has direct consequences for everyone related to the production chain, since the author challenges the system by proposing that production on a small scale, with more accessible technologies and the use of local labour, are more democratic and appropriate solutions on a global scale. His argument reinforces the concept that true sustainability is based on equality between different scenarios in the same country and between countries with different levels of development.

On a global scale, the UN conference held in Stockholm in 1972 is a reaction to *The Limits to Growth* and is the first that places environmental concerns on the world agenda. Environmental issues began to be discussed on an international level, since their consequences do not respect the territorial limits demarcated by borders. Meanwhile, the conceptualization of the term sustainable development was first pointed out in the Brundtland Commission report, in 1987. According to Dresner (2012) the report was left with the difficult task of making sustainable development politically acceptable. This meant the search for reconciliation between environmental protection and the desire for economic development.

The direct result of the Brundtland report, besides the strengthening of environmental concern in the global context, is the United Nations Conference on Environment and Development (UNCED), also known as ECO-92. The conference is also held as a reaction to the 1990 Intergovernmental Panel on Climate Change (IPCC) report, according to which "a 60 per cent reduction in carbon dioxide emissions from present levels would be needed to stabilize the climate and prevent levels building up in the atmosphere indefinitely" (Dresner, 2012, p. 42). Moreover, one of the main outcomes of ECO-92 was the advent of the United Nations Framework Convention on Climate Change (UNFCCC).

Since 1995, the parties to the UNFCCC meet annually at the Conferences of the Parties (COP) to advance cooperation and commitments to address the causes and effects of climate change. Significant advances have been achieved since the first COP, among

which we highlight the Kyoto Protocol of 1997 and the Paris Agreement of 2015. However, the IPCC has continued to release reports in which it warns about the insufficiency of the measures adopted by all countries to avoid the worst-case scenarios.

In a more recent context, we highlight in 2015 the definition of the 17 Sustainable Development Goals in Agenda 2030 (Fig. 1). According to the UN (n.d.) they are an enhancement of the 8 Sustainable Millennium Development Goals, established between 2000 and 2015. They aim to address the various dimensions of sustainable development (economic, social and environmental), in addition to promoting peace, justice and efficient management institutions. They are a call to action to promote equality by protecting the planet to ensure that by 2030 people enjoy peace and prosperity.

Figure 1

Sustainable Development Goals

Note. Diagram showing the goals for sustainable development, highlighting goals 2 and 12. Adapted from: Sustainable Developmento Goals, by U.N. n.d. *(https://www.un.org/sustainabledevelopment/blog/2016/07/17goals17days-progress-made-on-sustainable-development-goals).*

As mentioned above, in this research we sought to combat food waste on a domestic scale, facilitating access to information and supporting more sustainable practices in the context of kitchens. By thinking of alternatives that help consumers in the more

conscious management of food, we corroborate directly with two of the goals established in 2015, goal 2, *Zero Hunger*, and goal 12, *Responsible Consumption and Production*.

In goal 2, *Zero Hunger*, we can observe, among the various actions proposed, the main purpose of strengthening and qualifying food production, especially on a small scale and by the most sensitive producers, such as women, indigenous peoples and other traditional communities. Based on this strengthening, we identify the proposal to improve the distribution network, so that food is accessible to all, to eradicate hunger and malnutrition.

In goal 12, *Responsible Consumption and Production*, the main objective is sustainable management and efficient use of natural resources. As already mentioned, the food waste means the waste of valuable natural resources such as land, water, and energy. Therefore, one of the targets defined in this goal refers precisely to the issue of this research: "(b)y 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses" (FAO, 2021b). Moreover, by reducing food waste we also collaborate with reducing waste generation and raising awareness among the population towards healthier lifestyles that are more harmonious with nature.

According to the Sustainable Development Report 2020, produced by the United Nations (UN), Portugal is in 25th position among the most sustainable countries in the world. The country has been fulfilling the seventh SDG, related to renewable and accessible energies, and has been facing major challenges in goals 2 (*Zero Hunger*), 13 (*Climate Action*) and 14 (*Life Below Water*).

1.2. Food Waste

In the context of this research, it is important to define the concepts of waste and loss, from the food perspective. The FAO (Food and Agriculture Organization of the United Nations) defines waste as "the decrease in the quantity or quality of food resulting from decisions and actions by retailers, food service providers and consumers" (FAO, 2021a). In this case, food is defined as "any substance - whether processed, semi-processed or raw - that is intended for human consumption" (UNEP, 2021, p. 9). The concept of waste

corresponds to "a natural by-product of the production and industrial systems' inefficiencies"[4] (Baptista et. al, 2012, p. 26).

In a report published in 2021, the United Nations Programme (UNEP), in partnership with WRAP (The Waste and Resources Action Programme), estimated that about 931 million tons of food were wasted in the year 2019, 61% originating from the domestic scale, 24% from food services and 13% from food retail. This figure symbolises that about 17% of all food produced in the world must have been wasted. Furthermore, it reinforces the importance of actions focused on the domestic environment, since "it is in the familial environment that food waste proves to be high*er*"[5] (Baptista et. al, 2012, p.42).

About greenhouse gas emissions, in 2013 the FAO estimated that the carbon emissions resulting from the production of food that is not consumed on a global scale was 3.3 Gt of CO2. This means that food waste, if it were a country, would be third in the ranking of major emitters, second only to the United States and China.

In Figure 2 we can see that the average amount wasted on a domestic scale, per year, in countries with high purchasing power is about 79 kg per person. Furthermore, the data demonstrate one of the main findings of the report which is that, contrary to what previous studies suggested, household scale waste in countries with different economic levels has similar values. This suggests that the need for action at the consumer scale is equally relevant in these different contexts.

[4] Excerpt translated by the author from the original *"(...) um resultado natural de ineficiências dos sistemas produtivo e industrial."*

[5] Excerpt translated by the author from the original *"(...) é nas famílias que o desperdício alimentar se revela mais elevado."*

Figure 2

Average food waste (kg/capita/year) by World Bank income classification, average confidence medium and high for countries.

Income group	Average food waste (kg/ capita/ year)		
	Household	Food service	Retail
High-income countries	79	26	13
Upper middle -income countries	76	Insufficient data	
Lower middle -income countries	91	Insufficient data	
Low income countries	Insufficient data		

Note. Table showing Average food waste, with emphasis on the household numbers. Adapted from "Food Waste Index Report 2021," by UNEP, 2021 (p. 8)

In a complementary way, Ponis, Papanikolaou, Katimertzoglou, Ntalla & Xenos (2017) demonstrated that food waste impacts the entire production and distribution chain, i.e., it means waste of land, energy and water. This shows us that better management of production and consumption has major positive impacts on the fight against climate change and maintaining people's quality of life, as "(f)ood waste means all of the environmental impacts of food production without any of the benefits of people being fed" (UNEP, 2021, p.92). Moreover, this interconnection between various sectors of a long chain demonstrates the difficulty of understanding the scale of the problem from end-to-end, and therefore, of proposing multilevel solutions.

In addition, the waste still results in a decrease in food availability and in the increase in the price of healthy food for many people, both in rich and poorer countries, which directly impacts on the growth of obesity levels and related diseases (Ponis et al, 2017). This is because food systems, due to their current configuration, which promotes intensive agriculture, low price in the final product, animal protein production and massive transportation by land, sea, and air, favours the existence of foods with several artificially added preservatives and low weight. These specificities end up originating processed foods, often with high energy value and low nutritional value, produced at low cost.

Several studies have been conducted to investigate behaviours related to food waste on the household scale, since consumers are, currently, the biggest contributors to the

problem (Visschers, Wickli & Siegrist, 2016). It is, therefore, still necessary to understand factors such as what and in what quantity we waste, why we waste and what difficulties consumers encounter to reverse the situation.

Aschemann-Witzel, Giménez and Ares (2019). point out that consumers play a crucial role in waste, not only in their homes or in the choices they make at the time of purchase, but also directly influence the decisions of stakeholders throughout the food production chain. This relates to the purchasing and product selection criteria, dictating which products will be available for sale, and those that, despite being perfect for consumption, will be discarded. It is also worth mentioning that actions in the opposite direction are equally relevant. Aschemann-Witzel, De Hooge, Amani, Bech-Larsen and Oostindjer (2015) have identified that a synergy between the actions of governments, stakeholders and retailers are very promising.

Moreover, the complexity of the issue shows us the need for studies in the area that help to understand it comprehensively and in the search for long-term solutions that represent significant changes in behaviour (Ponis et al., 2017).

In Portugal, the main reference when talking about the measurement of food waste is the study conducted in 2012 by Baptista and colleagues. The results of the mentioned research point out that about 17% of edible food produced for human consumption is wasted every year. Of this total, it was estimated that about 324 thousand tonnes are wasted on the household scale, which represents 32kg per person per year (see Fig. 3).

Figure 3:

Annual food losses in the supply chain in Portugal

Note. Diagram showing food losses numbers in Portugal, with emphasis on the household numbers. Adapted from "Do campo ao garfo Desperdício Alimentar em Portugal " by Baptista et al. . *Lisboa: Cestras.* ISBN: 978-989-20-3438-6. (p. 24.)

In the UNEP report (2021), developed in a more recent context, waste on the household scale in Portugal was estimated to be 84kg per year per person, a figure much higher than the one obtained by Baptista and collaborators in 2012. It is important to mention that one of the main findings of the report is that food waste was being significantly underestimated in different countries. This can be explained by the fact that in most countries data is scarce, unreliable and uses different measurement methodologies. In the case of Portugal, the country fits in the study in the group in which there was not yet sufficient data on the subject and, therefore, had its number estimated from an extrapolation of data from other countries with similar income and cultural characteristics. According to the report itself, this number is, therefore, only a reference to support actions to combat the problem, while there is no more concrete data.

1.2.1. Why and what do we waste?

Understanding why people waste food is a complex task. Behaviours related to food waste vary between the stages of food handling, purchase and use, in addition to very specific situations of the individual and the environment in which he/she is. (Aschmann-Witzel, Giménez & Ares, 2019) In other words, wasting is a moment resulting from multiple other practices, which happen inside and outside the home environment. (Ganglbauer, Fitzpatrick & Comber , 2013).

Food waste can occur at different times and for different reasons. In general, FAO (2021a) points out three main ones which are (i) the deviation of the food from the standard considered optimal (in terms of shape, size and colour, for example), which leads it to be removed from the consumption chain or neglected by consumers; (ii) the approaching of the "best-before" date which causes food to be discarded often without apparent need; and (iii) large quantities of food that are not used and are thrown away by consumers in household kitchens or commercial establishments.

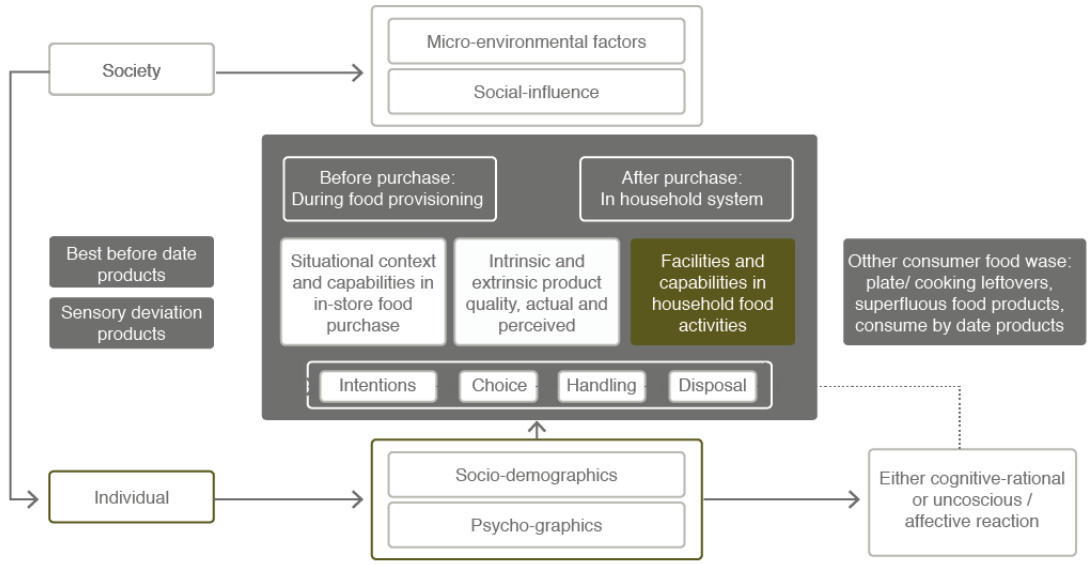
In Portugal, when it comes to food waste, there are several causes, including overcooking, lack of purchase planning, difficulty in managing food stocks and lack of technical knowledge. In short, they are direct causes of actions related to planning,

purchasing, storage and consumption, in addition to routines and lifestyles (Baptista et al, 2012).

In Aschmen-Witzel and collaborators (2015) we found a model (Fig. 4) that summarizes the multiplicity of influences on waste, focused on the consumer, catalogued from the literature review. The authors divide them into two major groups: the social and the individual influences. In the first group, there are those related to the macro-environmental and social conditions. In the second, we find those related to socio-demographic and psychographic conditions. In the middle, we can identify the set of factors which are the result of a cross between this diversity of influences and relate to the moment of pre and post purchase of food. This research focused on "*Facilities and capabilities in household food activities*" and demonstrated that understanding the user and their habits, especially those related to the factors presented in the model, is essential.

Figure 4:

Model of the factors of influence on consumer-related food waste.



Note. Diagram showing model of the factors of influence on consumer related food waste. From "Consumer-related food waste: Causes and potential for action." by Aschemann-Witzel et. al, 2015, In Sustainability,7(6), (p. 6461)

In addition, Doberning and Schanes (2019) reinforce the importance of action focused on "*Facilities and capabilities in household food activities*". The authors point out that the infrastructure of the home, which dictates the strategies of storage routines, can prolong the durability and freshness of food, avoiding waste. This infrastructure should be understood by space and storage conditions, structure for preparation, as well as technological equipment.

About the socio-demographic influences, cited by Aschmen-Witzel and collaborators (2015), we can state that the country of origin of consumers is a determining factor in food management, since the characteristic cultural aspects of each social group have a direct influence on their eating habits (Bravi, Francioni, Murmura, & Savelli, 2020). These influences are mainly "in terms of what they eat, where they eat, and how food purchases are planned" (Bravi, et. al, 2020, p.8). Therefore, the authors point out that countries with closer cultural characteristics, such as the Mediterranean countries, may have greater similarities on the issue of waste.

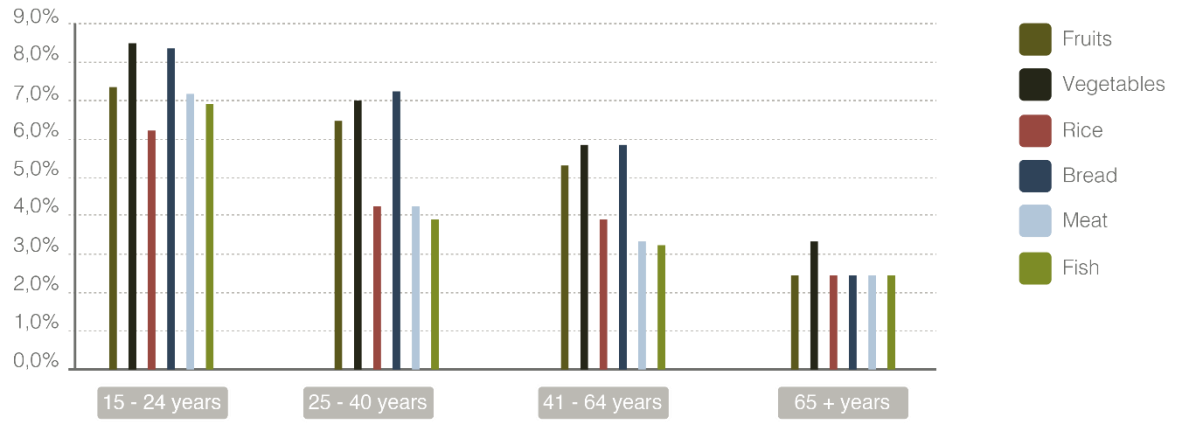
Still on the influence of the socio-demographic profile, in Portugal for example, the research results of Baptista and colleagues (2012) indicated that families with children tend to waste more. The main problem pointed out by the respondents was the difficulty in predicting children's appetite and, therefore, in adequately planning meals. The authors point out that, possibly, this waste is also related to "*time availability and/or with greater cooking skills*[6]" (p. 47) that increase as consumers age.

In Figure 5, produced by Baptista and collaborators (2012), we observe that the food waste figures by sector for the Portuguese scenario are higher in the younger age group (between 15 and 24 years). In addition, it can be observed that it is mainly present in the fruit, vegetables, and bread sector.

[6] Translated by the author: “disponibilidade de tempo e/ou com maiores competências de cozinha”

Figure 5

Reported food waste in Portuguese households by age.



Note. Graph showing food waste by food group, by age. Adapted from "Do campo ao garfo Desperdício Alimentar em Portugal " by Baptista et al. . Lisboa: Cestras. ISBN: 978-989-20-3438-6. (p. 45.)

We emphasise that, in the Portuguese context, the high wastage of fruit and vegetables is relevant information since these foods are very present in their eating habits. According to Graça (2020), until the mid-twentieth century the Portuguese cuisine was primarily plant-based, just like the great food culture of Southern Europe, consumption pattern that continues to the present day. Such products usually require good handling by the domestic consumer, as well as technique and creativity for their correct preparation. Still according to the author, the great use of vegetables combined with cereals, legumes and tubers result in the most iconic dish of what the Portuguese eat: the soup. Graça (2020) points out that the current average consumption of soup is 154g per inhabitant per day and the strong presence of vegetables is still a reality in everyday life, with people consuming on average 153g of vegetables and 131g of fruit per inhabitant per day. When compared to other European Union countries in a survey conducted by Eurostat in 2019, Portugal has 14.4% of inhabitants who consume 5 or more servings of vegetables and fruit per day, which places the country in seventh position in the study.

This shows that, despite being a sector of great consumption by the Portuguese, fruits and vegetables, along with breads, are the foods that are currently the most wasted, as shown Baptista and collaborators (Fig. 5). This is possibly because they are the most perishable, and, therefore, more susceptible to factors such as forgetfulness, storage

problems and cooking difficulties. According to Graça (2020) the technical knowledge on how to make use of food and how to transform it into nutritious meals is an ancestral knowledge. It involves not only how to prepare the food, but also its proper storage, as well as the correct evaluation of what should be consumed and what should be discarded. The author points out that this knowledge has been lost since the 1960s, when women, its traditional holders, have grown older or started to enter the labour market. The result is not only a decrease in the quality of Portuguese food, but also possibly in the increase in food waste.

As an example of the macro-environmental influences, pointed out by Aschmen-Witzel and collaborators (2015), we cite the geographical context in which the consumer lives. Doberning and Schanes (2019) point out that the accessibility and density of commercial infrastructure close to the home can impact not only on shopping frequency, but also on food planning and storage.

We see an example of social influences in the issue of awareness about food waste and the importance given to this problem. Many consumers are aware of it; however, they cannot understand what the scale of the environmental impact is, nor what their individual role is in this scale (Dobernig & Schanes, 2019). The difficulty of studying the problem comprises the different measurement methodologies, in addition to the difficulty of the consumer himself who has different impressions of consumption from what actually occurs in his daily life. The study of Davenport, Qi and Roe (2019), for example, found "evidence of systematic bias in self-reported expectations of food consumption, supporting the use of actual utilization as an indicator of food waste outcomes" (p. 12).

In Farr-Wharton, Choi and Foth (2014) we can see a more pragmatic presentation of the factors that lead to food waste and have a clue about possible courses of action. According to the authors, the three main ones are:

> "(i) Transparency (an individuals' forgetfulness or memory concerning the food they have placed in or taken out of the fridge / freezer / pantry); (ii) Awareness of available foods (an individuals' knowledge of food items available in the fridge / freezer / pantry for consumption); (and) (iii) Misled / incorrect tacit knowledge (the tacit knowledge of an individual who knows if a product with or without an expiry date is edible or not by the use of sight, smell and / or touch)" (p. 120).

Besides these, two other minority factors are identified:

> (i) "Unplanned events ('spur-of-the-moment' situations that led to a cancellation of a previously planned consumption of food that was purchased for that specific meal); and (ii) No desire to consume leftover food (a person having cooked a large meal with the intentional goal for the meal to last several consecutive mealtimes, but does not resume" (p. 120).

Similarly, the study conducted by Baptista and colleagues (2012) identified the aspect related to *Transparency and Awareness* of available foods, which is the dual role of the refrigerator and the freezer. Consumers reported that, if on the one hand these types of equipment help preserve food, on the other hand they collaborate so that these foods are forgotten for long periods.

It is also at the time of planning the purchases that it is determined whether that food will be consumed or not. The difficulty in planning is related both to the factor "*Unplanned events*" and "*No desire to consume leftover food*". People tend to buy more food than necessary and therefore cannot predict the use of all the food that is stored. Dobernig and Schanes (2019) state that most consumers connect food waste to routine shopping practices, such as "*buying too much"* or "*buying more than we need*". According to de Waal, van Daalen, Luning and Steenbekkers (2020) food, stored for long periods, is often forgotten, which results in waste.

Still on the issue of planning, Hebrok and Heidenstrøm (2019) state that, the general conclusion from the literature is that consumers are not planning enough. However, the authors have found that the key to avoiding waste lies in the consumer's flexibility rather than the meticulousness of their planning. Contrary to the traditional recommendation to plan weekly, the authors state that the ideal organization time is between 2 and 3 days. Thus, it is possible to avoid unexpected events throughout the week and consumers can use all the food they buy without having to make a weekly planning very close to reality. This optimal shopping frequency reinforces the importance of the existing commercial infrastructure around the household, pointed out by Dobernig and Schanes (2019).

In the Portuguese context, a study conducted in the metropolitan area of Porto (Portugal, Freitas, Cunha & Rocha, 2020) showed that most of the respondents reported a high level of purchase planning, as well as a positive attitude towards purchasing,

consumption and waste management. This indicates a particular concern on the part of consumers regarding food waste and its impact on the environment.

Davenport and colleagues (2019) also explore the factor "*Misled / incorrect tacit knowledge*" and reinforce its importance in the consumer decision process of food storage or disposal. The authors investigated the US population to understand the relationship between various food qualities (e.g. price, smell, among others), the relationship between household routines and the decision-making process, and the relationship between product characteristics and how they are used. The results show that "considerations relating to food safety and food quality are among the most important to respondents when deciding to keep or discard food" (Davenport et al, 2019, p.8) and that "consumers are primarily concerned with physical, followed by institutional, signals of food safety and quality when deciding whether to discard food" (Davenport et al, 2019, p.12).

Finally, we add a very recent factor, still little explored, the COVID-19 pandemic that impacted the routine of consumers worldwide, starting in the year 2020. According to Galanakis (2020) this context has led to new challenges for academia, brought new perspectives and introduced new tools to reduce waste.

In a report published in 2020(a), prepared by Kantar, two trends were observed in relation to food consumption: (i) the growth of delivery and take-away; (ii) and the increase in the number of meals made at home. In the case of Portugal, another study (Kantar, 2020 (b)) showed that there was a 23% drop in out-of-home food consumption between January to August 2020, if compared to the previous year. In addition, there was a 3% growth in in-home consumption (delivery and take-away). These figures can be explained by the large increase in teleworking during the lockdown period. According to Eurofund (2020) it was estimated that about 39,6% of paid work in the European Union was done at home in the first period of social distancing imposed as an action to confront the pandemic.

Another relevant study regarding the effects of COVID-19 on food waste is that of Jribi, Ismail, Doggui and Debbabi (2020) who conducted an online survey during the first two weeks of lockdown in the year 2020. The study, which collected demographic and behavioural data regarding wastage, revealed that 93% of the respondents had their wastage levels impacted by the pandemic. In addition, the study identified that the

lockdown has caused people to improve their shopping habits and most consumers have outlined strategies to save, store and consume leftover food. It is important to point out that this change in behaviour did not occur for environmental reasons, but rather for reasons such as restrictions on movement, reduced availability of food, economic insecurity and most likely the predictability of the quarantined family's routine.

In summary, the main conclusion is that the crisis made people adopt a more sustainable behaviour towards food waste. This change is not surprising, since "(the) fear of disease and that of food scarcity are two of the most powerful behaviour modifiers in humans"[7] (Graça, 2020, p. 44). The challenge lies in how to maintain these habits in the normal family routine, which is usually less predictable and more complex. Jribi and collaborators (2020) point out that to maintain these positive behaviours, it is necessary to encourage prevention, education and communication campaigns, in addition to providing consumers with tools and skills to deal with their food activities.

Furthermore, it is relevant to note that, according to the UN's Sustainable Development Report (2020), *Objective 2* (Zero Hunger), mentioned above, was impacted very negatively by COVID-19. This is because insecurity has increased in relation to the food distribution network, while hunger has increased due to the decrease in family incomes and, mainly, there has been an increase in food loss and waste due to transport challenges and reduced availability of labour.

Therefore, we highlight that it is impossible to discuss food waste without understanding the reality of the consumer, both in the internal dynamics of the household and in the external ones. This reality is composed of social factors, like the composition and organization of the space where they live, the available technologies, the food infrastructure network that surrounds them and, above all, their eating habits. (Doberning & Schanes, 2019).

1.3. Conclusive summary

Sustainability should be understood as a broad term, it can be comprehended as a philosophy (McLenann, 2004) that is based on three pillars: environmental, social and

[7] Translated by the author from the original: "(o) *receio da doença e o da escassez de alimentos são dois dos mais poderosos modificadores de comportamentos nos seres humanos*"

economic. Thinking about solutions that are more responsible and with less impact involves thinking about protecting the environment, considering economic viability and, above all, combating social injustice and ensuring equity.

We have seen, over the years, long discussions involving the real meaning of this term, which started to be debated by several actors and scientists, among them we highlight Rachel Carson (1962) that showed us that the technological revolution could have a negative side and that it was necessary to pay attention to its impact on the human body and on other species.

Since then, we have become increasingly aware of the limits of the Earth and, consequently, the limits of our economic growth. We try to understand that human beings are part of nature and that, therefore, they should have responsibilities about their actions. In this sense, Papanek (1971) demonstrates how the designer has a fundamental role as a professional who is able to guide choices and question what is produced.

Thus, one should not think about design without taking into account at least one aspect of sustainability, whether in the choice of materials, in the choice of energy production or in the use of labour, for example. The great difficulty lies in being able to widely approach these aspects and, above all, the main one, which is the real change in material culture. That is, to think about how to create new concepts of well-being, new senses of comfort and how to bring happiness to a population that should consume only 10% of what we consume today.

The very term *sustainable development* was created as a search for conciliation, a balance between the economic, the social and the environmental aspects. In other words, a way for us to protect the environment, guaranteeing today's natural resources for future generations, but also prosperity and development for today's society and businesses, along with the improvement of quality of life to everyone. However, today we are aware that it is impossible to maintain the system in the current production and consumption patterns. It is necessary to think of alternatives that reduce the use of our resources, increase our efficiency, and bring new meaning to our real needs.

Thinking about the problem that is the focus of our investigation, it is also important to remember that, according to recent studies mentioned, the consumer has a relevant role in the food waste figures. The highest percentage of loss in the chain is found precisely in

the consumption phase, which demonstrates the need for action in this segment. The great challenge lies in understanding the origin of the problem, in the difficult access and measurement of data related to daily habits and in proposing solutions that can be supported by technology and, at the same time, incorporate socio-cultural diversities.

Among the multiplicity of factors related to food waste and consumer difficulties, we selected those that relate more directly to the domestic environment, more specifically the kitchen environment. They are:

- Inadequate conditions (temperature, lighting, ventilation and humidity) of the structure available for food storage;
- Lack of visibility of stored food (in the refrigerator, freezer and cupboard);
- Difficulty in managing the food storage: lack of communication between the different family members, lack of space organization;
- Lack of knowledge regarding the ideal storage condition for each type of food;
- Lack of knowledge regarding food preparation;
- Lack of knowledge on how to measure the correct amount of food to avoid the accumulation of leftovers;
- Difficulty in using technological equipment to support daily practices;
- Lack of connection to the food production cycle, the value of the product and understanding it as an organic being; and
- Lack of knowledge regarding the individual impact on food waste and the actual figures for own consumption.

In addition, we also highlight some specificities of the target audience of this research, which takes place in the Portuguese scenario:

- Food waste in Portugal is concentrated in the food group of fruits, vegetables and bread, with the meat and fish group also being higher in the younger public.
- The main audience for action to combat waste in Portugal is made up of young people (between 15 and 24 years old) and couples with small children.

CHAPTER 2: Design for food waste reduction

After briefly presenting and analysing the problem of this research in the previous chapter, we seek in this chapter to present what are the main strategies related to the sustainable design project. In addition, we analyse the design tools for behaviour change found in the literature, focusing both on sustainable behaviour and on the reduction of food waste itself.

2.1. Design for sustainability

2.1.1. Action strategies

A truly sustainable society would have to live with 10% of the resources that are consumed today (Manzini & Vezolli, 2002). This means that there needs to be a real revolution in our choices and habits. The above-mentioned authors approach the subject under a more realistic perspective, arguing that we need to reflect on design for sustainability; i.e., one that can "promote the capacity of the productive system to meet the social demand for welfare using a quantity of environmental resources drastically lower than the levels currently practiced" (Manzini & Vezzoli, 2002, p. 21).

Furthermore, it is essential to think of projects that are, above all, of quality and with better performance. For McLenann (2004), the idea that being sustainable means reducing comfort and well-being is wrong, because, in fact, sustainable design should be, overall, beneficial to people. The author understands that it is necessary to find a balance, to ensure maximum comfort with minimum impact.

In his work, McLennan (2004) works mainly on sustainability in design and architecture and defines six principles that guide this philosophy, focusing mainly on its environmental aspect. According to the author, these principles, identified by several groups of researchers, are the true wisdom of sustainable design. They are:

a. *Respect for the Wisdom of Natural Systems – The Biomimicry Principle*

It is the idea that the human being should understand himself as part of nature and not superior to it. Our machines should not replace natural elements but mimic them. We must respect the wisdom of nature and use it as a great tool of knowledge.

b. Respect for People – The Human Vitality Principle

We design essentially for people and our environmental concern should not be against them. If we care about protecting the environment it is because we care about future generations. In addition, design should always think about the quality of life of the user, about how they take ownership of that project and how it remains appropriate to their needs for as long as possible. Sustainable design "is about honouring diversity in individuals and giving control back to people for their environments and personal comfort" (McLennan, 2004, p. 46).

c. Respect for Place – The Ecosystem / Bioregion Principle

We need to rescue the respect for place, for the knowledge and traditions developed throughout our history. The author deals with the valorisation of traditional methods, mainly in the construction field, which are adapted to the environmental conditions of where the project is designed, and which encourage the consumption of local labour and materials. McLennan (2004) points out that this is not a matter of romanticism, of going back to the past, but of rescuing and valuing unique characteristics, which can (and should) be protected by the project.

d. Respect for the Cycle of Life – The "Seven Generations" Principle

It means understanding that we are part of the cycle of nature and that we have responsibility, since all things have continuity. In nature there is no such thing as waste, "(n)othing is ever wasted but becomes a key part for another organism or another system. One animal's waste is another's food" (McLennan, 2004, p. 64). The designer needs to think about the life cycle of his product, to think about all phases, from production to the end of life. McLennan (2004) provokes us to think that it would be

good if, as in nature, “everything we created contributed to the birth of something else” (McLennan, 2004, p. 67).

e. Respect for Energy and Natural Resources – The Conservation and Renewable Resources Principle

We need to stop using our natural resources as if we lived on a planet without limits. McLennan (2004) says we need to remember that natural products have value on their own, not only when transformed and industrialised. Only then, will we respect our natural resources. Moreover, we must always be in search of more efficient uses of what we have, reducing, or even eliminating, waste: “(w)e need to head to a future where all our energy should come directly from the sun, the wind and the tides and from chemical processes within a hydrogen economy” (McLennan, 2004 p. 79).

f. Respect for Process – The Holistic Thinking Principle

It is about how things are done, not exactly what is done. McLennan (2004) summarizes this principle in “if we want to change a result, we must first change the process that led to the result” (p. 86). In other words, if we want to have different outcomes, it is necessary to think of new ways of projecting, considering the scope and multiplicity of sustainability. It is important to rethink the way our designers are trained, since the current training has not given support to these decisions. The author subdivides this principle into some essential commitments for holistic thinking:

i. A Commitment to Collaboration and Interdisciplinary Communication;
ii. A Commitment to Holistic Thinking;
iii. A Commitment to Life-long Learning and Continual Improvement;
iv. A Commitment to Challenging Rules of Thumb;
v. A Commitment to Allowing for Time to Make Good Decisions;
vi. A Commitment to Rewarding Innovation.

We can see that the six principles established by Mc Lennan (2004), despite being presented with a focus on the environmental aspect, are especially relevant because they structure a sustainable way of thinking and guide paths to new solutions. The author questions the existing methods, gives clues to professionals about ways to follow

and understands that the sustainable project must, above all, represent respect to nature and people.

When we seek more pragmatic approaches that guide the designer's work, we found in Vicente (2012) a table (Fig. 6) that presents the strategies developed by Vezzolli and Manzini and (2008), for the creation process of sustainable design, more specifically the product design. According to Vicente (2012), among the various authors who studied and sought to establish practical guides to assist the professional, the work of Vezzoli and Manzini (2008) stood out as the most current and complete. We can observe a selection of strategies that encompass the design phase, manufacturing, use and post-life of the product.

Figure 6

Ecodesign strategies

Strategies	CRITERIA
A1 To minimise the material consumption	To minimise the quantity of material
	To minimise wastage
	To minimise or avoide packaging
	To encourage more efficient systems and consumption
	To encourage more flexible material consumption systems
	To minimise material consumption during development
A2 To minimise the energy consumption	To minimise energy consumption in pre-production and production
	To minimise energy consumption during transportation and storage
	To select systems with energy-efficient operating phases
	To use dynamic energy consumption
	To minimise energy consumption
A3 To minimise toxic emissions	To select non-toxic and non-harmful materials
	To select non-toxic and non-harmful energy resources
A4 Renewable resources	To select renewable and bio-compatible materials
	To select renewable and biocompatible energy resources
A5 Optimisation of product lifetime	To design for appropriate lifespan
	Reliable design
	To facilitate upgrades and adaptability
	To facilitate maintenance
	To facilitate repairs
	To facilitate reuse
	To facilitate remanufacturing
A6 To improve the life of materials	To adopt a cascade approach
	To select materials with the most energy-efficient recycling technologies
	To facilitate collection and transportation at end-of-life
	Material identification
	To minimise the number of different incompatible materials
	To facilitate cleaning
	To facilitate composting
	To facilitate combustion
A7 Design for disassembly (to reduce and facilitate assembly and separation operations)	General architecture
	Shape of components and parts
	Form and accessibility of joints
	To use reversible joining systems
	To use permanent joining systems that are easily collapsible
	Co-design of special technologies and features for crush separation

Note. Table showing Ecodesign strategies. Translated by the author from "Contributos para uma metodologia de design sustentável aplicada à indústria do mobiliário. O caso português.", by Vicente, J. M. A. N., 2012, (p. 97)

Similarly to Vicente's work (2012), Stieg (2006) sought in his research alternatives to assist the professional, in this case from the interior design area, in the implementation of more sustainable practices. The author explored the difficulties of the professional

daily life and concluded that there is a large gap between the knowledge built and acquired in the academy and the possibility of putting them into practice in the professional daily life.

Besides Stieg (2006), several other authors (Maté, 2006; Maté, 2007; Bacon, 2011; Aktas, 2013; Hayles, 2015) have explored the difficulties of professional practice, especially those related to the specification of sustainable materials and the conception of an interior design project with a lower environmental impact.

Within the different strategies we see in Figure 6, it is notable that the choice of materials, in the case of interior design, draws attention since "(t)he selection of inappropriate materials can result in considerable waste of resources, as interiors are renewed-or "churned"-every five to seven years" (Maté, 2006, p. 1).

Hayles (2015) states that "the frequency with which interior designers make sustainable choices in real practice is still limited, particularly where materials selection is concerned" (p. 100). The author's research identified several factors related to these difficulties, among them, we highlight the efforts to obtain knowledge about sustainable materials and products, which consume a lot of time within the tight schedules of the professional's daily life.

Moreover, Stieg (2006) states that, in addition to various concerns such as the choice of materials, production techniques, air quality of the designed environment, it is necessary "(to) understand how the development of interior space contributes to the sustainability of a design through efficient space planning, effective natural and artificial lighting systems, and wise use of resources" (p. 18). In other words, we should consider how the design of the space can influence not only the planning phase but also the user phase: it can define habits, guide users and improve the consumption of resources, such as water and energy.

On the other hand, without losing sight of the strategies we have just considered, working with food waste reduction means above all addressing the problem of sustainability from a social perspective. In this sense, Manzini (2015) states that design for social innovation is a necessary tool for solving society's most challenging issues. Problems, such as food waste, are "a vast, worldwide social problem the solution to which cannot be found in traditional economic models and in top-down initiatives (even though these initiatives are desperately needed too)" (p. 12). The author adds that, in

these cases, "most importantly, individuals, families, and communities must actively and collaboratively participate" (p. 12).

Manzini (2015) defines design for social innovation as "everything that expert design can do to activate, sustain, and orient processes of social change toward sustainability" (p. 62). For the author, this can be pointed out from a mixing of certain components: (i) original ideas and visions, (ii) practical design tools and, (iii) creativity within a design approach. In general, this represents the adoption of strategies that seek solutions that go beyond the definitions of processes and materials and instigate a change in the users' behaviour.

2.1.2. Sustainable design and social transformation

In a very pragmatic way, Manzini and Vezolli (2002) point out that, if we want to change the course of our actions, there are two main axes of action: (i) decreasing the flow and consumption of raw materials and energy and (ii) the dematerialization of demand. That is, the reduction in the number and intensity of products and services necessary for social well-being. This means that it is not necessary to give up well-being itself, but to change what it means for people.

Still on the concept of well-being, we can consider that it derives from the complexity of social relations and the current times in which we live, something very related to culture. It is complex to think of tools that give the designer the ability to intervene, to be accepted and in fact make a difference. However, in Walker (2012) we see that more sustainable approaches in design are able, not only to assist in environmental and ethical concerns, but also help to create a new beauty, a beauty "in which we can find delight because it is a meaningful expression of human values that are responsible, ethical and caring" (p. 37).

Valente Pereira (2012) states that by realizing that the Earth is finite and being aware of the social and economic consequences arising from environmental problems, we understand that a change in the development paradigm is required. Similarly, Manzini and Vezolli (2002) point out that this change should happen so that development can be measured not in quantity of production and consumption, but in reduction of these.

In this sense, Manzini (2015) points out that to create a discontinuity with the current behaviour it is necessary "to create something that breaks the routine by proposing ways of behaving that are radically new" (p.14). And radical innovations are not only "a new strategy to solve a given problem, they reformulate the same problem, leading to very different results" (Manzini, 2015, p. 14).

Walker (2012) points out that this discontinuity will only happen if we manage to subvert the logic of mass production that underpins design education to a new context. It is necessary to " think about how to create a material culture that is consistent with, and beneficial to, personal and social well-being, environmental stewardship and economic stability "(p. 36). In this sense, Manzini and Vezzolli (2002) add that to achieve environmental sustainability, “it is not enough to improve what previously existed, but to think of products, services and behaviours that are different from those known until today" (p. 23)[8]. In short, it is necessary to think of new ways of organising daily life, think about the sustainable aspect of the product as a cycle and consider the way it influences its users.

Manzini (2015) states that "(t)he convergence of social and technical innovation interacts with the way people are and think" (p. 22) and this results in a cultural innovation. This innovation impacts on new ideas related to quality of life.

Therefore, design must play an important role in changing meanings in material culture and the very concept of well-being. In other words, there must be a paradigm shift through the development of products and spaces that tend to promote new quality criteria, which mean a reduction in the material needed to achieve the well-being (Manzini & Vezolli, 2002).

Hence, it is necessary to think of inspiring solutions, which mean a new look for the consumer and corroborate with the transformation towards a new model of a society: "(a) society in which there is solidarity, in which democracy is seen as an interweaving of networks and relationships and in which weaving contacts between people is one of the social qualities to be sought" (Manzini & Vezzoli, 2002, p. 59). This is because, for Manzini (2015), social innovations are the great tool for change, they are the ones that

[8] Excerpt translated by the author from the original “não é mais suficiente, pois, para atingir a sustentabilidade ambiental, não é suficiente melhorar o que antes já existia, mas sim pensar em produtos, serviços e comportamentos diversos dos conhecidos até hoje”.

"will play the role that, for good or bad, technological innovation (and industrial development) played one century ago" (p. 26).

2.2. Design for behaviour change

Besides the process of selecting materials, we also highlight the influence of space design on users' attitudes. The sustainability of the space should not be restricted only to its design phase itself, but also how it is used, i.e. how it can collaborate to reinforce or even create more responsible habits.

We argue that the creative process of a project should consider new forms of organization of the daily life, beyond the sustainable aspect of the product throughout its life cycle. In summary, the development of design for sustainability should aim at a change in the user's behaviour (Manzini, 2015). For this, "there is a need to understand behaviour and its determinants" (Strömberg, Selvefors & Renström, 2015, p. 163).

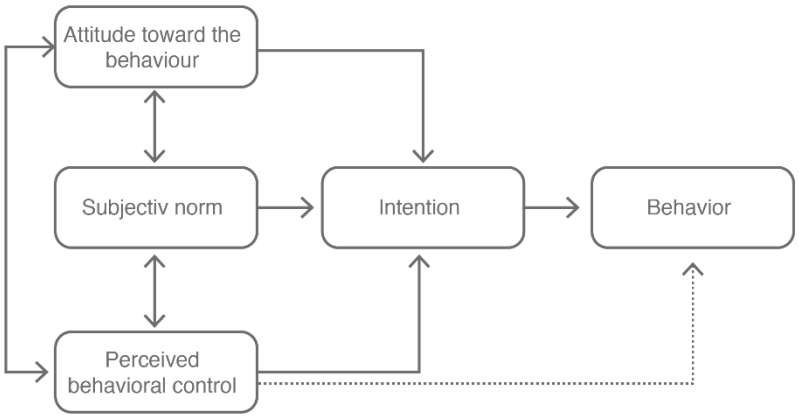
When we talk about behaviour itself, the model (Fig. 7) of the Theory of Planned Behaviour (TPB), created in 1991 by I. Ajzen is, to this day, one of the main references in the literature. It aims to deal with behaviours over which people do not have full control. In the centre of the model are the intentions, defined by Ajzen (1991) as "indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior" (p. 181). Also, according to the author, they have a positive relationship with behaviour because "(a)s a general rule, the stronger the intention to engage in a behavior, the more likely should be its performance" (p. 181). There are three antecedents of intentions:

- Attitude toward the behaviour: “refers to the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question” (Ajzen, 1991, p. 188).
- Subjective norm: “refers to the perceived social pressure to perform or not to perform the behavior” (Ajzen, 1991, p. 188).
- Perceived behavioural control: “refers to the perceived ease or difficulty of performing the behavior and it is assumed to reflect past experience as well as anticipated impediments and obstacles” (Ajzen, 1991, p. 188).

Ajzen (1991) explains that the stronger these antecedents, the greater the intention and, consequently, the more likely the individual will exhibit the behaviour in question. Furthermore, the author adds that the importance of each of them varies according to the situation being studied.

Figure 7

Theory of planned behaviour



Note. Diagram showing the model of the Theory of planned behaviour. Adapted from "The Theory of Planned Behavior.", by Ajzen, I., 1991 (p. 182).

The use of the TPB as a theoretical framework is present in the study of Lee, Allen and Kim (2013), as well as in that of Du Toit, Wagner and Fletcher (2017). Speaking more particularly about the work of Lee and colleagues (2013), it reveals that the TPB framework can provide us with valuable insights into the development of efficient strategies regarding sustainability-related decision-making. According to the authors, the three determinants of the theory associate positively with the behavioural intention to choose more sustainable materials.

Another theoretical reference in the study of behaviour is *nudging*. The concept assumes that information alone is not enough to guide behaviour and acts as a guide that facilitates or bars certain behaviours. According to Lehner, Mont and Heinshkanen (2016): "(t)his can be done by simplifying the information provided or by offering default choices in a way that facilitates socially desirable decisions" (p. 167).

Regarding the concept of *nudge*, Thaler and Sunstein (2008) define it as "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (p. 6). It is worth noting that, to be considered a *nudge*, the intervention must be easy and cannot be compulsory. And who are the architects of choice? For Thaler and Sunstein (2008) they can be anyone who, even without realizing it, "has the responsibility for organizing the context in which people make decisions" (p. 3).

In Thaler and Sunstein (2008) we could also identify the six principles that guide what they referred to as the good architecture of choice:

- *Defaults - Padding the Path of Least Resistance*: people tend to prioritise the path of inertia, the one that requires the least effort and change. Therefore, the choices presented as "defaults" are very powerful.
- *Expect error*: people make mistakes and good design should be able to anticipate them and do everything possible to avoid, or even solve, them.
- *Give feedback*: the best way to aid choices and improve performance is to provide information and give feedback to users.
- *Understanding "Mappings" - From Choice to Welfare*: this is about making information clear, visible, and understandable to users so that they can map and thereby select what is best for them.
- *Structure complex choices*: People adopt different strategies according to the availability and complexity of options to be chosen. The role of choice architecture is to guide these choices and "(a)s alternatives become more numerous and more complex, choice architects have more to think about and more work to do, and are much more likely to influence choices (for better or for worse)" (Thaler & Sunstein, 2008, p.95).
- *Incentives*: this is the main topic addressed by economists. For the authors, good choice architecture can position the right incentives in the right place.

Environmental psychology studies have shown that one of the main influencers of behaviour is space (Scott-Webber, Konyndyk, French, Lembke & Kinney, 2017). We have found examples of these impacts in behaviours in the literature related to workspaces (Vischer, 2008), educational / library spaces (Campbell & Schlechter, 1979; O'Kelly,

Scott-Webber, Garrison & Meyer, 2017; Scott-Webber et al. 2017) and health and wellness spaces (Ulrich, 1991; Petermans & Pohlmeyer, 2014).

Sommer (1969) points out that little evidence is given to the relationship between the configuration of space and the activities users perform within it. The author states that "not only must form follow function, but it must assist it in every way" (p. 5). Similarly, we found in the work of Augustin (2009) indications that reinforce that space design can define choices and behaviours. The author points out that well-designed spaces differ in several aspects but have some in common. They are:

- "*Complying* with the activity planned" (Augustin, 2009, p. 35).
- "*Communicating* important information about the people who use them and providing opportunities for people to socialize or not" (Augustin, 2009, p. 35).
- "*Comforting* because they meet psychological needs for perceived control of our environment (including whether to be alone or with other people) and refreshment" (Augustin, 2009, p. 35).
- "*Challenging* because they provide opportunities for the people in them to grow and develop as a person" (Augustin, 2009, p. 36).
- "*Continuing* across time, evolving and changing as appropriate" (Augustin, 2009, p. 36).

For Thaler and Sunstein (2008), every designed space has consequences on the user, since "there is no such thing as a "neutral design"" (p. 3). In the same vein, Montazeri, Gonzalez, Yoon and Papalambros (2012) sought to understand why the designer can create spaces that generate demands and encourage people to behave in certain ways. The above-mentioned authors concluded that colours could affect the salience of an object and, consequently, arouse actions related to it. However, they argue that the psychological mechanisms that act on these behaviours are not clear.

In view of the above, we can state that the influence of space can go beyond the limits of the environment itself and may impact the society in which it is inserted. In this sense, Barnes (2012) studied how green libraries can be used as a teaching tool for the community. The author identified that sustainable building projects can not only educate their audience, but also inspire the whole community to start using similar techniques in their daily lives, in their homes and in their jobs.

Still, it should be kept in mind that transparency in tools, such as *nudging*, is a critical aspect of design for behaviour change (Lehner, Mont & Heiskanen, 2016). This is because consumers need to be able to know what kind of interventions are being implemented if they are interested in doing so. In this sense, Lehner and colleagues (2016) state that "(i)t is democratically worrying to use nudging to influence the behaviour of those not able to identify a nudge" (p. 175).

Still on this ethical issue, Thaler and Sunstein (2008) introduce that the *nudging* is related to the term "libertarian paternalism" and explain that, although the two words of the term seem contradictory, they make sense as a set. The libertarian aspect lies in the idea that people are free to choose what they want, while the paternalistic aspect lies in the fact that the architecture of choice should influence people to behave in ways that improve their lives. It is important to stress that, as already mentioned, in the case of *nudging*, there are no prohibitions and interventions should always be simple.

Finally, it is also important to remember that, as Thaler and Sunstein (2008) point out, in many cases, it is impossible not to choose some behaviour to be influenced. In addition, the authors draw attention to the fact that often people do not have enough information for proper discernment and, therefore, will not always make the best choices for themselves.

2.2.1. Design for sustainable behaviour

For the purposes of this investigation, it is also necessary to understand which are the difficulties and which are the available tools in terms of behavioural change focused on sustainability. In this sense, Wever, Van Kuijk and Boks (2008) point out that solutions for sustainable design should be focused on the user and present non-intrusive results, with high usability because "research shows that there is only a limited percentage of consumers willing to buy sustainable products only because they are sustainable, and prepared to compromise on functionality somewhat" (p. 18).

In a complementary way, Lehner and colleagues 2016) analysed how the *nudging*, a set of strategies already mentioned, could be implemented under the perspective of sustainable consumption. The authors sought to understand, through literature review and the study of existing initiatives, whether it is possible to help consumers make

better choices. Their study concludes that, although *nudging* has been used as a tool to support policies in different countries, it is complicated to measure the real results of these interventions. The problem lies in the diversity of cases and, as already mentioned, in the complexity of human behaviour.

On the relationship between behaviour and the configuration of space, Wu, DiGiacomo, and Kingstone. (2013), Cummings (2012) and Montazeri, Gonzalez, Yoon and Papalambros (2012) investigated the impact and influence of space on sustainable decisions to identify how design can act to promote sustainability-friendly behaviour.

The work of Wu and colleagues (2013) investigated whether simply being in a sustainable building can influence behaviour, in this case, the correct disposal of waste. The results indicate that it does and provide empirical support that the impact of our surrounding environment is profound and positive.

In addition, some research (Junior, da Silva, Gabriel, & de Oliveira Braga, 2015; Kraus & Emontspool, 2017; Kollmuss & Agyeman, 2002) have sought to understand another aspect: the difficulty in connecting the possession of knowledge regarding sustainability and sustainable behaviour itself. This simple task is challenging, since it is complex to identify why people make certain choices and what are the barriers to adopting more appropriate behaviours (Kollmus & Agyeman, 2002).

When we specifically address pro-environmental behaviour, Kollmus and Agyeman (2002) point out that the older models of behaviour analysis, created in the 1970s, were based on a linear progression, in which knowledge would lead to awareness, which in turn would result in pro-environmental behaviours. The authors realised that these models were soon proven wrong, as research showed that, more often of the time, this connection does not take place in such a direct way. They define some possible explanations for such lack of effectiveness:

- Direct experiences have much more influence on behaviour than indirect experiences.
- Social norms, cultural customs and traditions influence and define attitudes.
- Temporal discrepancies between the time of data collection and the time of awareness.

- Discrepancy between measures of behaviour versus attitudes. While the former is more specific, the latter are more generic.

In Kollmus and Agyeman's (2002) research, the main frameworks for analysing pro-environmental behaviour were reviewed. As a result, the authors propose a current map, which considers new factors for determining behaviour. These are:

- Demographic factors: gender and level of education.
- External factors:
    - Institutional: certain behaviours require minimal infrastructure.
    - Economic: mainly responsible for purchase choices.
    - Social and cultural: can be major positive as well as negative influences.
- Internal factors:
    - Motivation: is determined by direction and intensity around which behaviour is organised.
    - Values: are mainly influenced by the personal "micro-system", i.e. the social circle that surrounds us.
    - Environmental knowledge: a small fraction of behaviour is influenced by the information we possess.
    - Attitudes: these are determined by positive or negative feelings about some person, object or issue.
    - Environmental awareness: means information about the impact our actions have on the environment.

Furthermore, it is important to emphasize that it is a challenge for the user to understand the real consequences of their behaviours. For Bhamra, Lilley and Tang (2011) the user's difficulty in making the connection between information, his own behaviour and its social and environmental impact causes more difficulty to motivate real changes. For the authors, the designer, when considering the user phase as a tool, has in his hands the power to make the connection between intention and behaviour. Furthermore, Bhamra and colleagues (2011) draw attention to the importance of seeking to change standard behaviour: "(h)abitual and routine behaviour contributes to the awareness-intention-behaviour gap between environmental and social values and everyday interaction with products" (p. 430).

In a complementary way, Lockton, Harrison and Stanton (2008) studied different disciplines and different initiatives related to sustainability and behaviour. The authors present in their study three groups of approach to solve the problem:

- *Affordances and constraints:* manipulation and planning of a system that limits and directs the user.
- *Persuasion and feedback:* less coercive methods of convincing the user from the provision of information and feedback regarding the "efficiency" of their behaviour.
- *Context-based approaches:* means adapting the two previous strategies to the situation in which the user finds himself.

Similarly, in Stromberg, Selvefors and Resntröm (2015) we found a map of pathways that guide sustainability behaviour according to different possibilities that users have to engage with artefacts. There are 5 pathways:

- *Path 1- Choice of artefact:* choice of products that require less resources during their use.
- *Path 2 - Changed use:* user makes an active choice to change the way he/she uses the artefact to decrease resource consumption.
- *Path 3 - Maintenance and Repair:* user maintains the artifact in good conditions to increase its durability.
- *Path 4 - Mediated use*: user chooses a secondary artifact as support to decrease the resource consumption of the original artifact.
- *Path 5 - Regulated artefact:* the user installs an artefact which regulates the consumption of resources of the original artefact.

In Bhamra and collaborators (2011), 7 intervention strategies were presented (Fig. 8), identified from literature review and previous works of the authors, which can be applied in design. These strategies were elaborated for the area of products and services; however, it is valid to state that they are also relevant to the area of space design.

Figure 8

Design strategies for sustainable behaviour

Note. Table showing design intervention strategies. Adapted from "Design for sustainable behaviour: Using products to change", by Bhamra et. al, 2011, in *The Design Journal*, *14*(4), (p. 431)

It is worth noting that the authors recognise that these strategies have not yet been properly tested; so, there is no clear evidence about their effectiveness. In addition, the authors state that the choice of these strategies should ideally be made based on the application of techniques that request the opinions of those who are in the context to be worked on.

2.2.2. Design to reduce food waste

We present here references, found in the literature which sought to understand the design for behaviour change with a focus on food waste.

In Aschemann-Witzel and colleagues (2015) we identified three main points to be considered in the creation of effective solutions: (i) *date labelling*; (ii) *expectations and perceptions*; and (iii) *improving consumer behaviour in food handling at the household scale*.

On the first aspect, data labelling, Davenport and colleagues (2019). point out that it is a key strategy to achieve a decrease in the level of food waste. In a study conducted in American households, the authors concluded that strengthening and clarifying the signs related to food quality and safety is essential. It is necessary to create strategies and campaigns that seek to educate consumers so that they can clearly understand the signs of food safety, both at the time of purchase and when handling food in the home, in addition to standardising the data labelling system.

On the second aspect, Aschemann-Witzel and colleagues (2015) point out that the perceptions and expectations that consumers bring when judging the acceptability of food are crucial. This can be achieved through the use of awareness campaigns, as well as changes in social norms, i.e. instigating the consumer to rethink the consequences of the predominance of specific aesthetic standards of food.

The third aspect relates more directly to the focus of our research and is pointed out as a central issue for Aschemann-Witzel and collaborators (2015). The authors state that improving consumer behaviour in terms of purchasing, preparation skills and storage is a difficult issue to change. However, they suggest that it is necessary to have a collaboration between actors of different phases, creating a combined action that, on the one hand provides tools and means, on the other, creates the necessary motivation emphasizing the socioeconomic and environmental reasons of the choices.

Thus, we note that understanding the problem of food waste and thinking about solutions to it requires a multilevel approach that can take a broad view and organize different identified factors (Boulet, Hoek & Raven, 2020). De Waal and colleagues (2020) reinforce the statement and point out that an approach that combines different types of interventions can have a greater impact than individual interventions. The authors show

us that for effective waste reduction to occur, consumers must "(i) know how to reduce the waste of food and (ii) be willing to reduce food waste" (de Waal et. al, 2020, p. 8). In addition, Aschemann-Witzel and colleagues (2015) demonstrate that synergistic actions between different sectors are the most promising, i.e., actions that raise consumer awareness and, at the same time, support behaviour at the macro scale.

More specifically on a practical action, we point out that one of the major determinants, when it comes to food waste on the household scale, is the structure of the house. This is because having the right storage space, i.e. having enough space as well as the right conditions (temperature and lighting, for example) are crucial points indicated by consumers to ensure that the food they buy stays fresh (Dobernig & Schanes, 2019). Therefore, it is essential to think of alternatives in the scope of interior and product design that provide support for this type of storage.

Related to this specific topic, Doberning and Schanes (2019) point out the role of technology in educating and assisting the everyday of domestic life. The authors argue that, if today the consumer has difficulties, regarding how each type of food should be stored, design and technology can try to provide this kind of support. In Doberning and Schanes' (2019) research, people reported difficulties such as knowing the durability of food in the freezer, the correct processes for freezing food and the ideal position of each type of food in the refrigerator considering the different temperature and humidity conditions. This shows that it is necessary to guide consumers so that they do not see technological appliances as a procrastination, a space for forgetting about food, but rather as tools to help them in their daily lives.

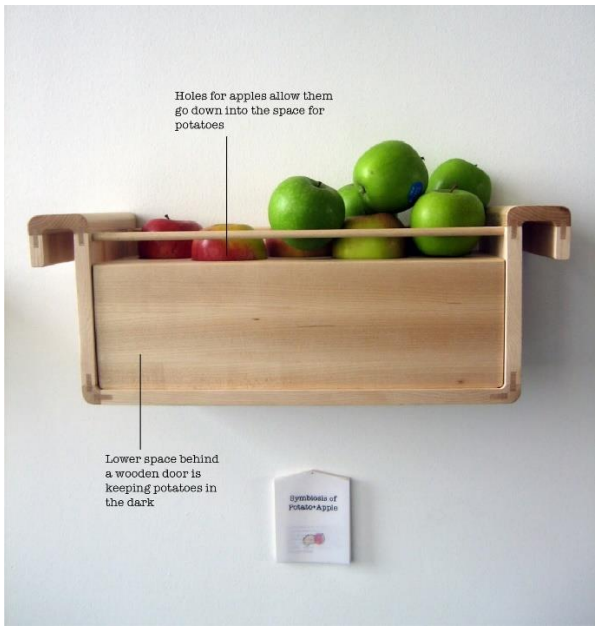
Similarly, Ganglbauer and colleagues (2013) discuss the role of technology and its potential benefits to the consumer. The authors analyse the intervention called "*Fridge Cam*" in which, using a video camera installed inside the fridge, daily habits of the family are analysed in a very practical way. Another key point of the investigation was to show how technology can support more careful buying habits, reinforcing its power as a helper.

The work of the designer Jihyun Ryou (n.d), entitled *Save Food from the Fridge* (Fig. 9 and 10), has a distinctive approach that calls on consumers to take a more active role with technology to create a respectful relationship with the food life cycle. The designer proposes solutions based on traditional knowledges that create alternative spaces to

foods that are typically placed in the fridge. The proposal is focused on maximizing the visibility of the food and creating in the user a sense of care, a routine in which one looks at fruits and vegetables as one looks at plants in one's home.

Figure 9

Symbiosis of Potato + Apple



Note. Photograph of Symbiosis of Potato + Apple. From *Save food From the Fridge*, by J. Ryou, n.d. (http://www.savefoodfromthefridge.com/p/symbiosis-of-potatoapple.html).

Figure 10

Humidity of Fruit Vegetables

Note. Photograph of Humidity of Fruit Vegetables. From *Save food From the Fridge*, by J. Ryou, n.d. (http://www.savefoodfromthefridge.com/p/humidity-of-fruit-vegetables.html).

In this sense, we affirm that an important point in the fight against waste is the creation of awareness about the difficulties of production, especially of vegetables and fruits that often do not have high added value to the consumer. Doberning and Schanes (2019) point out that "the less you know and have experienced what it takes to produce a tomato, the harder it is to appreciate and ultimately value the growing process and the produce itself " (p. 487).

Another interesting initiative is the "*Color Coding Scheme*" (Fig. 11), developed by Farr-Wharton, Choi and Foth (2014). It involves the creation of a scheme of colour labels, used to distinguish the different food groups and create a map of organisation of the fridge. It is a relatively simple solution based on the problem of "*Awareness of available food*". The study's conclusions are that participants experienced a significant increase in family members' awareness of the food present in the fridge, as well as being able to find food more quickly and efficiently. An unexpected finding was that people usually connect specific colours to certain food groups.

Figure 11

Colour Coding the Fridge

Note. On the left we see the system applied in a refrigerator and on the right the organization map of the labels. From "Colour coding the fridge to reduce food waste" by Farr-Wharton, G., Choi, J. H. J., and Foth, M., 2012, In Proceedings of the 24th Australian Computer-Human Interaction Conference (p. 121).

In addition, we highlight in the research of Ganglbauer and colleagues (2013), mentioned above, a series of design strategies, divided between the support of dispersed practices and the support of integrated practices. The dispersed practices are those that can occur at different times, from food production, purchase, consumption and waste. The integrated practices, on the other hand, are built from the dispersed ones, and may not have as a result only the benefit of waste reduction. They are the following:

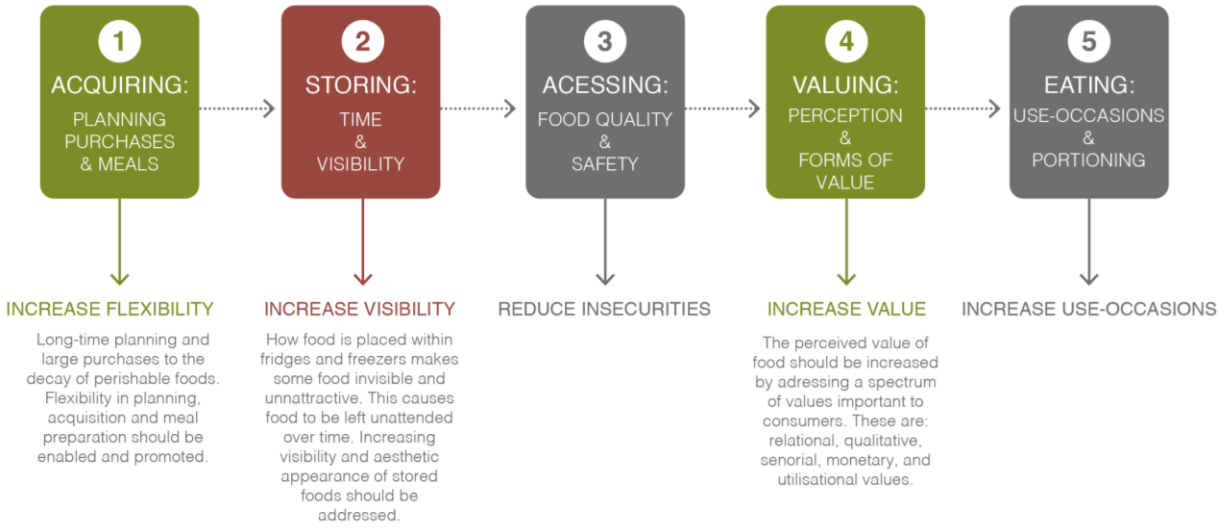
- *Strategies to support dispersed practices:*
    - Connecting the moment of consumption (purchase) and its future consequences of waste;
    - Making the path from food to table clearer and more visible to the consumer;
    - Making production costs more visible (ethical, environmental, social and health costs);
    - Creating real opportunities for a more direct connection between producers and consumers; and
    - Support reflection on the gap that exists between intention and actual behaviour, i.e. provide consumers with tools to analyse their own practices;

- *Strategies to support integrated practices*
    - Assist with planning and purchasing;
    - Assist with storage and stock management;
    - Promote sustainable practices in food preparation, encouraging the consumption of the different types of ingredients available;
    - Coordinate the division of food consumption, making a connection between the different households;
    - Promoting the cultivation of urban gardens (connecting those who have space, tools with those who have knowledge and the possibility of work); and
    - Connecting people who have their own strategies, skills and tools to reduce waste, creating a social circle for sharing information and resources.

In this sense, Hebrok and Heidenstrøm (2019) divide the daily path of the domestic consumer into decisive moments and point out how it is possible for us to act in each of them (Fig. 12).

Figure 12

Food handling practices: decisive moments in everyday life for food waste prevention.



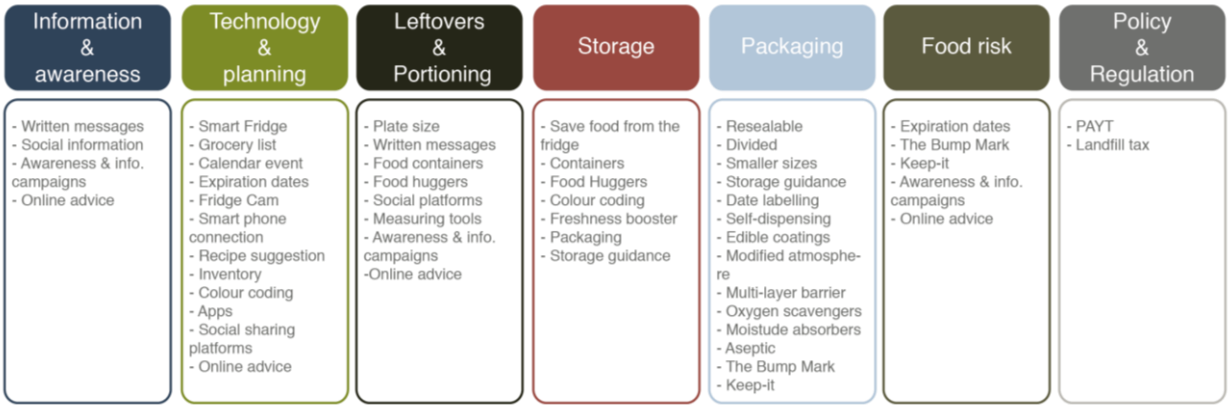
Note. Diagram showing decisive moments in everyday life for food waste prevention, with emphasis on moments 1,2 and 4. Adapted from "Contextualising food waste prevention-Decisive moments within everyday practices", by Hebrok, M. & Heidenstrøm, N. ,2019, in *Journal of Cleaner Production* (p. 1446)

Despite the attention that has been paid to the topic of household wastage, there are still few results that assist the development of interventions and guide future research (Boulet et.al, 2020). Bravi and collaborators (2020) point out that the two main gaps in the topic consist of defining factors affecting wastage at the household scale; and conceptual and action methodologies for wastage prevention. Furthermore, the authors state that previous studies have mainly focused on defining wastage and not finding more diverse solutions.

For this reason, the work of Hebrok and Boks (2017) is relevant, in which we find a cataloguing of the solutions in the field of design that exist in the market and in the literature. The authors, based on extensive literature review, establish the following fields of action in the field of design: Information and Knowledge, Packaging, Food Risk and Regulations (Fig. 13). Moreover, the authors point out that several factors lead to food waste and these are related both to social factors (preferences, culture, lifestyles), and the structure of the kitchen and its surroundings (storage space, packaging available for purchase, for example).

Figure 13

Food waste drivers and interventions



Note. Diagram showing food waste design interventions, by typology. Adapted from "Household food waste: Drivers and potential intervention points for design–An extensive review", Hebrok, M., & Boks, C. ,2017, in *Journal of Cleaner Production*, *151* (p. 390)

Similarly, in a more recent context, Reynolds and colleagues (2019) conducted a survey of articles, published between 2006 and 2017, that proposed and analysed interventions

aimed at reducing household food waste with design. Seventeen interventions were selected, in which the authors sought to evaluate the results presented and, from them, suggest paths for future research. The authors divided the interventions into three categories: (i) Information; (ii)Technology; and (iii) Policy/ System/ Practice change. Among the recommendations for the design of future studies we highlight the following: (i) initially define if the intervention focuses on the proposal of a new intervention or the understanding of an existing intervention; (ii) define the audience of the designed intervention; (iii) apply techniques that help in the design process, such as logic mapping; and (iv) have a theoretical basis that helps in the understanding of tools for behavioural change.

In this research we sought to analyse and complement the survey conducted by Hebrok and Boks (2017), by Reynolds and colleagues (2019) and by Dott (2020), from literature review and market research, in order to select existing or non-market interventions that are focused on the domestic environment and can suggest creative solutions in kitchen design. The results of this selection are presented in Table 1 displayed at the end of this sub-item.

Finally, it is worth noting that we need to understand the kitchen space and the structure it provides as a system rather than as a collection of equipment and storage spaces. Hebrock and Bocks (2017) show us that there is little diversity in existing solutions in the market and literature and there is great potential for more innovative thinking, thinking that can actually understand the kitchen space as a whole and challenge existing practices in a more profound manner.

Table 1

Compilation of design interventions to reduce food waste

Name (Author)	Category	Description	Application possibilities in kitchen design	Difficulties	Strategies (Design for behaviour change)	Current situation/ Results
The table for living (IKEA and IDEO)	Product Design	Interactive table that can identify ingredients placed on via camera and image-recognition technology. It suggests other ingredients to combine with and recipes.	Layout Cabinet and countertop design	Lack of knowledge in food preparation.	ECO-Choice ECO- Information ECO-Technical intervention Understanding Mappings	Prototyped /No results found.
The modern pantry (IKEA and IDEO)	Product Design	Individual, transparent refrigerated storage spaces that encourage a closer relationship with the food	Cabinet and countertop design Choice of Appliances	Lack of visibility of stored food. Lack of connection to the production cycle. Inappropriate food storage conditions.	ECO-Technical intervention Incentives ECO-Steer	Prototyped /No results found.
ZmartFri (Bucci, Calefato, Colombetti, Milani and	Product Design	" Intelligent refrigerator concept that includes expiration date alerts and the production of shopping lists, to	Cabinet and countertop design Choice of Appliances	Lack of visibility of stored food. Difficulty in managing food stock.	ECO-Technical intervention Incentives Understanding Mappings	Prototyped /No results found.

Name (Author)	Category	Description	Application possibilities in kitchen design	Difficulties	Strategies (Design for behaviour change)	Current situation/ Results
Montanari, 2010)		be sent by sms or email"(p.388)			Structure complex choices	
Colour Coding the Fridge (Farr-Wharton and collaborators, 2012)	Product Design	The authors created a simple intervention based on a colour scheme in which each colour represents a type of food (defined by users) to be organised in the fridge. This scheme is translated into a map, placed at the door of the fridge to guide all household members.	Cabinet and countertop design Layout	Lack of visibility of stored food. Difficulty in managing food stock.	Incentives Understanding Mappings Eco-Steer	Prototyped / Results show that the product helped the participants to orient themselves with the food in the fridge, especially those not involved in the purchase. In addition, this meant a decrease in food being thrown away and spoiled.

Name (Author)	Category	Description	Application possibilities in kitchen design	Difficulties	Strategies (Design for behaviour change)	Current situation/ Results
The Fridge-Cam (Ganglbauer, Fitzpatrick and Comber, 2013)	Design probe	Fridge-Cam is a camera used as a design probe. Placed inside refrigerators, it sends images with the aim of helping to understand everyday practices.	Cabinet and countertop design Choice of Appliances	Lack of visibility of stored food. Difficulty in managing food stock. Lack of knowledge about the numbers of individual consumption and the individual impact on food waste.	ECO-Technical intervention Incentives Understanding Mappings Eco-information	Prototyped / The authors state that the product is an example of how technology can support food care habits.
LG's Smart ThinQ and Instaview (LG)	Product Design	Smart refrigerator that connects to the user through Wi-Fi. It allows temperature control to avoid energy waste, as well as existing products and expiry date. In addition, it has transparent door space for food storage with high visibility.	Cabinet and countertop design Choice of Appliances	Lack of visibility of stored food. Lack of connection to the production cycle. Inappropriate food storage conditions.	ECO-Technical intervention Incentives Understanding Mappings Eco-Steer	Available on the market / No results found.

Name (Author)	Category	Description	Application possibilities in kitchen design	Difficulties	Strategies (Design for behaviour change)	Current situation/ Results
The Family Hub (Samsung)	Product Design	Smart refrigerator with built-in cameras that allow the user to see what's inside the fridge, helping with grocery no matter where the user is. Besides that, it can recognize items inside the fridge, help the meal planner and personalize recipes.	Cabinet and countertop designChoice of Appliances	Lack of visibility of stored food.Lack of connection to the production cycle.Inappropriate food storage conditions. Lack of knowledge in food preparation.	ECO-Technical interventionIncentives Understanding MappingsEco-Steer	Available on the market / No results found.
Vita Fresh (Bosch)	Product Design	Smart refrigerator with bult-in cameras and removable drawers adapted for the storage of fruit, vegetables and meat. According to the manufacturer, the humidity, temperature and air circulation control in these drawers makes the food up to 3x fresher than a regular fridge.	Cabinet and countertop design Choice of Appliances	Lack of visibility of stored food. Lack of connection to the production cycle. Inappropriate food storage conditions.	ECO-Technical intervention Incentives Understanding Mappings Eco-Steer	Available on the market / No results found.

Name (Author)	Category	Description	Application possibilities in kitchen design	Difficulties	Strategies (Design for behaviour change)	Current situation/ Results
Save food from the fridge (Jihyun Ryou)	Product Design	The project is a translation of how traditional knowledge can be used for food storage in the kitchen without using the refrigerator. Besides signifying an alternative space, it increases the visibility of the food and instigates actions of care.	Cabinet and countertop design Layout	Lack of visibility of stored food. Difficulty in managing food stock. Lack of connection to the production cycle. Inappropriate food storage conditions. Lack of knowledge in food preparation.	Incentives Understanding Mappings Eco-Information Eco-Steer Structure complex choices	Prototyped, not available on the market /No results found.
Love Food Hate Waste (UK Government)	Awareness campaign	Awareness campaign that has a website with information on proper food storage conditions, recipes for using leftovers and whole foods, temperature adjustment tips for different models of fridges and help with meal planning.	Layout Cabinet and countertop design	Inappropriate food storage conditions. Lack of knowledge in food preparation. Lack of knowledge about food storage conditions.	Eco-Information Eco-choice Understanding Mappings	Available online. / No results found.

Name (Author)	Category	Description	Application possibilities in kitchen design	Difficulties	Strategies (Design for behaviour change)	Current situation/ Results
Matvett (Norwegian Government)	Awareness campaign	Awareness campaign that has a website with information on proper food storage conditions and recipes for using leftovers and whole foods.	Cabinet and countertop design	Lack of knowledge in food preparation. Lack of knowledge about food storage conditions.	Eco-Information Eco-choice Understanding Mappings	Available online. / No results found.
BinCam (Comber and Thieme, 2013)	Product Design	Camera installed in the bin with the aim of sharing images of food thrown away on social network, which instigates change by changing social norms. Suggests reflection and evokes feelings of shame.	Waste disposal Cabinet and countertop design	Lack of connection to the production cycle. Lack of knowledge about the numbers of individual consumption and the individual impact on food waste.	Eco-Information Understanding Mappings	Prototype / Authors state that, in general, social influences have a high power to change behaviour, but do not present specific results for this experiment.
Ecomate (Lim, 2017)	Product Design	E-COmate is a bin that captures images of household waste to provide consumer information. It demonstrates the quantities of waste to make people aware of their eating practices and	Waste disposal Cabinet and countertop design	Lack of connection to the production cycle. Lack of knowledge about the numbers of individual consumption and the	Eco-Information Understanding Mappings	Prototyped / Product represented a motivating point for the users. The quantification and

Name (Author)	Category	Description	Application possibilities in kitchen design	Difficulties	Strategies (Design for behaviour change)	Current situation/ Results
		thus support actions to create new habits.		individual impact on food waste.		visualization of wasted food increased awareness and signified a start for change.
Social recipes (Lim, 2017)	Concept	Social Recipes aims at improving awareness of what one has available (in contrast to what one has wasted). Social Recipes promotes food sharing as a way to support sustainability.	Cabinet and countertop design	Lack of connection to the production cycle. Lack of knowledge about the numbers of individual consumption and the individual impact on food waste.	Eco-Information Eco-choice Understanding Mappings	Not prototyped (conceptual model) / Participants reported: impacts on awareness, creativity, coordination and collaboration, knowledge and connectedness. Also, there were negative aspects: preparation values,

Name (Author)	Category	Description	Application possibilities in kitchen design	Difficulties	Strategies (Design for behaviour change)	Current situation/ Results
						travel distance and trust.
EETMAATJE (Netherlands Nutrition Centre)	Product Design	It is a tool that helps the consumer to measure the right amount of various products such as pasta, rice, etc. This helps to prevent overcooking.	Cabinet and countertop design	Lack of knowledge in food preparation.	Eco-Information Understanding Mappings	Available for free. / Studies conducted in 2020 show that 85% of consumers mentioned that the product was easy to use. In addition, 80% said it was helpful in reducing rice and pasta waste.
The fridge and freezer stickers	Product Design	These products provide consumers with knowledge on where to best keep several	Layout Cabinet and	Lack of visibility of stored food. Difficulty in managing food	Eco-information Incentives Understanding	Available online for free. / Research shows that around

Name (Author)	Category	Description	Application possibilities in kitchen design	Difficulties	Strategies (Design for behaviour change)	Current situation/ Results
(Netherlands Nutrition Centre)		commonly used food products and product categories.	countertop design	stock. Lack of knowledge about food storage conditions.	Mappings Eco-Steer	60% of the consumers use/look at the sticker when storing food and 50% feel that using it increases shelf life of products. One problem is that consumers are unwilling to place it on their fridge.
Too Good to go (Not available.)	Digital Product Design	Digital application that connects food retailers to consumers. Food that is close to its expiry date is made available to consumers at reduced prices through the Too Good to Go app to be collected at the end of the day.	-	Lack of connection to the production cycle. Lack of knowledge about the numbers of individual consumption and the individual impact on food waste.	Eco-information Incentives Eco-choice	Present in 15 countries with 3.265 active partners. / The effective results are not yet clear, but it seems that its focus is on consumers who are already

Name (Author)	Category	Description	Application possibilities in kitchen design	Difficulties	Strategies (Design for behaviour change)	Current situation/ Results
						inclined to reduce waste.
The organization labels (Dott , 2020)	Product Design	It is a label that divides food into groups to be organised inside the fridge, with information of where it is better stored.	Layout Cabinet and countertop design	Lack of visibility of stored food. Difficulty in managing food stock. Lack of knowledge about food storage conditions.	Incentives Understanding Mappings Eco-Steer	Prototyped / The author states that participants who evaluated the product positively, stating that it was easy to use and implement.
Colecao Zero Desperdicio (Zero Desperdicio - Portuguese Association)	Product Design/ Awareness campaign	A Portuguese initiative that aims to raise children's awareness of the fight against food waste, through four books aimed at primary school children.	-	Lack of connection to the production cycle. Lack of knowledge about the numbers of individual consumption and the individual impact on food waste.	Eco-information Eco-choice	Digital book available online and printed book available to Portuguese school municipalities. / No results found.

Name (Author)	Category	Description	Application possibilities in kitchen design	Difficulties	Strategies (Design for behaviour change)	Current situation/ Results
No Waste App (Founder: Kasper Hjortsballe)	Digital Product Design	Digital application that helps the user organise and manage food at home. It is possible to create shopping lists, create alerts, scan barcodes, consult recipes and connect with the family.		Lack of visibility of stored food. Difficulty in managing food stock. Lack of knowledge in food preparation	Eco-Information Understanding Mappings Incentives	Available as a free version, with the option of upgrades to the paid version / No results found.

2.3. Conclusive summary

In this chapter, we aimed to understand procedures for design to be built in a more sustainable way and, above all, how it can encourage change so that its users behave more consciously. We understand that it is relevant to consider the choices involving production processes and the use of materials and resources, especially for the case of interior design projects that are renewed frequently. However, we point out that it is essential that the designer also acts to create discontinuities, drawing strategies that break the routine and instigate new behaviours of use and consumption.

We have as focus the study of tools that help the design of spaces, more specifically the kitchen space. We know that the way the environment is organized directly affects its use. Therefore, the choices made during this process are an opportunity to create new habits in food consumption.

After surveying and analysing the bibliography, we understand that the six principles presented by McLennan (2004) can be used as guides in the creative process, as they represent a very comprehensive understanding of sustainable design. Relating them directly to our problem, we were able to conclude:

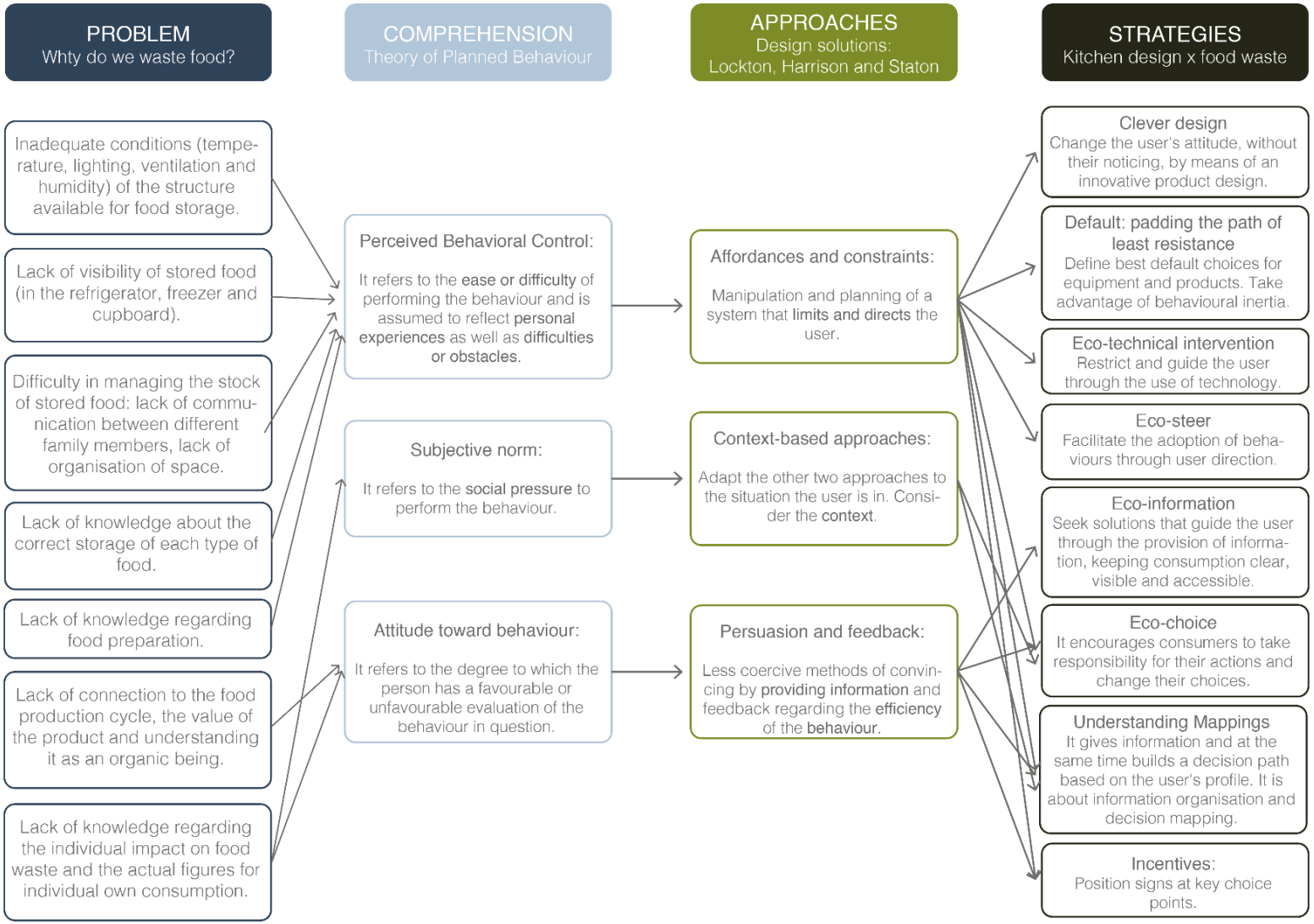
- *Respect for the Wisdom of Natural Systems*: it is about respect for the food cycle, how to rescue the vision of food as part of nature and understand how it should be stored, handled, and consumed.
- *Respect for People*: our design must be a portray of the user's reality, which means understanding the reasons, and difficulties they face in their daily lives.
- *Respect for Place*: we need to use not only the physical conditions of where we study but also the user and his cultural practices that should be used as a design tool.
- *Respect for the Cycle of Life*: dealing with food means understanding and respecting natural cycles, thinking of proposals that value and protect favourable conditions for them.
- *Respect for Energy and Natural Resources*: it is about valuing choices that respect the design context and reflect a concern for sustainability at all stages.

- *Respect for the Process*: is the main principle, as it questions how we think and how we produce design for sustainability and talks about how we can use it as a guide for new forms of consumption.

In Figure 14 we present a scheme that connects the difficulties presented in the previous chapter, the groups of antecedents of behavioural intentions defined in Ajzen's TPB (1991), the groups of possible approaches established by Lockton and colleagues (2008) and, finally, the strategies defined from the intersection between the references presented on item 2.2., especially the nudging and the tools we found in Bhamra and colleagues (2011).

Figure 14

Conclusive schema



From the intersection between the user difficulties, raised in the previous chapter, and the background of the TPB, created by Ajzen (1991), we can understand which type of approach is the most effective to be adopted in the search for solutions to the problem of food waste. We see that most of them relate directly to what Ajzen (1991) calls "Perceived Behavioral Control", which is in fact the aspect that relates personal experiences and the obstacles they encounter in acting in a certain way.

When we relate the antecedents of the TPB to the possible solution approaches pointed out by Lockton and colleagues (2008), we see that the main one, in the context of food waste, is the creation of a system that limits and directs the behaviour (*Affordances and constraints*) because this gives the user more control and ease, therefore, can achieve the greatest number of difficulties listed in the context of food waste. On the other hand, we can observe that the *Context-based approaches* solutions are related to the "*Subjective norms*" group, since the context in which the user finds himself is directly connected to the habits and customs of certain social groups. The solutions of the "*Persuasion and Feedback*" group are methods that provide information in the sense of giving the user power of choice about his behaviour from an evaluation of the same; in this way, we can connect this approach to the antecedents of the "*Attitude Toward the Behaviour*", group in which the behaviours are performed from personal evaluations.

When we think about the focus of this research, which is the assistance to the user in reducing food waste in the home kitchen environment, we see that from the paths presented by Stromberg and colleagues (2015), the paths 2 (*Changed use*), 4 (*Mediated use*) and 5 (*Regulated artefact*) are of special importance. They can assist the user in changing choices in the use of a traditional space and represent the support (whether technological or not) that design can give to them in this process of change.

From the schema (Fig. 9), presented previously, created by Hebrok and Heidenstrom (2019), where we can see the decisive moments of food handling practices we understand that our key point of action is in STORING, which indicates the search for solutions that aim to increase visibility. Besides, it is possible to think of allied solutions that help in ACQUIRING, since the proper organisation of stock leads to more adequate planning of purchases and meals. Finally, it is possible to collaborate with VALUING since the allocation

of a proper space for fresh food and the encouragement of care helps to create new values related to food.

Based on the literature review it was possible to understand that within the *nudging* strategies presented by Thaler and Sunstein (2008), we can identify three that are essentials to this research. These were selected because they represent strategies that direct the user's choice through the provision of information (*Understanding Mappings*), the restructuring of the default space (*Default*) and the use of instruments that draw the user's attention (*Incentives*).

- *Default - Padding the Path of Least Resistance:* How to create new standards for kitchen organisation and use?
- *Understanding "Mappings" - From Choice to Welfare:* People have lost traditional knowledge about food handling and storage, find it difficult to care for fresh produce and have little time to select information about it. How to organize information and guide the user to more certain choices?
- *Incentives*: How to create new connections with nature in the home environment? How to encourage the consumption of natural products?

In addition, we selected the four strategies presented by Bhamra and colleagues (2011) which proved to be most useful for our research. Based on the reading of the bibliography and on our intervention scenario, we chose those that (i) complement the nudging strategies selected a priori, (ii) represent alternatives to be implemented in different contexts with or without the use of technology and (iii) represent possibilities of interior design intervention. They are:

- *Eco-Information - design oriented education*: It is necessary to seek solutions that guide users and, at the same time, enable them to manage food more actively, based not only on infrastructure but also on information and education.
- *Eco-choice - design oriented empowerment*: It is important to encourage people to think about the impact of their actions and their ability to change.

- *Eco-steer: design-oriented affordances and* constraints: It is necessary to think about a design of space that guides the user to combat the difficulties that exist in relation to the handling and storage of food, as well as the gaps in family planning.
- *Clever design*: It is imperative to look for intelligent solutions to reduce waste, which do not require the high costs (like the ones found today in some technological equipment) and which can be implemented in different contexts.
- *Eco-technical intervention*: Use technology as a tool to support and encourage good food management, connect the community, and provide information to users.

In conclusion, we sought to translate these strategies listed above, as well as the references found in the market and in literature related to food waste presented in *Table 1*, into practical actions to be considered by professionals in the creative process of kitchen project design:

- To increase the visibility of stored food;
- To improve daily life by creating strategies for stock organisation and management;
- To provide differentiated conditions for different food groups, increasing their life span and ensuring consumer safety;
- To facilitate meal planning, considering the average family consumption;
- To encourage understanding of the value of food and its cycle as a natural product;
- To encourage sustainable food preparation practices;
- To offer conditions for the cultivation of food, such as small vegetables, when possible; and
- To foster exchange and connection with the community.

CHAPTER 3: Kitchen focused interior design

3.1 Brief history of kitchen design

The earliest kitchens of which we have record were simply areas with fires, most often located outdoors, when weather conditions allowed. (Baden- Powell, 2006). Over the years, the space has transformed itself in diverse ways, in different contexts and cultures. We sought to understand how this space has evolved over time, how it is currently organized, and what it means in the family dynamics in the contemporary days, focusing on the Western context, the scenario that is the object of this research.

We started from the assumption that domestic space is an environment for exploring the interface between the future and the past, a picture of how the history of the design can understand human as a social creature (Freeman, 2004). In Bell and Kaye (2002), Bech-Danielsen (2012), Shove and collaborators (2007), and Freeman (2004) we found an investigation of the kitchen as a relevant space in the development of modern society, as well as an exploration of how changes in everyday life over the years have directly influenced the configuration of residential architecture.

In this sense, we add that the kitchen, the act of cooking and the food itself constitute a set of cultural icons, understood as complex metaphors of our society throughout history (Bell & Kaye, 2002).

In more archaic societies, such as the Saxons, Baden-Powell (2006) points out that it was common homes in which food was prepared over central fireplaces in the *living room*, a space with a high ceiling that served as the family's central environment, where everyone also ate at the same table. There were no chimneys and the smoke was eliminated through windows or a hole in the ceiling. Rybczynski (1987) explains that even later, the typical bourgeois family home in the 14th century was characterized by the lack of division between rooms, with a single, multifunctional space, "*the hall*," where the family ate, slept, and entertained. In other words, there was no private space and almost all the family's activities took place in the same space, an environment occupied by sparse and multifunctional furniture.

About this context, Rybczynski (1987) points out that the change in the conditions of domestic life occurred gradually, from the late Middle Ages to the early seventeenth century. Technologies such as the evolution of the chimney, an innovation that allowed smoke reduction in the environment, brought more quality to the kitchen space. However, using Victorian homes as an example, Baden-Powell (2006) points out that during this period, kitchens began to separate from the great halls, especially in upper-class homes. The smells, the heat and all the workflow developed in the space meant that it was considered a dirty environment, to be positioned away from the noble area of the family. The same occurs with the French house: Rybczynski (1987) tells us that the typical bourgeois family houses in Paris, from the 17th century on, started to be arranged around an inner courtyard and the kitchen started to be positioned on the other side of this courtyard, away from the "*salle*" (a space similar to the hall).

In Portugal, Monteiro and Mattoso (2011) point out that "(o)ne of the main changes that occur between the 16th and 18th centuries will be associated with the multiplication of interior divisions and the greater functional specialization of the various compartments"[9] (p. 224). It is important to clarify that the authors refer to large houses, that is, the houses of the Portuguese titled nobility. On the other hand, the same authors state that, both in the city and in the countryside, until the 18th century, dwellings were characterized by polyvalence, a single, multifunctional room that was sometimes occupied by different households.

As early as 1843, Catharine Beecher was one of the pioneers to worry about the quality of the kitchen environment as a working space. The author stated that an adequate kitchen for the American middle class, strategically placed and organized, meant the health of the family, as well as the quality of life of the women who worked in it. According to the author, "(t)here is no point of domestic economy, which more seriously involves the health and daily comfort of American women, than the proper construction of houses" (p. 258). Besides proposing solutions for the organization of the kitchen itself, Beecher (1843) also

[9] Excerpt translated by the author from the original: "(u)ma das principais mudanças que ocorre entre os séculos XVI e XVIII estará associada à multiplicação de divisões interiores e à maior especialização funcional dos diversos compartimentos".

presented, in a very objective way, the position of the room in relation to the dining space, the house entrance and the storeroom, understanding domestic work as a productive system to be organized.

Furthermore, Beecher (1843) claims that domestic service needed to be professionalised and that, women, "in the more wealthy classes, are not trained for their profession" (p.6), which meant a life of hardship for them and their family, because "(t)he person who decides what shall be the food and drink of a family, and the modes of preparation, is the one who decides, to a greater or less extent, what shall be the health of that family" (Beecher, 1843, p. 94).

Moreover, Beecher (1843) was already able to understand that the organisation of domestic space was necessary because the lack of servants was a reality in the United States. The author states that "(e)very year, as the prosperity of this Nation increases, good domestics will decrease, and young mothers are hereafter to be called to superintend and perform all branches of domestic business" (p. 262).

This was a condition that remained, especially on the north American houses, until the early 1900s, as Bech-Danielsen (2012) points out. According to the authors, until this time, it was very rare to see a middle-class bourgeois woman in the kitchen; therefore, having a beautiful kitchen was far from being considered a matter of status. Moreover, the kitchen space, in wealthier homes, was large and servants were cheap, so there was no interest in understanding it as an important workspace.

Baden-Powel (2006) states that the change of scenery that resulted in the concern with the design of kitchens coincides with the industrial revolution, with the mechanization of work and the social implications of this moment. Furthermore, it is relevant to mention that the end of slavery and the increase in salaries are factors that drove the return of the middle class to the kitchen space. According to Bell and Kaye (2002), it was in 1893, during the Chicago World's Fair, that domestic science and home economics were presented as disciplines in the United States. This shows us that the home, more specifically the kitchen space, began to be understood as a working space to be exploited as a promising market, especially for household appliances.

In this sense, Rybczynski (1987) states that, the great change that occurred after the 1900s, in the United States, is the result of a series of economic factors and, above all, "was encouraged by the many books on housekeeping that made their appearance after 1900" (p. 156). For the author, the great novelty in the American house was not the mechanization of work, but a change in the definition of what domestic comfort was.

In this context, it is essential to highlight somewhat later works, such as Lilian Gilbreth and Christine Frederick's *Household Engineering: Scientific Management in the Home* (1919). Bech-Danielsen (2012) states that the authors' work "became almost a bible for architects at the Bauhaus working on developing a modern kitchen" (p. 460). Gilbreth and Frederick, from the influence of Taylorism that was expanding across the United States, drew attention "for the transformation of the home into a site of modern, clean and hygienic, and above all efficient, production." (Bell & Kaye, 2002, p. 50) and, for the transformation of the housewife "into a respectable professional manager of household affairs" (Cieraad, 2002, p. 264).

Baden-Powell (2006) and Cieraad (2002) explain that after the outbreak of the First World War the decline in the availability of women to return to work with domestic service meant that the middle class had to learn to carry out domestic activities without so much help, which reflected directly on kitchen design. In the author's words, "(d)omestic service, once the most respectable job for a working-class girl, became the least desirable, compared to the fixed working hours in offices and factories" (Cieraad, 2002, p. 265).

Inspired by the work of Gilbreth and Frederick, modernist architects found in the kitchen space "an ideal place to demonstrate rational methods and functional analysis to streamline the workflow and optimize use of space" (Bech-Danielsen, 2012, p. 459), transforming it from a “workshop” to a "laboratory- clinically clean" (Bech-Danielsen, 2012, p. 460). The house then came to be planned and organised from a functional rather than a decorative perspective. (Baden-Powell, 2006).

In this context, it is important to mention the creation of the Frankfurt kitchen, in 1926. Influenced by Gilbreth and Frederick, Grete Schûtte-Lihotzky designed the space whose proposal was the creation of the "domestic machine" (Schneiderman, 2010). In the same

vein, between 1932 and 1934, General Electric and Westinghouse in the United States brought together engineers, chemists, architects and kitchen professionals to investigate all aspects of the space and all the work process developed in it.

Besides the space of the kitchen itself, the concern with its position in the house plan, already identified in Beecher's work in 1843, began to be a relevant issue for the architects of the time. Cieraad (2002) points out that the efficient connection between service and family became a key point. She exemplifies this by saying that in the 1930s, a housewife in the Netherlands had to answer the door on average 15 times a day, which meant a great waste of time with the kitchen space far from the entrance. As a result, we see a drastic change in the layout of houses, identified especially from the 1960s onwards.

It was no longer necessary for the middle-class bourgeois housewife to be left in isolation from the kitchen for most of the day, since the emergence of increasingly efficient extractor hoods eliminated the problem of smells. The kitchen then once again became a family space. It remains the domain of women, but the popularisation of eating spaces in the kitchen in the 1950s meant that they were no longer alone in it (Bech-Danielsen, 2012), making it a comfortable environment for social activities.

Therefore, we noticed that when we study the configuration of the current kitchen space, it is essential to understand this historical evolution because, as Freeman (2004) points out, the kitchens we have today are a reflection of the management theories of that time, in addition to technical and aesthetic aspects of the modernist architecture of the 1920s and 1930s.

In this sense, it is important to remember that the way people use the kitchen and how it is organised varies greatly according to the context in which it is analysed. Bell and Kaye (2002) reinforce this point of view by recognising that in European homes the influence of Taylorism and its notions of efficiency is not as direct as in the United States. Furthermore, the authors state that in the former there is "a greater separation of home and work life" (p. 55).

We also add that, although the new technologies of the home were being created with the intention of bringing comfort and ease to women's domestic work and freeing them from

their domestic isolation, Bell and Kaye (2002) state that this was not exactly the result obtained. The authors point out that, to this day, women spend the same amount of time on domestic tasks as they did 50 years ago, which shows that the space, the technologies and the practices created, instead of changing, have reproduced gender differences.

Also in the 1950s, studies at Cornell University resulted in the creation of the concept of the kitchen triangle, in which the relationships between the three main pieces of equipment are explored: the sink, the cooker and the refrigerator. (Baden-Powell, 2006). To this day the concept is one of the main references in the organisation of kitchen design.

In addition, the development of easy-to-clean cabinets and worktops has brought a new perspective to the space, which is increasingly presenting itself as a symbol of pride and status (Baden-Powell, 2006). Bech-Danielsen (2012) explains that as the kitchen became the central space in many homes, they came to be designed with an important aesthetic concern as "(t)hey are 'life-style kitchens', which demonstrate the 'good taste' of the residents and reflect their personalities." (p. 457).

Despite the importance that space has been gaining and the high number of investments that have been made in kitchen renovations and equipment purchases, Bech-Danielsen (2012) states that space has been conceived as a reflection of opinions and personality, and not necessarily durability and working comfort. Bell and Kaye (2002) adds that we still study space with the goal of transforming the act of cooking into domestic science, however, the result we observe is an attempt to make it just a set of artifacts made to decrease human work, but that does not consider the habits and the real daily needs.

Still on technology, Bell and Kaye's (2002) main criticism is related to the lack of connection between the creation of appliances and the social dynamics of space. According to the authors, "(p)reserving the role of food as storyteller and mealtime as a space and site for the production of meaning requires a willingness to think beyond digitally enhancing food preparation" (p. 56). In other words, it is necessary to think of the kitchen space as a place for exchanges, creation and support for everyday life, not as a collection of technological instruments.

In this sense, Shove and colleagues (2007) sought to understand why kitchens, or even parts of them, are, on average, renovated every seven years in the UK. That is, to understand the reasons why this space ended up becoming an environment that reflects consumerism. The authors point out that it is necessary "to understand the multiple types of restlessness and modes of social and material contentment that lie behind contemporary patterns of consumption" (Shove et.al, 2007, p. 38).

Among the several possible explanations for the growing desire to remodel kitchens, Shove and collaborators (2007) highlight some that we present here: (i) the kitchen is a key point of consumer expression and identity; (ii) the kitchen is a reflection of the social, political and economic context surrounding domestic life; and (iii) the emergence of new practices and habits creates new needs that are suppressed by the creation of new cooking spaces and new types of equipment. In summary, the authors conclude that "consumption and practice are simultaneously structured or designed by past experience and by an image (or images) of the future" (Shove, et. al, 2007, p. 26).

Furthermore, Cieraad (2002) demonstrates that one of the explanations for the continuous growth of investment in kitchens and in equipment for this space is that they reflect the aspirations of men who increasingly use the space as a hobby, especially on weekends. The author states that "(t)he aspirations of these hobby cooks demand the purchase of expensive, professional kitchen equipment, similar to a full-blown restaurant" (p. 276, Cieraad, 2002) and, furthermore, directly encourages the creation of the so-called cooker-island, which "causes a complete and costly restructuring of the former kitchen nook" (p. 276, Cieraad, 2002).

It is interesting to note that, as Freeman (2004) explains, Western kitchens today are constituted as a combination that seems to be contrasting, between the space that is "the heart of the home" and the "eating machine". After a brief evolutionary analysis of the space, we can understand the diversity of factors that led to each of these aspects, which also involve the increasing inclusion of women in the labour market, the desire and charm for technology, and, to some extent, the illusion that it can be the solution to all everyday difficulties.

Moreover, it is relevant to mention that, as a dynamic space and a social reflection, there are great differences of this space within the same context and even within the same family. Bech-Danielsen (2012), citing the Italian designer Mondadori (1991), points out the existence of two currents of trends in the early 1990s: (i) the fast-food home, in which food is increasingly heated up to be eaten in front of the television, and the 'convent-home' in which the act of cooking is actually part of the ritual of socialisation and cooking is a true lifestyle.

Shove and colleagues (2007) investigated how the organisation of space relates to the development and persistence of everyday practices and patterns. Bech-Danielsen (2012) explains that social norms and changing everyday practices have altered our view of the home and the way they are planned, with the focus on the kitchen space.

We have seen that thinking about contemporary kitchens means thinking about spaces that are often promoted and represented as spaces of sociability (Shove et. al, 2007). In this sense, Bell and Kaye (2002) present in their research an example of an Italian kitchen, in which everything happens in that room and the table becomes the centre of the house.

Finally, we can observe that the kitchen as a multifunctional space and family meeting centre represents what Baden-Powell (2006) calls a full circle in history. That is, we identify, in a way, a return to the vernacular house, in which the space for cooking represented the centre of the house, a place where everyone gathered around a central fireplace.

3. 2. The stages of kitchen design

In this section we discuss the different stages of designing domestic kitchens, relating them to the topics discussed in the previous chapters. We present references to the parameters and guidelines present in the literature that serve as a basis for the proposition of the guidelines presented in *Chapter 4*.

3.2.1. User and project scenario determination

The initial stage of project development deals with understanding the client's wants and needs, in addition to the moment of predicting how the space will be used. Understanding the kitchen as a space that relates to social norms, practices and daily habits (Bech-Danielsen, 2012) and the domestic food waste, as a result of multiple internal and external factors, we can state that this stage is the key point to draw the action strategies.

Understanding the user and their daily habits as an important initial step in the kitchen design and, especially, for the proper sizing of space for each activity and for the different storage needs. Knowing the needs of this user means "to consider the cultural traditions that will influence how and what your client will prepare" (Beamish, Parrott, Emmel & Peterson, 2013, p. 195). To do this, it is essential that, in a first moment, the professional can understand "(h)ow will the kitchen be used and by whom? What are the clients' particular requirements, if any?" (Baden-Powel, 2006, p. 23). Similarly, Beamish and colleagues (2013) suggest that the professional organises questions, the answers to which are classified between: Goal or Purpose, Objective and Priorities, and Activities and Relationships.

Bell and Kaye (2002) point out that, to design kitchens, it is important to understand what people actually do in their domestic space and design around these activities. Another approach, pointed out by the authors, is to investigate "what people cannot do in their domestic spaces, but for which there is a historic preference or an expressed desire" (p. 58). The authors design a manifesto for kitchens, based on the user experience, proposing guidelines that were important reference for this investigation, which seeks to explore one of the social aspects of design for sustainability, the change of user habits. These guidelines are: (i) value experience over efficiency; (ii) understand the use of objects in context; (iii) consider context to be cultural and dynamic; (iv) pay attention to people and their experiences; and (v) find and support rituals of domesticity." (Bell & Kaye, 2002, p. 60).

3.2.2. Definition of materials and construction methods

The step of defining materials and construction methods tells the professional what their limitations are in terms of layout and furniture design. Furthermore, we can interpret, from the table of Ecodesign Strategies in Vicente (2012), that when we talk about sustainable projects, the choice of materials relates directly to strategies for minimising energy consumption, minimising toxic emissions, using renewable resources and optimising the product's lifespan.

In the Portuguese scenario, it is worth highlighting the importance of the wood sector in the national market. Vicente (2012) states that it represents one of the main employers in Portugal, being one of the country's great economic and environmental riches. The author draws attention to the environmental responsibility of the sector and the positive impact it means on the environment, since managed forests are more efficient than those left in their natural state. In other words, "the creation of value for forests through the use of their wood is a very important factor for their preservation and even a human development factor as long as this is associated with sustainable management"[10] (Vicente, 2012, p. 74). This means that the choice and prioritisation of this type of material in project design is very relevant in this context.

On the choice of construction methods, Schneiderman (2010) concludes in her research that the kitchen is the most successful architectural element in prefabrication. According to Beamish and collaborators (2013), the space has come to be used by different family members, which is why it was necessary to establish measures that, while providing an average level of comfort for most users, facilitate the modular production process. However, Schneiderman (2010) does not actually consider this a success, since setting standards such as height and the location of the modules does not enable the flexibility that the space needs.

On the other hand, thinking about the sustainability aspect, it is important to add that furniture modularisation facilitates maintenance, reconfiguration and recycling, besides

[10] Excerpt translated by the author from the original: "a criação de valor para as florestas pelo uso da sua madeira é um factor muito importante para a sua preservação e até um factor de desenvolvimento humano desde que a isso seja associada uma gestão sustentável".

enabling the best use of resources during production. Such qualities, as we mentioned in the previous chapter, can reduce the environmental impact of this space which has been renovated so frequently in recent years.

3.2.3. Appliance's definition

One of the great challenges in thinking about the contemporary kitchen and the kitchen of the future is, as said in the previous item, in the connection between the creation of a technological space that can support the real needs of people and the practices of the present. In this sense, Bell and Kaye (2002) argue that "(t)he house of tomorrow is a vision perpetually deferred, one that tells us more about the preoccupations of the time than about the designs of the future" (p. 51). In other words, we usually think of the "house of the future" without it being in fact a space of innovative design, with the proposal of creating new habits, but rather as a portrait of our current problems.

When we analysed the references of products that combat food waste *Chapter 2*(item 2.2.2), it was possible to identify many solutions present in refrigerators, such as integrated cameras, transparent doors for internal visualization and mapping systems of the product and the user's consumption. Therefore, we can see two aspects: (i) the importance of these appliances that have been the main solution present in the market and accessible to the consumer, even if restricted to high purchase values, and (ii) the limitations of these solutions, which, as identified in the work of Hebrok and Boks (2017), are little innovative for following acting in the way "within the construction of how a fridge looks today" (Hebrok & Boks, 2017, p. 390).

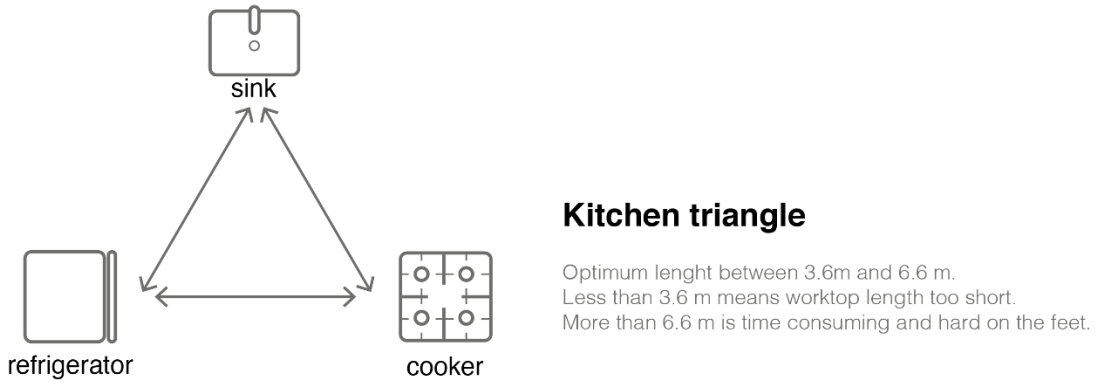
Therefore, the step of choosing equipment in project development is important since, besides being the products that relate directly to the consumer's energy and water consumption, they can be allies in the user's eating practices. Intelligent refrigerators, for example, when well integrated into the user's daily life, can help when buying, preparing and managing food.

3.2.4. Layout and furniture design

The design stage of the kitchen layout, the result of the organisation of the different activities to be developed in the space, is a subject that has been studied for some years. Since 1950, the kitchen triangle, developed by Cornell University, (Baden-Powell, 2006) is one of the main foundations in the organisation of the space. Exploring the three most used pieces of equipment in the space (the refrigerator, the cooker and the sink) the relationships between them are investigated and rules for positioning these pieces of equipment in the kitchen are established. Baden-Powell (2006), in a more recent approach, portrays the concept (Fig. 15).

Figure 15

Kitchen triangle scheme.



Note. Diagram illustrating the kitchen triangle scheme. Adapted from "Architect's pocket book of kitchen design" by Baden-Powell, C., 2006 (p. 32)

Going further, Overhill (2014) explores the distributions established by the triangle from the perspective of proxemics, a term developed by anthropologist Edward T. Hall that refers to the necessary space for a person in a social environment. Despite the limitations of the methodology of the study, developed with a small sample and involving the researcher himself, he identified issues in the kitchen triangle that explores the human body only as a dotted line, without considering its volume in space. Admitting the

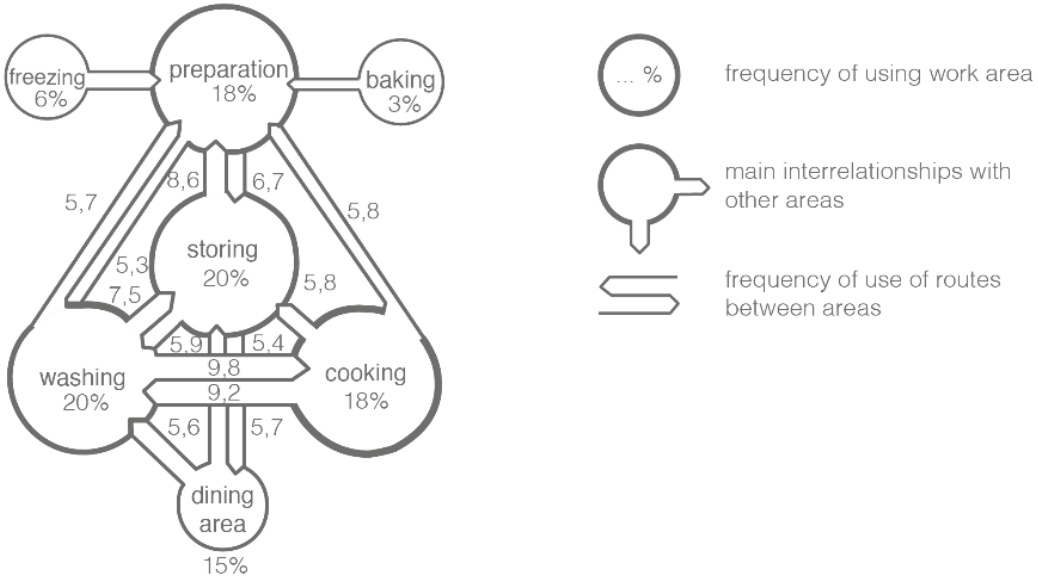
difficulties surrounding proper space planning, Overhill (2014) suggests that "architectural planning should define the "size" of a moving body as a flexible zone of probability rather than as a finite, hard shape" (p. 82).

In this sense, Pohl, Puigjaner and Najera (2012) point out that, although the triangle remains the most common design parameter since the year 1946, this concept has been encountering limitations. This is because kitchen equipment has been changing a lot, as well as the life parameters of the 21st century. According to the authors, "(t)endencies related with mobility, work schedules, or even street food culture can dramatically change the way we conceive the kitchen today, and we can even go further, wondering if there is a need for such domestic spaces at all... at least in the way it was conceived in the middle of last century" (p. 122). Moreover, they conclude that, regardless of the form, architects need to be aware of new dynamics and open to untested options. We consider that sustainable practices, more specifically the one that most interests this research, which is the reduction of food waste, are among the trends that have been dictating new rules to space and raising new alternatives to its conception.

In Neufert and Neff (1999) we find a diagram that divides the activities of space, based on the work triangle, between four main axes: (i) preparation, (ii) storing, (iii) washing and (iv) cooking; and three smaller ones: (v) freezing, (vi) baking and (vii) dining area. In this diagram (Fig. 16) the authors analyse the frequency of use of the different kitchen spaces, the main user routes, and the relationship between them. We highlight that the storage space appears as a central point, connected to activities performed in other four axes.

Figure 16

Use of different kitchen areas



Note. Diagram showing the different uses for the kitchen area, by frequency. From "Casa–Apartamento–Jardim. *Projetar com conhecimento, construir corretamente. " by* Neufert, P., & Neff, L., 1999.

In the manual of kitchen planning, prepared by Beamish and collaborators for the American National Kitchen & Bath Association (NKBA), in 2013, we find guidelines for professionals in the sector with the objective of ensuring that "the space meets the needs of residents and is truly functional" (Beamish et. Al, 2013, p. 195). About the organization and optimization of tasks in the kitchen space, the authors rely on the concept of work centres, in which certain types of tasks are grouped inspired by the triangle composed by the main kitchen equipment. Each of these centres is presented below:

Sink centre: *"is the most used centre in the kitchen because it is the place of both food preparation and clean-up*" (Beamish et al, 2013, p. 210).

- Activities: food preparation (e.g. sanitising, cutting, using water for cooking), cleaning and general activities (e.g. drinking a glass of water, arranging flowers, cleaning hands).

- Recommendation for location: it should be positioned at the centre of the kitchen, at the most accessible point, and between the cooking area and the food storage area.

Refrigerator centre: "(it) can be considered a somewhat passive centre" (Beamish et al, 2013, p. 218). The relevance of its location is related to the organisation and experience of the cook. An organised person needs to access it only once while cooking a meal, while a less organised person needs to access it several times.

- Activities: food storage in refrigerated areas.
- Location recommendation: it should be positioned at one end of the kitchen layout so that the unit, which is typically tall, does not interfere with the workflow in the room. In addition, it should be accessible for family members to serve themselves or prepare to serve the table.

Cooking centres: “(w)hile the sink centre may be the most frequently used area in the kitchen, the cooking centre or centres may be the true heart of the kitchen” (Beamish et. al, 2013, p. 221).

- It can be divided into other centres, according to the family's habits:
    - Surface cooking
    - Oven cooking
    - Microwave cooking
    - Speed cooking
    - Small appliances
- Location recommendation: it should be positioned considering the position of the sink so that there is no obstacle between the two, as the cook is used to standing between these two centres most of the time.

Furthermore, Beamish and colleagues (2013) propose that the combination of these different centres should be thought of considering the main workflow: Gather → Prepare → Cook → Serve → Clean-up. In addition, multiple cooks need to be considered and for this, the authors guide that multiple triangles and independent flows need to be planned.

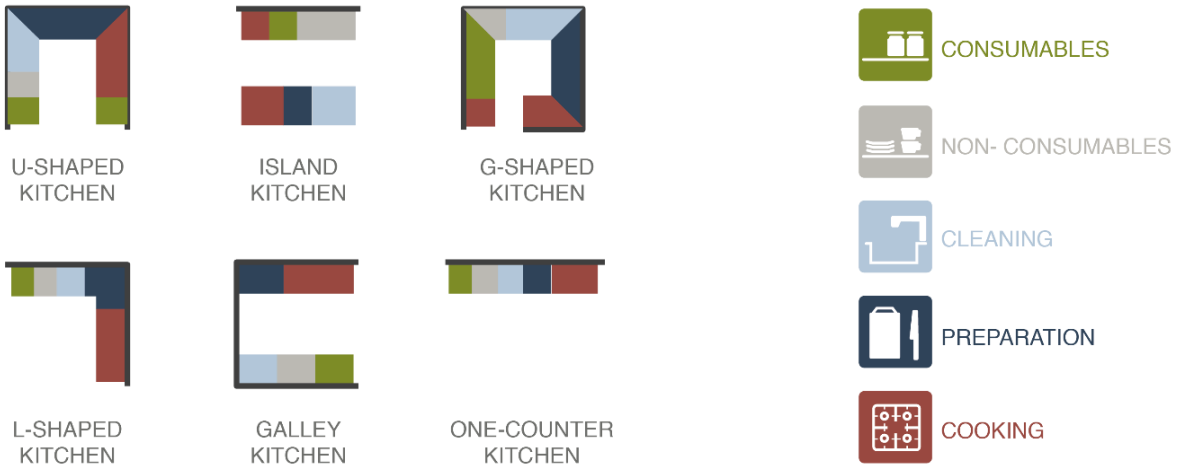
Currently, one of the great researchers of the kitchen space is the American company Blum, which in recent years has dedicated itself to the investigation of the user's needs for the

creation of products aimed at what, according to them, are the main characteristics of the kitchen: the simplicity of the workflow, the optimisation of the use of space and the maximum quality of movement in the space. The company has brought their ideas together in a product called *Dynamic Space (Fig. 17)*, whose purpose is to help architects and designers make kitchen space even more practical. In it, the work scheme is divided into five zones, which can be organised in different ways according to the kitchen layout options presented in the same manual:

1. Consumables: space for food storage;
2. Non-consumables: space for crockery, glassware and utensils for food storage;
3. Cleaning: space with dishwasher and sink, and cleaning utensils;
4. Preparation: space for food preparation utensils, located between the Cooking and Cleaning areas.
5. Cooking: space for cooking utensils, with enough space for pots and pans.

Figure 17

Blum Optimal workflows layout

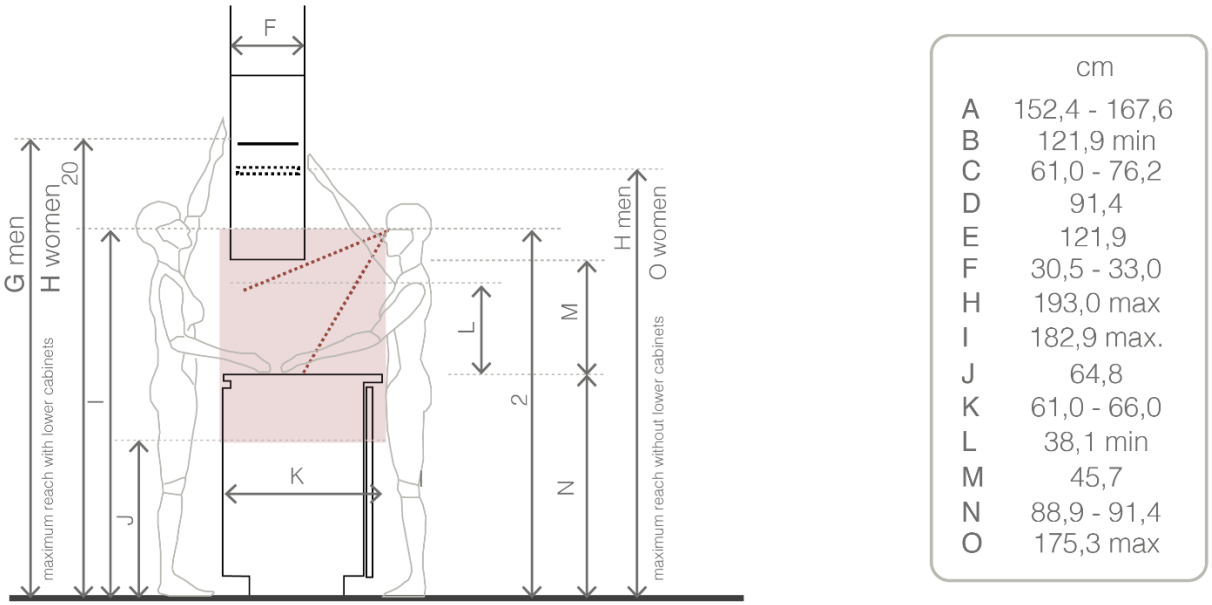


Note. Diagram showing different options of layout, with 5 working zones. Adapted from Dynamic Space,by Blum, n.d. (https://www.blum.com/aa/en/ideas/dynamic-space/workflow/)

When we scale down a bit and approach kitchen furniture design, the literature shows us that there are also important parameters to be used as references. Works like Panero, Slenik and Castán's (1996) and Neufert and Neff (1999) are important references for professionals. In them, it is possible to find a series of drawings with basic measurements that kitchens require. As in this research we focus on the creation of innovative spaces related to the storage of food, we highlight the scheme by Panero and collaborators (1996), in which the comparative reach measurements in the cupboards are presented, in addition to the high visibility area for the user (Fig. 18).

Figure 18

Comparative range in kitchen cabinets

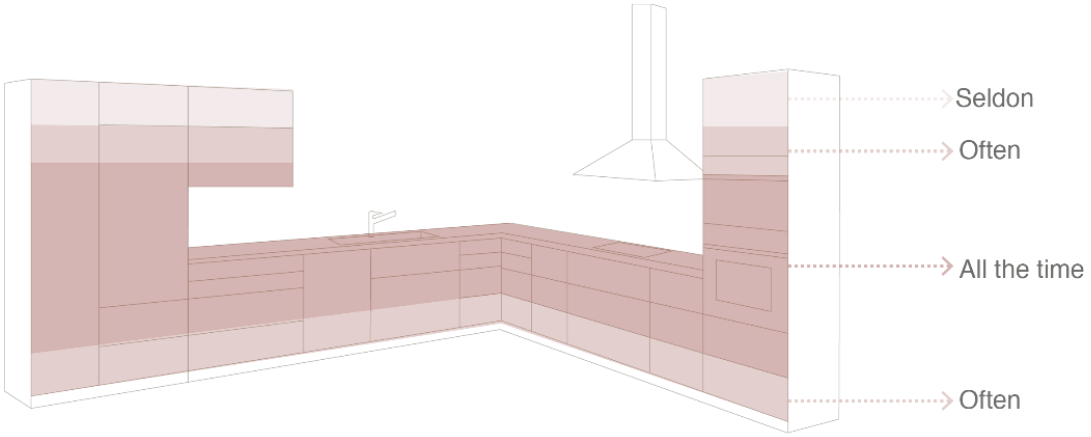


Note: Drawing showing kitchen cabinets dimensions according to the human body. Adapted from" Las dimensiones humanas en los espacios interiores: estándares antropométricos" by Panero, J., Zelnik, M., & Castán, S., 1996, (p. 162)

Just as Panero and collaborators (1996) highlight the user's comfortable reach area, we see in *Dynamic Space*, mentioned above, some instructions to improve access to equipment, utensils and food that guarantee the user's quality of movement. According to the company, the ideal is to keep only drawers in the low units and these should be well organised in order to guarantee good visibility of their contents. Finally, it is necessary to pay attention to the distribution of the items of greater use in the zones of easy access for the user (Fig. 19). Knowing which is the area of greatest access and how to ensure visibility is a particularly important issue for this research, as we seek to define what the ideal space for food is within these traditional rules and parameters.

Figure 19

Blum Ergonomic levels distribution



Note. Diagram showing different levels of distribution of kitchen space. Adapted from Dynamic Space,by Blum, n.d. (https://www.blum.com/aa/en/ideas/dynamic-space/workflow/)

We mentioned in sub-item 3.2.2, which deals with the choice of construction methods, the importance of modularisation in furniture production. In the kitchen space, this modularisation is facilitated by the existence of a standardisation of measures, the result of anthropometric studies which defined comfort parameters for most of the population. Panero, Selnik and Castán (1996) point out that this data only began to be used in 1940,

especially in the aeronautical area, due to the war context. However, it is important to remember that the authors call attention to the fact that professionals should use them only as a support tool, because anthropometric data are not such a precise science.

3. 3. Conclusive summary

During this chapter, it was possible to understand, through literature research, how the Western kitchen space has developed over the course of history and what were the key moments that have defined the configuration of the space as we see it today. We saw a space that starts as a simple fire, a meeting point, becomes a place of heavy and "dirty" work, transits as a laboratory of "housewife" tasks, is incorporated into social environments as a reflection of "lifestyle" and becomes again the central point of the domestic environment.

We understand that the aspects involving the configuration of the kitchen, the act of cooking and the choice of food are cultural factors, strongly embedded in the material culture of the society in which it is inserted. To this day, we see that the innovation that occurred in American homes in the 1900s and added the demands of comfort also for domestic work (Rybczynsk, 1987), is still very strong and is one of the great drivers of renovations. The kitchen is the stage for renovations every seven years on average (Shove, et. al, 2007), and this can be explained by several factors, among which we highlight the constant search for a space that accommodates the permanent emergence of new needs.

We also discussed in this chapter several parameters and rules for kitchen design. Such parameters have their origin with the first authors who started to study the space in search of quality for work traditionally attributed to women, such as Catherine Becker, still in 1843. After her, the work of Lilian Gilbreth and Christine Frederick (1919) was also one of the relevant contributions that culminated in the development of the work triangle, by Cornell University in 1950. Our kitchens are still today a reflection of these investigations (Freeman, 2004) and of technical and aesthetic aspects explored by modernism architecture.

Next, we presented, in a synthetic way, considering the information in the cited literature, relevant aspects that guide the professional in the different stages of the kitchen project:

a. Determination of the user and project scenario: at this stage it is necessary to understand the family's needs which are relevant to the project, as well as their habits. This step is the initial tool for creating a space that is innovative, but above all integrated with the family and consistent with their dietary practices and needs.
b. Defining materials and construction methods: when we think about sustainability, this step becomes especially relevant, especially when we see the high number of renovations of the space. The conscious choice of materials and construction methods means reducing the impact of the project in its whole lifecycle. Furthermore, we approached the importance of furniture modularization as a solution that enables its adaptation and reuse. In the Portuguese case, we highlighted the use of wood as an important design choice because it represents a natural wealth of the country and a great source of local jobs.
c. Appliances definition: in this stage, we approached the importance of seeking an integration between the kitchen appliances and the valorisation of solutions that help in the daily life supporting food practices, especially in the preparation and storage phases. In this sense, we draw attention to the existence of several solutions in the market, especially refrigerators, which help the user to reduce food waste.
d. Layout and furniture design: we presented some parameters to be used as a design tool by the professional. We highlighted especially those related to storage spaces and the guarantee of access and visibility for the user.

CHAPTER 4: Guidelines Definition

4.1. Project guidelines: strategies and principles

In this research, we address the theme of sustainability, focusing on the use phase of the product, with attention to the user's behaviour regarding the choices that the kitchen space provides. We treat waste as a problem that involves the three pillars of sustainability, i.e., not only the environmental aspect, but also economic and social.

We sought to understand how the design professional can help the user in the face of the multiplicity of factors that determine the behaviours related to food waste in the domestic environment. To this end, we selected several strategies and tools from both the sustainability and design fields, analysed references and previous experiences, and translated this information into 9 strategies for kitchen design. We intend these strategies to be useful to professionals who seek a broad approach to sustainability, want to go beyond the choice of materials and energy saving and aim to promote awareness at the time of use of the space.

As in Van Hemel's work (1999), we adopted the term strategy "as potential routes a company can follow if it wishes to apply the principles of design for environment to one or more of its products" (p. 29). In our case, we understood as a *company* the professional of interior design or architecture. Each strategy is composed by a set of principles, which are "described as a potential means of operationalizing or realizing a DFE [Design for Environment] strategy" (Van Hemel, 1999, p. 29).

Furthermore, like Van Hemel (1999), the strategies and principles set out here aimed to ensure their applicability in professional practice and, to this end, they "are expressed in terms of design objectives with a positive environmental outcome" (Van Hemel, 1999, p. 32). This means that they are structured and presented to inspire the professional in the search for new ideas for the creation of the kitchen space.

Our strategies are a design response to the problem of food waste based on the conceptualisation of sustainable development, made in *Chapter 1*. They are the result of the crossing between: (i) the user's main difficulties in relation to food waste, identified

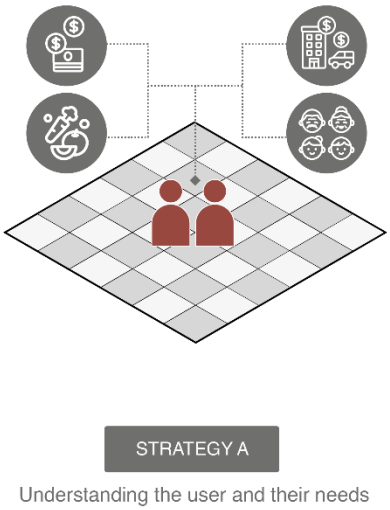
through the literature review, as presented in *Chapter 1*; (ii) the existing strategies and tools in design for behaviour change, as well as the analysis of existing references in the area of design, presented in *Chapter 2*; and (iii) the stages of the kitchen design project, identified and presented in *Chapter 3*, which represent the moment when the professional can make choices capable of directly influencing the use of the space.

Strategy A: Understanding the user and their needs

Comprehending who the project is aimed at, that is, who our target audience is, is the first step towards identifying the difficulties related to that family in terms of food waste. At this moment of understanding, we need to identify aspects directly related to the size of the family, the dynamics of the meals taken by them and what is the interest of the members in the act of cooking and in the search for sustainable food, for example (Fig. 20).

Figure 20

Strategy A



Principles:

A.1. Consider the composition of the family: origin, size and age of the members

In *Chapter 1* (item 1.2.1) we pointed out that the family composition is directly related to the problem of food waste, since aspects such as the origin and size of the family reflect directly on their eating habits. This can be translated by a greater or lesser need for certain storage and preparation spaces, for example.

In addition, we saw in *Chapter 2* (item 2.2.2) initiatives that promote communication and interaction between users, showing that the number of family members can be an indication of how difficult communication between household members and, consequently, stock planning and organisation can be.

Finally, we understood how the age of household members is an important factor to be considered in the project, since the families with children tend to waste more food, mainly due to difficulties related to meal planning. In addition, young people (between 15 and 24 years) corresponded to the highest amount of wastage per food group (*Chapter 1*, Figure 5). These difficulties are, in many cases, a reflection of the lack of preparation skills, which

can result in overcooking and, consequently, in a lack of creativity in the use of food and leftovers.

A.2. Consider family dynamics and habits

As mentioned in *Chapter 3* (item 3.2), the kitchen, the act of cooking and the choice of food constitute a set of cultural icons. Therefore, understanding the habits of the family for which the project is being designed means understanding how the kitchen space will be used and what their real needs are. When we think about the practices related to the use of food and the difficulties each of these users has in avoiding waste, it is clear that there must be different approaches.

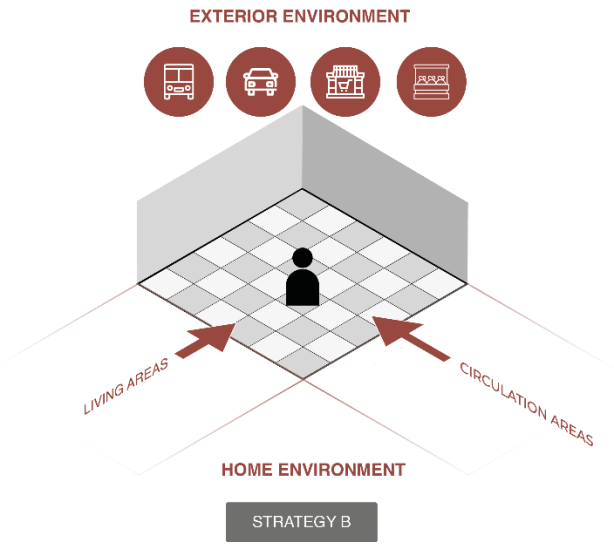
Furthermore, it is essential to remember the aesthetic preferences of that family, since the kitchen, in many cases, is directly connected to social spaces and is increasingly a status symbol, as we also saw in *Chapter 3* (item 3.1). This means a greater or lesser openness of these public to non-traditional solutions, such as those that put food in evidence, for example.

Strategy B: Understanding the context in which the kitchen space is located

The second strategy deals with extrapolating the environment of the kitchen itself and its domestic setting, since eating practices also involve external factors. Therefore, the user's needs and the possibilities of design choices vary according to the context in which they find themselves (Fig. 21).

Figure 21

Strategy B



Understanding the context in which the kitchen space is located

Principles:

B.1. *Consider what the environmental conditions are in the region of implementation of the kitchen*

It is only when we consider the environmental conditions of the place where the projected kitchen is located that we can actually seek solutions that are suitable to factors such as temperature, humidity and lighting, in addition to the choice of project materials themselves. We saw in *Chapter 2* (item 2.1.1.) that the Respect for Place, which means the understanding the design context conditions besides the valorisation of its natural materials and methods, is one of the main principles of the philosophy of sustainable design.

These natural factors become especially essentials in projects where alternatives that favour the storage of more perishable products in the user's sight, that is, outside the fridge, are sought.

B.2. Consider the commercial infrastructure around the residence

We pointed out in *Chapter 1* (item 1.2.1) that accessibility and commercial density have a relevant impact on eating routines. It means that understanding it can reflect on the need for storage space for different food groups.

We mentioned in the same chapter that the ideal frequency of food shopping is between 2 and 3 days, as this time allows flexibility in meal planning. Therefore, we set this time as a parameter for the distribution of storage space, however, it is always necessary to consider the feasibility of this frequency according to the context in which the user is.

Strategy C: Definition of the zoning of the kitchen

This strategy deals with the integration of the food storage space in the kitchen organization system. This means thinking about this space without neglecting important aspects of this environment, which can be interpreted as a workspace, with emphasis on efficiency and user comfort (Fig. 22)

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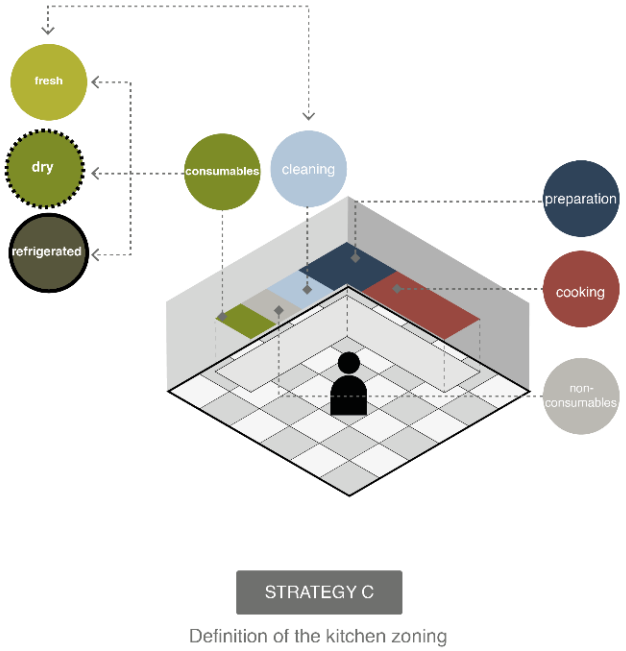
Figure 22

Strategy C



Principles:

C.1. To consider the fresh food storage area as an integrant part of the zoning of the kitchen space; to divide the consumable area between perishable and non-perishable

In *Chapter 3* (item 3.2.4), we presented the zoning of the kitchen, based on the triangle of activities, which divides the environment into three work centres: for cooking (cooker), for cooling (refrigerator) and for cleaning (sink). The relationship between the different centres is explored by the work triangle proposal, so that, from it, different layout possibilities were created in which the activity zones are organised: Consumables, Non-consumables, Cleaning, Preparation and Cooking.

We propose that the layout of the kitchen should be organised considering a division of the Consumables zone between non-perishable and perishable Consumables. The former should be positioned at the traditional points of the Consumables, while the latter should be positioned considering areas consistent with the needs of these types of foods:

- free from heat or direct sunlight;

- in key points, easily accessible to all the members of the family; and
- ventilated.

C.2. Position the fresh food storage area near the sink, the point of greatest use in the kitchen.

Still in *Chapter 3* (item 3.2.4) we presented the different centres that constitute the kitchen space. From them, we saw that the cleaning centre is defined as the focal point, the area that involves the greatest number of tasks and therefore where people spend most of their time.

On the other hand, we saw at *Chapter 2* (item 2.2.2) that one of the focus of design proposals to address the food waste problem at the storing phase is increasing visibility and aesthetic appearance of the food.

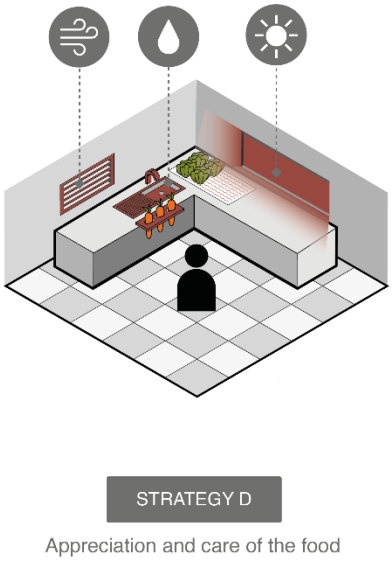
In view of this and with the aim of preventing people from forgetting perishable food, we propose to use the sink centre as the priority space for the positioning of the Perishable Consumables zone.

Strategy D: Appreciation and care of the food

We saw in *Chapter 2* (item 2.2.2) that the less is known about the costs related to the production of food, the more difficult it is for the user to value it, as well as to value its production process and everything that surrounds it. In this sense, we seek alternatives that encourage care with food and the perception of values that go beyond economic ones (Fig. 23).

Figure 23

Strategy D



Principles:

D.1. Provide infrastructure for cultivation: access to natural lighting

We propose the cultivation of food in the domestic environment as an educator, both in the sense of healthier eating and in the appreciation of the natural product. The aim is to create a closer connection between the user and awaken in them a sense of care and respect for the food. Therefore, it is important to provide infrastructure that enables this cultivation and thus encourages the practice.

In cases where it is possible, in the process of distributing the kitchen areas, it is recommended to reserve an area near the windows for cultivation. Even if there is no direct exposure to sunlight, choosing an area where there is natural light is sufficient for growing many varieties of vegetables.

D.2. Providing infrastructure for cultivation: irrigation and water drainage

Another important factor for facilitating food cultivation is the provision of infrastructure related to access to water and sewage. This point must be considered both in the plumbing distribution project and in the design and detailing of the kitchen furniture.

D.3 Promoting active practices of caring for stored food

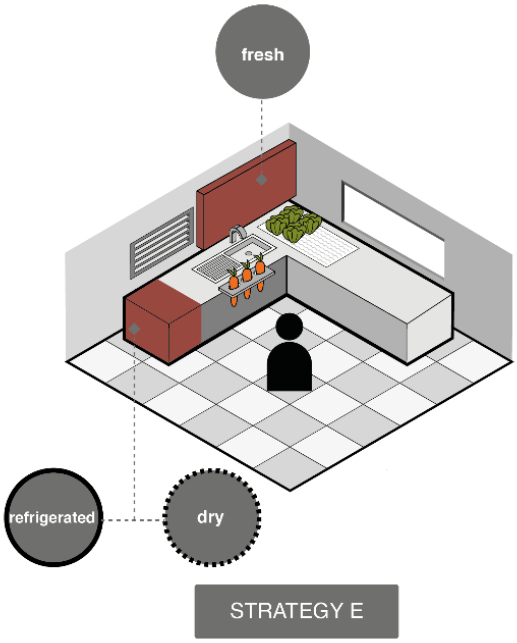
In addition to growing, the incentive to care for what is bought also represents the valorisation of food. In *Chapter 2* (item 2.2.2), we saw references created by Jihyun Ryou (n.d.) in the project *Save Food From the Fridge.* This project encourages active care practices of stored food, such as the water tray that keeps vegetables moist. Similarly, we encourage the search for solutions that jog the user's memory of stored products and create a new sense of caring.

Strategy E. Optimizing the storage of different food types.

This strategy is about guiding the professional in the search for intelligent solutions that manage to exploit the natural conditions suitable for the storage of the different food groups (Fig. 24).

Figure 24

Strategy E



Optimizing the storage of different food types

Principles:

E.1 Consider what conditions are needed for each food group: humidity, lighting, ventilation and temperature

Based primarily on Ryou's (n.d.) work, *Save food from the fridge*, presented on *Chapter 2* (item 2.2.2.) we established a division that guides the organisation of perishable food outside the fridge (Fig. 25). Our proposal is to guide the professional in organizing the space in a practical and appropriate way to these different needs. We group them according to their similarities in storage conditions:

Group 1- Roots: Root vegetables, such as carrots, belong to this group. They must be stored in a ventilated area, in an upright position, with controlled humidity. According to Ryou (n.d.), verticality is an important factor to help this group of organisms save energy and maintain their freshness.

Group 2 - Potatoes: They should be stored in a ventilated area, protected from light and close to Group 4 (especially to apples), as ethylene gas assists in preventing the germination process (Ryou, n.d.).

Group 3 - Onions: Should be stored in a ventilated area, protected from light and with minimum humidity.

Group 4 - Climacteric fruits: "(A)re fruits that ripen even after being harvested"[11] (Bron & Jacomino, n.d., p. 9) and "normally have higher respiration rates"[12] (Bron & Jacomino, n.d., p. 9). This means that they should be stored in a ventilated area, with attention to temperature and at a point of easy access and viewing for the user. When they reach the ripening point, they must be taken to the refrigerator, if not consumed. For example, apples, avocados, bananas, mangoes, papaya and pears belong to this group.

Group 5 - Non-climacteric Fruits: "(A)re those which do not present an increase in the respiratory rate and in the ethylene production" (Bron & Jacomino, n.d., p. 9); that is, these normally arrive at the consumer's home ready for consumption. This group must also be stored in a ventilated area, however, without the need for as much attention as Group 4. Limes, oranges and figs, for example, belong to this group.

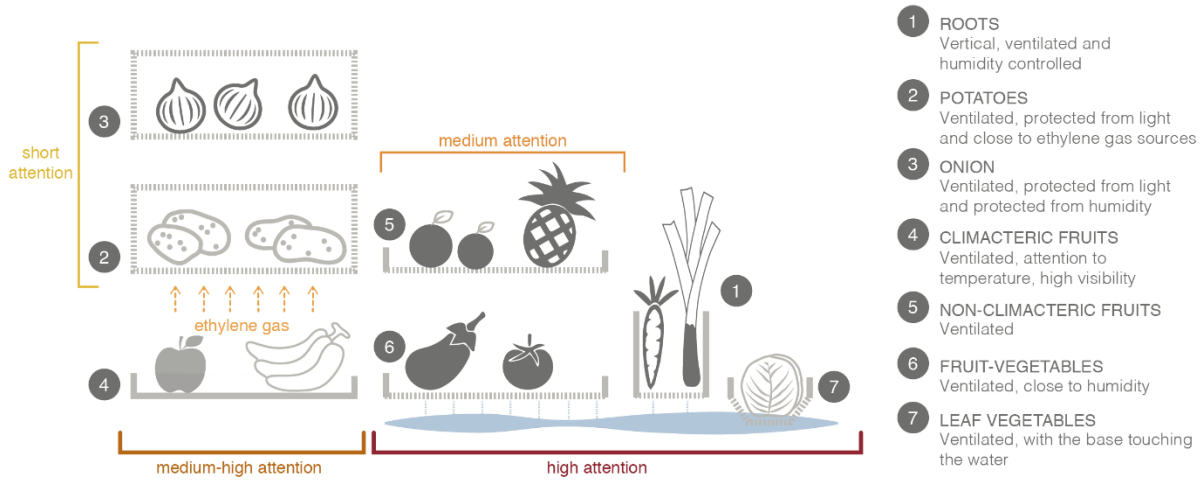
Group 6 - Vegetables-Fruits: They are fruits biologically, but commercially they are called vegetables, such as courgette, aubergine, cucumber and bell peppers. They can be stored outside the refrigerator as long as it is possible to keep them in a ventilated area with humidity to prevent them from losing too much water (Ryou J., n.d.).

Group 7 - Leafy vegetables: This group includes leaves that, joined together as stems, should be stored with a little water to prevent them from drying out, as per *Leafy Base* project reference by Jihyun Ryou (n.d.).

[11] Excerpt translated by the author from the original: “(S)ão frutos que amadurecem mesmo depois de colhidos”.
[12] Excerpt translated by the author from the original: “normalmente apresentam taxas respiratórias mais elevadas”.

Figure 25

Optimizing storage for different food types

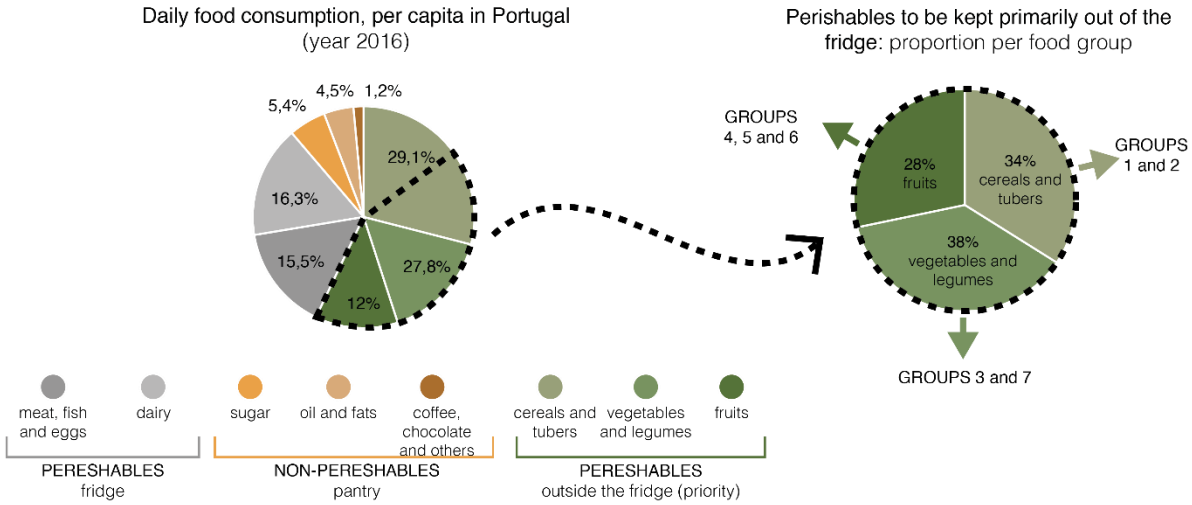


E.2. Providing the necessary space for each food group

From an infographic made by PORDATA (2016), which identified the daily per capita consumption of the Portuguese, divided between food groups, it was possible to estimate the necessary percentage of storage for the groups presented in Principle 5.1. Therefore, we created a reference for the compartmentalization of the kitchen furniture project (Fig. 26).

Figure 26

Food storage distribution



E.3.: Prioritize the choice of food management tools

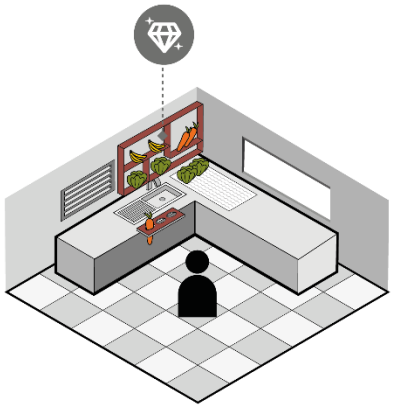
In addition to helping the user create spaces for different food groups, it is important to prioritize the choice of appliances that helps the process of organizing, purchasing and managing stock. This means, for example, favouring the choice, when possible, of refrigerators with mapping technology, mentioned in *Chapter 2* (item 2.2.2.). While providing valuable help, appliances with technologies are not essential, as it is possible to have good food waste reduction results with solutions based on kitchen design and planning.

Strategy F. Visibility and access to stored food

One of the decisive moments in the user's daily life, when it comes to preventing food waste, is storage, as pointed out in *Chapter 2* (item 2.2.2.) In this sense, we state that increasing the visibility and improving the appearance of stored food are critical action points. Based on this, we structured the sixth strategy in the sense of seeking alternatives that work with these objectives (Fig. 27).

Figure 27

Strategy F



F.1. Explore the use of materials with different levels of transparency

It is not always possible to keep perishable foods fully visible, both for reasons of suitability of storage conditions and for aesthetic acceptance by the target public. Therefore, it is important to favour materials which filter visibility and which allow the creation of projects for different contexts.

In the case of the choice of equipment, this transparency can be understood by choosing alternatives with food visualization technology, i.e., refrigerators that have transparent doors or integrated video cameras.

F.2. Explore the use of artificial lighting as a visual tool

Artificial lighting can be used as a focal tool, as in museums or exhibitions where it is possible to highlight objects of value through the lighting design. In other words, it can be used at key points to highlight stored food.

If connected to equipment such as time counters or mobile phones, for example, lighting equipment can, in an automated way, bring information and provide incentives to users. Moreover, its use combined with the use of translucent materials gives the user control over the visibility or not of certain parts of the kitchen, which can be useful especially in the case of environments integrated with the social area.

F.3. To provide adequate lighting for evaluation of foods to be consumed and those to be discarded

Adequate lighting in exposed food storage and handling locations can directly influence the evaluation of the food itself. We pointed out in *Chapter 2* (item 2.2.2.) that the moment of access to food quality and safety are key points among everyday practices. Lighting can be one of the factors that support this moment of decision, valuing the food and keeping its true colouring.

The European Committee for Standardization (2011) establishes that the value of comfort illuminance for performing tasks related to the preparation of fruit and vegetables in an indoor area, namely cutting and separation, is 300 lx. Therefore, we adopted this value as an ideal reference for the illumination of these spaces, besides the use of a light source with a good colour rendering (90+).

Strategy G. Food preparation

In *Chapter 1* (item 1.2.1.), we saw that one of the frequent factors leading to food waste is related to difficulties in food preparation. The process of measuring quantities at the moment of preparation is a complicated task for many users, who end up cooking "too much", which leads to another problem, namely the lack of appetite for the consumption of leftovers and the lack of creativity to reinvent these foods or consume meals that were not in the family planning. This strategy seeks to address the problem by seeking solutions to assist the user in measuring the food, searching for recipes and connectivity with the social environment in which they find themselves as a support to culinary practices (Fig. 28).

Figure 28

Strategy G

G.1. Providing space for tools to help the user measure the food to be prepared

In our analysis of existent products and design projects (*Chapter 2*, item 2.2.2) we saw simple, yet very powerful, solutions created to assist the user in measuring various types of basic food. We propose the encouragement of the use of this type of tools and the search for solutions that can be integrated into the design of kitchens.

G.2. Connecting users from different households as a source of information related to different cooking habits

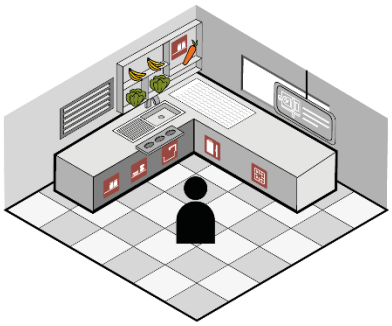
The connection between different households has the power to promote the exchange of habits that are very beneficial to the cause of reducing food waste, as we saw in solutions like Social Recipes (presented on *Chapter 2*, Table 1). From sharing food, in the case of cooking too much food, to sharing recipes and habits that work in families living in similar contexts. Therefore, it is important to seek and prioritise alternatives that encourage these connections, such as fridges that connect to social networks. In addition, it is relevant to think how the domestic space can promote them.

Strategy H. Signage and communication in the kitchen environment

In this strategy, we seek to work on the communication of the space with the users, as well as of the users among themselves. We understand that communication tools are essential to guide the user in the use of the space and for the connection between the household (Fig. 29).

Figure 29

Strategy H



H.1. Signposting the different storage spaces

The signage of the different types of spaces created is an extremely important factor for the success of the project. It is necessary to think of alternatives that guide the user who lacks information and has difficulty in managing food. Facilitating the process of choice, increasing communication and creating incentives for use are key points in the kitchen design.

The references presented on *Chapter 2* (item 2.2.2) showed us that this signalling can be done both in an analogue way, using colours and identification signs, and also via digital,

through the choice of refrigerators, fridge cam or even a cellphone with an app, that map and signal the place of each type of food, for example.

H.2. Define space for interaction and communication between users.

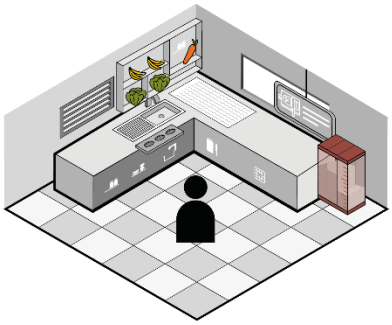
The creation of an interaction space enables increased communication between different family members. In *Chapter 2* (item 2.2.2.) we saw as an example the creation of a map of the fridge that served as a guide that avoids confusion towards buying food that was already available or even cooking when meals were already prepared. Similarly, we propose that the kitchen should have a space that guides and communicates, a space that helps users who do not meet to know if the food has been there for some time or if it is newly arrived, for example.

Strategy I: Household waste perception

In *Chapter 2* (item 2.2.), we addressed the gap between environmental awareness and responsible behaviour. Often the user does not realise the impact that individual action means and/or is not really willing to make significant changes in their lifestyle. In this strategy, we seek to assist the user in the perception of household waste, both in the dimension of the problem and in the understanding about the difficulties that lead to it (Fig. 30).

Figure 30

Strategy I



I.1. Create space for differentiated rubbish disposal

When we talk about the reduction of the waste production, and here we also include the organic rubbish resulting from the food waste, the incentive to the differentiation presents itself as an aid so that the user can understand what his waste is composed of and then think of effective reduction actions. In this sense, the creation of infrastructure to support the differentiation of waste, as we saw on initiatives presented on *Chapter 2* (item 2.2.2.) can help reduce waste, since the user is able to visualise the problem and more easily see the results when the family begins to opt for more responsible choices.

I.2. Encourage the choice of appliances with technology to map discarded rubbish

In *Chapter 2* (item 2.2.2.), we saw two alternatives that work with discarded waste mapping technologies. One of these, Ecomate, works to assist the user in understanding the composition of his or her waste. The other, BinCam, works connected to social networks in order to make the user behave based on social evaluation, that is, to be concerned about what others think of what they discard. These two approaches demonstrate that

encouraging technologies with waste mapping, as well as stock mapping, are important in the fight against waste.

I.3. Encourage the choice of appliances that assists the user in understanding their daily consumption

In Strategy E, we dealt with stock mapping as an important tool to assist in stock management and in the purchasing process itself, seen in references such as Fridge Cam or even the integrated chamber of some of the refrigerators presented in the reference analysis of *Chapter 2* (item 2.2.2.). However, besides helping the user in the buying process, in this strategy we deal with another very important aspect: giving the user tools to understand what the family's eating habits and choices are, in order to make him/her able to identify which are the key action points to modify the patterns.

4.2. Evaluation of strategies

After defining the strategies, we sought to validate them by implementing an online survey with professionals in the sector, who are the target audience for the results of this research. Our objective was to obtain information related to:

- *Clearness*: to understand if they are clearly described, so as to be easily understood by their users;
- *Applicability*: to understand if the professionals are able to visualize ways of making them operational and what are the difficulties and/or opportunities related to this;
- *Acceptance*: to understand if the professionals would be willing to implement them and if they believe that clients would be willing to accept them;
- *Motivation/inspiration*: to understand if they represent a benefit to the professional and to the resolution of the problem, if they inspire the search for new solutions and motivate different creative methods.

4.2.1. Sample and evaluation method

We chose to implement an online survey, applied only in professionals with experience with architecture or interior design. The choice of this implementation format was due to the limitations of time and face-to-face contact in the period in which this research was developed. The restriction of the social profile of the sample (only professionals in the area) was justified by the fact that only people with previous experience in kitchen design would be able to evaluate the mentioned aspects.

The survey was composed of three parts: the first part consisted of questions that sought to establish the interviewee's socio-demographic profile; the second part consisted of an individual evaluation of each of the strategies; and the third part was an evaluation of the set of strategies. The participant's evaluation was only based on the description of the strategies and not from an example, to avoid any type of biases.

For the individual evaluation of the strategies (second part), we structured the survey considering each one of them as a product to be evaluated by the users (in this case, the professionals of the sector). We used a product evaluation questionnaire (User Experience Questionnaire), created by Martin Schrepp (2018), in which each feature is evaluated on a seven-point semantic differential scale. According to Schrepp (2019), the seven-point scale is the most appropriate as it avoids the user's neutrality tendency, since there are less options located at the central area. Furthermore, Maitland (2009) points out that scales with many points are inappropriate for assessing attitudes and behaviour since it demands too much by forcing respondents to make a fine distinction that is often not possible.

As we needed an evaluation of 9 strategies, it was necessary to select among the various characteristics evaluated in the UEQ questionnaire those that were the most important, to avoid a very long and tiring survey. Thus, the following were evaluated: Perspicuity (Complicated - Simple / Confused - Clear), Dependability (Obstructive - Conducive), Stimulation (Demotivating - Motivated) and Novelty (Conventional - Original).

Finally, in the third part of the survey, we sought to understand how the set of strategies is evaluated by users. That is, what is their applicability in the professional's daily life and what is the professional's intention to implement them. At this stage, we chose to use a

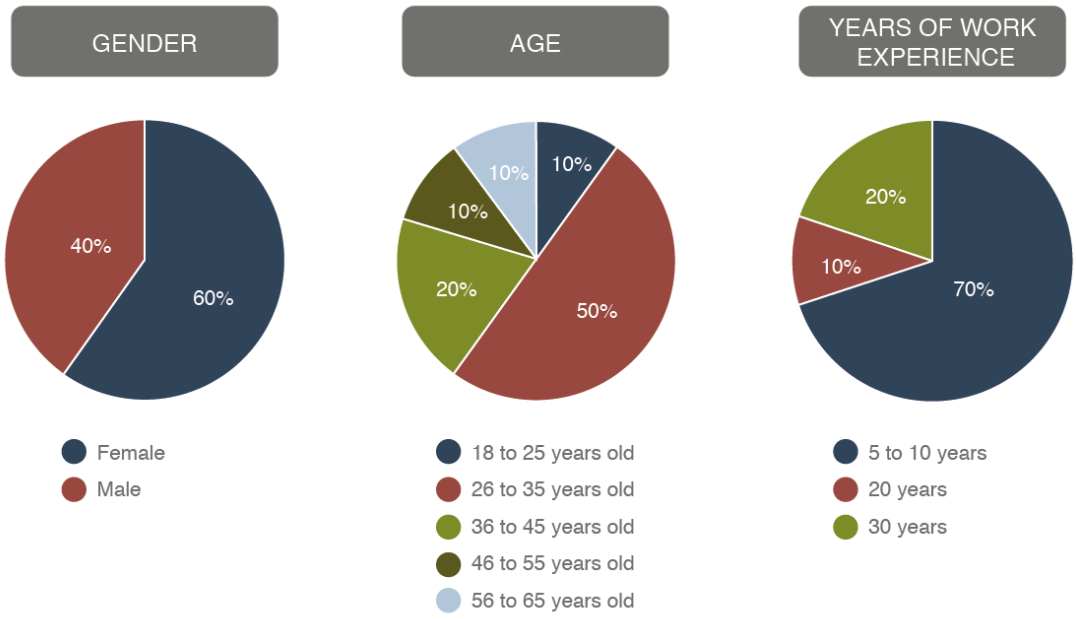
Likert response scale, frequently used for measuring attitudes in survey research (Maitland, 2009). Favourable statements were presented to be evaluated on a five-point scale, ranging from Strongly Disagree to Strongly Agree.

4.2.2. Results of the survey

We sought to collect information from a diverse public, composed of professionals who work in varied contexts and that have a diverse background. The questionnaire was answered by ten professionals, being six women and four men. Five respondents were between 26 and 35 years old, two were between 36 and 45 and three were between 18 and 25, 46 and 55 and 56 to 65 years old. Most of them (90%) have architecture as their area of training and are currently working in Portugal (40%), Brazil (40%), France (10%) and Germany (10%) (Fig. 31).

Figure 31

Results of the questions related to gender, age and years of experience of the respondents



All strategies were individually evaluated in a mostly positive way. Most of the answers were to the right of the scale, which represents a positive characteristic. The full results are available in *Annex 1*.

In the first aspect (Obstructive/ Supportive), we sought to understand to what extent the strategy means a limitation to the creation of solutions and to what extent it leads the professional in the search for innovations. We highlight *Strategy F (Visibility and access to stored food)*, evaluated only positively (on the right of the scale). In addition to it, *Strategies G (Food preparation)* and *H* (*Signage and communication in the kitchen environment)* showed primarily positive results, with only 30% and 10% neutral, respectively. We think that this result can be related to the fact that the latter two strategies cited are more unusual practices for professionals, which can mean an inspiration for the search for new and creative solutions.

In the second aspect (Complicated/Simple) we sought to assess the difficulty or ease of implementation of the strategy. *Strategy B* (*Understanding the context in which the kitchen space is located*) stood out, with 90% of positive evaluations and 10% neutral. Furthermore, we draw attention to Strategies D (*Appreciation and care of the food)* and G (*Food preparation)*,in which 40% of the respondents evaluated them negatively. It seems to us that the predominantly positive evaluation of *Strategy B* can be explained by the fact that it is more common practice in project development, even if for different purposes.

The third aspect (Confusing/ Clear) dealt with the professional's ability to understand the strategy in a simple and direct manner. Except for Strategy G (*Food preparation*), in which 40% of the professionals evaluated negatively, all strategies were evaluated as mostly clear.

In the fourth aspect (Demotivating / Motivating), we sought to evaluate whether the proposed strategies mean a source of inspiration or inhibition for professionals. In most of the strategies this aspect was evaluated very positively. We draw attention to Strategies F (*Visibility and access to stored food)* and I (*Household waste perception)*, which presented 20% of respondents with negative evaluations. We believe that the positive priority result may be related to the professionals' acceptance of the set of strategies, as well as the motivation may be connected to the discovery of an aspect little explored in the space, which is the issue of food waste.

In the fifth and last aspect (Conventional / Inventive), we evaluated the degree of novelty of the strategy, as well as the familiarity of the professional with what is being proposed. Among all the aspects assessed, this is the one in which we found more values to the left or middle of the scale. In Strategies A (*Understanding the user and their needs)*, B (*Understanding the context in which the kitchen space is located)*, C (*Definition of the zoning of the kitchen)*, G (*Food preparation)* and I (*Household waste perception)* at least 40% of the respondents evaluated as Conventional or Neutral. This result may be related to qualitative comments that were made to the effect that some strategies (such as A, B and C) are already considered at design stage.

We also obtained valuable information in the part where the respondent was given the possibility to make comments or suggestions regarding the strategies evaluated For Strategies A (*Understanding the user and their needs)* and C (*Definition of the zoning of the kitchen)*, we received feedback that demonstrated that these are common practices in the profession, since knowledge of the user would be a "minimum and usual requirement". There were also comments to the effect that careful planning of kitchen space requires adequate definition of storage spaces.

In Strategy B (*Understanding the context in which the kitchen space is located*), which relates to the importance of studying the project context, we obtained comments from professionals who reported not being in the habit of considering the commercial infrastructure when thinking about solutions for kitchens. Moreover, it was added that this infrastructure analysis could also involve the perception of the presence of urban gardens and green local markets.

In Strategy D (*Appreciation and care of the food*), which deals with valuing and caring for food, it is interesting to mention the suggestion to include the compost bin as an important gaining factor in the perception of being organic. Furthermore, some professionals drew attention to the need for educational support to the user, so that he can in fact take advantage of the proposed system. Another important piece of information acquired is that this strategy can be extended from the interior of the kitchen to the design of the house as a whole and can be connected to decisions related to the projection of windows and connection with external gardens, for example.

In Strategy E (*Optimizing the storage of different food types*), related to the optimization of the storage of different food types, we obtained comments that foresee difficulties in adapting the proposed system when faced with changes in eating habits (more restrictive diets or changes in family composition, for example). In addition, one professional drew attention to difficulties related to costs and to clients' awareness of needs that are not yet seen as essential.

Strategy F (*Visibility and access to stored food*), which deals with increasing the visibility of food, received very positive comments, such as "the easiest to implement". This probably occurred because it is one of the strategies whose implementation is widely explored in solutions present in the market (refrigerators with transparent doors, for example), which makes professionals familiar with it.

In Strategy G (*Food preparation*), which deals with helping with food preparation, we found comments that question the role of the kitchen space in connecting the different households and how the professional can help with preparation, since the definition of utensils is left up to the client. We had already seen in the evaluation scales that this strategy presented a high number of evaluations in the characteristics Confused and Complicated. We understand that this strategy is the most challenging, since it demands the proposal of solutions which are far from the kitchen format we are used to.

In Strategy H (*Signage and communication in the kitchen environment*), related to signage and communication between users, it was relevant the comment that highlighted the difficulty that any type of information, whether graphic or otherwise, has in overlapping with the strength of the routines of the domestic environment.

In Strategy I (*Household waste perception*), which deals with the perception of waste, professionals perceived the importance of organizing and managing the production of waste, but draw attention to the obstacles that are often imposed by the infrastructure outside the home environment. In other words, the space and the equipment may support the organization and separation of rubbish, but if there is no selective collection in the vicinity of the house, this task will hardly be performed.

Finally, we saw that, after reading and evaluating the whole set of strategies, the professionals showed willingness to implement them in their projects. We obtained comments that classified the set as interesting and innovative, and recognised its relevance in addressing an important theme, still very little explored.

From the general evaluation of the set, we identified that the main difficulty foreseen by the professionals is the awareness of clients regarding the problem of food waste and the importance of innovative design solutions. We identified insecurity regarding the economic feasibility of implementing the strategies, as 50% of the respondents assessed this question in a neutral way. Furthermore, 30% disagreed that clients would accept the related burden. Regarding the aspects that influence client acceptance, professionals believe that it is mainly Economic (45%) and Environmental Awareness (40%).

CHAPTER 5: Kitchen project: The fresh exhibit

5.1 Ideation process

The initial step of the project ideation process was the definition of the requirements and questions that we sought to answer, which went beyond our guidelines, since it is a model project for a specific public. These are:

- Adaptability: possibility of implementing the solution in varied scenarios and dimensions, in order to guarantee access to a wide public and as 'future-proof', as possible through the use of a modular equipment;
- Convenience: thinking of a solution which is easy to use and understand. Provide conditions so that the space is a tool and not an obstacle to day-to-day food handling;
- Comfort: to be comfortable both to the physical and psychological needs of the user so that the execution of the activities is done without stress or great difficulties;
- Durability: to propose solutions made with durable materials, but, at the same time, with sufficient adaptability so that they can be used, even if there are changes in the lives of their users; and
- Simplicity: to guarantee the functioning of the proposal in a simple and low-costly way, that is, without depending on little accessible technologies.

Therefore, we developed a creative process that sought to respond to these needs through a multilevel approach focusing on the qualities pertinent to more sustainable projects and the strategies outlined in this research. The sketches developed during this phase can be seen in the *Annex 2*.

5.2. Proposition

We call our proposal *The Fresh Exhibit Kitchen*, a space that portrays a system implemented in a layout with minimal dimensions, ideal for a family consisting of a couple with a child.

Our concept was structured from the creation of a privileged space for the storage of fresh food. In this proposal, fruit, vegetables and legumes are part of the visual composition and

the identity of the kitchen and have space allocated and organised according to their different needs (e.g., lighting and humidity), in order to maximise their durability outside the fridge. (Fig. 32)

Figure 32

The Fresh Exhibit Kitchen – Project Overview

5.2.1. Zoning

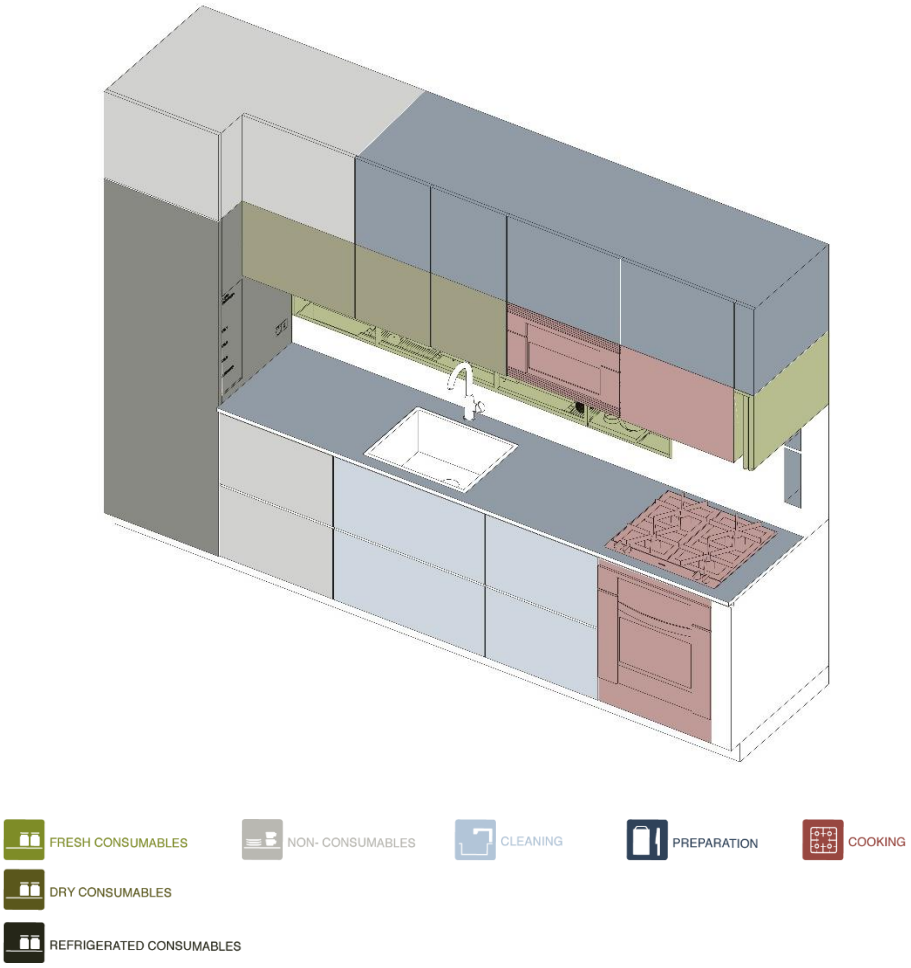
We divided the kitchen space into zones based on the references mentioned in *Chapter 3* (item 3.2.4) (Fig. 33).

In the central area, of maximum visibility and close to the sink, is the storage space for the most perishable foods, those which need the greatest attention from the user. In the centre of the kitchen is the sink area and, in the cupboard below it, there is the cleaning and waste disposal area. To the right, in the cupboard below the sink, is the dishwasher and, just above it, the microwave and the storage space for preparation utensils. To the left of the sink is the space for non-consumables, such as dishes and glassware. At the left end of the countertop is the storage area for food to be refrigerated, which is high and therefore

always at the ends so that it is not an obstacle in the workflow. At the right end of the worktop is the cooking area, consisting of the oven and hob.

Figure 33

Kitchen space zoning



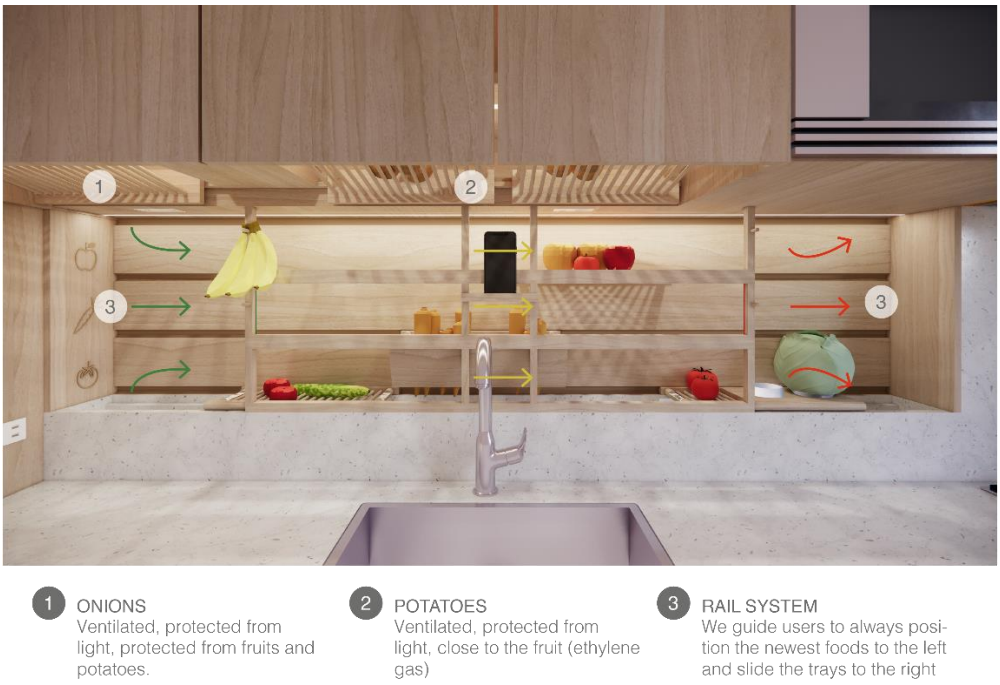
5.2.2. The rail system

We took advantage of the space located behind the preparation worktop, next to the sink, to create a rail system in which modular trays and baskets always run from left to right.

Our proposal is to aid the family's communication, establishing a routine in which new food always enters on the left and runs to the right as it's time to be eaten(Fig. 34).

Figure 34

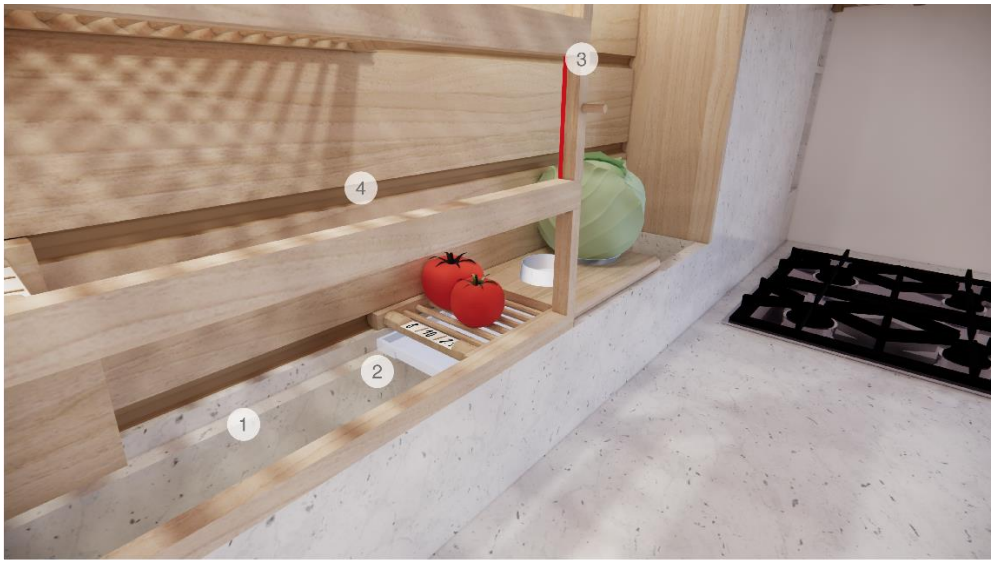
The perishable food storage system



In addition, we created a signage system that guides users to always position the food considering its need to be closer to humidity, isolated or protected from light. This signage is provided both by the use of graphic symbols and the choice of materials. Therefore, the area finished in raw wood is intended for food and the area finished in white paint is intended for domestic utensils (Fig. 35, 36, 37, 38 and 39).

Figure 35

Detailing of wet area and signage



1 WET AREA
With water draining point

2 SUPPORT FOR WATER TRAY

3 SIGNALLING
Red: to be consumed with urgency

4 TRAY SUPPORT RAIL
Semi-circular trench with metal coating for protection against humidity

Figure 36

Detailing of mobile phone support and socket

1 CONNECTIVITY
Support and socket for mobile phone or tablet

2 MODULE 2
Root support with vertical storage priority

3 MODULE 1: CLIMATERIC FRUITS
Ventilated, high visibility, do not spoil the other vegetables.

Figure 37

Detailing of the family planning mural

1 FAMILY PLANNING MURAL
Close to the fridge

2 INSTRUCTIONAL SIGNAGE

Figure 38

Dry food storage space

Figure 39

Modules options for trays

5.2.3. Project Detailing

We opted for the organisation of the layout in a single wall to facilitate adaptation and implementation in different scenarios. We used as a reference for sizing the width of the cabinet modules (60 and 80 cm), the measurements used by the Swedish company IKEA, which, according to a report made by the Portuguese DGAE (Direção Geral das Atividades Econômicas) in 2017, is the largest furniture company in the country.

The system has a total depth of 80 cm, so we were able to guarantee a depth of 60 cm for the worktop area and 20 cm for the food organisation system.

The materials present in the project are:

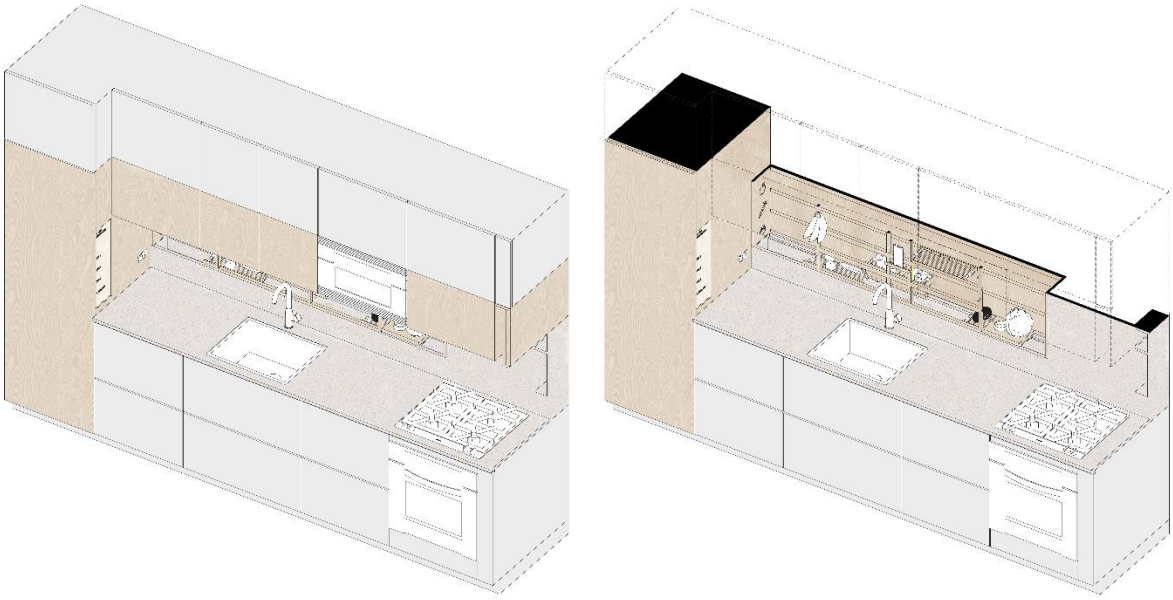
- National wood: present in the whole structure, in the cabinet doors and in the modules for the trays.
- Stainless steel: present in the sink and faucet, besides the rails to protect the wood and facilitate the use of the system.
- Corian ®: present in the worktop. According to the manufacturer, in addition to the qualities that the material has in terms of hygiene and resistance, it is made with up to 20% recyclable materials and can be easily repaired, refurbished and reused countless times.

It is important to add that the solutions and concepts proposed in this project can be adapted to different material choices. We understand that these definitions are very much related to the manufacturers' limitations and the reality of project implementation.

The technical drawings of the project, still in the preliminary design phase, are in *Annex 3.* In addition, we present below a perspective (Fig. 40) that helps to understand the system.

Figure 40

Axonometric perspective



5.3. How does the kitchen project respond to the guidelines?

Below we briefly present how we sought to respond to each of the proposed guidelines in this research:

Strategy A: Understanding the user and his needs

We considered as target audience of this project a family of a couple with a small child. Therefore, we searched for a solution that helps planning, privilege communication and collaborate with the busy daily life. We favoured simple and practical ideas that facilitate the daily life of a family that works, has difficulty preparing food and suffers from forgetfulness of poorly stored products. We can identify them in:

- The use of the family planning mural as a space for exchange and communication between its members. Positioned in a strategic area, near the fridge, it directs users to plan meals for the next three days (number of days with easy forecast of the family schedule), define priorities and urgencies and save ideas for the next days.

- The use of a sliding rail with module trays for storing fresh food. It helps communication and organisation as it directs the organisation of the food between fresh and old.

Strategy B: Understanding the context in which the kitchen space is located

We used this strategy to choose the materials that integrate our proposal, as well as its constructive system. In this sense, we made the following proposals:

- The use of wood as the main material to be worked with. As we mentioned in *Chapter 3*, the material has significant participation in the Portuguese industry, besides being a solution easily worked by the local workmanship.
- Module drawings widths (60 and 80 cm) were derived from existing units in the Portuguese market. This choice, besides facilitating the project implementation, allows the adaptation of furniture already available in Portuguese homes.

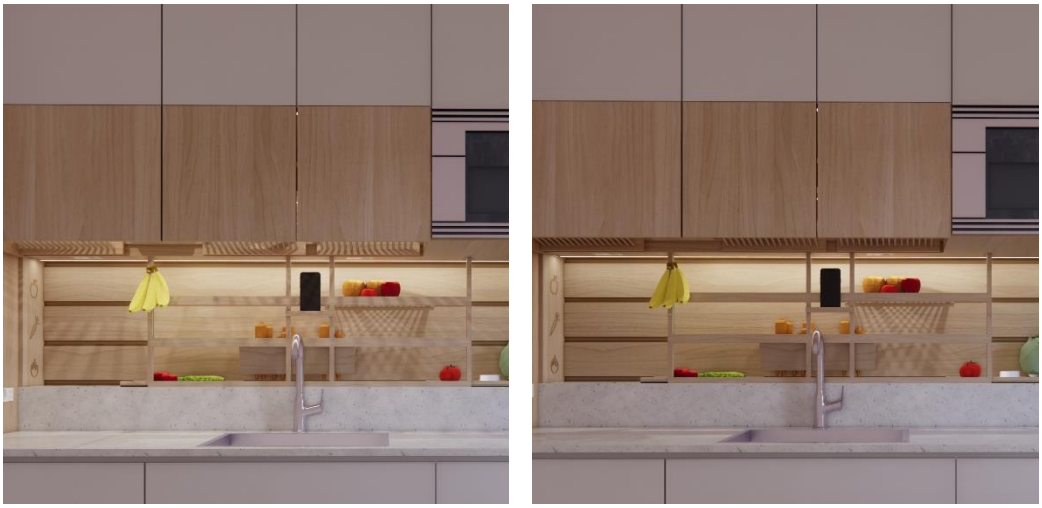
Strategy C: Defining the zoning of the kitchen

We implemented this strategy by defining the area for food storage at eye level and at key points for user access:

- The most perishable (fresh) foods were positioned along the worktop, always exposed in front of the sink.
- The non-perishable foods (dry), as well as those that need to be protected from light (onions and potatoes), were placed in cabinets that are seen whenever users need to access any utensil or dishware. Furthermore, we proposed a responsive lighting system for the onions and potatoes area that can be switched on whenever the space is occupied, flashing every half hour so as not to let users forget them (Fig. 41).

Figure 41

Lighting system



Strategy D: Valuing and caring for the food

The answer to this strategy was inspired by the work *Save Food from the Fridge*, Jihyun Ryou (n.d.), where we were able to find strategies that instigate the care with food. We proposed:

- The use of a wet trough, in which a tray of water can be positioned under the modules to ensure the freshness of the food and promotes user care, as this water must be changed regularly. Moreover, this same trough can be used for growing herbs, according to the presence or absence of natural lighting of the context in which it is designed.
- A learning experience, since the use of the rail system provides users with an apprenticeship in the sense of adapting the positioning of the different types of food according to the climatic conditions and the state of ripening of the food. Our proposal was to create a space that is educational, but at the same time flexible to different needs.

Strategy E: Optimizing the storage of different types of food

We responded to this strategy by creating a system consisting of a space with different storage conditions. We support the use of this structure by the creation of a communication system that educates and guides the user. We have the following areas:

- Lower trough area (humid): destined for fruit-vegetables (such as tomato, aubergine), leafy vegetables, with the possibility of being with the feet in direct contact with water and the cultivation of small vegetables.
- Intermediate rail area: destined for non-climacteric fruits (those that are not in the ripening process and therefore do not need to be isolated from other vegetables) and for box modules that allow roots (such as carrots, leeks) to be positioned vertically and kept close to the controlled humidity.
- Upper rail area: destined for climacteric fruits (such as bananas), it is in a high visibility position, as it is intended for foods that are still in the ripening process. Besides, they are in an area close to the potatoes and isolated from other vegetables that may be harmed by the high presence of ethylene gas.
- Area for potatoes: it is a ventilated space, protected from light and close to the fruits in the upper trough.
- Area for onions: it is a ventilated space, protected from light and from contact with the potatoes and fruits in the upper trough.

Strategy F: Visibility and accessibility of stored food

The answer to this strategy lies in the choice of space for the positioning of fresh foods, as well as in the solutions proposed for dry foods. In can be found in:

- The use of the rail system as a highlight in the aesthetic composition of the kitchen.
- The choice of the area near the sink as storage space for fresh goods.
- The choice of sharing the cabinets for dry foods with those for the preparation tools. We designed a cabinet in which food remains ventilated and protected from light and, at the same time, is not forgotten because it is visible whenever meals are being prepared.

- The use of lighting as a tool to highlight the areas where consumables are stored.

Strategy G: Food Preparation

We responded to Strategy G by providing infrastructure that supports the user's connection to social networks and other households. This is:

- The mobile phone or tablet holder and sockets located in front of the sink, such as a stand and the presence of sockets. It assists the user in finding information, which helps them to overcome preparation difficulties, such as accessing recipes and video tutorials on websites or even connecting with friends or family.

Strategy H: Signage and communication in the kitchen environment

The communication system thought to respond to Strategy H is composed of the following solutions:

- Use of the family planning mural as a space for exchange, communication and between its members.
- Use of labels positioned on the mobile trays designed for the user to fill in with the date on which the purchase of that food was made.
- Use of colours (red, yellow and green) on the vertical structures to guide the positioning of the trays in the rail system.
- Orienting the use of the trough system from left to right, so that everyone in the household knows that what is on the right has priority for use.
- Division of finishing materials (raw wood x white paint) indicating the spaces for food and the spaces for non-consumables.
- Use of lighting to highlight the food on display.
- Use of lighting system and timer to highlight the food stored in the protected areas and avoid forgetting it.
- Use of graphics indicating the ideal positioning of the food in the rail system.

Strategy I: Household waste perception

We proposed a response to Strategy I by establishing the positioning of the waste disposal area in a delimited space near the sink. This means:

- The definition of a limited space for waste which enables the organization of differentiated bins and assists the user in the perception of the frequency and production of waste.

FINAL CONSIDERATIONS

In this research we were able to approach the theme of sustainability in a comprehensive way. We built a mosaic that systematised and interpreted information ranging from the approach to the concept itself, to understanding our key problem, which is food waste, to defining strategies useful to professionals in our area of study, which is kitchen design.

We have seen that, for the problem of food waste, the consumer phase represents the biggest impact in the whole chain. Therefore, we approached design for sustainability, focusing on the user phase. Then, it was important to understand the multiplicity of factors that lead to waste, as well as to establish which strategies make sense as action tools in the context of project development for domestic kitchens.

Furthermore, by studying domestic kitchens it was possible to understand how the space evolved, mainly in the Western context, as a reflection of the social dynamics of its time and of different configurations and daily lives. We divided the project process in 4 stages, defining what are the relevant information for the kitchen project in each one of them. They are: (i)determining the user and project scenario, (ii) defining materials and construction methods, (iii) defining equipment and (iv) designing the layout and furniture.

Our main result was the definition of a set of strategies and principles that guide professionals in the construction of a kitchen project focused on avoiding food waste. We made an evaluation of these strategies with professionals and we could see that they are received in a mostly positive way. Moreover, we could see that the main difficulty identified by the professionals is in convincing customers of the importance of the issue, as well as the acceptance of the charges of these strategies.

In closing, we presented a project which was a proposal for the implementation of these strategies that sought to answer the result of this investigation in a very practical way. We consider that we managed to cover all the topics addressed in the set of guidelines, with different levels of approach.

We may state that, after all this journey, we were able to achieve an answer to the general question of this research, which was "*How can the design of domestic kitchens help the user*

to decrease their food waste?". This answer is composed by the analysis of the comprehensive literature, carried out during *Chapters 1, 2* and *3*, by the systematization of the information that resulted in the definition of our guidelines, presented in *Chapter 4* and finally, by the creation of a project in *Chapter 5*, which portrays our process and materializes all the information we obtained.

With no doubt the investigation of food waste in the domestic scenario in Portugal is still not very relevant in the academic scenario. Ten years have passed and the 2012 study by Baptista and collaborators was still one of our main sources of information. We saw in the last UNEP report (2021) on the subject that the food waste data in the country are still scarce and unreliable. Therefore, we propose a research path for the future studies, that can penetrate Portuguese homes and build a more relevant knowledge in this scenario, to support investigations addressing food waste in different areas of knowledge.

In addition, we recognise that another limitation of this research was in the audience reached by the evaluation of the guidelines. The criteria of the sample that evaluated our results, brought quality to the information collected, since the respondents had sufficient technical knowledge and experience for a in depth evaluation of our strategies. However, the criteria, at the same time, limited the access of a larger and more differentiated sample, within the time and limitations of a Master's level research.

Finally, we think that the prototyping and evaluation of the project we propose in *Chapter 5* is an important topic for future research. The construction of a prototype, even if in parts, and its implementation in a controlled domestic environment or in a laboratorial setting may bring relevant information. Only a user evaluation will allow the collection of proper data related to the efficiency of the project in fighting waste, besides other important issues such as ergonomy and functionality of the environment.

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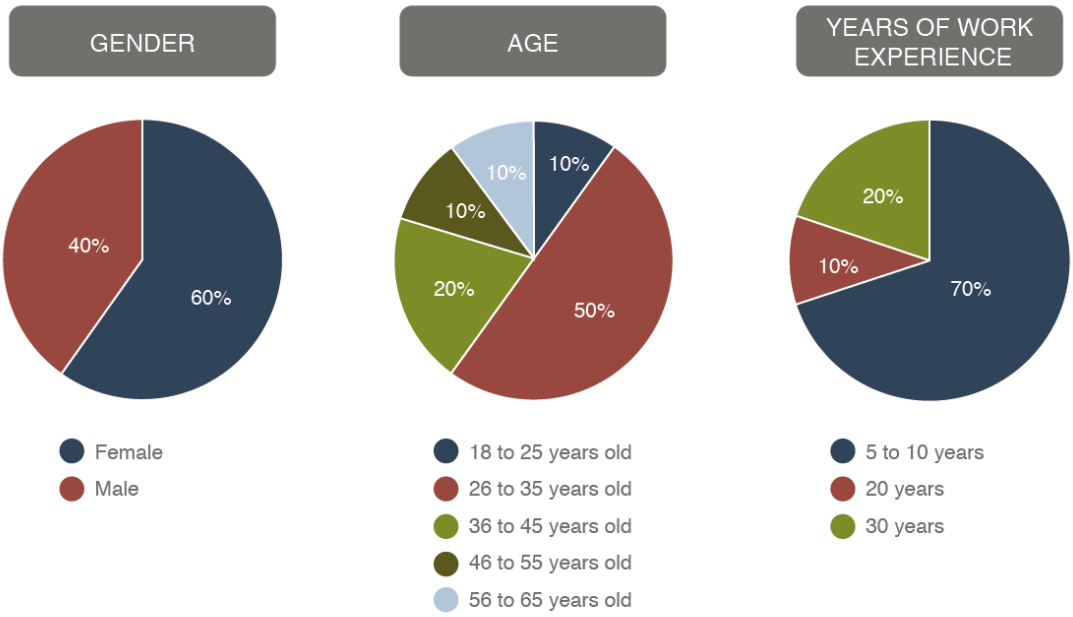
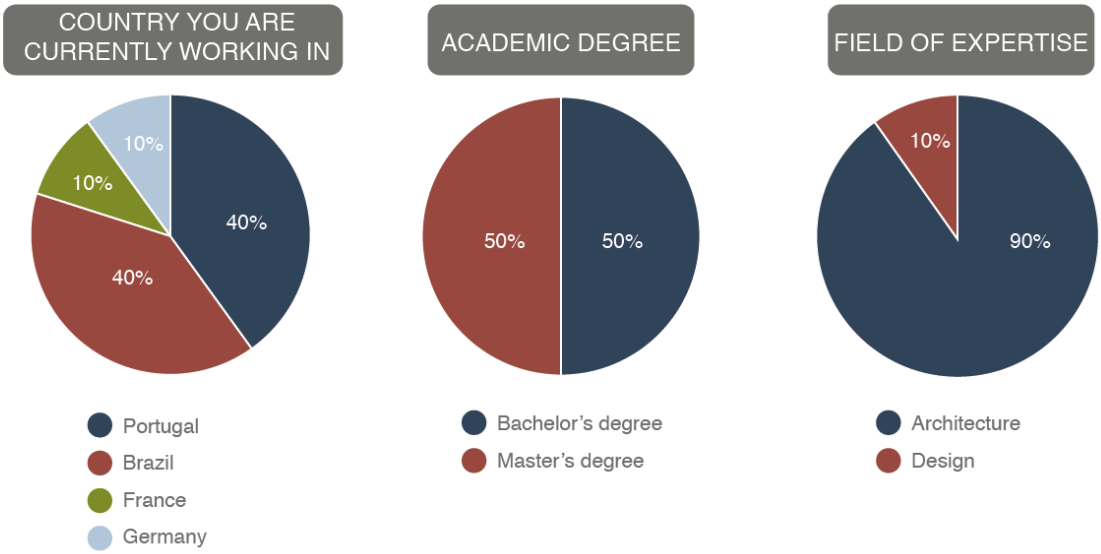
ANNEX 1: Guideline's evaluation results





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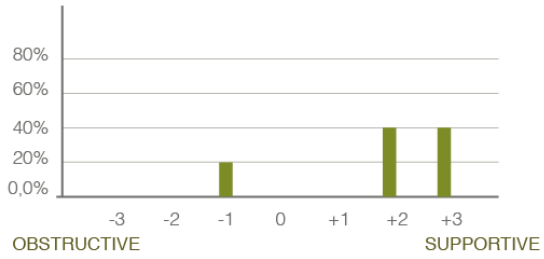

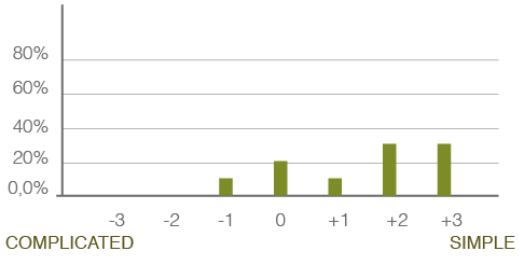

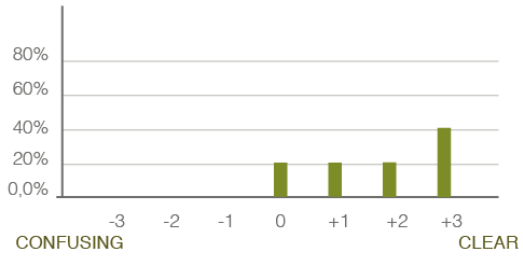

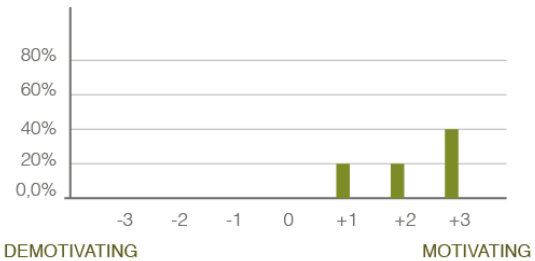

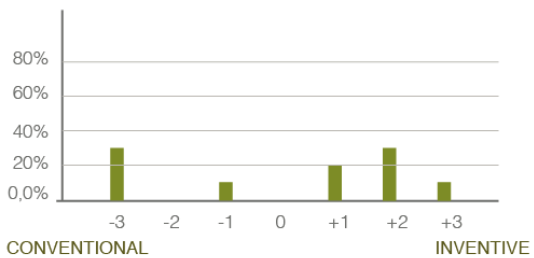

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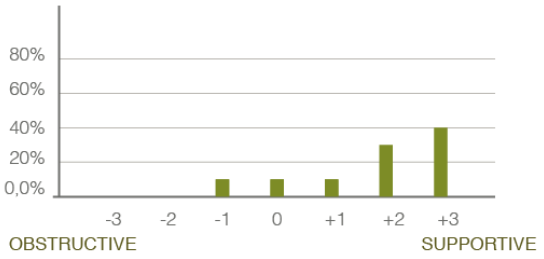

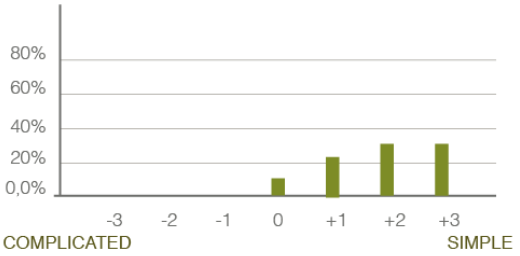

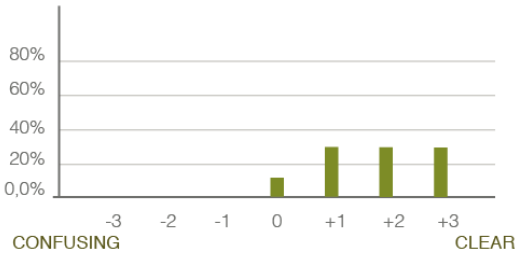

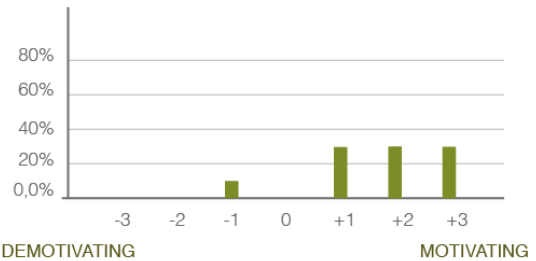

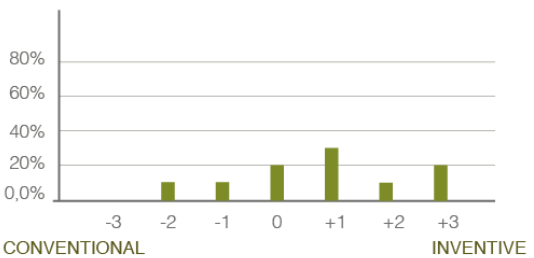

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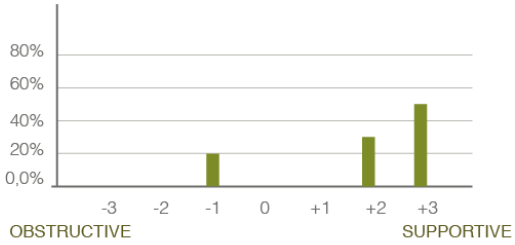

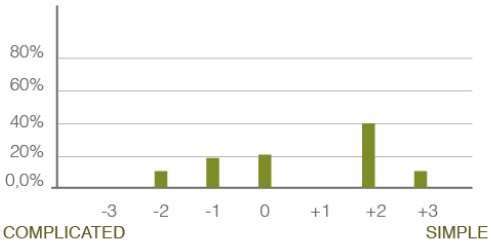

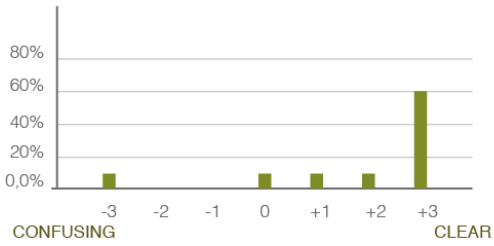

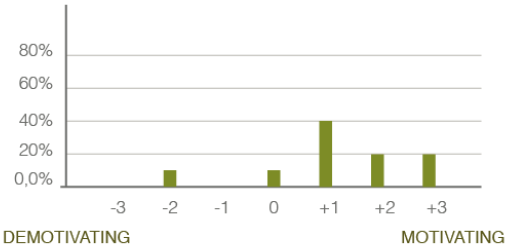

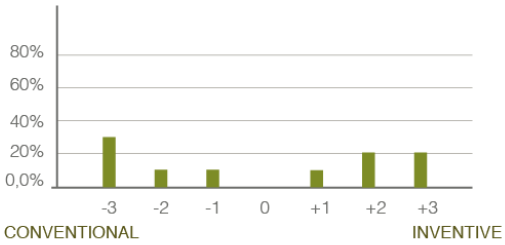

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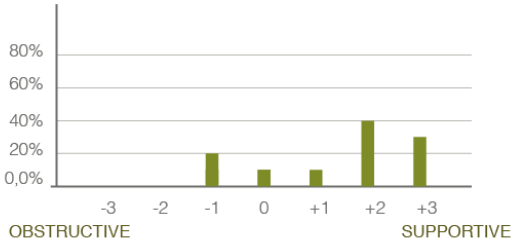

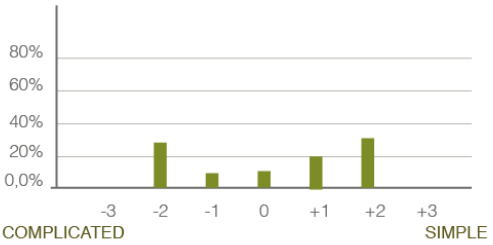

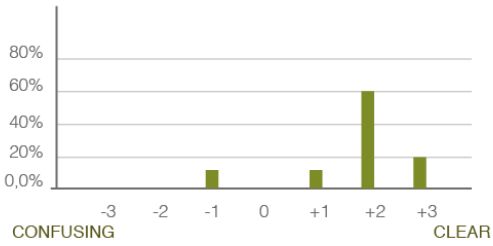

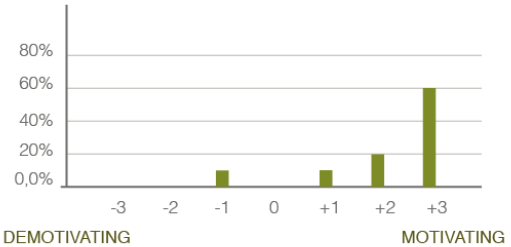

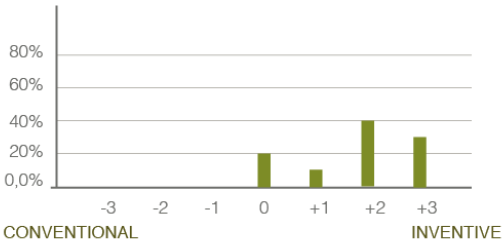

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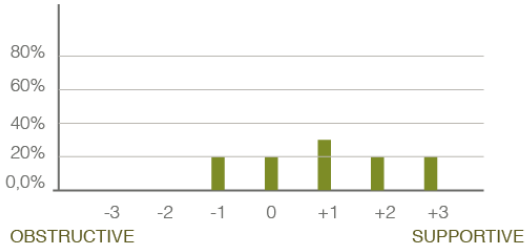

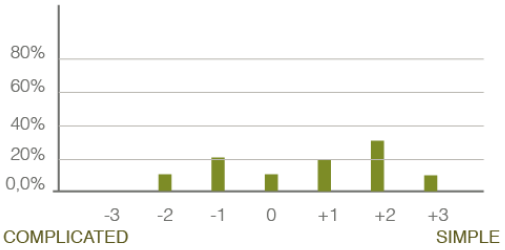

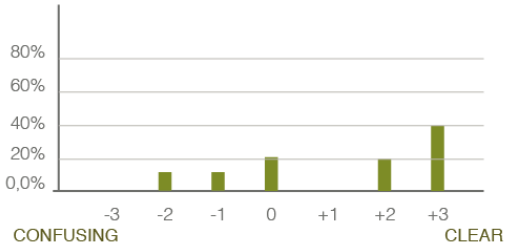

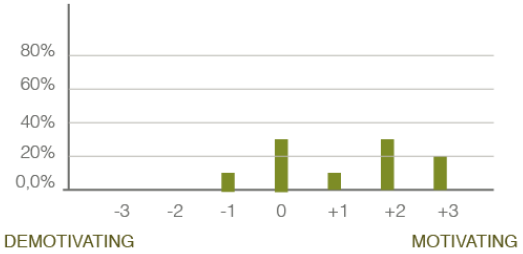

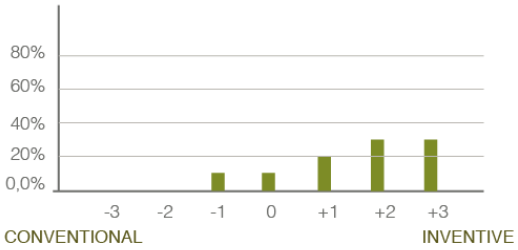

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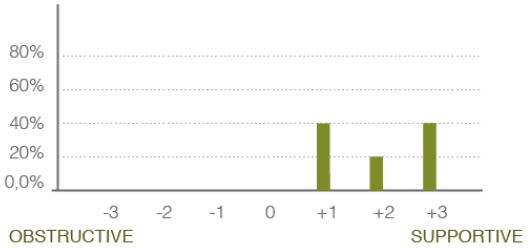

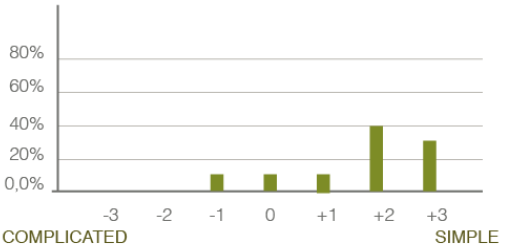

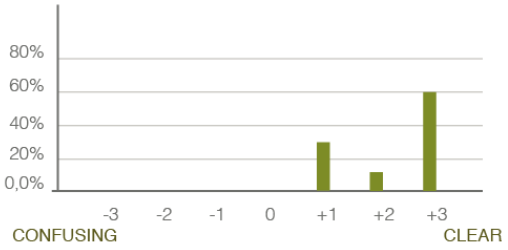

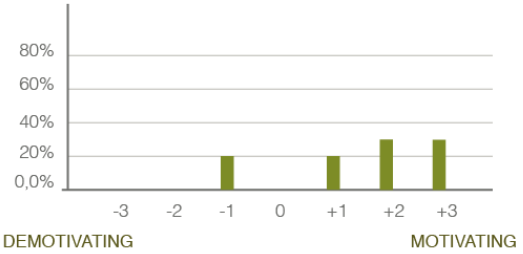

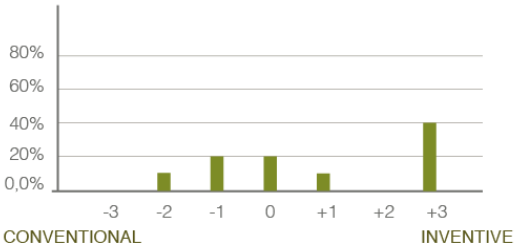

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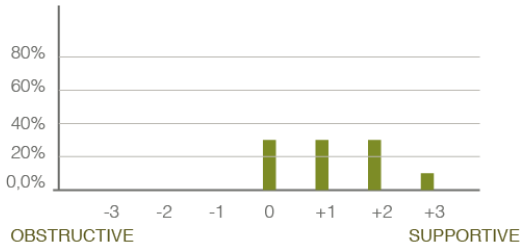
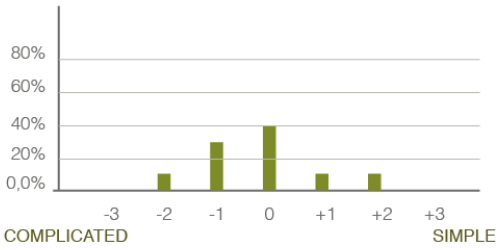
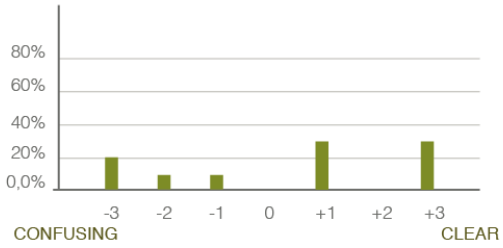
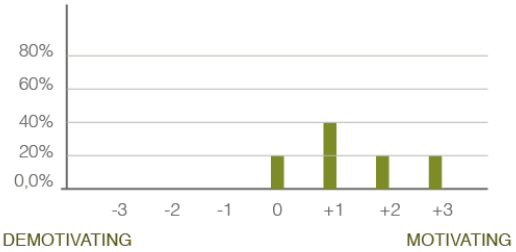
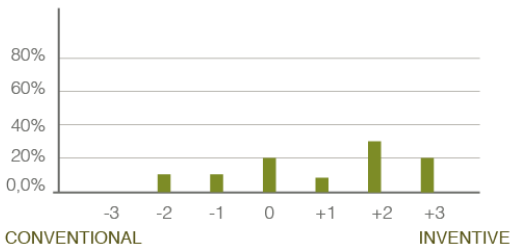


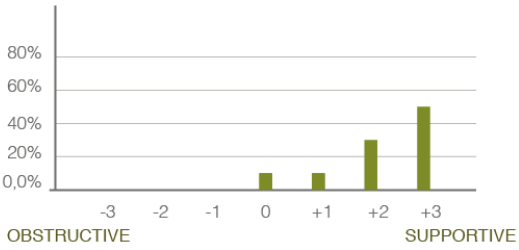


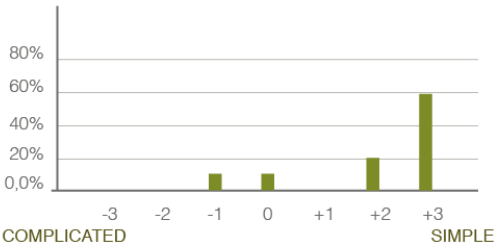


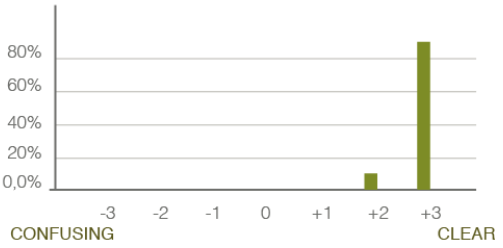


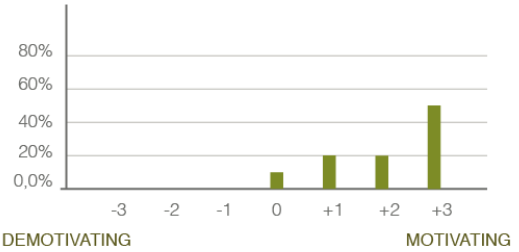


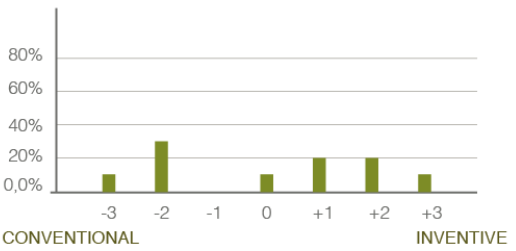
STRATEGY H



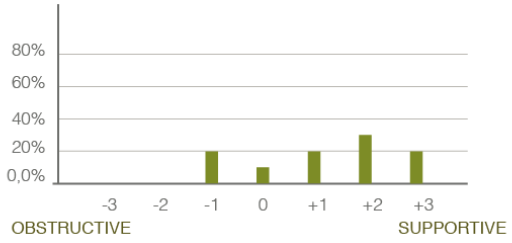


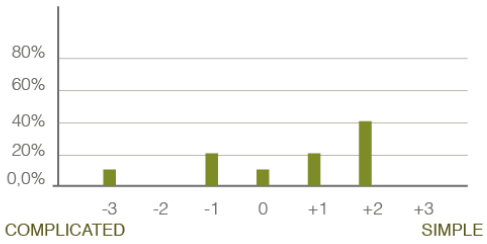


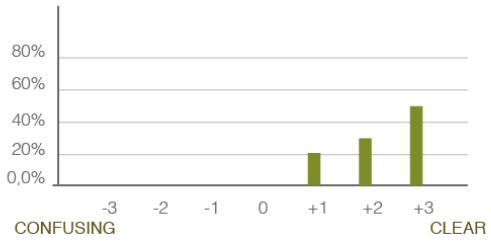


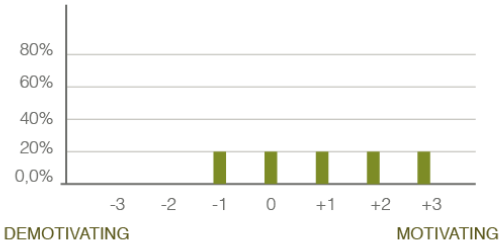


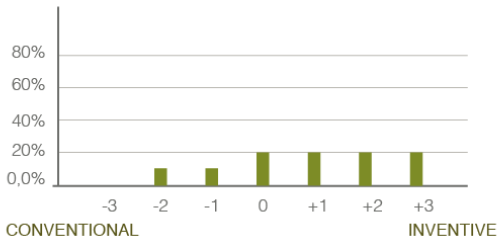
STRATEGY I





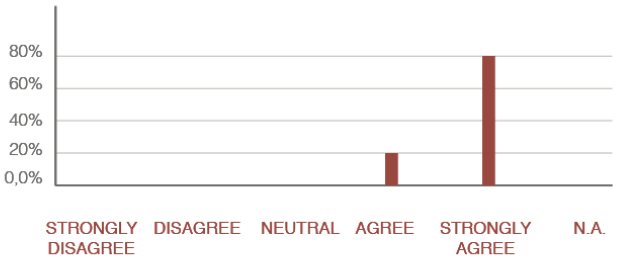




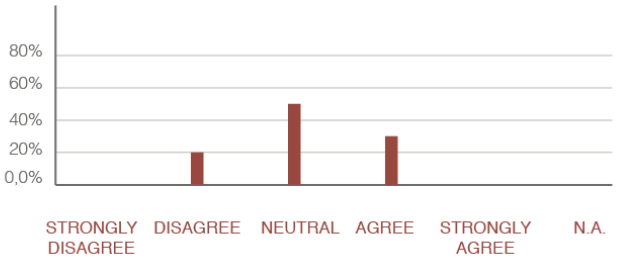


SET OF STRATEGIES

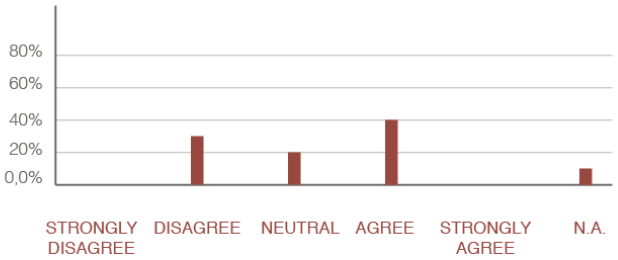
I would be willing to try to implement these strategies in my projects.



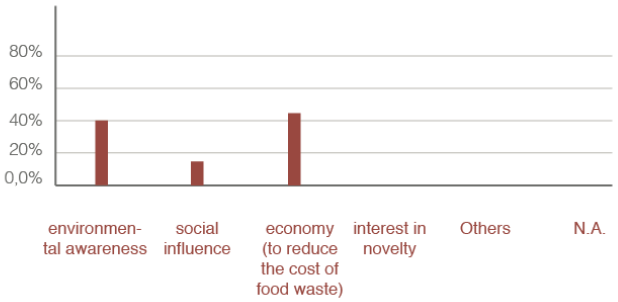
The implementation of these strategies in my projects would be economically viable



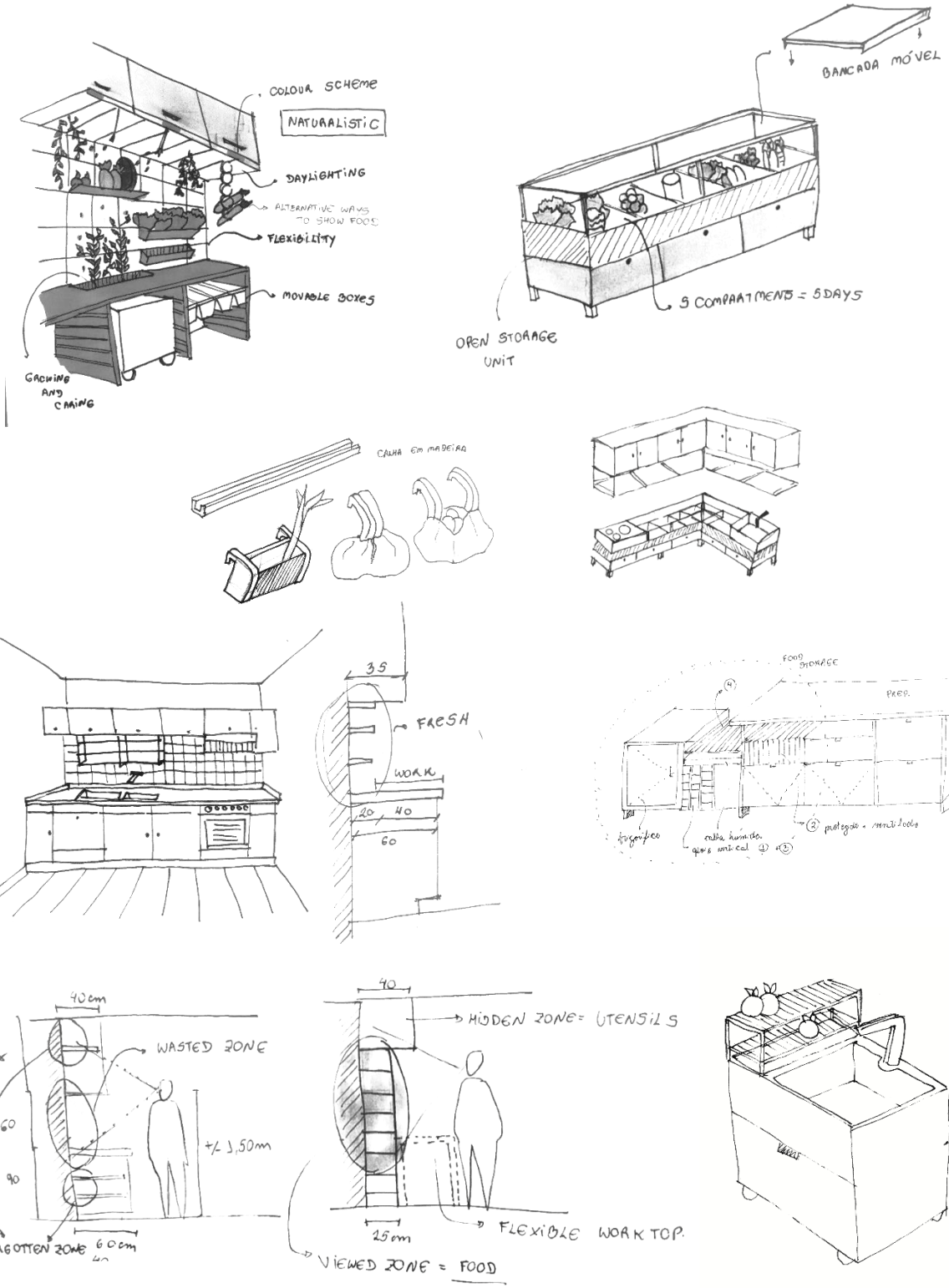
My clients would accept an additional charge for creating solutions that consider the use of these strategies.



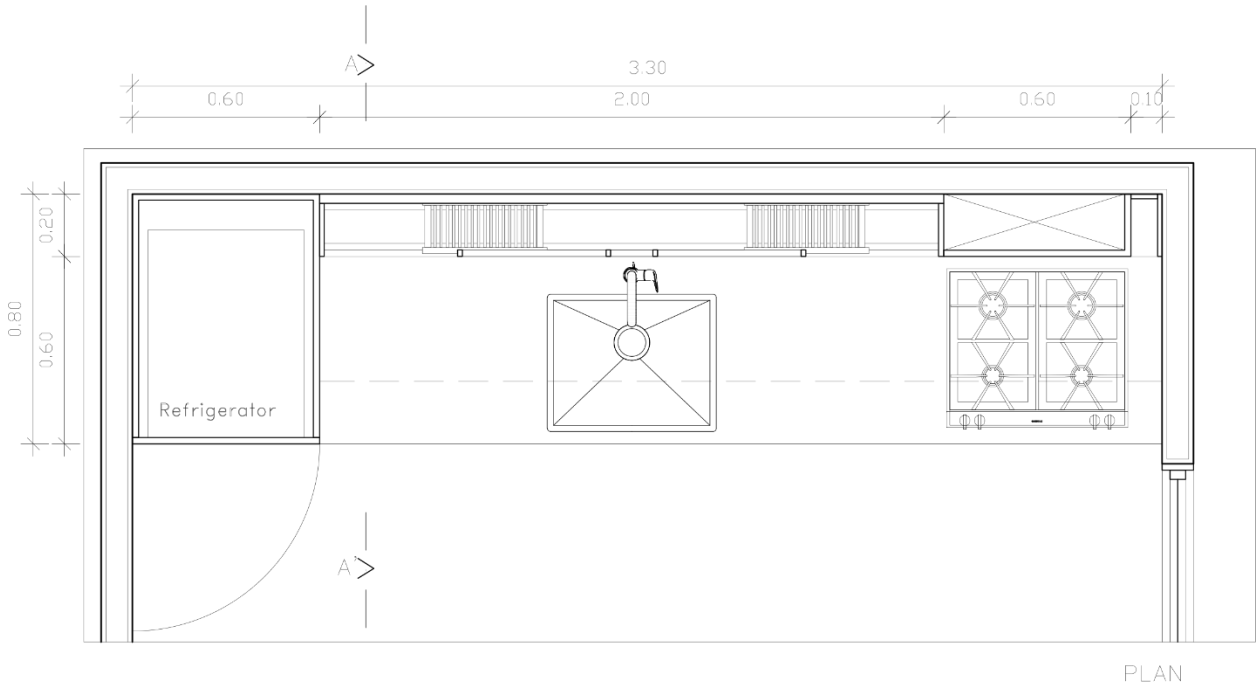
What do you consider could influence your clients to accept a cost related to the implementation of these strategies?



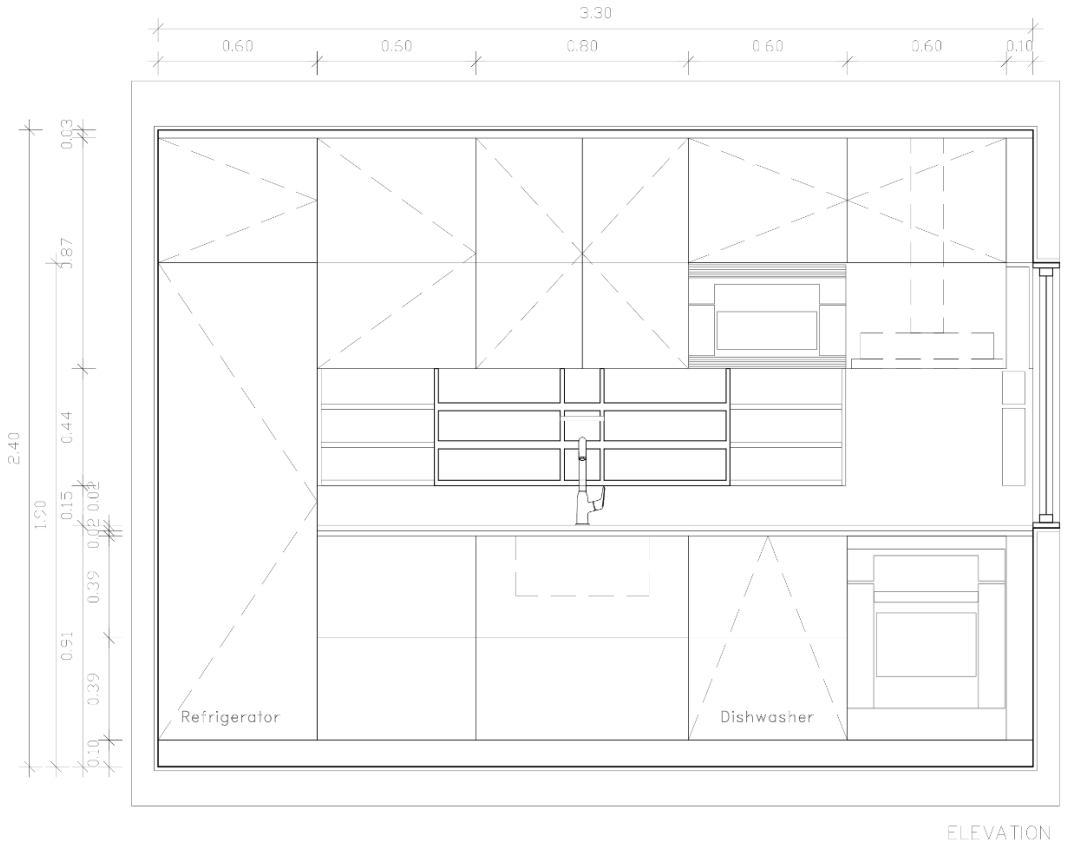
ANNEX 2: Development Sketches



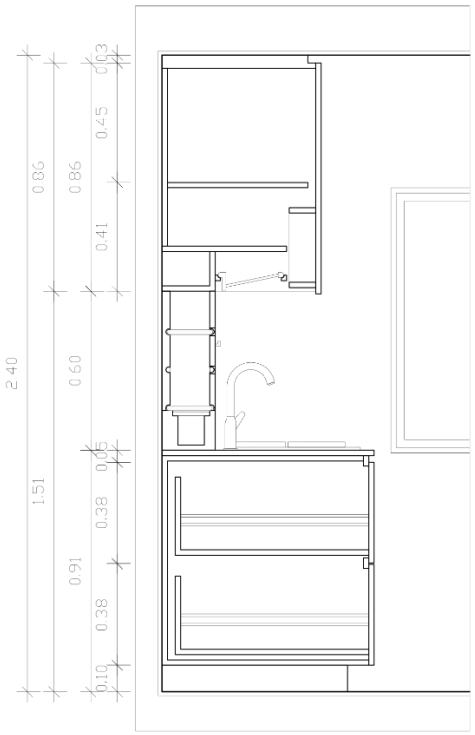
ANNEX 3: Technical Drawings



PLAN



ELEVATION



SECTION AA'