SUPERMARKET OF THE FUTURE

Dealing with Changing Environments

Master thesis
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DPM 2065
13 December 2023

UNIVERSITY OF TWENTE.

Supermarket of the Future – Dealing with Changing Environments
MSc Thesis
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Master programme: Industrial Design Engineering
Master track: Management of Product Design

Educational Institution
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Examination date
13th of December 2023

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Preface

As I sit down to write this preface, I realise that these are the last written words of my career as a student at the University of Twente. I am looking back on an unforgettable phase in my life, in which I have developed myself both academically and personally, but above all, I have met a lot of amazing people whom I will cherish.

Ever since I was a little kid, I have always enjoyed arranging things nicely. Back then, it was just a matter of sorting the marbles or the pencil box. My interest in working on the best possible representation and structuring became more useful when I became older. In the group projects for the bachelor's and master's courses in Industrial Design Engineering, I was not the person working on specific, in-depth tasks, but mostly I was the person who connected the dots and kept an eye on the progress. In my first years of studying, I sometimes saw a lack of in-depth expertise as a shortcoming. However, in my later career, particularly during my board year at the Kick-In, I realised that being able to see the bigger picture and combine the different perspectives of various stakeholders could also be considered an expertise of its own. In this thesis, I have been able to combine my interest (and urge) for organising systems in a neat manner together with my expertise in integrating different perspectives.

I would like to take this opportunity to thank all the people involved in the realisation of this graduation project. Special thanks to my supervisor, Bjorn, for cheerfully guiding me through the process while asking critical questions. And thank you, Bjorn and Eric, for introducing me to the topic of supermarkets, which appeared to fit my interests even better than I had initially expected.

On a personal note, I would like to express my gratitude to my boyfriend, Koen. In addition to providing mental support, you also provided me with fruitful discussions and valuable insights into the content of this work. It is a privilege to share both academic and personal journeys with you.

To my parents, thank you for your endless support and for giving me the freedom to go in any direction I wanted. Furthermore, I would like to say thanks to my close friends for their interest in my daily work and for providing me with fun distractions along the way.

I hope you enjoy reading my thesis!

Esther Schakel
29th of November 2023

Glossary

Attribute	A property of an entity placed into a context
Characteristic	A trait belonging to an entity that describes a quality or behaviour
Conceptual framework	A theoretical structure that is an abstract, simplified view of the world one wishes to represent to gain a deeper understanding [1]
Decision Support System (DSS)	A computer-based tool that supports people and organisations in analysing complex problems and enhancing informed decision-making [2]
Entity	A thing with a distinct existence
Parameter	Something that decides or limits the way in which something can be done [3]
Property	A trait belonging to an entity that describes a variable of the physical state

Abstract

This master thesis delves into the dynamic landscape of supermarkets, recognising their central role in Dutch society. The world is constantly evolving, with innovations introduced at an increasing pace. Supermarkets need to adapt to change, without knowing the nature or timing of these changes. To understand what the impact of a change is on the internal business processes of a supermarket, it is necessary to understand how the elements within the system are connected. This thesis aimed to conceptualise the supermarket shop floor to provide actionable insights for the supermarket management.

The objective of this research was to create an intervention which functions as a decision support system (DSS) to enhance decision-making when changes occur in the environment of a supermarket. The research topics range from information structuring and approaching 'change' to identifying trends and stakeholders in the industry. Combining the insights from literature and the industry, a conceptual framework was developed that includes supermarket-related entities and their interrelations. Finally, the conceptual framework was translated into a functional DSS.

The concluding part outlines the development and working principles of the proposed DSS, providing a practical tool for informed decision-making. The DSS is designed based on the interests of the identified stakeholders. A proof of concept is established for predefined scenarios based on the current industry trends, offering a glimpse into the potential of the proposed DSS.

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INTRODUCTION

This first part introduces the research topic and explains how this topic is approached.

1. The assignment

1.1. Project Background

Suppose you want to know what the supermarket will look like in the future. Would it be completely high-tech and automated, or would it only sell healthy and sustainable food? In this case, you need to forecast future scenarios, using historical data as input to make informed predictions about the future direction of trends [4]. However, you will never know if this prediction comes true, so it remains only a plausible scenario. On the other hand, what you do know for sure is that the world is evolving every day and changing over time. This means that the supermarket of today should be able to effectively adapt its processes to a changing world to survive and still be a supermarket in the future. In other words, the supermarket of the future is one that can deal well with change and is able to adapt effectively to a changing environment.

Supermarkets play a central role in food retailing in Dutch society and are the largest source (70%) of the consumed food by Dutch inhabitants [5]. Supermarkets have a societal responsibility, while customers have a significant influence on which products can be found on the shelves through their purchases [6]. A supermarket is a place where people from all backgrounds come together, and where experiments are conducted regarding technology, packaging or product variety [7, 8]. Nowadays, there are multiple channels for shopping (e.g. in-store, home delivery, pickup) and this, together with the new possibilities offered by experimentation, brings more variables for supermarket management to consider. The analysis of business processes is becoming more complex, and the increasing number of variables continues to challenge retailers [9].

When dealing with changing environments, it is essential to know (a) what variables are present in the supermarket and (b) how these variables are related. This information allows for a quick review of the impact of the changing variable on the current situation. The impact may vary in magnitude: the introduction of deposit legislation on cans caused a significant impact on the in-store operations while contracting one new stocker would not make a big difference. The supermarket management needs to assess the impact and decide whether to respond and how to do so in order to optimise the store processes.

Making decisions is a necessity but can be complicated by uncertainties and trade-offs that arise from conflicting interests. For instance, what is beneficial for the customer or society may come at the supermarket's expense [10]. Hence, the supermarket management has to handle a lot of data to make well-informed decisions that take all interests into account. Capturing information within a framework contributes to a better understanding of the information and improves the application of the information [11]. This thesis focuses on conceptualising the supermarket shop floor and the analysis of the interconnectivity between the various components within the supermarket to enable informed decision-making about business operations.

1.2. Offering Organisation

The assignment is conducted within the department of Design, Production & Management of the faculty of Engineering Technology at the University of Twente. Since the research is conducted for the university, and not for a specific supermarket chain, this thesis aims to address the supermarket in general and as objectively as possible.

2. Thesis Set-up

2.1. Design Objective and Research Questions

It is believed that the supermarket of the future will be able to react effectively to changes in its internal and external environment and adapt to the new situation. This thesis will investigate how supermarkets can monitor the changing environments and aim to design an intervention that supports supermarkets in deciding if and how to react to the changes. Therefore, the design objective is stated as follows:

To create an intervention which functions as a decision support system to enhance decision-making when changes occur in the environment of a supermarket.

Research questions are defined to achieve this design objective. First, it will be investigated how the 'building blocks' of the intervention can be structured in order to know which elements are required for the intervention.

RQ A: How can 'change' be approached?

RQ B: What does the process conceptualisation entail?

Then, the landscape of supermarkets will be explored to define those building blocks.

RQ C: Which trends can be identified in the supermarket industry?

RQ D: Which stakeholders are involved in a supermarket?

Lastly, the identified elements will be placed into their context in the structures.

RQ E: How can a supermarket deal with change?

RQ F: How can a supermarket be conceptualised?

RQ G: How can the conceptualisation be translated into a system that supports decision-making?

2.2. Thesis Structure

The core of the thesis is subdivided into four parts to approach the research questions systematically. Part I includes the theoretical framework, which is composed of a literature review. It elaborates on how 'change' can be approached (*RQ A*) and delves into concepts of information structuring, which can be used to conceptualise a supermarket store (*RQ B*).

In Part II, the current trends in the Dutch supermarket industry are analysed to gain insight into the various changing variables a supermarket has to deal with (*RQ C*). Additionally, it focuses on what types of stakeholders can be identified in a supermarket organisation (*RQ D*). The industry analysis is achieved through a study of popular science (e.g. newspapers and industry reports) and interviews with stakeholders. Knowledge is obtained on the supermarket processes and the current challenges experienced by the experts in the field. Furthermore, the differences between the Dutch supermarket chains are discussed.

In Part III, the theoretical concepts explained in Part I are combined with the industry analysis of Part II. Firstly, this results in a methodology of how a supermarket can react to a changing environment (*RQ E*). Secondly, a conceptual framework of a supermarket is built by establishing the entities of a supermarket and synthesising the interrelations between the different entities (*RQ F*). The conceptual framework will serve as the basis for the decision support system (DSS).

Part IV describes the design together with the functionality of the DSS, and it evaluates the design with design guidelines established based on the exploration phase (*RQ G*). The answer to research question G is considered to be the means to meet the design objective.

Figure 1 demonstrates how the chapters follow up on each other and indicates which chapters within the parts provide answers to the research questions.

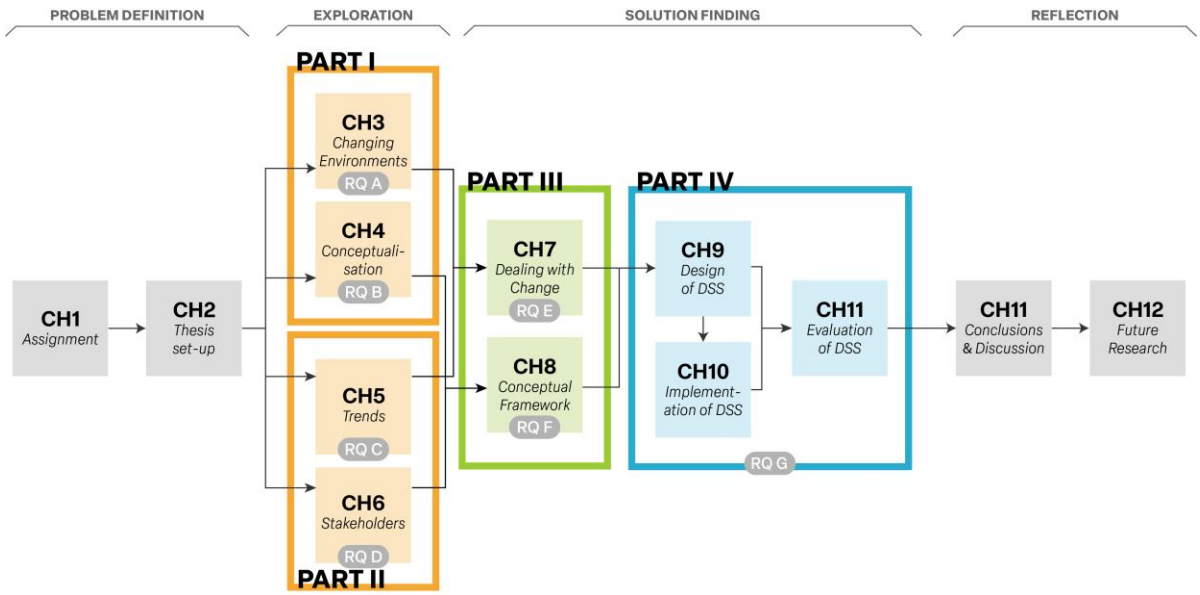


Figure 1: Structure of the thesis

2.3. Scope

The interpretation of what a supermarket is, together with its the accessory standards, highly depends on the country where the supermarket is located and on the target group of customers. The general definition of a supermarket is described as [12]:

SUPERMARKET *[ˈsuːpəˌmɑːkɪt] - noun*
a large retail market that sells food and other household goods
which is operated on a self-service basis.

This thesis focuses on brick-and-mortar Dutch supermarkets, referring to retail markets with different sections offering a wide range of products, mainly food but also non-food, where in-store employees serve individual customers. People initially go to a supermarket to get their groceries, and they can pick their products themselves by walking through the aisles. This interpretation of the Dutch supermarket is applied to the analysis of the industry and will be elaborated on later.

The primary focus of the designed intervention is its functionality by developing the methodology of classifying entities in the supermarket system and, thereafter, visualising the connections in an effective and user-friendly manner. A proof of concept will be worked out for predefined scenarios.

2.4. Design Methodology

This research follows the reasoning pattern Abduction-2, where the result is conceived in terms of value [13]. The starting point of this thesis was determining the end value of this research: a supermarket being agile to changes in its environment by knowing about the connectivity of the elements in its system. However, the 'what' and the 'how' to achieve that determined value are to be designed. This open form of reasoning is applicable to conceptual design, where an idea is visualised. This thesis aims to visualise the idea of connectivity in the supermarket. The challenge is that the 'what' and the 'how' design processes happen in parallel and depend on each other.

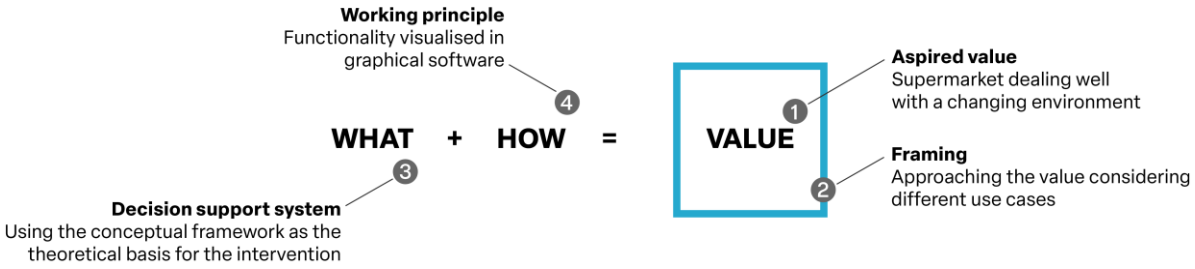


Figure 2: Design methodology following Abduction-2 (adapted from [13])

PART I

THEORETICAL FRAMEWORK

This part elaborates on the definitions of the concepts considered the core of this research: Change and information management. A deep understanding of these concepts is crucial to achieving the design objective.

3. Changing Environments

A supermarket is part of the supermarket industry, which in turn is part of a bigger whole: society. Environments can be approached on three levels, from large to small: the macro level (contextual environment), the meso level (transactional environment) and the micro level (organisational environment) [14]. Approaching the supermarket from the macro, meso, and micro levels allows for a comprehensive and holistic understanding of the complex system by analysing it from different perspectives and scales.

By examining the interplay between these environmental levels, one can gain insights into how changes or actions at each level might impact the others. The three levels can be combined with Steven Covey's theory, and can be identified as the circle of concern, the circle of influence and the circle of control [15]. Covey's theory primarily focuses on individual development and effectiveness at the micro level, but it can be extrapolated to understand group dynamics at the macro and meso levels.

The macro level regards external factors that could affect the supermarket industry and in-store operations. Supermarkets have no control over the advancements at this level, but developments do concern them. The DESTEP method enables to analyse change at the macro level by reviewing the key external factors influencing an industry or a business [16]. DESTEP stand for Demographic, Economic, Social, Technological, Ecological and Political factors are identified. Compared to other macro analysis methods like the PESTLE, the DESTEP method focuses more on the demographic factors, which are considered vital for supermarkets due to their direct influence on customer behaviour [17]. Understanding and adapting to these six macro level factors is crucial for supermarkets to remain competitive, meet consumer demands, ensure regulatory compliance, and sustain growth in an ever-evolving market landscape.

The meso level entails the influence of the supermarket industry on a supermarket store, for example, when new point-of-sale software becomes available on the market. Conversely, an individual supermarket can only indirectly influence the factors at this level. The meso level is considered to be the circle of influence. The meso level can be analysed using the ABCD method to investigate the factors of the customer, branch, competition and distribution (in Dutch: Afnemers, Bedrijfstak, Concurrenten en Distributie) [18]. The ABCD method is a holistic method to approach the factors within the meso level, while an alternative like Porter's diamond model has the purpose of identifying areas of improvement and developing strategies to improve competitive advantage [19]. Changes in these meso factors should be analysed to adjust the in-store operation accordingly.

The micro level includes all organisational aspects within the supermarket store, and therefore, the supermarket management directly influences these internal factors. The micro level is considered the circle of control. There are a lot of different methods to analyse specific operations within the micro level, for example, focusing on risks, financial performance or customer satisfaction. However, no general analysis method was found to investigate the in-store operations as a whole. This thesis aims to fill that gap since it is considered of high importance when a supermarket has to deal with change.

Table 1: Overview of the macro, meso and micro level

LEVEL	Macro level	Meso level	Micro level
CHANGING FACTORS	External	External	Internal
INFLUENCE OF SUPERMARKET	No influence (Circle of Concern)	Indirect influence (Circle of Influence)	Direct influence (Circle of Control)
ANALYSIS METHOD	DESTEP	ABCD	*Design Objective of this research*

4. Conceptualisation of a Supermarket

This thesis aims to conceptualise the micro environment of the supermarket to provide insight into the connections between key elements. These insights into the connectivity between the elements should enable the supermarket management to react effectively to contextual changes. In this chapter, the key concepts of information structuring are identified and explored in relation to the design objective. Moreover, the connections between the key concepts are described in the context of the supermarket of the future.

4.1. Conceptual Framework

A conceptual framework is a theoretical structure that is an abstract, simplified view of the world one wishes to represent in order to gain a deeper understanding [1]. It establishes the concepts, principles, and interrelations between variables that are relevant to the subject matter and should be considered when making decisions. To build a conceptual framework of a Dutch supermarket, the entities in the supermarket need to be established, after which the interrelations have to be identified. Entities can be either physical items (e.g. products, interior, people, etc.) or abstract concepts (e.g. consumer behaviour or brand identity). Some entities will support each other in achieving their function or purpose, while others will compete with or work against each other.

4.2. Decisions Support System

A decision support system (DSS) is a computer-based tool or software application that supports people and organisations in analysing complex problems and enhancing informed decision-making [2]. A DSS integrates data, analysis techniques and a user interface to support the end-user throughout the decision-making process [20]. Performance data from the real world is communicated to the DSS, after which the system analyses the data and responds with suggestions for optimisation. A significant source of input data for the to-be-designed DSS for the supermarket of the future could be derived from the checkout. Different data sources could be relevant depending on the problem the supermarket management would like to have recommendations on.

A conceptual framework provides the underlying structure and understanding of the problem domain, after which the DSS utilises this framework to assist the decision-makers in evaluating various alternatives and selecting the best course of action. A conceptual framework can be seen as the analysis technique and helps define the relevant supermarket concepts and their interrelationships that should be incorporated into the DSS. The framework guides the design of the system and ensures that it aligns with the conceptual understanding of the problem.

4.3. Connectivity and Modularity

Connectivity can be described as the level of connectedness within a system, corresponding to a structured set of relationships between the entities in the system [21]. Connectivity can be deconstructed into different forms, for example, functional or physical connectivity. Which forms are relevant is determined by the context. For example, a cashier and a checkout have a functional connection as they both support the customer in the purchasing process.

The quantity and quality of the connections between entities define the intensity of the connectivity. For example, a shopping cart and a shopping basket have a more intense connection than a shopping cart and a bottle of water: the shopping cart and basket serve the same purpose and are possibly made of the same material (two connections), while a shopping cart and a bottle of water are only connected when a customer brings them together in the same location (one connection). The shopping cart and the bottle could both be made from plastics, but when the cart and basket are made of the same type of plastic, this connection is of higher quality.

If the level of intensity among a group of entities within a (sub)system surpasses that of other entities, it indicates modularity, the principle of which is illustrated in Figure 3. In other words, the internal relations within a module are stronger than the connections between modules. Modularity refers to the extent to which a system comprises distinct, semi-independent modules [22]. Applying modularity to a system enhances flexibility, testability and maintainability since the modules function as an integrated whole but are (re)designed independently [23].

To create an overview of which entities have a connection and what type of connection this entails, matrix-based tools are used. Such connectivity matrices provide insight into the extent of modularity, as modules can be identified after clustering. The only thing that does not directly become clear from a matrix representation is why this interrelation exists [24]. For this thesis, this limitation of matrices is no problem as this research aims to visualise the interrelationships between the entities of a supermarket to understand the impact of a change in the environment.

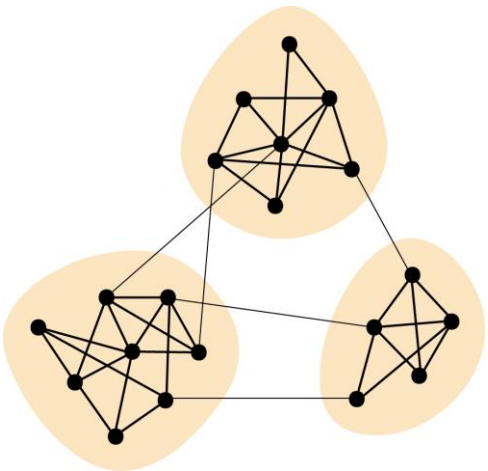


Figure 3: Modularity

Conclusion Theoretical Framework

The theoretical framework was created to lay the foundation for conducting the analysis and interpreting its outcomes. Regarding research question A: '*How can 'change' be approached?*', it can be said that change can be classified according to the environmental level at which it occurs. Each level considers a different scale of processes and determines which stakeholders are involved. By integrating insights from various levels of analysis, a more holistic understanding of complex systems can be achieved, providing valuable insights into how different scales interact and influence each other. This knowledge will be used as a starting point to establish how a supermarket can react to change in Part III.

To answer research question B: '*What does the process of conceptualisation entail?*', it can be stated that the process of conceptualisation results in a conceptual framework including supermarket-related concepts or entities and their interrelations. These interrelations can be categorised based on their nature and provide more insight into the modularity of the system.

PART II
ANALYSIS

In this part, the current situation of Dutch supermarket industry is explored to gain insight into the performed actions and the trends going on, and get a better understanding of the involved stakeholders.

5. Trends in the Supermarket Industry

The aspired value of this research was determined in the introduction: a supermarket being agile to changes in its environment. The second step following the design methodology, as explained in Section 2.4, is framing: a set of statements is defined in which the 'how' and 'what' results in the value. As the end value is the only known factor in the equation at this point, the frame will be based on the aspired value. For the framing of this research, various use cases are determined based on the outcomes of the industry analysis.

Desk research is conducted to discover the trends in the supermarket industry, and empirical research is done to gain a deeper understanding of the status quo of supermarket processes, procedures and stakeholders. Besides, a co-design session is organised to approach the current state of affairs and possible future scenarios from different perspectives. This chapter describes the most remarkable findings of the three types of research.

TREND *[trend] - noun*

General development or change in a situation or in the way that people are behaving [25]

5.1. Desk Research

Publicly available sources of information (i.e. reports, books, websites, mobile applications and podcasts) were examined on relevance regarding the research topic. The sources were reviewed to explore the current trends impacting the supermarket industry. The supermarkets initiate some trends while other movements are driven by customer demand or other external influences. The most outstanding trends are described below.

5.1.1. Rise of E-commerce and In-store Technology

The (food) retail industry is increasingly experiencing a shift to e-commerce, which was particularly stimulated by the Covid-19 pandemic [26]. The Netherlands is one of the leading countries in Europe in the size share of online grocery in the supermarket industry: where this was 7.5% in 2021, it is expected to be 19% in 2030 [27]. However, most supermarkets do not completely switch to online grocery but combine the brick-and-mortar store with an online home delivery service: this principle is called omnichannel retailing [26]. E-commerce has found ground in the supermarket industry, although the contribution of digital versus physical shopping to the revenue of Dutch supermarkets in 2021 was 7% and 93%, respectively [28]. Besides, research has shown that 85% of consumers globally prefer a blend of physical and digital shopping channels, while only 10% prefer only digital channels [29]. Hence, it is believed that brick-and-mortar supermarkets will remain in society for the upcoming future.

Next to using technology to realise e-commerce, supermarkets also innovate and experiment with in-store technology for the purpose of making processes more efficient and the customer experience more convenient [30]. Innovations include electronic price tags, smart shopping carts and theft prevention with RFID or computer vision. The trend of using technology to optimise business processes has been going on for a long time and keeps evolving [31]. In 1987, Albert Heijn introduced the self-scan in the Netherlands, and nowadays, the first stores without staff or checkouts are opened [32].

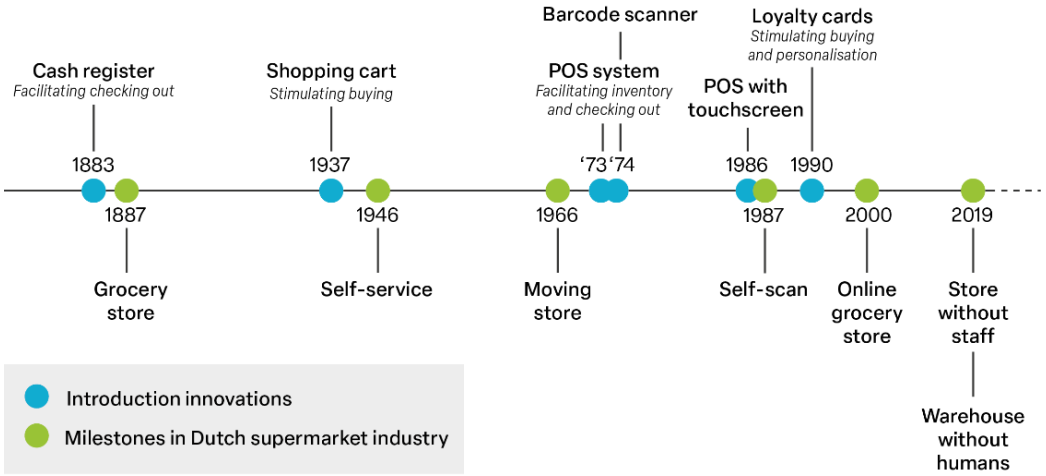


Figure 4: History of introductions in the Dutch supermarket industry (based on [20])

The timeline in Figure 4 shows that introductions of (technological) innovations are often followed by milestones in the Dutch supermarket industry. For example, a few years after the introduction of the shopping cart, the first self-service store was realised. Furthermore, it is also observed that the frequency of technological innovations increases over time.

5.1.2. Focus on Customer Experience & Personalisation

Home delivery covers the purely functional part of doing groceries and saves the customer time. Accordingly, retailers are rethinking the role of the brick-and-mortar supermarket [33]. The focus of the physical stores shifts towards social engagement, giving advice, including haptic stimuli in the store and doing groceries overall being an enjoyable experience [34]. Grocery retailers also aim to educate their customers more about product backgrounds since customers increasingly want transparency regarding the source of their groceries [35]. It has been shown that supermarkets focusing on customer experience are more resilient during recessionary periods [26].

It is seen that society has become more individualistic, and people focus on the efficient use of their time [36]. Nowadays, most Dutch supermarkets offer loyalty programmes to their customers. The supermarkets can gather data about purchase behaviour while the customers are presented with personalised promotions. The loyalty programmes create a personalised and convenient customer experience and let people feel connected to the brand.

5.1.3. Higher Food Awareness & Focus on Sustainability

Dutch consumers have become more focused on making informed food choices and demanding more information provisions [37]. People often choose products which are fruitful for their health or sustainable for the environment [38]. The preference for healthier food choices could be clarified due to the rise of health monitoring wearables and applications [39]. Furthermore, since 2015, a growing interest in organic, plant-based or local food has been identified, and people are more concerned about sustainability [40].

Next to the customers becoming more aware of sustainable food choices, supermarkets also focus more on sustainable behaviour: inventory management is optimised to reduce food waste, reusable bags are promoted, and more sustainable packaging is offered. Some initiatives are started by supermarkets themselves, while other sustainability measures are introduced by the government, e.g. legislation forcing a deposit fee on metal cans [41].

5.1.4. Horizontal and Vertical Integration

Horizontal integration regards the integration between industries. Supermarkets integrate elements of the catering industry, which can be recognised by the food and coffee corners [38]. Furthermore, horizontal integration is also seen in selling non-food products, like pharmaceutical products. This trend has been going on longer: in the past, grocery stores only marketed dry foods and bakeries, butcheries and milkmen for fresh foods. The specialists were located in different stores, while today they are centralised into one supermarket store. Vertical integration occurs in the supply chain and can be recognised by offering store brands and refill systems where customers can refill their packing in the supermarket [42]. Vertical integration enables the supermarket to reduce costs in the supply chain, create more transparency for the customer and create more personalised products. Figure 5 illustrates the integration movements.

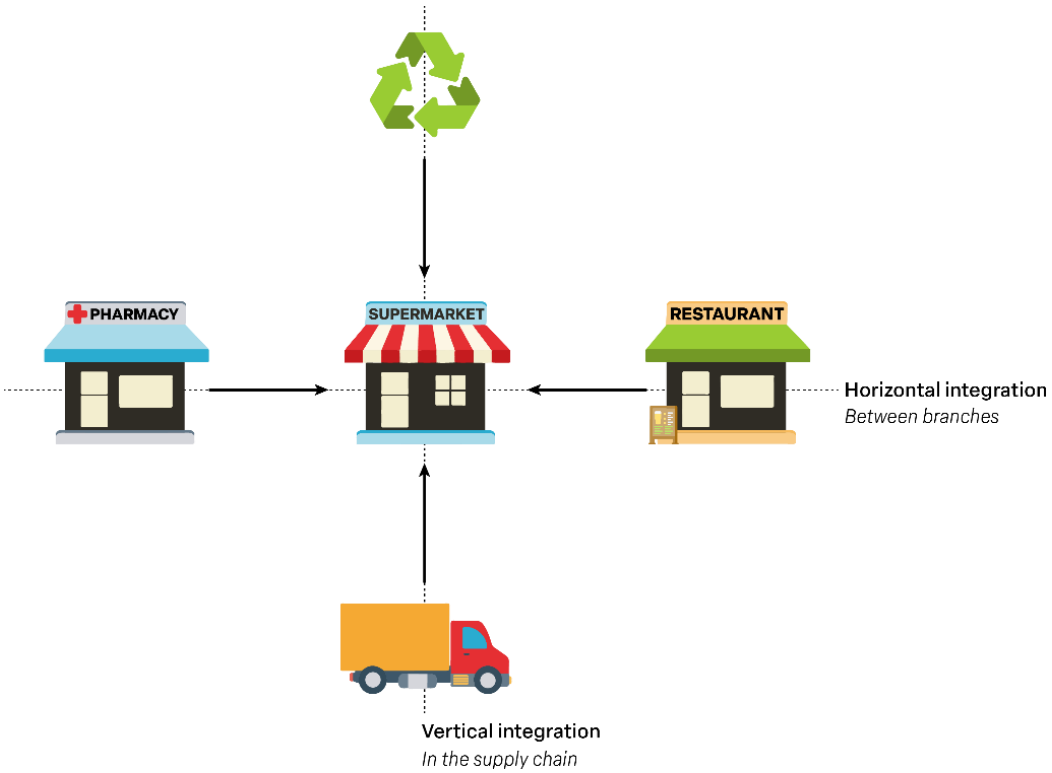


Figure 5: Horizontal and vertical integration in the supermarket industry

5.1.5. More Uniform Supermarket Landscape

It has been noticed that the diversity in supermarket formulas has decreased [43]: bigger Dutch supermarket chains have grown even more, and locally oriented formulas have been taken over. For example, Super de Boer (2009), C1000 (2012) and EMTÉ (2018) stores were taken over by Jumbo, and Albert Heijn took over Deen (2021) and Jan Linders (2022) stores. In 2021, Coop announced its merge with Plus under the Plus brand. Since 2017, the number of mergers and take-overs per year has increasingly risen [36].

5.1.6. Investing in Modularity

Research taking into account 332 Dutch supermarkets (2021) shows that supermarkets tend to invest more in modularity [28]. Modularity in a supermarket can have several benefits, including greater flexibility in the store layout, more efficient product stocking, and the ability to respond quickly to changing consumer demand.

5.2. Empirical Research

Semi-structured interviews are conducted with employees with varying functions and from different Dutch supermarkets as defined in the scope. This form of qualitative data collection relies on asking open-ended questions within a predetermined thematic framework [44]. However, the questions are designed to be flexible and exploratory. The prepared questions were based on their function profile.

It was discovered that there are differences between the supermarket chains regarding who is responsible for making decisions about the different processes. One supermarket centralises and automates its inventory management and layout, while another organises its processes more regionally. In addition to gaining a better insight into the business processes of a supermarket in general, the interviews are used to investigate the actions taken by the supermarket organisation in Section 7.3 and to identify variables for approaching supermarkets in Section 8.1.

The interviewees are also asked about the challenges of the supermarket environment. It is mentioned several times that the industry is dynamic, and decisions have to be made quickly, sometimes faster than all the information available: A category manager at the headquarters decides which products to put on the shelves and which promotions to run in a given period. The headquarters works with research agencies, but in practice the decisions are often made before the advice report is available. The challenges are considered in the design process of the design objective of this research.

5.3. Co-design Session

A co-design session was organised together with an expert in future vision workshops. Eight Industrial Design Engineering students of the University of Twente participated in the co-design session. Next to the students being regular customers in various Dutch supermarkets, they are also trained during their studies to put themselves in the shoes of other stakeholders, identify problems and come up with creative solutions. The session's goal was to illuminate different perspectives on issues of the brick-and-mortar supermarket. The starting point of the co-design session was the following problem statement:

In what ways can supermarkets develop or optimise to keep attracting customers in the future?

Building on their own experiences, the participants brainstormed what could be improved in the supermarket and were asked to write each idea on a post-it. Each individual had the freedom to create post-its without any restrictions on quantity. Next, the participants were asked to cluster the notes with improvement opportunities and subsequently label the clusters. The participants labelled the clusters by the following themes: efficiency, sustainability, product choice, staff, health, accessibility and inventory. Figure 6 presents an overview of the summarised results considering the times the topic was mentioned on the post-its. The unprocessed results can be found in Appendix A.

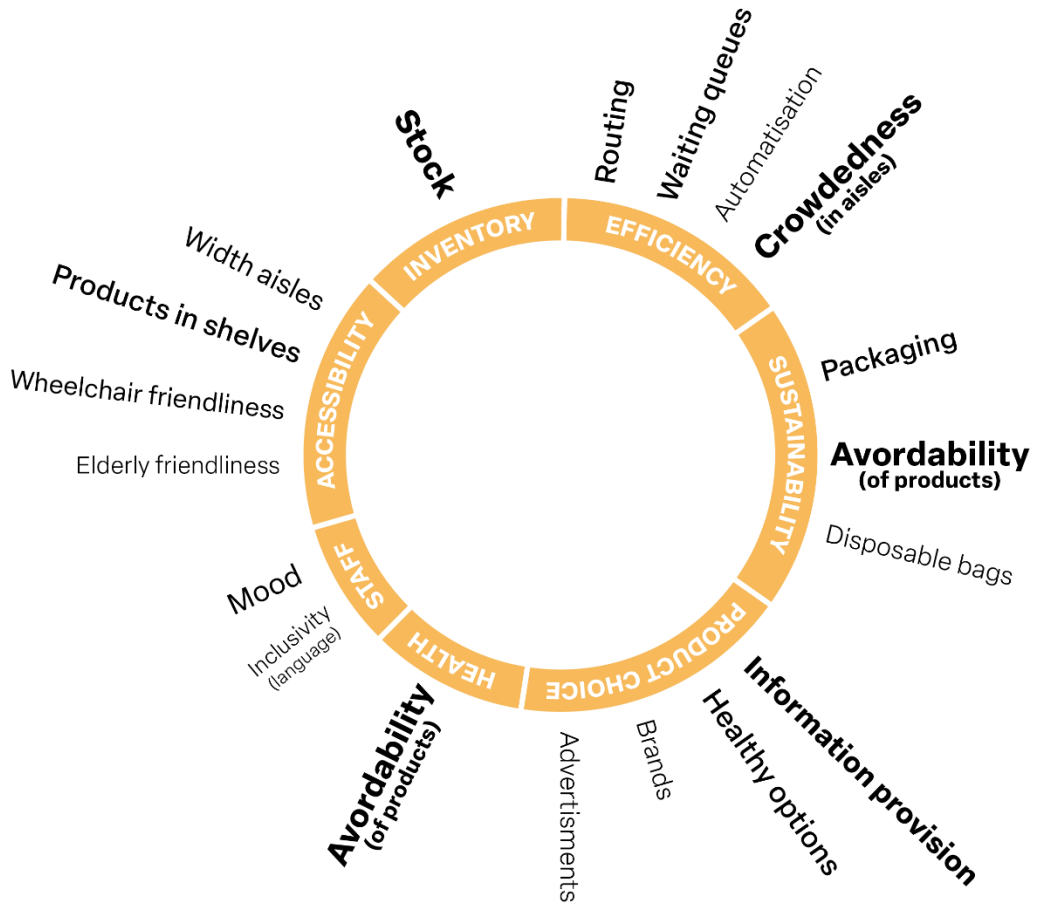


Figure 6: Summarised brainstorm results on the problem statement of the co-design session

The most frequently cited frustrations and areas for improvement in the supermarket concerned products being out-of-stock, inefficiency caused by too many people in one place, and sustainable and healthy products being more expensive than alternatives.

The organisation of the co-design session created a list of varying roles covering different perspectives beforehand, for example, the supermarket CEO, policy maker, supplier or elderly shopper. The complete list can be found in Appendix A. All participants got a role assigned. Besides, the participants also received one of the thirteen fundamental psychological needs from Desmet and Fokkinga to keep in mind. These needs include, for instance, autonomy, comfort and community, and are considered the basic needs for our functioning and the ingredients for our advancement [45]. Previous qualitative research of the future vision expert indicated that people perform better during a brainstorm about future scenarios when they keep in mind the need for improvement.

With these predefined conditions, everyone came up with two positive, two negative and two disastrous scenarios for the supermarket of the future. The scenarios were placed in a matrix with the axes representing horror-hype and individual-community (see Appendix A).

The horror scenarios the participants came up with are:

- Supermarkets not being accessible for people from all financial backgrounds or ages due to physical or cognitive obstacles;
- Too much automation resulting in no social interaction at all;
- Technology taking over with algorithms deciding what you should eat.

The hype scenarios regarded:

- Reduction of food waste;
- Support in making profound product choices and efficiently fetching them;
- Interesting and playful discount systems.

Technology is recognised as an important factor for opportunities but is also seen as a threat when not ethically applied. Furthermore, it can be stated that the outcomes of the co-design session align with the identified trends in the desk research.

Figure 7: Co-design session set-up

6. Stakeholders

6.1. Staff

Different supermarket chains arrange their organisational structure and the functions of employees in their own way. Figure 8 and Figure 9 illustrate examples of the organisational structures of Albert Heijn and Jumbo (two Dutch supermarkets as defined in the Scope), composed using the retrieved information from the desk and empirical research. Although the structures can differ in the coordinating and managing functions, multiple similarities can be seen in the organisational structures. This section aims to create a baseline for the intervention to be designed.

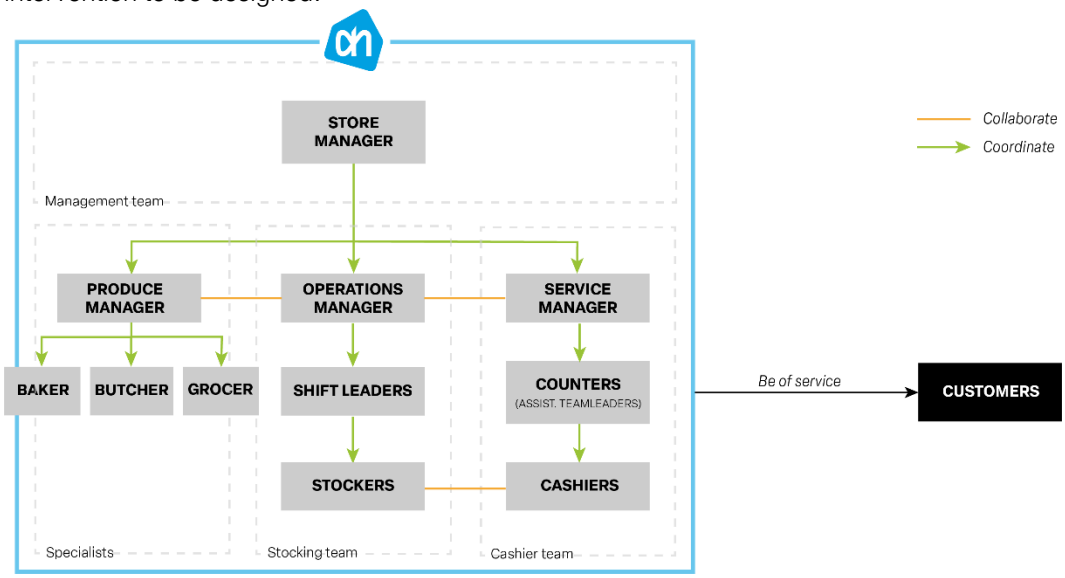


Figure 8: Organisational structure regarding the store operations of Albert Heijn (based on [46])

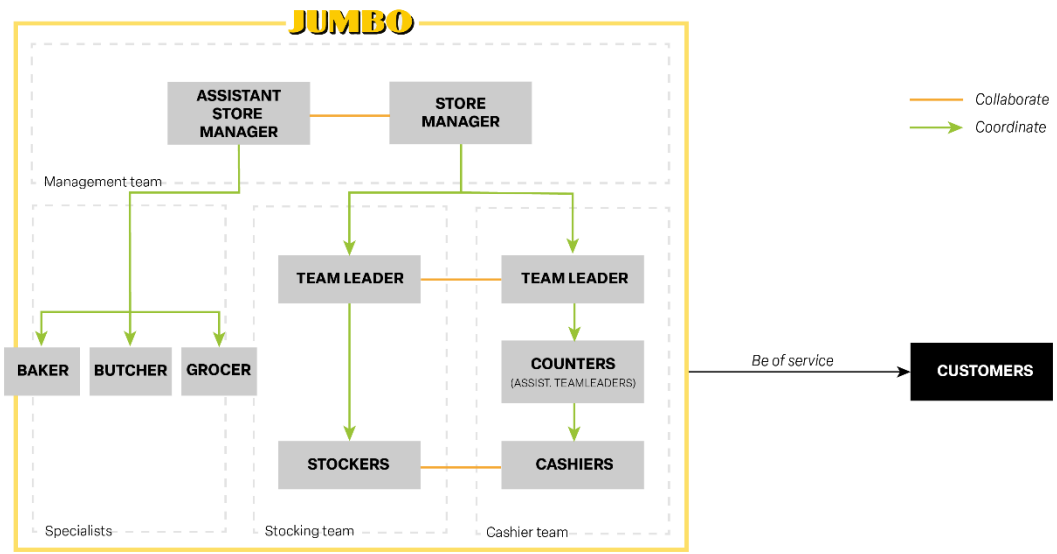


Figure 9: Organisational structure regarding the store operations of Jumbo

The organisational structure is often based on the product sections in the supermarket. The specialists (i.e. baker, butcher and grocer) are responsible for the fresh food work in their sections and have little interaction with the stocking and cashier teams. They often have more job experience and carry responsibility for running their section. The stocking and cashier teams are large teams that interact with each other a lot during a workday. One of the challenges of these teams is that the majority of stockers and cashiers are often between 16 and 18 years old, as this age group is the most financially attractive. For most of them, this is their first and only temporary job, and they do not always feel much responsibility for the quality of their work. The stockers and cashiers carry out the operational tasks on the shop floor, such as stocking the shelves, serving the customers at the checkout, or cleaning the interior. The higher the position in the structure, the greater the organisational responsibilities. Team leaders or managers oversee recruitment, training (new) staff and administrative duties such as staff planning and hour registration. At Jumbo, a weekly meeting is held with the team leaders and the (assistant) store managers to discuss the progress and make decisions regarding the next steps in business processes.

The functions within the organisational structure of Albert Heijn and Jumbo are well-defined. In contrast, at Aldi and Lidl, the functions are more flexible. Most employees can fulfil multiple functions: The bakery personnel also stocks the shelves of other sections and is trained to handle the checkout. The multifunctional staff leads to more freedom in staff scheduling and reduced costs.

Next to the supermarket chain, the functions within a supermarket also depend on the size of the supermarket store. For example, there are multiple assistant store managers in the larger Albert Heijn stores, while in smaller stores, only a store coordinator exists [47].

6.2. Customers

The customer is an important stakeholder when researching the business processes of a supermarket. A supermarket provides a service to its customers and tailors its processes to its target group. For example, the range of products found on the shelves depends to a great extent on the data produced by the checkouts [6].

In a supermarket, people from many different backgrounds come together. The reason why a customer visits the supermarket, together with its values and interests, determines how a person navigates through the supermarket and, consequently, which actions are performed. Literature review shows significant differences in customers' buying behaviour in the supermarket regarding age, gender, background or interests [48]. This, together with the interviews conducted with stakeholders with an organisational perspective, it is concluded that the following factors are crucial to determining customer profiles:

- Age - Older adults are often more loyal to a specific store and develop stronger habits in doing groceries [49]. For these habitual customers, price is the most critical driver. Young adults, especially single ones, mostly do not plan their weekly groceries and are more sensitive to impulse buying. For these less experienced customers, convenience is the driver: a speedy checkout and a user-friendly store layout are essential [48].

- **Financial and cultural background** - Affluent single adults are more open to socialising with staff and other customers and are more likely to be influenced by experiential aspects [49]. People with lower incomes appear to be more loyal to one store, while people with higher incomes tend to vary more in which store to visit. Furthermore, one's cultural background influences food choices [50].

Next to demographic or social factors influencing the buying behaviour, literature distinguishes relations within the in-store behaviour:

- **Duration visit** – The length of the supermarket visit or the regularity of visiting does not increase the number of purchases made during a visit, although it might influence unplanned purchases [51]. On average, 70% of the purchase decisions are made in-store.
- **Carrier system** – The type of carrier system (shopping cart, shopping basket or no equipment) a customer grabs at the beginning of the supermarket appears to be an objective measure that consistently explains the difference in travel distance, shopping duration, store area coverage, walking speed, number of purchases, and shopper efficiency [52].

The discovered relations in buying behaviour are considered when building the conceptual framework of the supermarket.

Conclusion Analysis

The desk research and co-design session answer research question C: *'Which trends can be identified in the supermarket industry?'*. Several trends are going on in the industry, ranging from external influences to shifts in focus within the industry. Both the desk research and the co-design session led to the same positive and plausible future scenarios in which supermarket systems are optimised to reduce food waste, help the customer make informed product choices, and collect the products (financially) efficiently. Technology is an important driver in these optimisations. The current trends will be used as use cases to frame the aspired value.

The empirical research and Chapter 6 answer research question D: *'Which stakeholders are involved in a supermarket?'*. It differs per supermarket chain and store size what stakeholders are involved in the organisational perspective. Consequently, who is responsible for decision-making also differs per supermarket. Therefore, the intervention will not be designed for a specific job profile but for the right person within the organisational structure of a supermarket: namely, the person with the responsibility to make decisions about the operations on the shop floor. In the examples of Albert Heijn and Jumbo, this is a team leader or the operations manager. Part IV will elaborate further on the details of the end-user. Another important stakeholder is the customer. A supermarket aims to provide the best possible service to the customer. Because of this, the customers indirectly have a significant influence on the store operations since the operations are tuned to the wishes and needs of the customer target group.

PART III
SYNTHESIS

In this part, the theoretical framework is combined with the industry analysis to synthesise a conceptual framework of a supermarket. The conceptual framework will serve as the underlying structure for the decision support system. As the aim of the DSS is to enable the supermarket management to react effectively to change, firstly is elaborated on how a supermarket could react to change. Next, the elements of the conceptual framework are defined and finally the interrelationships between these elements are determined.

7. Dealing with Change

A supermarket must cope with various factors influencing its environment, which can advance over time. For example, currently, much attention is paid to technological developments. Technology is widely recognised as a driver of organisational change and provides the supermarket with new opportunities and challenges [53]. Next to technology, changes regarding many other topics could occur and are also relevant for a supermarket to keep an eye on. Figure 10 gives realistic examples of possible changes that could impact the in-store operations based on the macro, meso and micro analysis methods. The supermarket has a direct influence on in-store operations, an indirect influence on the industry (meso level) and no influence on the environmental factors (macro level).

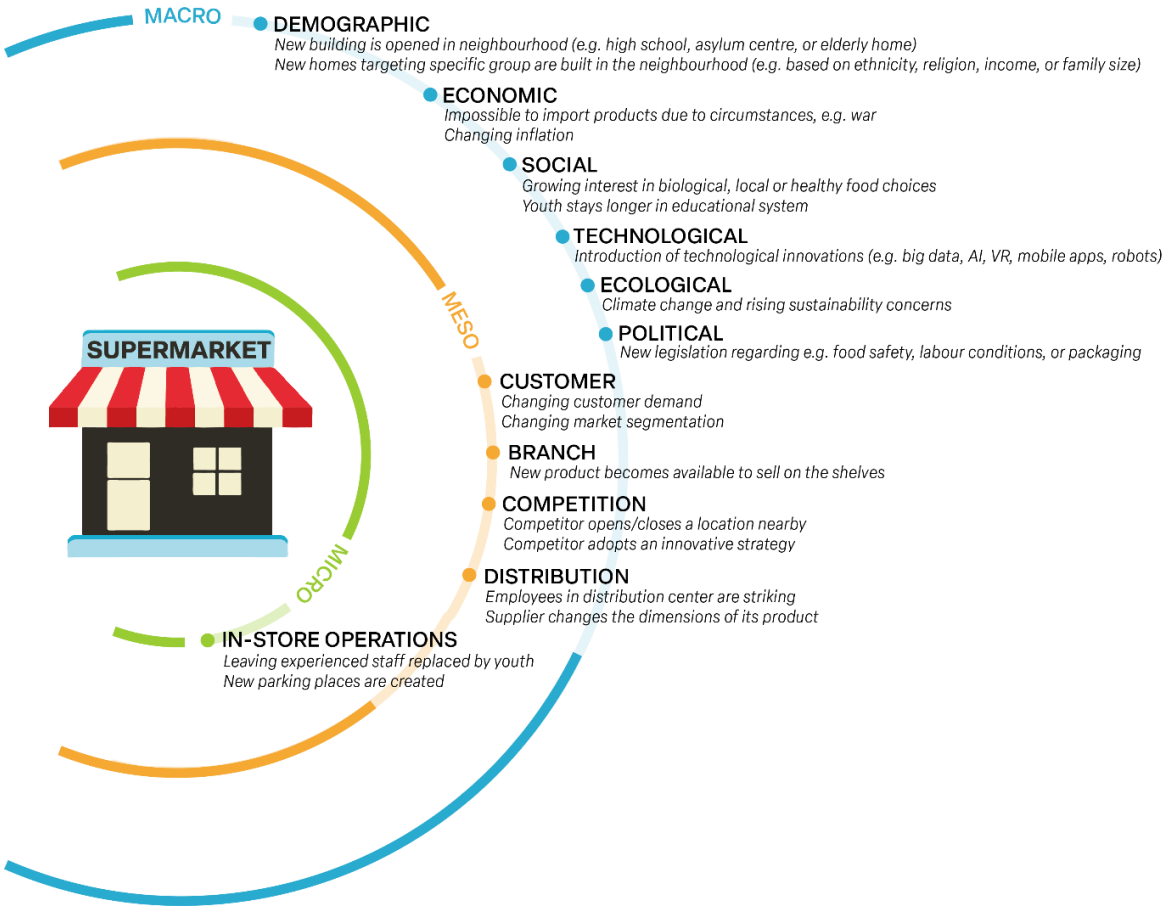


Figure 10: Possible changes categorised in the macro, meso and micro level

7.1. Reactions to Change

As mentioned, the changing factors in Figure 10 are just a few examples of a wide range of external and internal changes that could occur in a supermarket's landscape. The supermarket management has to analyse the new situation and decide if and how to react, independent of where and which variable changes.

The in-store operations are categorised into themes based on the marketing mix's components (Product, Price, Place, Promotion, Personnel and Presentation). The marketing mix is used to formulate the retail strategy, address customer needs, coordinate operations and respond to competition [54]. The six P's are identified as the controllable parameters of the in-store operations of a retailer. Thus, with these parameters, the supermarket can initiate a reaction to a change [55]. The parameters are translated into reaction categories which are relevant in the supermarket context. A review by C. L. Goi discusses the numerous proposed modifications over time regarding the P's of the marketing mix and concludes that the mix does not consider the unique elements of service well enough [56]. Therefore, the fifth category is not based on one of the six P's but focuses on the services provided by the supermarket to the customers.

The methodology of the marketing mix serves as a basis for the micro analysis method of this research. The methodology is applied and adjusted to the context of a supermarket. Some parameters are combined, and 'Place' is translated to the product's place instead of the store's place in the area initially meant. The themes of reactions to change are defined as follows:

1. **Inventory** *[Product]* – Inventory management includes everything around the assortment of products and the product flow (ordering, stocking and selling). When external changes influence customer demand, for example, demographic changes impacting the composition of customers from the supermarket or trends based on social aspects influencing customers' interests, there should be a reaction regarding inventory processes.
2. Store **Layout** *[Place & Presentation]* – This theme entails where the products are made available to the customer and how the products are presented. In other words, this theme regards routing in the supermarket and product placement on the shelves. When something changes in the assortment, e.g. when a product is out of stock or when a new product is placed on the shelves, the supermarket should react regarding the store layout. Decisions around the layout aim to use the valuable space as effectively as possible.
3. **Pricing** *[Price & Promotion]* – This theme entails financial aspects around the selling of products, including loyalty programmes, marketing and strategies to persuade the customer to buy the product. Reaction in this theme is expected when opportunities or threats occur due to competition or developments in the branch.
4. **Staff** *[Personnel]* – This theme includes the employees and their functions, salaries and performance. Besides, it also entails the team's composition, labour schedules and working conditions. When something changes, impacting the work or workload of the staff, a reaction within this theme is required.

5. Customer **Service** – Service refers to the interaction between the customer and the supermarket and the support the supermarket organisation provides to enhance the shopping experience and meet customers' needs. Reaction in this theme is expected when new concepts are introduced to the customers for additional support.

The first four themes are rather self-explanatory, while the fifth theme requires more elaboration. In the past, customer-employee interaction was the key differentiating factor in customer service. But, customer service should be approached more holistically: all systematic factors and human interaction in general contribute to customer service satisfaction. Service in a supermarket includes, for example, the mood and expertise of the staff, stimulating low waiting times or offering tools that make doing groceries more convenient.

Each reaction theme has different stakeholders who should be involved in making decisions about the topic. For example, the team leader of the stocking team has a good overview of what is happening around inventory management, and the counters know what is happening around service because they receive complaints at the service desk.

7.2. Effects of Reactions to Change

An organisation is a web of interconnections; a change in one area will have an impact on others [57]. A change invoking a reaction in one of the five themes could also affect processes in another theme as a side-effect. This effect can be clarified because the five reaction themes also influence each other. The effects are visualised in Figure 11, where the arrows represent a theme affecting another theme.

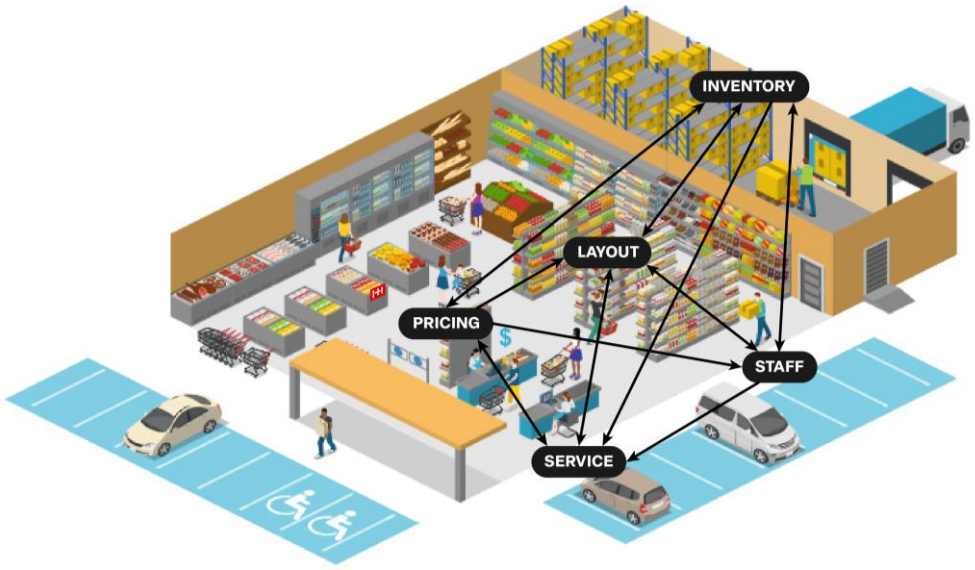


Figure 11: Effects of the reaction categories on each other

The staff is responsible for ensuring the inventory is at the right place and time. So, inventory planning influences the staff schedule as well as the store's layout. The other way around, the layout also influences the inventory orders when it is decided to take a product off the shelves and the staff schedule when certain sections are extended at the expense of other sections. For both inventory and layout yields, the quantity and quality of the staff determine whether the goals of the categories are achieved.

Furthermore, pricing and inventory also go hand in hand. When a product is promoted, the inventory should account for more sales. When a product is oversupplied in the inventory, its price should be adjusted to prevent it from turning into waste. Next to this, the layout will be rearranged according to the promoted product. Lastly, all other categories will influence the service: when a product is out of stock, no staff is available to answer questions, the layout is unclear, or too many stimuli are given by marketing signs, this negatively impacts the service perceived by the customer. On the other hand, when the operations around inventory, pricing, layout and staff are conducted well, the customer will receive the service positively. The other way around, aiming to provide customer service could influence the layout by adding social corners and the staff by training them to be more knowledgeable.

Table 2 summarises the impact of the themes on each other and how they take shape. The themes in the top row influence the themes in the left column. For example, Inventory affects Layout when the number of products per product group changes, while Layout influences Inventory by setting boundaries for the number of products.

Table 2: Overview of influences of reaction categories on each other

Influence of category →

Category being influenced ↓

	INVENTORY	LAYOUT	PRICING	STAFF	SERVICE
INVENTORY		Size of sections set boundaries for number of products	Promoted products are ordered more	Move products and manage inventory system	Offering carrier systems stimulates buying more products
LAYOUT	Out of stock or new product changes product placement or store layout		Promoted products are placed on the shelves at the end of the aisles	Stockers influence the neatness of the layout	Creating spaces for social engagement takes floor space
PRICING	Oversupply or almost expired products priced lower				Offering higher service results in higher prices
STAFF	Incoming inventory influences staff schedule	Size of sections determine number of staff	Higher pricing creates higher expectations of staff		Training staff
SERVICE	Special products gives higher services	Layout determines appearance	Interesting and personalised promotions give higher service	Staff giving advice, handling complaints and their mood upgrades service	

7.3. Reactions at the Micro Level

The interviews described in Section 5.2 are, amongst others, used to investigate the (re)actions performed in and around the environment of a supermarket. Table 3 presents an overview of how the interview results contribute to understanding the reaction themes. People with varying functions and interests from different Dutch supermarket chains are spoken to. The interviewees are anonymised, and the letters behind the names stand for a Dutch supermarket chain.

Table 3: Overview of conducted interviews

INTERVIEW	CHAIN	FUNCTION OF INTERVIEWEE	TOPIC OF THE INTERVIEW	INVENTORY	LAYOUT	PRICING	STAFF	SERVICE
1	A	Supermarket owner	Social engagement in supermarket and organising cooking lessons with almost expired food	X	X			X
2	B	Logistics Preparation	Factors influencing personnel planning in the distribution centre (DC) and general operations between DC and stores	X			X	
3	B	Floorplan Manager	Data model determining the optimal store layout		X			
4	B	Supermarket owner	Freedom and decision-making of a franchise entrepreneur	X	X	X	X	X
5	B	Teamleader Stocking team	Daily operations on the shop floor	X	X			
6	B, C	Product Manager	RFID technology making inventory management more accurate	X				
7	D	Category Manager	Process of determining promotions and factors influencing assortment	X		X		
8	E	Sales Interior	Designing and producing shelves and renewing interior		X			X
9	E	Technical Coordinator	General operations between DC and supermarket stores	X				
10	E	Teamleader Checkout	Staff planning and training of cashier team and organisational structure				X	
11	F	Operator	Operations at different sections on the shop floor	X			X	X
12	F	Rayon Manager	Organisational structure, external changes and decision-making				X	X

Table 4: (Re)actions at the micro level and their data sources

REACTION CATEGORY	REACTIONS	DATA
INVENTORY	Stock counting Stocking products Forecasting products Ordering products Receiving products from distributor Putting products in /out of the shelves Selling products at the checkout Theft prevention Category management	**Inventory management system** • Checkout • Stockers scanning: - Incoming products - Remaining products - Waste **Assortment planning**
STORE LAYOUT	Composing the store layout Product placement in shelves Renewing interior	**Floor plan** **Planogram**
PRICING	(Re)placing the price tags Promoting products Managing loyalty programmes Selling products at the checkout	**Financial system** • Financial administration - Staff - Products • Loyalty programmes • Promotions
STAFF	Recruiting new staff Training staff Planning shifts Access control Hour registration Paying salaries	**Staff management system** • Staff profiles • Hour registration • Staff schedules
CUSTOMER SERVICE	Offering parking place Offering carrier systems Giving advice or help Being physically accessible for everyone Handing complaints fairly Having seating areas and/or food corners Crowd management	**Reviews** **Sensors** • Monotoring cluttered aisles

Based on the interviews, Table 4 presents an overview of the actions and processes related to the five reaction themes. The reactions are the physical processes by which the entities undergo changes in their current state. Section 8.2 will elaborate on the different entities and their states. The produced data and the information systems with those actions could be possible input sources for the decision support system (DSS) and will be considered in the design phase.

8. Conceptual Framework of a Supermarket

In this chapter, a conceptual framework of a supermarket is built to obtain the required insights into connectivity. Constructing the conceptual framework involves the identification of entities and their interrelations and, therefore, is a theoretical process [58]. As explained in the Design Methodology in Section 2.4, an abductive approach is used for the development: reasoning back from the aspired value. This results in the specification of the rules and principles for the classification of the elements. Creating the conceptual framework is an iterative process optimised by studying use cases.

The conceptual framework will function as the theoretical basis for the decision support system. But, before the building of the conceptual framework of the supermarket commences, the focus within the supermarket branch should be further specified based on the supermarkets of today.

8.1. Specifying the Dutch Supermarket

The Netherlands houses over 20 different supermarket chains. Every chain creates its own supermarket formula, which fits its retail strategy and brand identity. To distinguish between the different types of supermarkets (e.g. XL store and To Go store), a division is made based on the characteristics of the store and the products (see Figure 12). The store size is a crucial differential factor regarding business processes, such as the organisational structure described in the stakeholder analysis in Section 6.1. Product diversity influences the intentions of people coming to the store and, thus, the buying behaviour. A grocery store arranges its processes regarding inventory, pricing and service based on the buying behaviour of its customers. Hence, product diversity is used as a second axis to differentiate between the different types of grocery stores.

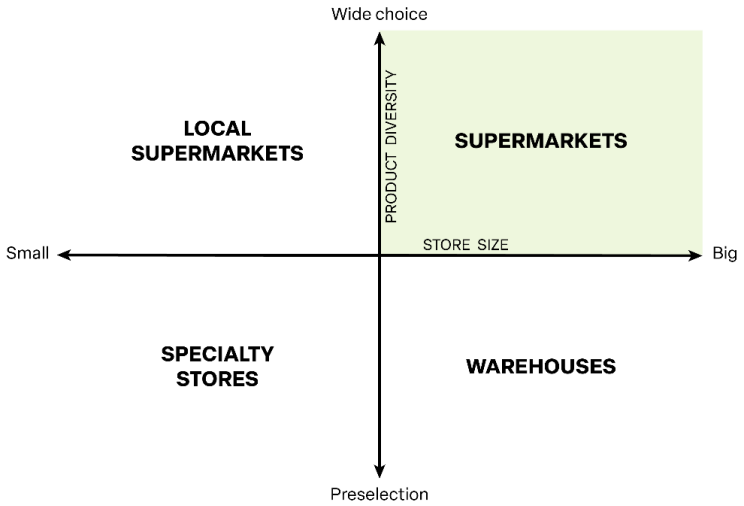


Figure 12: Segmentation of brick-and-mortar grocery stores

This thesis focuses on the considerable-sized Dutch supermarket (floor space around 750 to 1000 square meters) with wide product diversity: the upper right quadrant. In supermarkets, individual customers do their groceries rather anonymously, and the wide range of products is driven by customer demand.

Next to store size and product diversity, more characteristics of the supermarket are fundamental in decision-making about the in-store processes. The five reaction themes (Inventory, Layout, Pricing, Staff and Service) are considered to capture all in-store operations of a supermarket. Based on the empirical research, it is discovered that ownership of the store and the balance between price and quality influence more than one of the five themes. Hence, next to the two characteristics of a supermarket set in the matrix of Figure 12, the following two characteristics are added to approach a supermarket store formula:

- Corporate-owned vs. Franchise-owned store
  A corporate-owned store is directly operated by the parent corporation, which has complete control over the store's operations, branding, and overall business strategy. At a franchise-owned store, an entrepreneur purchased the right to operate a supermarket under an established brand's name and business model. It can be stated that a franchise-owned store is more flexible and responsive to the local market regarding inventory and service. A corporate-owned store is more standardised and consistent in inventory, staff training, service quality and store layout and is able to invest more since its financial risk is lower.
- Discount vs. Full-service store
  The perceived value of a product is a trade-off between perceived benefits and sacrifices by the customer [59]. To achieve a high product value, either the benefits should be high, or the sacrifices should be low. Supermarkets like Aldi and Lidl are discount stores that strive to keep the prices of their products as low as possible while not detracting from the product quality. Mostly, this results in a low variance in the inventory. A full-service supermarket like Albert Heijn prioritises customer experience and consequently offers products for higher prices.

The characteristics can be filled in per individual supermarket store and will be used as the starting point of the to-be-designed intervention. In this way, the recommendations given by the decision support system will fit the identity of the supermarket store. For example, if an Albert Heijn store in a medium-sized Dutch city centre uses the to-be-designed intervention, the AH representative would set the characteristics mentioned above, as seen in Figure 13.

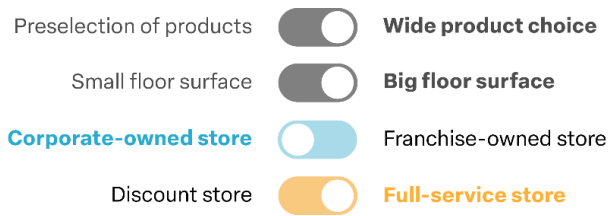


Figure 13: Set of characteristics to approach a store of Albert Heijn

Another additional characteristic could be whether the supermarket offers delivery or pickup services next to the in-store grocery shopping since these services fundamentally influence in-store processes like inventory management and staff scheduling. However, this is considered out of scope as this thesis focuses on the situation where customers do their groceries in the brick-and-mortar supermarket.

To check how the characteristics differentiate between existing supermarkets, the set of characteristics is determined for large Dutch supermarket chains (see Figure 14). Each set of four characteristics represents one supermarket store within the chain.

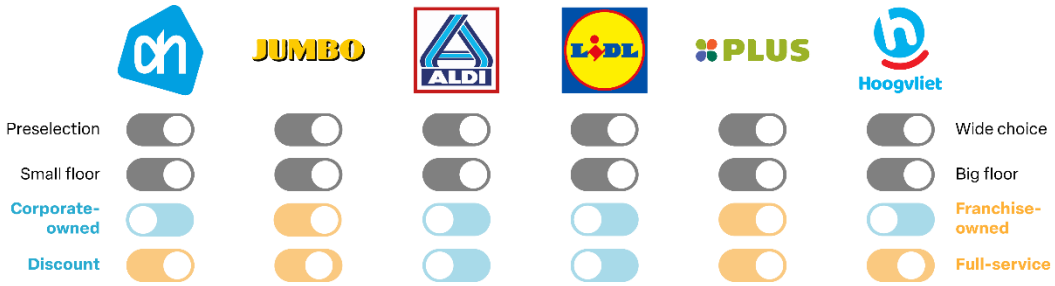


Figure 14: Determining the set of differentiating store characteristics for multiple supermarket chains

Aldi, Lidl and Hoogvliet have no franchise-owned stores [60], while Plus comprises around 75% of franchise stores [61]. Albert Heijn and Jumbo have corporate- and franchise-owned stores but are presented in their most common format in this example.

It should be noted that the store characteristics initially were presented as binary factors, while the characteristics are actually a spectrum in real life. For example, between a discount store keeping the prices low at the expense of other factors and a full-service store offering excellent customer service while selling products with higher prices, there are also in-betweens: quality discount stores provide average service and offer sharp prices, and value-for-money stores provide both service and prices on average level [62]. Furthermore, the extent of how much freedom a franchiser gets from the corporate formula could differ per agreement. In Figure 14, Albert Heijn and Hoogvliet would have the same set of characteristics if presented in a binary way. In reality, some significant differences in in-store processes could be identified. It was found that the identity of a supermarket could not only be approached in a binary way. Further research should be conducted into the thresholds between the different states.

The findings of the empirical research are compared with the literature for validation. The following three factors are pillars to approach a supermarket formula [63]: the target group, the market position and the marketing mix. The Discount versus Full-service store characteristic covers the marketing position and parts of the marketing mix. A missing characteristic in the current set is the location of the supermarket: The target group depends strongly on whether the supermarket is located in a city or the countryside and also on in which part of the Netherlands. In addition, different areas of a city may result in different demographic segmentation. The geographical location of the store should be added to the set of characteristics in Figure 14. Again, the location cannot be covered by a binary characteristic.

The insights obtained while specifying and approaching supermarket formulas are used as the starting point of the decision support system to have the decision support system (DSS) give accurate and personalised recommendations about the supermarket store.

8.2. Entities of a Supermarket

8.2.1. Identifying Entities

To compose the conceptual framework of a supermarket, firstly, the physical entities of the supermarket are identified and categorised. The identification is done via empirical research since no standardised categorisation nor methodology could be found in literature. Figure 15 categorises entities in layers based on their behaviour or functioning. The category People, with subcategories Staff and Customers, and the subcategory Interior are further divided into groups and units. The quarter of Selling Goods acknowledges a layer with sub-subcategories and subgroups and includes a far greater variance of units.

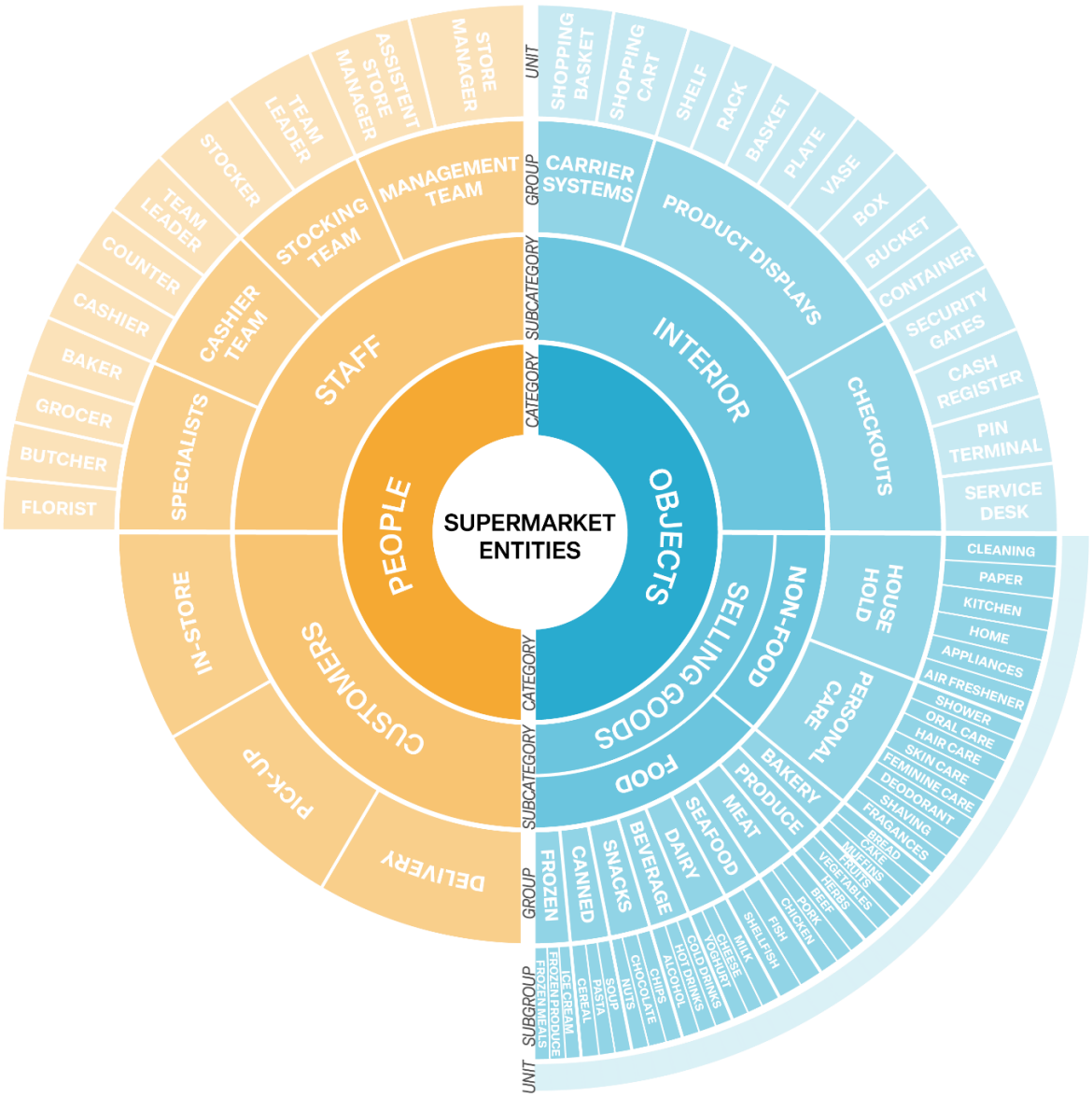


Figure 15: Sunburst chart of the entities in a supermarket

The more you go to the outside of the chart, the more detailed it gets. The subcategory Selling Goods has the common factor of containing entities a customer can buy. The sub-subcategory Food adds to this behaviour that it is consumable and provides the constraint that it has to be sold before the expiration date. The group Beverage specifies it is a liquid quenching your thirst, and the subgroup Alcohol that the consumer has to be an adult. One of the units of the subgroup Alcohol is a bottle of wine, owning then the behaviour of an object with the purpose of selling, before the expiration date, to quench your thirst, to be consumed by an adult.

The primary division of all entities is between living and non-living, as this is set and a crucial factor in defining behaviour. Thus, the two main categories are People and Objects. Further categorising reveals that behaviour is context-dependent. For example, a shopping cart is categorised as a carrier system but can temporarily serve as a product display filled with leftover products and placed in the checkout area. Additionally, there is variation in how supermarkets categorise their selling goods; Jumbo recognises 18 categories [64], whereas Albert Heijn acknowledges 21 product categories [65]. DekaMarkt, however, only distinguishes 12 categories [66]. The difference in the number of product categories may be explained by the fact that product categories are based on the buying behaviour of the customers of a supermarket [67]. The information structure presented in Figure 15 is considered a representation of reality, which would apply to many situations. Still, there are exceptions, such as the example of the shopping cart mentioned above.

A solution to capture all possible situations would be to connect the units with lines to the groups they could belong to in a particular context. Figure 16 illustrates an example of the interior quarter.

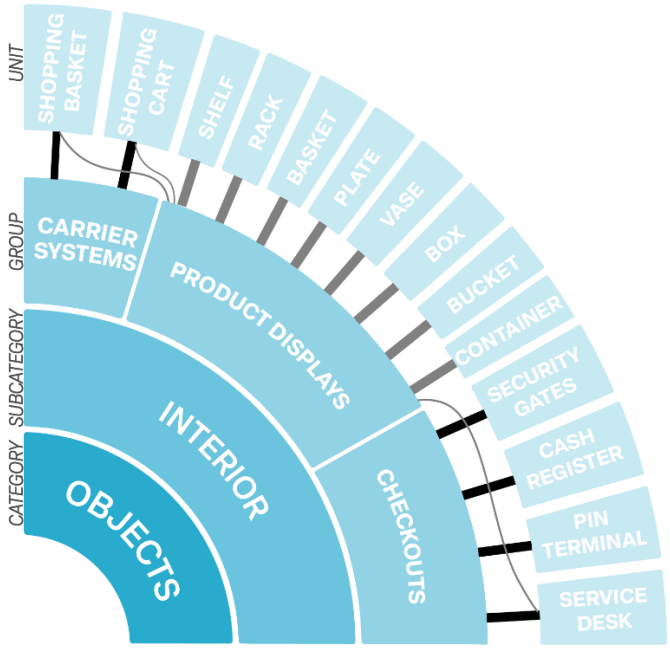


Figure 16: Supermarket entities connected to multiple groups

In addition to behavioural characteristics, each unit has properties. Figure 17 shows the properties of the unit Security Gates. Information structuring depends on the purpose of why the overview is created. In the case of a material or ingredient containing hazardous substances, it is more logical to filter the entities by the property of the specific material or ingredient rather than by the behaviour of the whole entity.

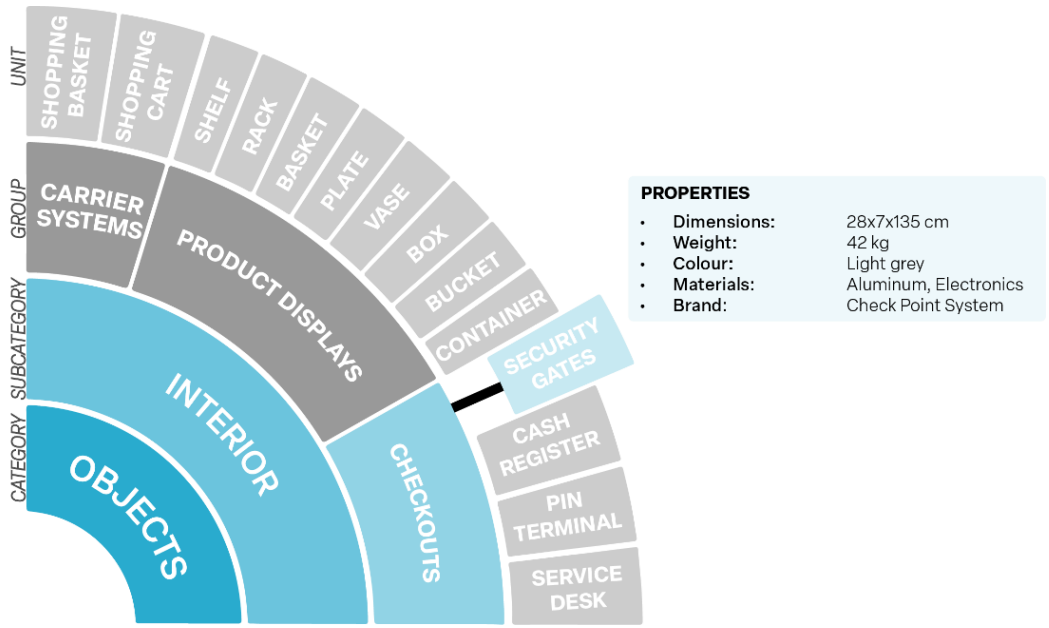


Figure 17: Example of the selected unit with its properties

The sunburst chart shows the supermarket entities in a 2D representation. The quarter of Selling Goods already gives an example of what a 2D representation looks like when there are multiple subcategories and subgroups within a category. Besides, Figure 15 is a general representation of a supermarket. If you create a sunburst chart for an actual brick-and-mortar store and translate all the entities into this representation, the chart may grow even more.

When the chart becomes even more detailed, it could become information overload. In the to-be-designed intervention, the entities will be presented in a three-dimensional representation to overcome this issue. When the unit is placed into a system, like the security gates into the supermarket system, as seen in Figure 18, the entity owns next to its properties also attributes. Performed actions could change the attributes without altering the nature of the entity. For example, the entity's temperature would drop if the staff installed a new air conditioning system above the security gates.

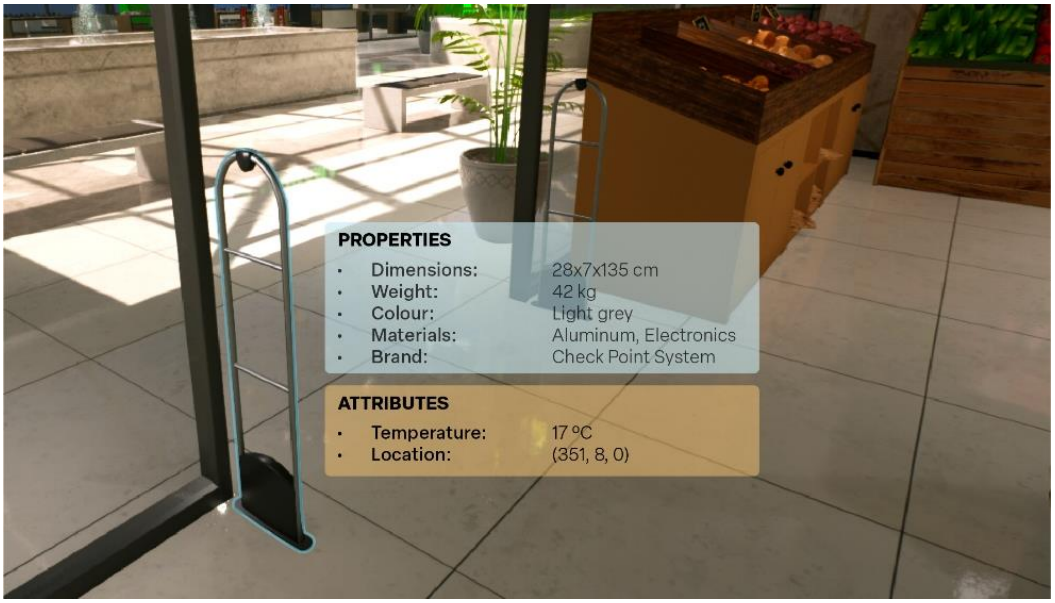


Figure 18: Example of the selected unit with its properties and attributes

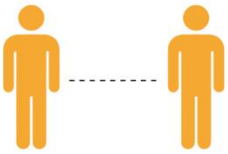
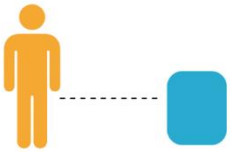
8.2.2. Interrelationships between Entities

As discussed, each entity has behavioural characteristics, physical properties and attributes. Entities are connected via an interrelationship based on their characteristics, properties or attributes, for example, when they are similar or complementary. As described in Section 4.3, connectivity can be based on different aspects depending on the context. In the supermarket environment, connectivity can be recognised in:

- Functional characteristics or behaviour;
- Physical properties;
- Spatial position of in-store;
- Temporal characteristics - a moment in time.

The connectivity matrix in Table 5 shows how connectivity is identified in the interrelationships between living and non-living entities. It should be noted that the interrelationship between two objects is not solely a connection between those two entities. The relationship should be acknowledged by a person to have value. For example, it is generally known that products with light blue packaging are mostly the diet variant, but a blind person will not acknowledge this interrelationship. The senses of a person receive the physical properties of objects. Also, the value of functional connectivity relies on people's cognitive ability. However, this thesis approaches the connection between objects as a one-to-one relationship.

Table 5: Connectivity matrix of entities in the supermarket

	 PERSON - PERSON	 PERSON - OBJECT	 OBJECT - OBJECT
FUNCTIONAL	Organisational structure	Means for goal	Substitute Complementary Competitive
PHYSICAL	*Irrelevant*	Object within reach (z)	Dimensions Weight Colour Materials
SPATIAL	Location in-store	Object in sight Object within reach (x,y)	Product placement Location in-store
TEMPORAL	Work shift Supermarket visit	Work shift Supermarket visit	Transaction External event

The characteristics should be measurable variables to determine the entities' interrelations objectively. Physical, spatial and temporal connectivity are naturally measurable by, for instance, length, coordinates or timestamps. Functional connectivity regarding objects is partially based on the value perceived by the involved people, which is subjective to interpretation since people weigh the value components differently [68]. While the functions of people are often clearly defined in a contract or job description, the primary functions of objects are often common sense but are not set in stone. For example, a chair is for sitting on and a table is for sitting at, so the two interior entities would have the functional connectivity of complementing each other. However, if there are not enough chairs for all the students in a lecture room and there are a few tables for the back row to sit on, then the table would be a substitute for the chair.

The following pages elaborate on the four types of connectivity and how they are recognised between the two main categories of entities.

Functional Connectivity

The functional connectivity between people expresses itself in an organisational structure. For supermarket staff, their function is based on the job description in their employment contract, which will define their functional connection to each other and to the customer. Customers receive the service of the supermarket organisation.

Regarding Person-Object, the functional connection depends on the individual's exact goal with an object and how they interpret the purpose of the object. The purpose of selling goods from the organisational perspective is to be sold to a customer (before the expiration date), but from the customer's perspective, it is to be consumed. For selling goods,

packaging plays an essential role in the communication towards customers about the features and purpose of the product [69]. For the interior, its function is based on the habits of people and what they were taught to do with it.

Lastly, whether two objects are considered substitutes, complementary or competitive to each other is based on the perceived value by the customer. The four dimensions that measure perceived value are quality, pricing, emotional value, and social value [70]. Translating this to selling goods in a supermarket, the price and brand of a product are measurable parameters crucial in defining the functional connectivity between two objects. For example, Douwe Egberts coffee and Pickwick tea are more likely to be bought together than Perla coffee and Clipper tea, according to the principle of buying inertia [71].

Physical Connectivity

Physical connectivity between a person and an object is relevant when focusing on whether the object is within reach of the person regarding height. A stocker should be able to fill the shelves ergonomically. Customers should be able to grab the product out of the shelves in a convenient way.

Objects could connect physically through dimensions, weight, colour or materials. For example, the packaging of selling goods is based on collo-modular dimensions [72]. Figure 19 illustrates the efficient use of space. The secondary packaging has a pre-defined ratio in outer dimensions, and the primary packaging of the selling goods is adjusted accordingly. Also, when selling goods have the same dimensions, this means that they are easily interchangeable on the shelves.

Physical connectivity based on weight plays, for example, a role in determining the type of product display for different products. Connectivity between objects via colour is relevant to communicate, for instance, flavours: in chocolate bars and chocolate sprinkles, the same colours are recognised in dark (red) or milk (blue) chocolate. Also, biological products are primarily green.

Figure 19: Collo-modular packaging [59]

Spatial Connectivity

The in-store location between staff is based on the employee's function: the cashiers are operating in the checkout area, and the specialists are working in separate areas next to each other. The location in-store of customers is less predictable. The Poisson point process states that the arrivals of customers in the store are discrete events, the timing of which is random [73]. This means that the inflow of customers is not constant, and customers tend to enter the supermarket in clusters. Within the store, the customers move freely but are influenced by other people. A crowded aisle creates stress and facilitates people to shop faster and less. Selling goods that take more time to decide on, such as coffee or baby food, are put in aisles with lower traffic [74].

A person and an object have a spatial connection when the object is in sight or within reach of a person. For customers, this connection is stronger when the product is easily visible. Supermarket organisations use this principle when designing the planogram of the shelves. For example, products with the highest margins are placed at the eye level of the average adult, and candy is placed at the eye level of children. Regarding staff, the connectivity is relevant when a stocker refills products on the shelves.

Lastly, objects with the same purpose or from the same product groups are placed together in the same aisles to have clear routing in-store.

Temporal Connectivity

People can have a temporal connection when they are in the same moment at the same place. This temporal connectivity could regard co-workers working on the same shift, an employee helping a customer during their work shift or two customers meeting each other during their visit to the supermarket. The same yields for the Person-Object connection; a work shift or a visit for grocery shopping could connect a person to an object.

Two products could be connected through time by a transaction at the checkout. Supermarkets use checkout data to analyse which combinations of products are often bought together. This knowledge could be used to decide on the offering of combination deals. The other way around, offering the combination deal of, for example, a sandwich and a smoothy is a form of temporal connectivity. Currently, experiments are also conducted using checkout data to prevent theft at self-scan checkouts. When one product of the standard combination is scanned but the other is not, the checkout sends a notification to the employee in the self-scan area to check on the customer. Furthermore, an external event like the soccer World Cup could connect products like beer and chips by raising sales of both together.

Conclusion Synthesis

Based on the controllable parameters of a retailer (6 P's), the in-store operations of a supermarket can be clustered into five themes: Inventory, Layout, Pricing, Staff and Service. To answer research question E: *'How can a supermarket deal with change?'*, clustering the themes defines the area of focus regarding the processes and which stakeholders should be included. The actions within the themes are directly related, while the themes also influence each other. From Table 2, it can be concluded that Inventory, Pricing and Service influence all other reaction themes in some way, while Pricing itself is not influenced that much by other themes. Performing reactions within these themes, people can change the attributes of entities and, therefore, the interrelations between entities.

A Dutch supermarket can be approached with five characteristics considered crucial in decision-making: store size, product variance, ownership of the store, the balance between price and quality and the geographical location of the store. Having a set of characteristics as the starting point of the DSS ensures that the intervention applies to different Dutch supermarket chains. To answer research question F: *'How can a supermarket be conceptualised?'*, entities and their interrelations were identified to build a conceptual framework. Connections are defined between living and non-living entities based on their functional, physical, spatial and temporal characteristics. These connections become more detailed when applying the type of connection to the subcategories or groups in the outer layers of the sunburst diagram of Figure 15. This network of entities and interrelations represents the conceptualisation of a supermarket and is the framework upon which the DSS will be designed.

PART IV
DESIGN

This part describes the design process of the decision support system and eleborates on the choices made during the design and implementation phase.

9. Design of the Decision Support System

The world is evolving at an increasing pace, and complex decisions must be made adequately to keep up with the changing environment. Hence, the design objective of this thesis was stated as follows: *"To create an intervention which functions as a decision support system to enhance decision-making when changes occur in the environment of a supermarket."* The intervention supports recognising changes in the supermarket environment and enables the supermarket to deal with the change. The decision support system (DSS) helps the supermarket analyse the impact of the change and recommends how to react effectively, if taking action is advised.

In Part III, the conceptual framework was composed as the theoretical basis upon which the DSS can function. This chapter describes the design process by presenting the design guidelines and explaining the strategic, tactical and operational elements (see Figure 20). The result of Part IV is a demonstrator, which the end-user can test to discover optimisations for the realisation and implementation of the DSS.

Figure 20: Strategic, tactical and operational level

9.1. Design Guidelines for the Decision Support System

As described in the Design Methodology, the intervention consists of two aspects:

1. The 'what' entails the DSS based on the conceptual framework with its entities and their interrelations as compiled in the Synthesis.
2. The 'how' refers to the functioning and the way of working with the DSS.

Qualitative guidelines for designing the DSS are established to evaluate both aspects. The guidelines are focused on the functionality of the intervention and are derived from the information gained during the analysis of the industry and the interviews conducted with the various stakeholders. The list provides a foundation for the design process and may be expanded upon in future research.

The following **guidelines for the 'what'** are compiled:

1.1. The DSS should be able to be applied to different (chains of) Dutch supermarkets.
1.2. The interconnections in the DSS should be an objective representation of the supermarket environment.
1.3. Expanding the conceptual framework with a new entity should be an activity of low effort.

The following **guidelines for the 'how'** are compiled:

2.1. The DSS should support reacting to changes occurring in the macro, meso and micro levels.
2.2. The process of generating recommendations with the DSS should take the user not more than a few moments.
2.3. The interface of the DSS should be understandable by a person without a background in programming.
2.4. The DSS should keep track of decisions made in the past and optimise its analysing technique over time to make more accurate recommendations.
2.5. The user should be in control over the decision-making.

9.2. Design on the Strategic Level

The strategic level focuses on the long-term objectives and entails why the intervention is designed and who is involved with the DSS.

9.2.1. Motive

The DSS should enable the supermarket to recognise a changing environment and respond efficiently and effectively. Reacting to change means that once a change is identified, the supermarket should first decide if the supermarket should do something, then what the supermarket should do, and finally, how the supermarket should take action. This process can take a considerable amount of time, during which the supermarket's operational performance can be suboptimal. The DSS aims to speed up the process by identifying the changing environment at an earlier stage and recommending to the supermarket whether and how staff should respond effectively to the change. Figure 21 illustrates the benefit the DSS should deliver. After the implementation of the DSS, the intervention aims to optimise the supermarket's overall operational performance by better aligning store operations with the environment of the supermarket, recognising a changing environment earlier in time and facilitating the user in dealing with the change.

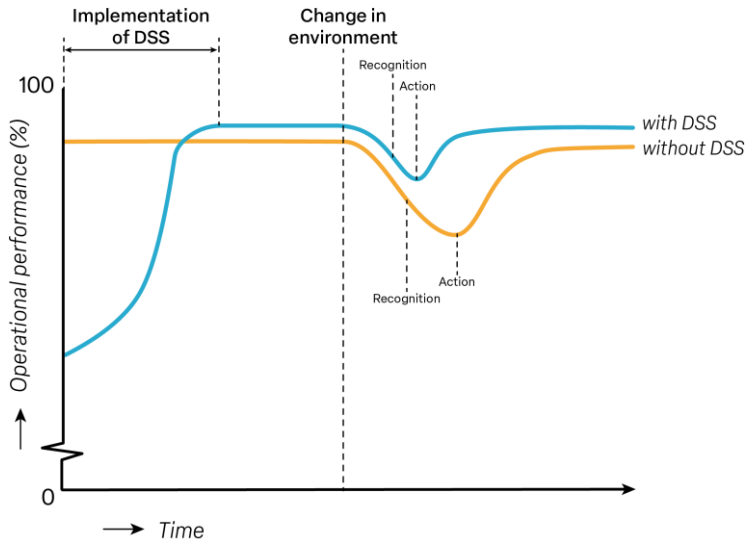


Figure 21: Operational performance of a supermarket with and without the DSS

9.2.2. Stakeholders

Various people within the supermarket organisation will either directly or indirectly come into contact with the DSS or experience its impact. It is essential to understand the interests and needs of the different stakeholders and their relationship to the DSS. The stakeholders identified in Chapter 6 are described based on their interest in and involvement with the DSS.

Traditional organisations are built around a structural hierarchy where decisions are made by the higher management and are passed down the chain [75]. On the other hand, agile organisations are characterised by a network of teams operating in decision-making cycles which have the right to make their own decisions.

The end-user of the DSS is the person who is in a position to make practical decisions on the shop floor. The interviews show that in the case of Albert Heijn and Jumbo, the team leaders of the cashier team and the stocking team are responsible for making the practical decisions in their sections and reporting them to the (assistant) store manager. Lidl, on the other hand, has a flatter organisational structure and does not work with separate teams per section. Furthermore, different supermarket chains have different titles for the functions within their organisational structure. It is concluded that the end-user of the intervention cannot be translated into a job profile but is the person within the lower management with the power and responsibility to make practical decisions. Figure 22 illustrates where the lower management is positioned within an organisational structure, using Jumbo's structure as an example.

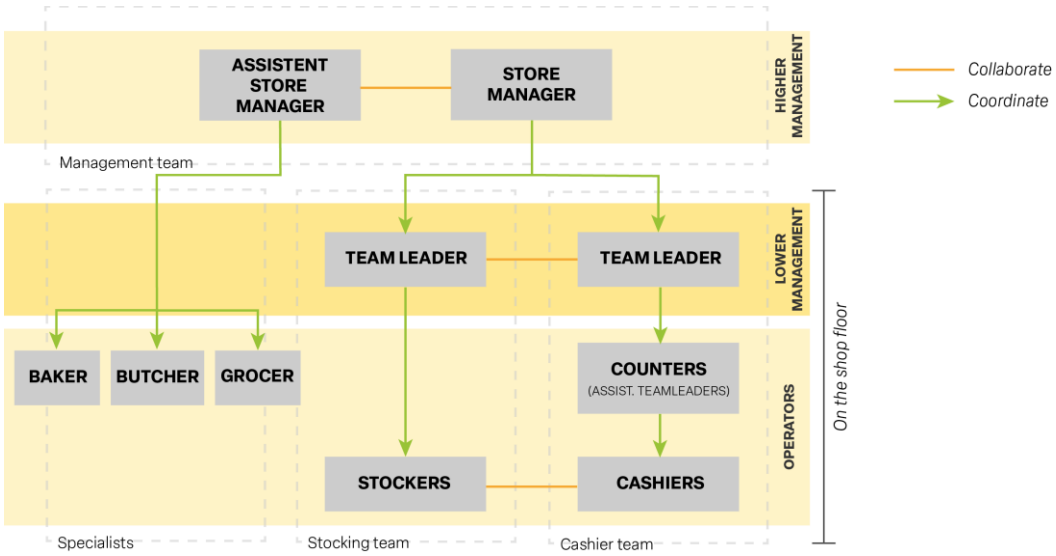
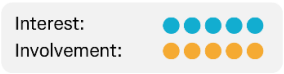


Figure 22: Management layers within an example organisational structure of a supermarket

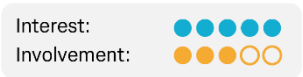
The general stakeholders to be taken into account during the design process of the DSS are outlined below. As the exact definition of the different jobs varies per supermarket chain, the stakeholders are described in broad terms that apply to the different Dutch chains. The extent to which the stakeholders benefit from implementing the DSS is described. In addition, the extent to which the stakeholders are involved with the decision-making process of the DSS within their function is also considered.

Team leader - Lower management



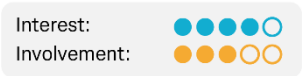
The lower managerial staff is physically present on the work floor during its shift and is the intermediate layer between the operating staff and the higher management. The DSS supports the team leader in making a plan of action, making its work more efficient. These employees are not specifically trained to use a technological tool like the DSS, which means that the user interface of the DSS should be intuitive and should provide guidance in getting recommendations out of the intervention.

(assistant) Store manager - Higher management



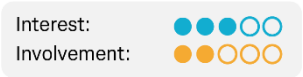
The (assistant) store manager(s) from the higher management is responsible for the long-term strategy of the supermarket and must approve the adopted decisions. They have to trust the system to make profound recommendations and the team leader to assess them well and consequently make the right decision based on them. The store managers should be considered in the implementation phase so they have knowledge of and experience with how the system works and how the DSS fits into their long-term strategy.

Headquarters



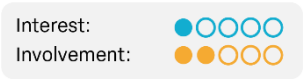
The headquarters of a supermarket chain guards the central policies around formula and promotions. Some decisions are made centrally and are communicated to the individual stores, while in other aspects, the supermarket store has the freedom to decide for themselves. A person within the headquarters is responsible for feeding information to the DSS about the central decision-making and external circumstances.

Suppliers and distributors



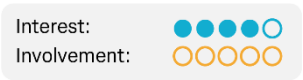
Suppliers, distributors and supermarkets are interdependent and work together, although they have diverging interests. Suppliers collaborate with supermarkets to optimise category management. Distributors adapt their planning according to the adopted decisions of the supermarket staff. In the current situation where a supermarket is not using a DSS, certain decisions tend to change over time. When a supermarket uses the DSS, decisions are made more deliberately, which is more convenient for the suppliers and distributors.

In-store operator



The in-store operators entail, amongst others, the stockers and the cashiers, execute the plan of the adopted decisions, and will experience the consequences from the implementation, for example, in their way of working or shift planning. There should be a feedback loop from how the adopted decision was realised on the shop floor. This task could be ascribed to the in-store operator.

Customer



The customers are not directly in contact with the DSS in the back end, but they experience the (positive) consequences of the intervention. The intervention's purpose is to find the balance between the organisational perspective and the needs and wishes of the customers. For example, positive consequences would be that the assortment fits the target group and products are not out-of-stock.

Technical expert

The supermarket staff will be interacting with the front end of the DSS, but there should also be someone who understands the back end of the intervention. It is not expected that anyone within the supermarket organisation has this expertise at this time. If the DSS is experiencing malfunctions or new features need to be implemented, a technical expert from the external organisation that owns the DSS software will be called in.

9.3. Design on the Tactical Level

The tactical level focuses more on the short-term goals and entails how the design should be realised and where it is implemented within the supermarket organisation.

9.3.1. Starting Point of the Decision Support System

For the DSS to give accurate recommendations, the system must be provided with specific information. As discussed in Section 8.1, the intervention is designed for Dutch supermarkets with an average to high floor space and a broad product diversity. Furthermore, the ownership of the store, the balance between price and quality, and the geographical location of the store are relevant to be programmed in the DSS at the start to personalise the intervention to a specific store. After that, the DSS should be fed with data about the physical store, entailing, amongst other things, the store's floor plan, inventory matters and staff schedules. In that way, the DSS is aware of the goals and whereabouts of the supermarket entities and can give recommendations for decision-making about the operational aspects.

Figure 23 depicts the order of the first steps to set up the DSS. Setting up the DSS has to be done only once in the beginning. The technical expert can guide the supermarket staff in this process.

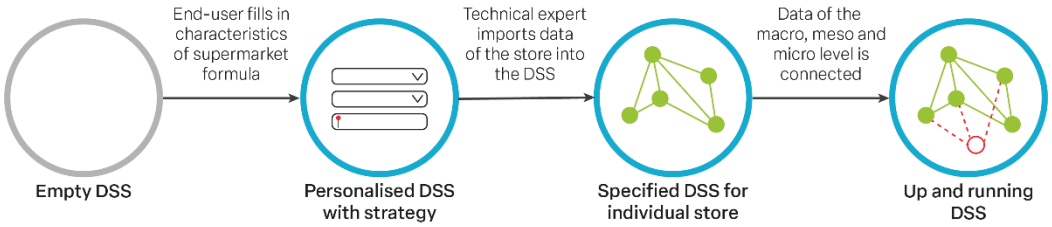


Figure 23: Setting up the DSS

The empty DSS represents the generic conceptual framework with entities and their interrelations. In the second step, the end-user has specified the supermarket's characteristics. In the third step, the DSS is fed with the data about the supermarket store and its entities. The technical expert will do this by importing files of the store layout and connecting information systems (e.g. inventory management system and staff system) to the DSS. Lastly, the system should be connected with data flows of the macro and meso levels to detect external changes, and the micro level should be up to date on the current situation in-store. After that, the DSS is set and ready to go. The following sections go into more detail about what is happening when the DSS is up and running.

9.3.2. Data Flows of the Decision-Making System

Nowadays, a lot of processes are captured in data. Research has shown that supermarkets own a large amount of data but do not know how to use this effectively and gain the most out of it [67]. Supermarkets let the suppliers inform them about trends in category management, for instance. There is much data available for the DSS as input, but it is not the more the better. Thus, the input sources are chosen based on the need: Which data is required to give recommendations about the in-store processes when a contextual change occurs?

As the name of the DSS states, the intervention supports the decision-making process. The user makes the decisions in the end. The DSS and the user are the two actors forming the decision-making system.

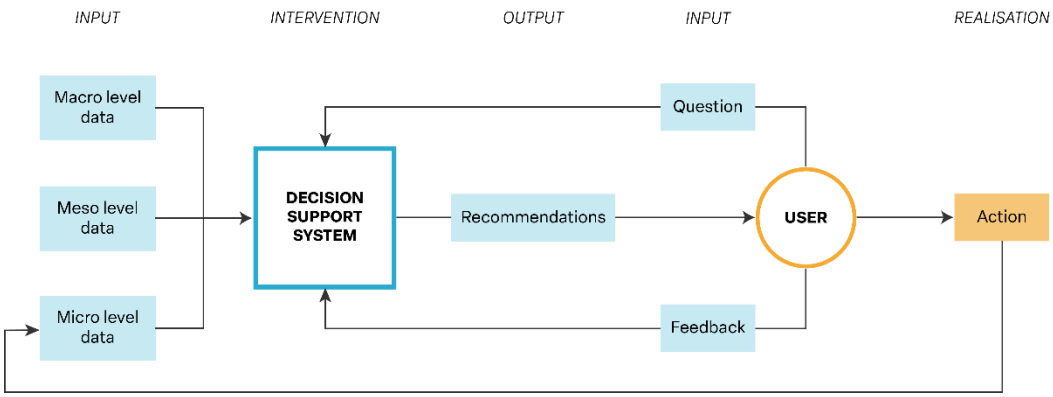


Figure 24: Data flow diagram of the decision-making system

Either of the two actors can initiate the generation of recommendations. Firstly, the DSS can draw attention to a particular area in the supermarket when it appears the area is not functioning optimally based on the input data flows. The DSS sends a notification to the user and provides recommendations on how to solve this issue. The user decides to either follow the recommendation and take action or choose one of the alternatives and give the DSS feedback about the course of action. Secondly, the interaction between the DSS and the user can also be initiated by the user. When the user observes something happening on the work floor or notices that the DSS has no access to a source of information, the user could give the system feedback about the real-life situation and possibly demand the DSS for help. The implementation of the recommendation, i.e. the action, is fed back into the system via the micro level data flow.

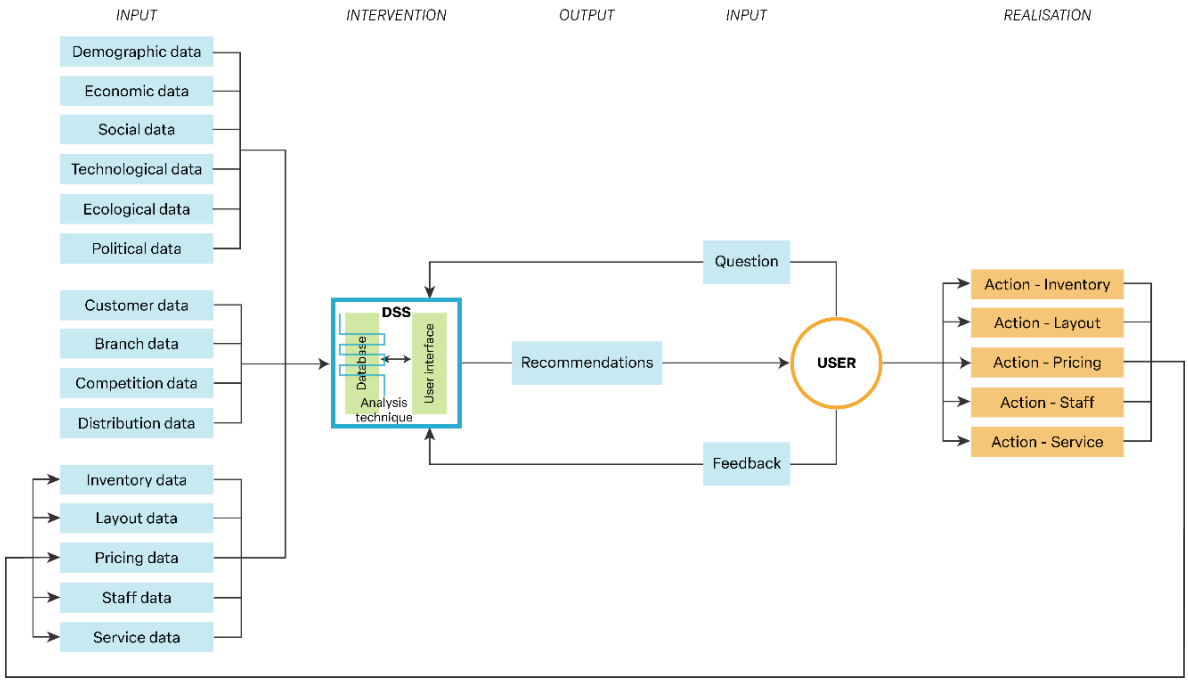


Figure 25: Detailed data flow diagram of the decision-making system

The data flow diagram can be more detailed with this thesis's previously gained insights (see Figure 25). The macro and meso level data flows are represented by the factors of their analysing methods as described in Chapter 3, and the micro level data flow by the five themes synthesised in Section 7.1. As described in Section 4.2, a DSS includes a database, analysis techniques and a user interface. The database is fed with all the input data. The data in this database is analysed with an algorithmic analysis technique. After that, the database interacts with the user interface and depicts the right information to the user at the right time. The preferred recommendations are provided to the user, after which the user can take action within the reaction themes based on the recommendations. The action will be registered in the DSS via the micro data flow.

9.4. Design on the Operational Level

Figure 25 shows which input data is fed into the database of the DSS and depicts the interaction between the user and the DSS. This section about the operational level elaborates on how these data inputs are obtained for the DSS and how the user operates with the DSS.

9.4.1. Data Inputs

As mentioned, supermarkets hold a lot of data as many in-store processes (inventory, layout, pricing, staff and service) are captured in data. Based on the empirical research, the data produced and held on the processes within the themes were identified (Table 4, Section 7.3). It can be seen that the input flows of data are covered at the micro level in the DSS, but the higher the level, the less quantitative and the less data in general is available.

At the meso level, data about the customer, the branch, the competition and the distribution are fed into the DSS. A lot of data is available about the customers of a supermarket. Many customers utilise loyalty programmes, allowing the supermarket to gather information on their preferences, dietary requirements and combinations of products via mobile applications installed on their smartphones. Additionally, supermarkets could obtain information from data analytics businesses, such as Nielsen [76], that measure consumer behaviour to provide their customers with population intelligence. It is anticipated that the collection of customer data will continue to grow. In the future, it may become a common practice to connect wearables to your loyalty programme to suggest food choices based on your lifestyle. Furthermore, a supermarket acquires data through its website. For example, if a particular recipe gets frequently labelled as a favourite, the supermarket can expect higher sales for its ingredients. While direct data on the supermarket industry is not available, external research agencies are occasionally hired to analyse trends in the branch. Furthermore, data on competitors' products could be obtained by monitoring their websites, and by using Google Maps, the DSS would know which stores are nearby. Finally, the supermarket has access to the aspects on which it collaborates with distributors and suppliers, such as order history and distribution planning.

At the macro level, there is even less concrete data available. Where to set limits in the search for data in the six factors of DESTEP should be investigated. Demographic data could be obtained from Statistics Netherlands (in Dutch: Centraal Bureau voor de Statistiek), economic data from stock markets and environmental data from weather forecasts. However, for social trends, technological innovations and new legislation, an extra step should be taken to translate the information into data that can be fed into the DSS. One possible way of doing this could be through an artificial intelligence application.

This research investigates what information is required to generate actionable insights for the supermarket. Technical details of how to make the input data compatible with the DSS are considered outside the scope of this thesis.

9.4.2. Interface Design

In the DSS, the physical shop floor of the supermarket is represented by a three-dimensional model which is part of the interface of the DSS. This helps the user place the entities and their interrelations in their context in the store. In this initial design, the interface of the DSS is designed to be used on a screen. This screen could be a computer screen standing on a desk, a touch screen on a mobile tablet, or a touch screen hanging against the wall within the back office of the supermarket store. The decision to implement a new technology into the working environment is often taken by the higher management, while the employees on the work floor have to work with the technology [77]. Some employees show resistance to change as modifying their way of working takes effort and could be against their preferences. Therefore, the DSS should be first introduced via an interface most people are familiar with and could evolve further from that initial point. In the future, the interface could evolve to be interacted with using new technologies like augmented reality glasses. However, this should only be done when the new mean provides the system with new opportunities.

Recommendations initiated by the DSS

A demonstrator of the DSS interface is built in the graphical software Unreal Engine 5.2. As mentioned, the DSS or the user can initiate the system to generate recommendations. When the DSS initiates the process, the system notifies the user, as depicted in Figure 26.

Figure 26: Interface of DSS - Starting screen with an overview of the supermarket store

After the notification, the user demands more information and investigates it by clicking the warning sign open. The model shows the physical connectivity between five entities (shelves and racks) belonging to the group of product displays within the area and explains why the warning sign popped up (see Figure 27).

Figure 27: Interface of the DSS - Connectivity shown between product displays in the produce area

In this case, the analysing technique in the DSS has calculated that renewing the product display is the best course of action, so the interface only displays one recommendation. If the user implements this recommendation, the DSS will present the action plan.

In Section 8.2.2, the connectivity matrix explained the four types of connectivity between person-person, person-object and object-object. The product display entities (i.e. the shelves) are functionally and spatially connected as they serve the same function of displaying products to the customers and are within a specific range located in the same store area. The interface in Figure 27 shows how four of the five product display entities are physically connected well based on their materials (green lines), but one product display does not match the material properties of the others (red lines). The DSS concludes that the product display on the right does not match the style of the other product displays and the produce area and recommends the user to replace the product display (in the physical supermarket) with a new interior entity which matches the other materials and thus the style.

Table 6: Cut out of connectivity matrix (O-O)

	OBJECT - OBJECT
FUNCTIONAL	Substitute Complementary Competitive
PHYSICAL	Dimensions Weight Colour Materials
SPATIAL	Product placement Location in-store
TEMPORAL	Transaction External event

When the user decides that the benefits would weigh up against the costs (i.e. time and resources) and implement the recommendation, the user must give feedback to the DSS on the implementation. The new entity (product display) should be uploaded in the three-dimensional model to update the layout data.

Recommendations initiated by the user

The previous example of the product displays began with the DSS initiating action. It could also be that the lower management observes a problem on the shop floor and demands more information about the connectivity of an entity. For example, when a product is temporarily unavailable to be stocked, the lower management is interested in whether this would also impact other products. Figure 28 illustrates the situation where the user selected a type of beer.

Figure 28: Interface of the DSS – Connectivity showed of beer can

The DSS shows the user how the type of beer is connected with other products. The DSS asks the user about its observed problem to filter which connections (functional, physical, spatial and/or temporal) are relevant. Based on history requests, the DSS predicts which problem the user is most likely experiencing and presents the options to the user. In this case, this could be, for instance, the beer getting renewed packaging, the introduction of a new competitor, or being out of stock. The last option provided in the option list is 'other', which the user can select when the problem is not included in the list. The interface will introduce a chatbot to which the user can explain the problem. Using artificial intelligence, the DSS will link the problem to a topic and formulate an answer through recommendations to the user.

Being out of stock is a common problem for products. External events and promotions can sometimes cause an unexpectedly high increase in sales. However, being out of stock due to increasing sales should be known by the DSS via the inventory data input. A product could also be out of stock when a stocker damages a batch during filling. In such an incidental case, the team leader has to give the DSS manual input. The user selects 'out of stock' from the provided options; consequently, the DSS shows the connectivity of the beer type. In this case, the DSS recommends the user either ask for urgent delivery of new beer

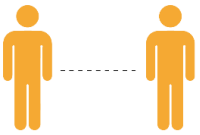
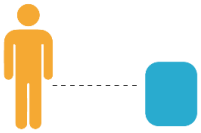
or shuffle around the layout based on functional connectivity (more substitutes and competitive, less complementary products) and temporary connectivity (product combinations often registered by the checkout to be bought together). The user can decide which way to go based on their practical experience and feedback to the DSS about the decision they made.

An advantage of the user being able to give the DSS data input is that the user can indicate upcoming issues before they are issues. For example, suppose the municipality updates the supermarket's higher management about a new elderly home being built in the neighbourhood. In that case, they will ask the lower management to think about how the operations on the work floor should be updated accordingly. Then, the lower management could provide the DSS with this macro level information and demand insights into which entities and processes will be influenced by this demographic change and ask for recommendations on which actions should be taken.

Two main categories of entities: Objects and People

The previous two examples explained the DSS generating recommendations based on connectivity between objects initiated by the different actors of the decision-making system. In the first example, the process of giving recommendations was initiated by the DSS, and in the second example, it was initiated by the user. Both examples entail connectivity between objects, but the DSS also includes entities in the category People. Table 7 shows the connectivity of people.

Table 7: Cut out of connectivity matrix (P-P, P-O)

	 PERSON - PERSON	 PERSON - OBJECT
FUNCTIONAL	Organisational structure	Means for goal
PHYSICAL	*Irrelevant*	Object within reach (z)
SPATIAL	Location in-store	Object in sight Object within reach (x,y)
TEMPORAL	Work shift Supermarket visit	Work shift Supermarket visit

Changing the focus from objects to people brings along topics like ethics and privacy, which can limit possible data inputs. For example, the location in-store of people can be mapped by heat cameras, but no distinction can be made between different customers, nor can staff members individually be tracked on the shop floor. However, not being allowed to track specific people spatially in the supermarket does not mean that people cannot be included in the three-dimensional model.

In Figure 29, the interface of the DSS shows the spatial connectivity between people on the shop floor without linking a character to a specific person. The three-dimensional model tells the user which aisles are the most crowded and recommends broadening them or placing the popular products into a lower-traffic area to even out the crowdedness.

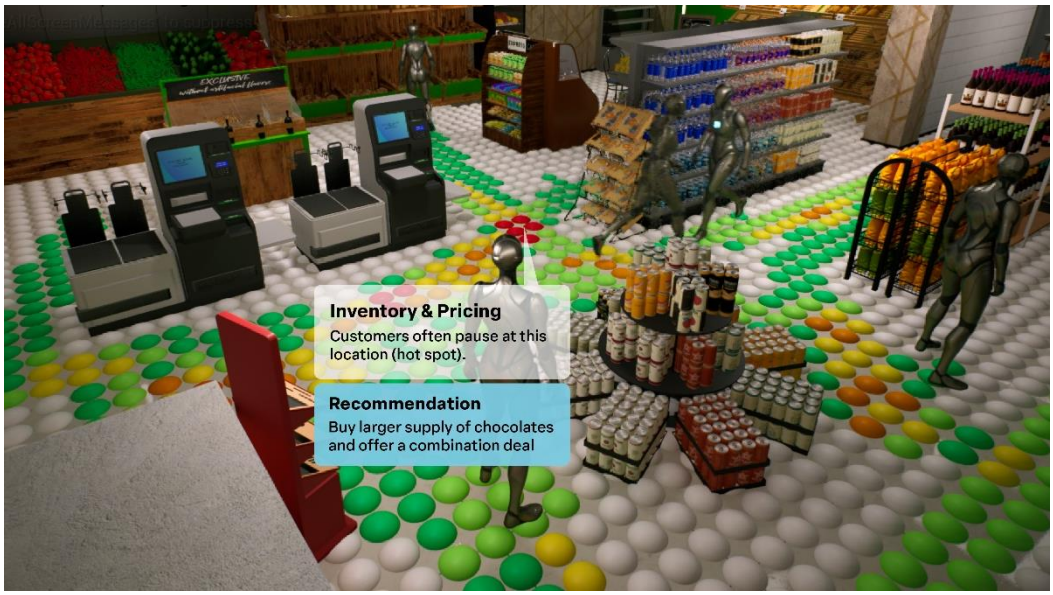


Figure 29: Interface of the DSS – Connectivity showed between people

The DSS can monitor the functional connectivity between people without tracking them in the physical supermarket. Figure 30 displays the network, which was constructed using the staff management system as an input in the DSS. This network of functional connectivity would run at the back end of the DSS and would not be seen by the user, as this is considered to be information overload. If the user wants to know which people are in a particular subteam or which colleagues are in direct contact with each other, the DSS could display this information in a text window. In addition, the DSS can also track which employees are present on the shop floor as they clock in and out at the beginning and end of their shift. This could be tracked at an individual level with employee IDs or, more generally, by showing how many people are present by function.

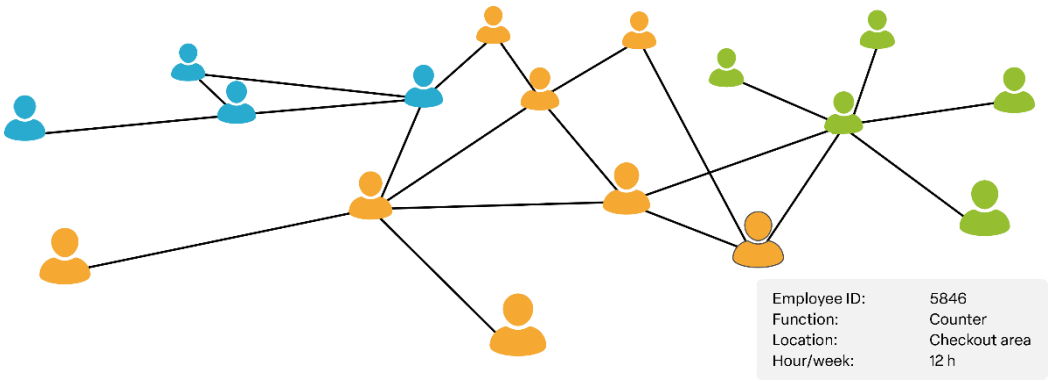


Figure 30: Functional connectivity between people

10. Implementation of the Decision Support System

The previous sections outlined the design process of the designed intervention together with its working principle. The next step involves placing this design with its intended functionality into the supermarket environment. The implementation is approached in three phases: before, during and after the implementation. Figure 31 provides an overview of the steps involved in each phase.

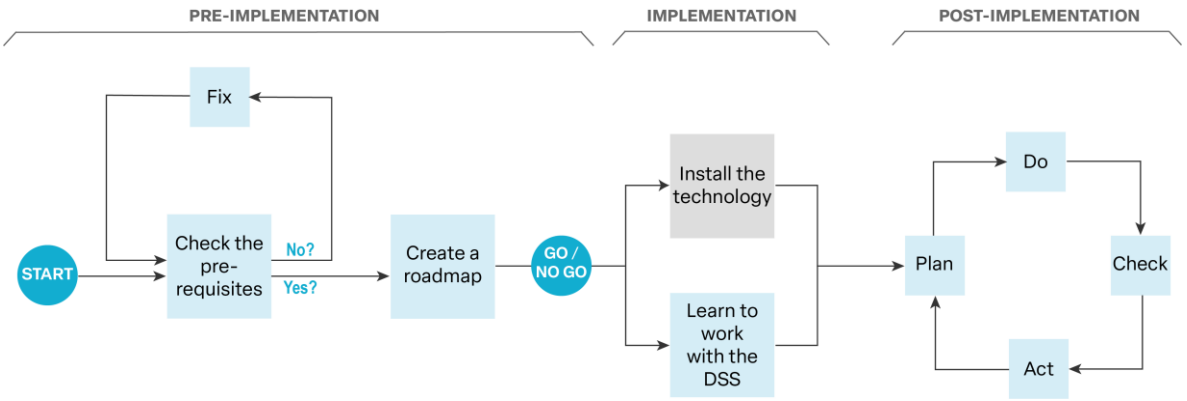


Figure 31: Overview of implementation steps

The squares represent actions, and the circles indicate decisions. The blue actions and decisions are the responsibility of the supermarket management, while the grey action is undertaken by the external organisation that owns the decision support system (DSS) software. The following sections will elaborate on the actions within the phases.

10.1. Pre-implementation Phase

When the management of a supermarket sees the added value of the DSS and decides that its organisation would benefit from implementing the new technology, it enters the pre-implementation phase. The first step is to get the organisation ready for implementation, and thereafter, the management should draw up an implementation plan.

Checking the Prerequisites

As described in the data flow diagram in Figure 25, the DSS runs on data inputs and needs inventory, layout, pricing, staff, and service data to capture all in-store processes and include all processes in the recommendations. Additionally, the organisational structure should allow the recommendations to be realised by the user. Before a supermarket can implement and use the DSS, it should reach a certain level of information management maturity and have a well-arranged organisational structure.

For the three-dimensional model in the DSS to be an accurate representation of the real-life situation of the physical supermarket store, inventory data should at least describe which products are in the storage, entered the shop floor and left the shop floor. The products should be labelled with the name of the product and product group combined with product characteristics like the brand and price. Additionally, the supermarket should have a digital version of the store's floor plan to show the entities in their context. The digital three-

dimensional model forms a significant portion of the user interface and is vital for communicating information to the user. To complete the supermarket system, staff data should be incorporated into the DSS, containing information on how many staff members per function are present in the supermarket. To be able to implement the DSS, service data could be disregarded in the minimal viable product. However, the more accurate the input data in the DSS is, the more accurate the output and recommendations will be.

Secondly, the organisational structure of the supermarket should be well-defined. This does not necessarily mean that the functions must be defined per store area, but how the responsibilities and tasks are divided amongst the staff members should be clear. Future users of the system should have the responsibility and freedom to make decisions about the operations on the work floor and implement the recommendations of the DSS. Furthermore, next to the management, also the other key stakeholders have to see the value of the DSS. They must show acceptance towards the implementation of the new technology for the DSS to be integrated into the way of working.

Creating a Roadmap

When a supermarket meets these two prerequisites for integrating the DSS into its environment, a roadmap for the implementation phase should be drawn up. Technology roadmapping is seen by practitioners in the field as an innovative strategic planning tool to visualise and formulate the linkage between the business and the new technology [57]. The roadmap should be created by the supermarket's higher management in collaboration with the lower management and touch upon all facets of the organisation [75]:

- **Structure:** Organisational structure, roles and responsibilities;
- **People:** Mindset of employees and work culture;
- **Process:** Planning and budgeting;
- **Technology:** Technological practicalities.

The roadmap should describe what steps need to be taken and for what purpose, in which time frame, and who needs to be involved in the steps. However, not everything can be planned in advance, and a roadmap should be seen as an iterative process. The higher management would be responsible for overseeing the progress of the roadmap, and the lower management would be tasked with the execution. When the roadmap is finalised, the supermarket will have a clear overview of the implementation phase and must decide if the project is feasible and viable.

10.2. Implementation Phase

If the supermarket decides to continue the project after the roadmap is drawn up, the implementation phase starts with two parallel processes: the technology has to be set up and the employees have to be introduced to the system. The implementation of the technology on the work floor is done by a technical expert from the organisation that owns the DSS software. The expert will install the software and set up the system by personalising it with the supermarket's strategy and connecting the data flows.

In addition to the physical implementation of the technology, the DSS's functionality should also be implemented in the team and integrated into the work culture. Introducing a new

technology to a business may lead to changes in business processes or work culture [57]. During the implementation of the DSS, it is crucial to apply a change management approach. Change management is a systematically structured method for transforming an organisation from its current state to a future state [78]. It assists organisations in comprehending the needs of individuals and addressing challenges in advance to minimise the chances of the employees rejecting the new system. Implementing the DSS in the supermarket system means not only installing the system but also training the staff members to work with it. It is essential to explain the reason for and purpose of the implementation to the stakeholders involved so they can see what they will gain from the effort they put in.

10.3. Post-implementation Phase

When incorporating the DSS into a supermarket, following the Plan-Do-Check-Act (PDCA) cycle is crucial to ensure continuous improvement [79]. During the Plan phase, an opportunity is recognised, and an action is planned accordingly. In the Do phase, the action is executed and consequently assessed whether the action achieves the desired result. Based on the Check phase, the action is implemented to improve the situation. The PDCA cycle is perpetual.

This thesis was primarily focused on the Plan phase, identifying the necessity and potential for supermarkets to deal with change more efficiently and effectively. The action was taken to design an intervention that functions as a decision support system to enhance decision-making when changes occur in the supermarket environment. The design guidelines checked the design, so the design is ready to enter the Act phase and be realised in the intended use context.

After implementing the initial version of the DSS in a supermarket, the PDCA cycle should be repeatedly applied. New prospects should be constantly monitored to ensure continuous enhancement of the designed intervention and the system around it.

11. Evaluation of the Decision Support System

The Design Methodology explained in Section 2.4 described how this thesis utilises an abductive approach to achieve the design objective.

The aspired value was derived from the design objective and was followed by framing the context in which the sum of the what and the how led to the aspired value. The framing is done by analysing the current Dutch supermarket industry and discovering trends that function as use cases. Figure 32 shows the trends found during the industry analysis categorised on the levels at which they are originating. It is seen that the supermarket of today have to deal with changing environments on all scales.

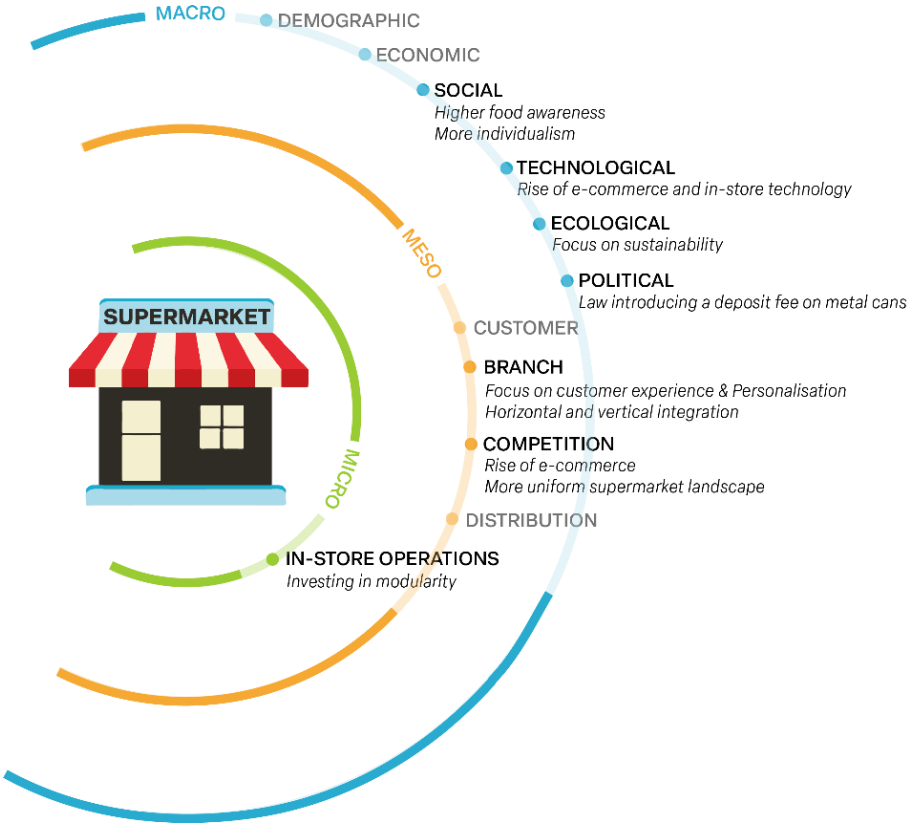


Figure 32: Trends in the supermarket industry on macro, meso, and micro level

The sum of the 'what' and the 'how' should be evaluated to check if the combination leads to the framed aspired value. The 'what' is represented by the design of the decision support system (DSS) and its underlying conceptual framework. The 'how' entails the working principle of the DSS when it is implemented into the supermarket store, which was visualised with the software Unreal Engine. In Section 9.1, design guidelines were established which are used to assess the 'what' and the 'how'. Next to that, not only the factors of the left hand of the equation should be evaluated, but also the aspired value since this is the ultimate goal of the developments of the DSS.

11.1. Evaluation of the Design

The design of the DSS should be reflected upon using the design guidelines compiled in Section 9.1. Per guideline, it is described how this was taken into account in the design.

1.1. The DSS should be able to be applied to different (chains of) Dutch supermarkets.

Customisation and standardisation are two interests which could counteract each other. While the developing organisation prefers to make the system as standardised as possible, the customer could demand features specifically introduced for that customer. The design of the DSS aims to find the balance between these two interests through the steps of setting up the system, as explained in Figure 23. The basis of the DSS is a generalised conceptual framework, which is consequently tailored to the supermarket's strategy by personalising it with three crucial factors in decision-making: the ownership of the store, the balance between price and quality, and the geographical location of the store. Furthermore, the end-user of the DSS is not a specific staff member but the person with the power and responsibility to make practical decisions on the work floor. Not pinpointing one function is more convenient, given that different Dutch supermarket chains apply different organisational structures.

1.2. The interconnections in the DSS should be an objective representation of the supermarket environment.

The interconnections between the entities are divided into functional, physical, spatial and temporal connectivity. Physical, spatial and temporal connectivity are naturally measurable; therefore, the interconnectivity representations are objectively based on these numbers. Functional connectivity regarding objects is partially based on the perceived value. This research aimed to substantiate the functional connections between Person-Person, Person-Object and Object-Object with literature, but functional connectivity remains subjective to interpretation.

1.3. Expanding the conceptual framework with a new entity should be an activity of low effort.

The sunburst chart (Figure 15) with entities is built with the structure of (sub)categories, (sub)groups and units. Each unit has properties based on its nature supplemented by attributes when placed in its context. If a new entity were to enter the supermarket system, the same steps as in Section 8.2 can be followed, starting from inside the diagram and working outwards to the outer layer. When entering a layer where the new entity cannot be placed in one of the existing (sub)categories or (sub)groups, a new (sub)category or (sub)group will be created. For example, if a technician is called to the supermarket due to a technical malfunction in the POS system and comes to the supermarket, a new unit would be added under People > Staff > External staff > Technician. The technician is a staff member but is not working daily in this supermarket store. A new group of 'External staff' is created to house the unit 'Technician'. Furthermore, when a new product is about to be sold on the shelves, it is anticipated that the supplier delivers the product information to the supermarket so that the lower management only has to indicate where the product will be positioned in the store layout.

11.2. Evaluation of the Working Principle

The working principle of the DSS is checked by running it through with various use cases. It is described to what extent the current working principle covers the guideline.

2.1. The DSS should support reacting to changes occurring in the macro, meso and micro levels.

The designed DSS considers that data from the macro, meso and micro levels must be fed into the intervention to react to changing environments. For each level, an analysis method is found to make the levels more tangible and to represent them with factors. Supermarkets have a lot of data on the micro level, as many in-store processes (Inventory, Layout, Pricing, Staff and Service) are captured in data. Therefore, the DSS supports the lower management of the supermarket in reacting to change by taking action at the micro level. However, the aspects of the macro and meso levels are not fully covered by data inputs. Information from these levels about the external environments must be translated into data that can be fed into the DSS. One possible way of doing this in future work would be through an artificial intelligence application. By applying the PDCA cycle and focusing on continuous improvement, the data flows of the macro and meso levels should be refined.

2.2. The process of generating recommendations with the DSS should take the user not more than a few moments.

The time required to generate recommendations depends on two factors. Firstly, the software should process data flows and user interactions efficiently. Secondly, the interface of the DSS should be user-friendly and intuitive, reducing the user's effort when searching for a feature. The current design of the DSS considered Guideline 2.2 by focussing on user-friendliness. The interface of the DSS is a digital three-dimensional representation of the store so that the user sees the entity within its context and quickly can navigate to the unit in a familiar setting. Furthermore, the intervention is introduced to the employees via a familiar medium and with the change management approach, the staff members will quickly learn to work with the intervention. This guideline can be validated during end-user testing of a prototype DSS.

2.3. The interface of the DSS should be understandable by a person without a background in programming.

In the current design, the end-user is only expected to interact with the front end of the DSS. For this, the user does not need any programming skills as the interface is designed to be interacted with in a familiar way (e.g. clicking on the warning sign opens a notification). A technical expert from the external organisation that owns the DSS software will install the DSS during the implementation phase and interact with the back end when there is a technical malfunction or when an extension is installed. Once the interface of the DSS has been further developed, it should be subjected to a heuristic evaluation to optimise its usability. Heuristics provide guidance for designing and evaluating interactive systems. Benyon's twelve heuristics assess the intuitiveness of a user interface and take into account, for example, learnability, effectiveness and consistency [80]. These heuristics are based on human perception, learning, reasoning, memory, and how intentions are converted into actions.

2.4. The DSS should keep track of decisions made in the past and optimise its analysing technique over time to make more accurate recommendations.

The data flow diagram illustrates that the decision-making system incorporates two feedback loops from the user to the DSS. Firstly, the user indicates which action is taken based on the recommendations presented by the DSS. In this manner, machine learning lets the system learn about the preferred course of action. The DSS measures the impact of the action via the micro level data flow. Additionally, when the user requests more information and/or recommendations about an issue via the system, the user can select the relevant entity. The DSS presents the most probable issues based on previous interventions. The longer the DSS is operative in a supermarket, the more accurate the suggestions and recommendations will become. In this way, the DSS's performance optimises over time, resulting in a more efficient interaction between the system and the user.

The analysis technique within the DSS utilises an algorithm that converts data in the database concerning entities and their connections into information and recommendations displayed on the user interface. This research focused on defining the functionality of the analysis technique but excluded the coding of the algorithm. In the following development phase of the DSS, programmers of the organisation that owns the DSS software must consider this guideline. After implementation, the supermarket management has to remain attentive to further refinement of the analysis technique according to the PDCA cycle.

2.5. The user should be in control over the decision-making.

As demonstrated in the interface design (Section 9.4.2), the interface not only offers a recommendation to the user but also explains the recommendation. Furthermore, in complex situations, the DSS will display multiple recommendations for the user to make the final decision by combining the recommendation with its practical experience. In an interview, an issue was addressed: higher management tends to make policy decisions that do not align with actual operations on the work floor. The lower management is identified as the end-user of the DSS due to their responsibility over and knowledge about the operations on the shop floor.

11.3. Evaluation of the Value

The desk research showed that e-commerce has found ground in the supermarket industry and that the Netherlands is one of the leading countries in Europe in terms of online grocery's share of the supermarket industry. However, the research also shows that a significant number of customers still prefers to do their shopping physically. Brick-and-mortar supermarkets will remain in society for the foreseeable future and will likely continue to exist in some form. The desk research also shows the timeline of the introduction of innovations over more than the last century. It is observed that the world keeps evolving at an increasingly rapid pace. If this trend continues, the aspired value of a supermarket being able to deal well with changes in its environment becomes increasingly important.

A deductive approach should be taken to justify the combination of the design and the working principle. This approach involves developing a functional prototype of the DSS and

validating it with end-users. To ensure that the implementation steps are carried out according to the plan and to optimize the implementation, a change agent should be involved in monitoring the introduction of the DSS to the supermarket organisation. The hypothesis proposed in Figure 21 can be tested to confirm optimised operational performance and to examine the achievement of the aspired value of this DSS design for Dutch supermarkets. The supermarket should have the capability to respond more rapidly and efficiently to a changing environment compared to the situation in which a supermarket operates without the DSS.

Conclusion Design

Chapter 9 discussed all elements of the design process based on the strategic level (Who & Why), the tactical level (How & Where) and the operational level (What). Research question G was as follows: *'How can the conceptualisation be translated into a system that supports decision-making?'*. The conceptualisation was translated into a DSS that will be used primarily by the supermarket's lower management. The empty DSS is personalised with the supermarket's strategy and specified for a specific store. The DSS works based on macro, meso, and micro data flows. When operational, the DSS makes recommendations, either initiated by the system when it detects a suboptimal situation or by the user when he has a request. The DSS maps the connectivity between objects and between people based on the information requested by the user. This initial design of the DSS is evaluated against the guidelines established by the industry analysis. This evaluation forms the basis of the recommendations for future work.

When the supermarket management decides to implement the DSS, the organisation will go through multiple phases of the implementation, ranging from preparations, such as making the organisation ready and planning, to aftercare with a focus on continuous improvement. Each phase has its challenges and involves different people. Higher management is responsible for overseeing progress and making policy decisions, whereas lower management is tasked with the execution of the implementation.

The design, its working principle and the aspired value are evaluated according to the guidelines established through industry analysis. All guidelines set for the 'what' are taken into account in the design and are verified in the evaluation. The design guidelines compiled for the 'how' are covered by the combination of the designed functionality of the DSS and its implementation. The next step for both aspects is to develop the functional prototype further and validate the guidelines with the end-user. The aspired value is justified based on the desk research. After end-user testing, the achievement of the aspired value can also be validated by people within the field.

CONCLUDING REMARKS

This last part concludes the thesis and reflects on the performed research. Recommendations are formulated on which future work can build.

Chapter 12
Conclusions and Discussion

Chapter 13
Future Work

12. Conclusions and Discussion

The title of this thesis is 'Supermarket of the Future'. A supermarket is a complex system where many different perspectives come together for the sake of serving customers to do their groceries. To ensure that the supermarkets of today keep up with the increasingly evolving world and are still present in the future, the design objective of this research was:

To create an intervention which functions as a decision support system to enhance decision-making when changes occur in the environment of a supermarket.

Within the design objective, three research areas could be recognised:

Changing environments

Change can be approached based on the environmental levels (macro, meso and micro). The macro and meso levels have acknowledged analysis methods (DESTEP and ABCD methods) to investigate the factors of the level. This research uses these methods to identify and structure the changes occurring in the external environment of the supermarket. No holistic analysis method could be found in the literature for the internal environment, the micro level. The in-store processes were categorised into five reaction themes: Inventory, layout, pricing, staff and service. These themes are used to analyse the supermarket's micro level by focusing on clusters of processes, pre-defining which stakeholders are involved. The industry analysis resulted in an overview of the current trends, which could be categorised using the analysis methods of the environmental levels.

Conceptualisation of a Supermarket

Additionally, to visualise the impact of the changing environments on in-store operations, this thesis dived into the conceptualisation of a supermarket store. Combining the literature of the Theoretical Framework (Part I) and the industry analysis (Part II) resulted in a conceptual framework including supermarket-related entities and their interrelations. These interrelations exist based on the characteristics of the entities and are categorised based on functional, physical, spatial and temporal connectivity.

The connectivity matrix displays how the four types of connectivity reflect in the connections between the two main categories of entities, people and objects. The fact that the type of connection exists does not necessarily mean it is interesting for the supermarket to explore. This thesis focused on designing the intervention's functionality and setting up a structure upon which to build further. In future research, the current design should be discussed with the end-user to identify the needs of the supermarket organisation. The design can be extended with more analysis techniques. Still, it should be kept in mind that everything included in the decision support system (DSS) should be there because the supermarket gets answers to inquiries from it and not just because it is possible with the vast amount of available data.

Primarily, all Dutch supermarkets have the same goal: providing customers with the service of doing groceries in their stores. However, it is concluded that supermarket chains

significantly differ in the supermarket's strategy and involved stakeholders while providing this service. The designed solution accounts for the differences between the supermarket chains while including personalised data to fit the identity of the supermarket.

Designing the intervention

The design guidelines served as a starting point for the design process of the DSS. The guidelines were established based on the industry analysis, with a primary focus on the functionality of the DSS. Applicability and feasibility were considered, but money was not considered a constraint. The guidelines do not focus on financial aspects with regard to producibility. If money becomes a priority and limits are set, design choices regarding the medium and input data could be reconsidered.

The intervention is designed based on the needs and interests of the stakeholders identified in the analysis. These stakeholders are the people who would have a connection to the DSS in the world of today. However, as the DSS is designed to be used by supermarkets in the future, new stakeholders could arise, which would influence the preferred functionality of the DSS. The functionality should be evaluated when new stakeholders come into play. It is important to remember that technology is a means to facilitate and support the goals and tasks of people.

This research focused on the brick-and-mortar Dutch supermarket, and the DSS is designed with this context in consideration. The supermarket was defined as 'a large retail market that sells food and other household goods which is operated on a self-service basis' [12]. Keeping this definition for the application area but changing the context to a non-food retail store as the Action would be interesting to research in future work. Also, would the methodology still be valid when the supermarket is not located in the Netherlands but in another country? Approaching the changing environments would require the same viewpoint. It is anticipated that the methodology of conceptualising the new store will follow the same steps. However, a new industry analysis should be conducted for the new subject to ensure congruence with the context. Furthermore, the set-up of the intervention could still be applied, but its functionality and implementation should be tailored according to the needs of the engaged stakeholders and the industry.

In conclusion, the current design of the intervention for the supermarket of the future aims to support supermarkets with changing environments in decision-making and offers a fundamental basis for future work. The development adheres to a continuous approach, maintaining its core structure and principles while advancing through practical application. Although the current design of the intervention may not yet be ready for full practical use, this continuous approach outlines the method for future work, enabling continuous improvement.

13. Future Work

Due to the scope created for this assignment, together with the limited time frame, some interesting insights have not been researched. Some recommendations are in place for continuing the work of this thesis.

Analysis of the supermarket industry

Based on the empirical research, this thesis supposed that the bottleneck of reacting efficiently to a changing environment is the decision-making process. The relation between the time consumed in the decision-making process and the capacity of resources required to realise the decision should be investigated.

***Recommendation 1**: Research the optimal balance between the time consumed in the decision-making process and the implementation of the decision on the work floor.*

Conceptual framework of a supermarket

Guideline 1.2 stated that the interconnections between the entities should be an objective representation of the supermarket environment. During the evaluation of the guidelines, it was concluded that the relation from person to object 'means to goal' is subjective.

***Recommendation 2**: Conduct empirical research to determine how functional connectivity could be made more objective.*

Design of the DSS (What)

This thesis focussed on designing the functionality of the DSS and the environment around the intervention. A demonstrator was built to visualise the designed functionality, provide a global check for missing parts, and provide a starting point for further research. The design is verified by evaluating design guidelines but not validated with stakeholders in its use context. If a more in-depth stakeholder analysis of user interaction is carried out, the list with design guidelines could be refined.

***Recommendation 3**: Initiate an in-depth stakeholder analysis involving user interaction to refine the existing list of design guidelines.*

The interface should be assessed with a heuristic evaluation, a method for identifying design problems, and the prototype must be checked with testing with the end-user. The end-user of the system is a staff member within the lower management (e.g. team leader). All examples provided in Part IV – Design are depicted from the perspective of the end-user. Section 9.2.2 described the stakeholders and their involvement with the intervention. The following steps regarding the interface design include focussing on the user experience from the various stakeholders. Furthermore, the interface of the DSS was designed to be displayed on a screen, a familiar medium. Future research could investigate whether other mediums (e.g. AR glasses) would improve user interaction and create new opportunities regarding the functionality of the DSS.

Recommendation 4: Conduct a thorough evaluation of the interface to identify and address usability issues. Enhance the user experience from the perspectives of various stakeholders and explore alternative mediums.

The current design uses green or red lines to depict the interconnections between entities. In the case of functional connectivity, the colours may indicate whether the entities are stimulating or counteracting each other. However, physical connections may also be neutral, without positive or negative connotations. Each of the four connectivity types distinctly conveys information.

Recommendation 5: Establish a colour coding system to represent different connection conditions based on defined value ranges.

Working principle of the DSS (How)

The data inputs from the three environmental levels are fundamental to the functioning of the DSS. After evaluating the working principle with Guideline 2.1, it was concluded that the data input of the micro level was covered for all five themes, but the data flows from meso and macro levels could be added to support the DSS in reacting to change at all levels.

Recommendation 6: Carry out further research on feeding data of the meso and macro levels into the DSS. Ensure that the data flows are compatible with the DSS.

The physical store environment is represented by a digital replica in the DSS interface. Although data inputs are available for all five themes of the micro level, it is concluded that this representation is as accurate as the micro level data input is. The status quo of information management within themes like Inventory and Pricing is significantly more mature than Service. The information management should as much as possible be automated to prevent the system from becoming prone to human error.

Recommendation 7: Investigate the potential of the Internet of Things to optimise the data input of the micro level.

Implementation of the DSS

The thesis focused on designing an intervention for the micro environment, where the impact of environmental changes is felt. Similarly, when introducing new technology, it is necessary to start small and scale up once the basics are in place. The future perspective for the intervention would be to incorporate the DSS in several supermarkets belonging to the same supermarket chain. The headquarters would then be able to oversee several stores within the region, leading to more impactful policy decisions. The DSS would not only translate the data from the macro and meso levels to the micro level but also vice versa. Interviews revealed that policy decisions are often made higher up in the chain by people lacking practical experience on the work floor. If the headquarters had insight into the status of in-store processes, decisions that are more in line with the situation on the work floor could be made.

Recommendation 8: Connect the decision support systems of multiple supermarket stores (micro level) and expand the designed intervention to a larger decision support system of the supermarket chain (meso level).

The functionality of the DSS was determined according to the needs of the stakeholders of the organisational perspective of the supermarket. To realise this functionality, a programmer must consider the technical practicalities like which software to use and how to make all inputs compatible and connect to the DSS. In addition, the functionality of the designed intervention heavily relies on data flows and stores all data in one database. Concentrating all the information regarding the supermarket's business processes in a single location and relying on one software exposes the information system to vulnerabilities. The supermarket must allocate resources to protect its data securely.

Recommendation 9: Have data experts look into the technical practicalities and security of the decision support system.

References

[1] N. Guarino, D. Oberle, and S. Staab, "What Is an Ontology?," in *Handbook on Ontologies*, S. Staab and R. Studer Eds. Berlin, Heidelberg: Springer Berlin Heidelberg, 2009, pp. 1-17.

[2] G. Talari, E. Cummins, C. McNamara, and J. O'Brien, "State of the art review of Big Data and web-based Decision Support Systems (DSS) for food safety risk assessment with respect to climate change," *Trends in Food Science & Technology,* vol. 126, pp. 192-204, 2022/08/01/ 2022, doi: https://doi.org/10.1016/j.tifs.2021.08.032.

[3] O. L. s. Disctionaries. "Definition of Parameter." https://www.oxfordlearnersdictionaries.com/definition/english/parameter (accessed 28 November, 2023).

[4] A. Tuovila. "Forecasting: What It Is, How It's Used in Business and Investing." Investopedia. https://www.investopedia.com/terms/f/forecasting.asp (accessed 12 September, 2023).

[5] Rabobank. "Detailhandel food: veranderende consument vraagt meer creativiteit." https://www.rabobank.nl/kennis/s011087550-detailhandel-food-veranderende-consument-vraagt-meer-creativiteit (accessed 12 September, 2023).

[6] R. de Kervenoael, A. Hallsworth, and I. Clarke, "Macro-level change and micro level effects: A twenty-year perspective on changing grocery shopping behaviour in Britain," *Journal of Retailing and Consumer Services,* vol. 13, no. 6, pp. 381-392, 2006/11/01/ 2006, doi: https://doi.org/10.1016/j.jretconser.2006.02.003.

[7] E. o. Food. "Hoe ziet de supermarkt van de toekomst eruit?" Pakhuis de Zwijger. https://dezwijger.nl/programma/hoe-ziet-de-supermarkt-van-de-toekomst-eruit (accessed 31 May, 2023).

[8] M. Long. "What will the supermarket of the future look like?" Food Matters. https://foodmatterslive.com/article/supermarket-2050-look-like-dutch-design-week/ (accessed 7 May, 2023).

[9] E. Anderl, J. H. Schumann, and W. Kunz, "Helping Firms Reduce Complexity in Multichannel Online Data: A New Taxonomy-Based Approach for Customer Journeys," *Journal of Retailing,* vol. 92, no. 2, pp. 185-203, 2016/06/01/ 2016, doi: https://doi.org/10.1016/j.jretai.2015.10.001.

[10] M. Lehner, "Translating sustainability: the role of the retail store," *International Journal of Retail & Distribution Management,* vol. 43, no. 4/5, pp. 386-402, 2015, doi: 10.1108/IJRDM-02-2014-0013.

[11] D. Lutters, "Manufacturing integration based on information management," PhD, Design, Production & Management, University of Twente, 2001.

[12] Dictionary.com. https://www.dictionary.com/browse/supermarket (accessed 3 November, 2023).

[13] K. Dorst, "The core of 'design thinking' and its application," *Design Studies,* vol. 32, no. 6, pp. 521-532, 2011/11/01/ 2011, doi: https://doi.org/10.1016/j.destud.2011.07.006.

[14] n.a. "Macro, Meso, Micro environment explained - Foresightcards." ivto. https://ivto.org/macro-meso-micro-environment-explained-foresightcards/ (accessed 21 September, 2023).

[15] Y. Y. Haimes and C. Schneiter, "Covey's seven habits and the systems approach: a comparative analysis," *IEEE Transactions on Systems, Man, and Cybernetics - Part*

A: Systems and Humans, vol. 26, no. 4, pp. 483-487, 1996, doi: 10.1109/3468.508826.

[16] n.a. "DESTEP Analysis: Your Guide to External Environment Analysis." Lucidity. https://getlucidity.com/strategy-resources/guide-to-destep-analysis/#:~:text=DESTEP%20stands%20for%20Demographic%2C%20Economic,that%20could%20impact%20your%20business. (accessed 21 September, 2023).

[17] R. Kumar and R. Kumar, "Impact of various demographic factors on customer behaviour - An empirical study of electronic products in Rural Himachal (India)," *Indian Journal of Economics & Business,* vol. 19, no. 1, pp. 109-127, 2019.

[18] n.a. "ABCD-analyse uitvoeren (uitleg)." Marketingscriptie.nl. https://www.marketingscriptie.nl/abcd-analyse/ (accessed 18 July, 2023).

[19] E. Ozgen, "Porter's Diamon Model and opportunity recognition: A cognitive perspective," *Academy of Entrepreneurship Journal,* vol. 17, no. 2, pp. 61-76, 2011.

[20] CFITeam. "Decision Support Systems (DSS)." https://corporatefinanceinstitute.com/resources/management/decision-support-system-dss/ (accessed July, 2023).

[21] J. T. Kool, A. Moilanen, and E. A. Treml, "Population connectivity: recent advances and new perspectives," *Landscape Ecology,* vol. 28, no. 2, pp. 165-185, 2013/02/01 2013, doi: 10.1007/s10980-012-9819-z.

[22] M. E. J. Newman, "Modularity and community structure in networks," *Proceedings of the National Academy of Sciences,* vol. 103, no. 23, pp. 8577-8582, 2006, doi: doi:10.1073/pnas.0601602103.

[23] M. Efatmaneshnik, S. Shoval, and L. Qiao, "A Standard Description of the Terms Module and Modularity for Systems Engineering," *IEEE Transactions on Engineering Management,* vol. 67, no. 2, pp. 365-375, 2020, doi: 10.1109/TEM.2018.2878589.

[24] A. Yassine, D. Whitney, S. Daleiden, and J. Lavine, "Connectivity maps: Modeling and analysing relationships in product development processes," *Journal of Engineering Design,* vol. 14, no. 3, pp. 377-394, 2003/09/01 2003, doi: 10.1080/0954482031000091103.

[25] C. Dictionary. "Trend." https://dictionary.cambridge.org/dictionary/english/trend (accessed 7 November, 2023).

[26] H. Briedis, A. Kronschnabl, A. Rodriguez, and K. Ungerman, "Adapting to the next normal in retail: The customer experience imperative," *McKinsey&Company,* 2020. [Online]. Available: https://www.mckinsey.com/industries/retail/our-insights/adapting-to-the-next-normal-in-retail-the-customer-experience-imperative#/.

[27] V. Simmons, J. Spielvogel, B. Timelin, and M. T. P. Gi, "The next S-curve of growth: Online grocery to 2030," *McKinsey&Company,* 2022. [Online]. Available: https://www.mckinsey.com/industries/retail/our-insights/the-next-s-curve-of-growth-online-grocery-to-2030#/.

[28] Marshoek, "Editie 2021," in "Supermarkten Benchmark," 2022. [Online]. Available: https://www.marshoek.nl/file/download/default/811F865F4B906ED6ADE1BBA918F6AB85/Benchmark%20Supermarkten%202021.pdf

[29] H. Y. D. Peiris, V. G. P. Lakshika, and R. M. K. S. Rasanjalee, "Factors affecting consumer acceptance towards omnichannel approach with reference to

supermarket sector," *Journal of Business Studies,* vol. 8, no. 81-104, 2021, doi: http://doi.org/10.4038/jbs.v8i0.68.
[30] C. Krieger. "A checkout-free future? How Trigo's AI technology is changing the way we shop." Food matters. https://foodmatterslive.com/article/checkout-free-future-how-trigo-powers-tescos-getgo-store/ (accessed 8 September, 2023).
[31] M. Wendorf. "The Evolution of the Supermarket From Dry Goods Stores to Amazon Go." Intersting Engineering. https://interestingengineering.com/innovation/the-evolution-of-the-supermarket-from-dry-goods-stores-to-amazon-go (accessed 15 September, 2023).
[32] AlbertHeijn. "Albert Heijn Geschiedenis." https://www.ah.nl/over-ah/geschiedenis (accessed 15 September, 2023).
[33] R. Ferreira, B. Jesse, F. Laizet, D. Läubli, and B. Rastrollo, "Transforming the EU retail & wholesale sector," *McKinsey&Company,* 2022.
[34] EuroCommerce, "Value of European Retail factbook," 2021. [Online]. Available: https://www.eurocommerce.eu/app/uploads/2022/08/2021_05_20-VERF-Full-FINAL.pdf
[35] n.a. "Vertical integration in grocery retailing." Strategy&. https://www.strategyand.pwc.com/de/en/industries/consumer-markets/vertical-integration-retailing.html (accessed 31 May, 2023).
[36] Brookz. "Trends en ontwikkelingen voor supermarkten." https://www.brookz.nl/branche-informatie/supermarkt (accessed 8 June, 2023).
[37] n.a. "Plus Duin is 'Mooiste Supermarkt van Nederland 2022'." https://www.almerezaken.nl/nieuws/algemeen/54420/plus-duin-is-mooiste-supermarkt-van-nederland-2022#:~:text=De%20Plus%2Dsupermarkt%20in%20de,harmonie%20is%20met%20de%20omgeving. (accessed 18 September, 2023).
[38] Panteia, "Trends in de detailhandel en betekenis voor de factor arbeid, Deelrapport 2: Supermarkten," Zoetermeer, 2017.
[39] R. Salome, "Hoe ziet de supermarkt van de toekomst eruit?," in *LevensmiddelenKrant*, ed, 2022.
[40] CBS. "Supermarkten verkopen steeds meer duurzame voeding." Centraal Bureau van de Statistiek. https://www.cbs.nl/nl-nl/nieuws/2021/38/supermarkten-verkopen-steeds-meer-duurzame-voeding (accessed 8 June, 2023).
[41] Rijksoverheid. (2023). *Statiegeld op blik vanaf 1 april*. [Online] Available: https://www.rijksoverheid.nl/actueel/nieuws/2023/03/27/statiegeld-op-blik-vanaf-1-april
[42] H. Dutzler, P. Hochrainer, and J. Greller, "Vertical integration in grocery retailing," *Strategy&,* 2019.
[43] J. v. d. Weerd. "Supermarktbranche in 2021: Jaar van concurrentieslag door consolidatie." Locatus. https://locatus.com/blog/jaar-van-concurrentieslag-door-consolidatie/ (accessed 20 July, 2023).
[44] T. George. "Semi-Structured Interview | Definition, Guide & Examples." Scribbr. https://www.scribbr.com/methodology/semi-structured-interview/ (accessed 18 July, 2023).
[45] P. M. A. Desmet and S. F. Fokkinga, *Thirteen Fundamental Psychological Needs*. Delft: Delft University of Technology, 2020.

[46] n.a. "Nieuwe winkelorganisatie Albert Heijn van start." Albert Heijn. https://nieuws.ah.nl/nieuwe-winkelorganisatie-albert-heijn-van-start/ (accessed 2023, 19 September).
[47] P. I. Clercq. "Grote reorganisatie Albert Heijn raakt 7500 winkelmanagers." RTLnieuws. https://www.rtlnieuws.nl/economie/bedrijven/artikel/5225465/ah-albertheijn-ahold-reorganisatie-functie-duizenden-banen (accessed 19 September, 2023).
[48] R. J. George, "Supermarket Shopping," *Journal of Food Products Marketing,* vol. 11, no. 2, pp. 1-20, 2005/09/05 2005, doi: 10.1300/J038v11n02_01.
[49] R. S. Parker, C. E. Pettijohn, and E. J. Rozell, "Has Grocery Store Loyalty Changed? An Analysis of Determinant Characteristics and Strategy," *Journal of Foodservice Business Research,* vol. 12, no. 1, pp. 72-83, 2009/03/03 2009, doi: 10.1080/15378020802672121.
[50] M. Story, D. Neumark-Sztainer, and S. French, "Individual and Environmental Influences on Adolescent Eating Behaviors," *Journal of the American Dietetic Association,* vol. 102, no. 3, Supplement, pp. S40-S51, 2002/03/01/ 2002, doi: https://doi.org/10.1016/S0002-8223(02)90421-9.
[51] C. Ritchie, G. Elliott, and M. Flynn, "Buying wine on promotion is trading-up in UK supermarkets," *International Journal of Wine Business Research,* vol. 22, no. 2, pp. 102-121, 2010, doi: 10.1108/17511061011061685.
[52] N. M. Larsen, V. Sigurdsson, J. Breivik, and J. L. Orquin, "The heterogeneity of shoppers' supermarket behaviors based on the use of carrying equipment," *Journal of Business Research,* vol. 108, pp. 390-400, 2020/01/01/ 2020, doi: https://doi.org/10.1016/j.jbusres.2019.12.024.
[53] P. Saskia Bayerl *et al.*, "The role of macro context for the link between technological and organizational change," *Journal of Organizational Change Management,* vol. 26, no. 5, pp. 793-810, 2013, doi: 10.1108/JOCM-05-2013-0076.
[54] N. S. Terblanche, "Customer interaction with controlled retail mix elements and their relationships with customer loyalty in diverse retail environments," 2017.
[55] G. Armstrong, S. Adam, S. Denize, and P. Kotler, *Principles of marketing*. Pearson Australia, 2014.
[56] C. L. Goi, "A review of marketing mix: 4Ps or more," *International journal of marketing studies,* vol. 1, no. 1, pp. 2-15, 2009.
[57] N. Gerdsri, P. Assakul, and R. S. Vatananan, "An activity guideline for technology roadmapping implementation," *Technology Analysis & Strategic Management,* vol. 22, no. 2, pp. 229-242, 2010/02/01 2010, doi: 10.1080/09537320903498553.
[58] R. F. R. Rasch, "The Nature of Taxonomy," vol. 19, no. 3, pp. 147-149, 1987. [Online]. Available: https://libres.uncg.edu/ir/uncg/f/R_Rasch_Nature_1987.pdf.
[59] M.-E. Ruiz-Molina and I. Gil-Saura, "Perceived value, customer attitude and loyalty in retailing," *Journal of Retail & Leisure Property,* vol. 7, no. 4, pp. 305-314, 2008/11/01 2008, doi: 10.1057/rlp.2008.21.
[60] n.a. "Bekende formules die niet aan franchise doen." De Nationale Franchise Gids. https://denationalefranchisegids.nl/bekende-formules-die-niet-aan-franchise-doen/ (accessed 26 September, 2023).
[61] n.a. "PLUS Holding." PLUS. https://www.plus.nl/info-over-plus/organisatie/plus-retail (accessed 26 September, 2023).

[62] S. Beentjes and T. Hooft, "Beantwoording vragen visie boodschappenstructuur gemeente Oosterhout," 2017.
[63] Auteursteam_Rubus, *Supermarkt - niveau 3-4* (Keuzedelen). Boom Beroepsonderwijs, 2020.
[64] n.a. "Jumbo producten." https://www.jumbo.com/producten/ (accessed 8 September, 2023).
[65] n.a. "Albert Heijn producten." https://www.ah.nl/producten (accessed 8 September, 2023).
[66] n.a. "DekaMarkt producten." https://www.dekamarkt.nl/boodschappen (accessed 8 September, 2023).
[67] C. Verhoog, "Hoe krijgt de fabrikant zijn product op het schap van de supermarkt," Bachelor, Industrieel Ontwerpen, University of Twente, Enschede, 2008.
[68] Y. P. Yeh, "Market orientation and service innovation on customer perceived value," *Management Research Review,* vol. 39, no. 4, pp. 449-467, 2016, doi: 10.1108/MRR-08-2014-0205.
[69] M. Poturak, "Influence of product packaging on purchase decisions," *European Journal of Social and Human Sciences,* no. 3, pp. 144-150, 2014.
[70] T.H.T. Phan, H.T. Nguyen, N.V. Nguyen, D.L. Nguyen, and N. L. N. Mai., "Factors Impact on Perceived Value of Customer in Higher Education," *International journal of Multidiscilinary Research and Analysis,* vol. 05, no. 07, pp. 1602-1604, 2022, doi: 10.47191/ijmra/v5-i7-02.
[71] n.a. "Inertia Buying - Marketing dictionary." Monash University. https://www.monash.edu/business/marketing/marketing-dictionary/i/inertia-buying (accessed 22 September, 2023).
[72] Bangma. "tussenlegger_1." https://shop.bangmaverpakking.nl/kartonnen-dozen/europallet-dozen-dubbelgolf.html (accessed 3 August, 2023).
[73] M. Baudin. "Saturation In Manufacturing Versus Service." https://michelbaudin.com/2017/03/22/saturation-in-manufacturing-versus-service/ (accessed 7 August, 2023).
[74] J. Logie. "Grocery Store Layout: Marketing Tricks & Strategy That Lead You To Spend More." https://www.regainedwellness.com/supermarket-psychology/ (accessed 8 September, 2023).
[75] D. Brosseau, S. Ebrahim, C. Handscomb, and S. Thaker, "The journey to an agile organization," *McKinsey&Company,* 2019.
[76] The_Nielsen_Company. "About Nielsen." https://www.nielsen.com/about-us/ (accessed 25 November, 2023).
[77] A. Carneiro, "Adopting new technologies," *Handbook of Business Strategy,* vol. 7, no. 1, pp. 307-312, 2006, doi: 10.1108/10775730610618981.
[78] B. Harpham. "8 ways you're failing at change management." CIO. https://www.cio.com/article/228185/8-ways-youre-failing-at-change-management.html (accessed 15 November, 2023).
[79] n.a. "What Does PDCA Stand For in Business? Plan-Do-Check-Act Cycle." Investopedia. https://www.investopedia.com/terms/p/pdca-cycle.asp (accessed 15 November, 2023).
[80] D. Benyon, *Designing Interactive Systems*, 3 ed. Pearson, 2014.

Appendix

Appendix A - Materials co-design session

Set-up

Phase 1: 20 minutes

- Based on the problem statement (PS) have the participants write post-its on the current supermarket based on their own experiences.
- Based on the PS, have the participants write post-its on the current supermarket from the perspective of their assigned role.
- Let the participants cluster the post-its of themselves, their role, and the trends (prepared by the organisers) of the supermarket clustering into development themes.

Phase 2: 30 minutes

- Everyone chooses a development theme (or we choose 1 for everyone - depends on the session) and gets 1 of 13 fundamental psychological needs to come up with 2 positive, 2 negative, and 2 disastrous ideas for the future about it.
- Participants plot their ideas on a matrix (with x-axis from hype to horror and the y-axis to be determined by the participants).
- Participants can sticker ideas which they find innovative and/or interesting.

Phase 3: 30 minutes

- Participants make groups of two.
- Per group, they choose an idea (from phase 2 or possibly come up with new ones if it turns out we are missing something).
- They think up further elaborations of this idea - more in-depth, e.g. with ChatGPT (5 min)
- They work out a scenario where they explore one idea further to see how their concept works or how it affects consumers (10 min).
- Poster / visual making of their concept (with Midjourney or drawing) (10 min).
- Pitch (1 minute per group).

Closing: 10 minutes

Roles

Decision-Maker (Supermarket CEO): "We will invest in technology that allows for personalised shopping experiences and empowers customers to make informed choices about the products they purchase. We will also prioritise creating a comfortable and welcoming store environment that encourages customers to spend more time in the store."

Decision-Maker (Technology Vendor): "We will create technology that streamlines the supermarket shopping experience, reducing wait times and making it easier for customers to find the products they need. We will also prioritise building in features that allow for personalised recommendations and easy checkout."

User (Busy Professional): "I want to be able to complete my grocery shopping quickly and efficiently, without feeling overwhelmed by the number of choices available. I also want to be able to access healthy food options and receive personalised recommendations based on my preferences."

User (Elderly Shopper): "I want to be able to navigate the supermarket easily and comfortably, without feeling rushed or overwhelmed. I also want to be able to receive expert guidance on healthy food options and recommendations that cater to my unique dietary needs."

Policymaker (Health Department): "We want to ensure that supermarkets prioritise healthy eating habits and provide access to healthy food options. We also want to ensure that supermarkets create a safe and welcoming environment for all customers, including those with mobility challenges or other disabilities."

Policymaker (Environmental Agency): "We want to encourage supermarkets to prioritise sustainable practices, including reducing waste and promoting locally sourced products. We also want to ensure that supermarkets are reducing their environmental impact and promoting eco-friendly practices."

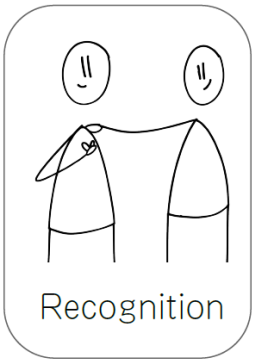
Executer (Store Manager): "We will prioritise creating a comfortable and welcoming store environment that caters to the needs of all customers, including those with mobility challenges or other disabilities. We will also invest in training our associates to provide excellent customer service and expert guidance.

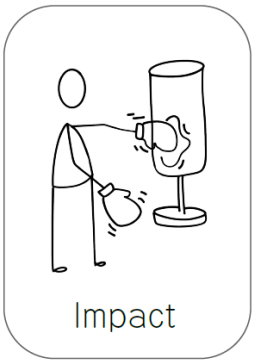
Executer (Associate): "We will prioritise providing excellent customer service and expert guidance to help customers find the products they need and make informed choices. We will also work to create a welcoming and comfortable store environment that encourages customers to return.

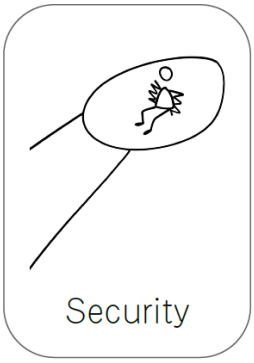
We will prioritise working with supermarkets that share our values of sustainability, quality, and promoting healthy eating habits. We will also work to create partnerships with supermarkets that provide expert guidance on the benefits of our products and encourage customers to make informed choices.

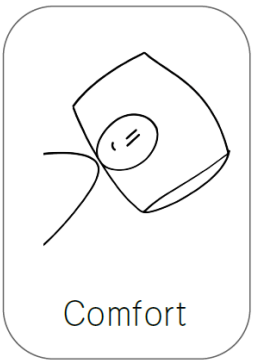
Supplier (Local Farm): "We will work with supermarkets to provide locally sourced products that prioritise sustainability and quality. We will also work to create partnerships with supermarkets to promote healthy eating habits and provide expert guidance on the benefits of locally sourced products.

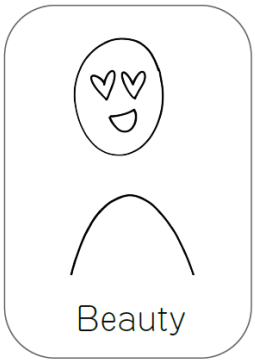
13 Fundamental needs

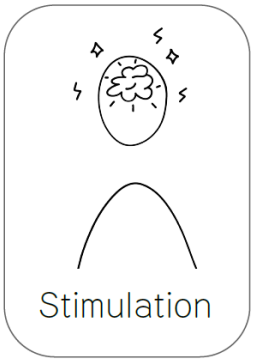


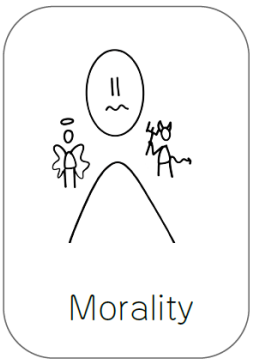


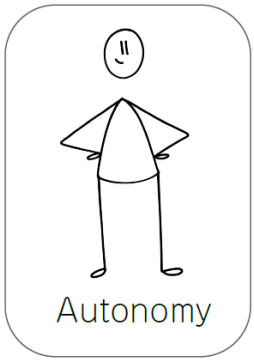












Seeing your actions or ideas have an impact on the world and contribute to something, rather than seeing that you have no influence and do not contribute to anything.

- Influence
- Contribution
- Building something
- Legacy

Having warm, mutual, trusting relationships with people who you care about, rather than feeling isolated or unable to make personal connections.

- Love & intimacy
- Camaraderie
- To nurture and care
- Emotional support

Getting appreciation for what you do and respect for who you are, instead of being disrespected, underappreciated or ignored.

- Appreciation
- Respect
- Status & prestige
- Popularity

Feeling that the world is a place of elegance, coherence, and harmony. Rather than feeling that the world is disharmonious, unappealing, or ugly.

- Unity & order
- Elegance & finesse
- Artistic experiences
- Natural beauty

Having an easy, simple, relaxing life, rather than experiencing strain, difficulty or overstimulation.

- Peace of mind
- Convenience
- Simplicity
- Overview & structure

Feeling that your conditions and environment keep you safe from harm and threats, rather than feeling that the world is dangerous, risky or a place of uncertainty.

- Physical safety
- Financial security
- Social stability
- Conservation

Having a clear sense of what makes your life meaningful and valuable, instead of lacking direction, significance or meaning in your life.

- Life goals & direction
- Meaningful activities
- Personal growth
- Spirituality

Being mentally and physically stimulated by novel, varied, and relevant impulses and stimuli, rather than feeling bored, indifferent or apathetic.

- Novelty
- Variation
- Play
- Bodily pleasure

Feeling that the world is a moral place and being able to act in line with your personal values, rather than feeling that the world is immoral and your actions conflict with your values.

- Have guiding principles
- Acting virtuously
- A just society
- Fulfilling duties

Having control over your environment and being able to exercise your skills to master challenges, rather than feeling that you are incompetent or ineffective.

- Knowledge & understanding
- Challenge
- Environmental control
- Skill progression

Being part of and accepted by a social group or entity that is important to you, rather than feeling you do not belong anywhere and have no social structure to rely on.

- Social harmony
- Affiliation & group identity
- Rooting (tradition, culture)
- Conformity (fitting in)

Being the cause of your actions and feeling like you can do things your own way. Rather than feeling that external conditions and other people determine your actions.

- Freedom of decision
- Individuality
- Creative expression
- Self-reliance

Having and using a body that is strong, healthy, and full of energy, rather than having a body that feels ill, weak, or listless.

- Nourishment
- Health
- Energy & strength
- Hygiene

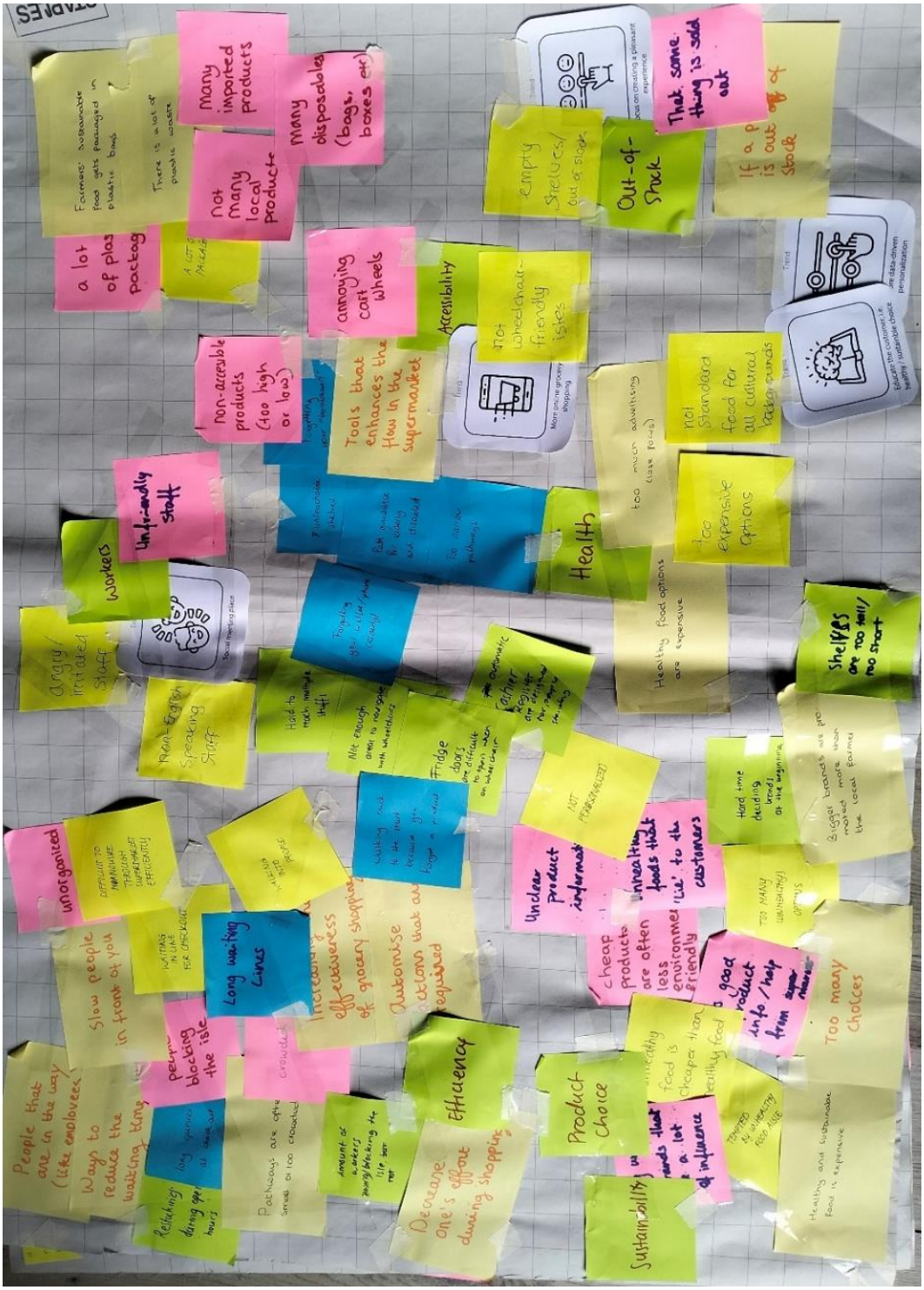


Figure 33: Brainstorm results on improvements in supermarkets

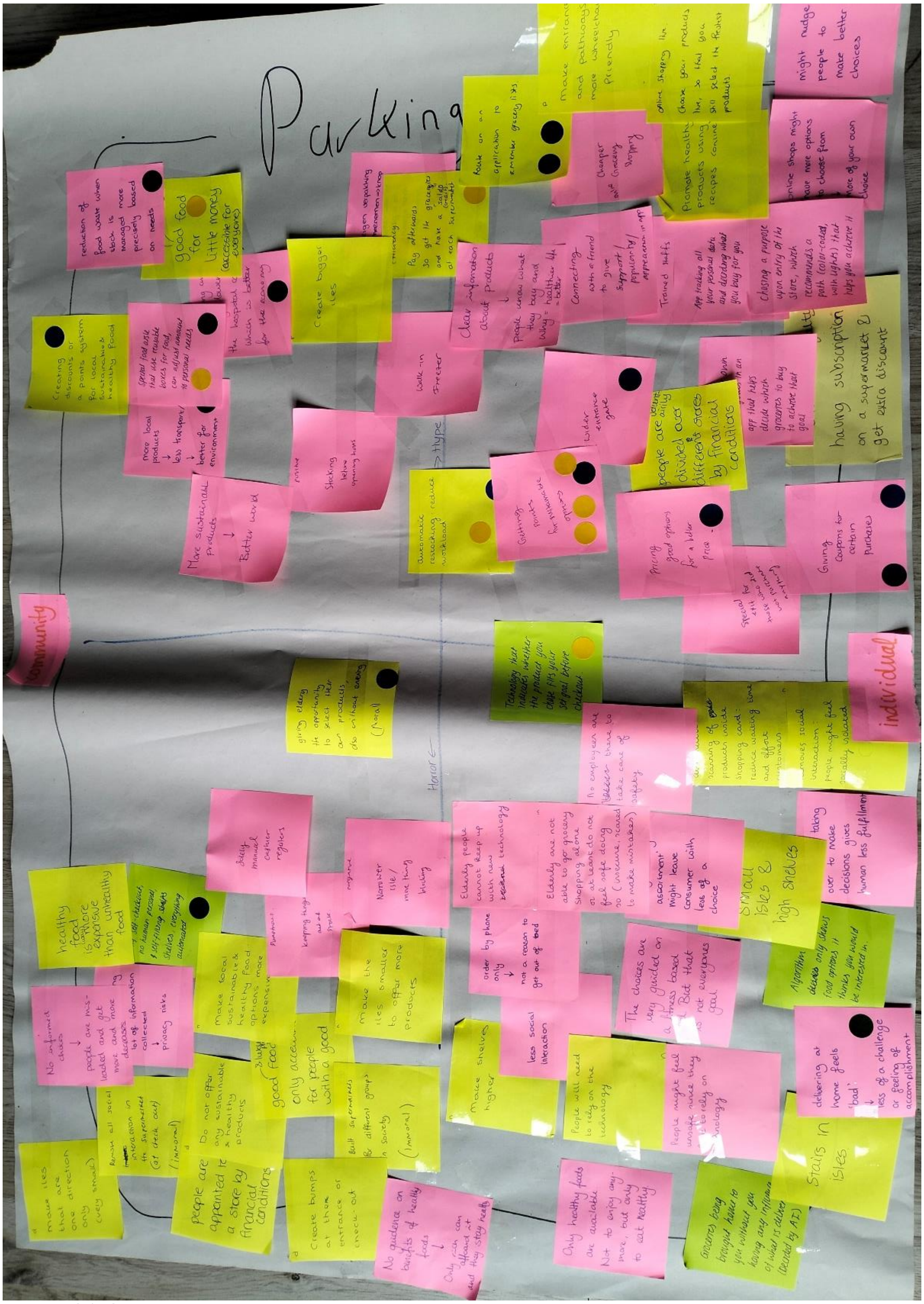


Figure 34: Scenarios placed on axes horror-hype and individual-community

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