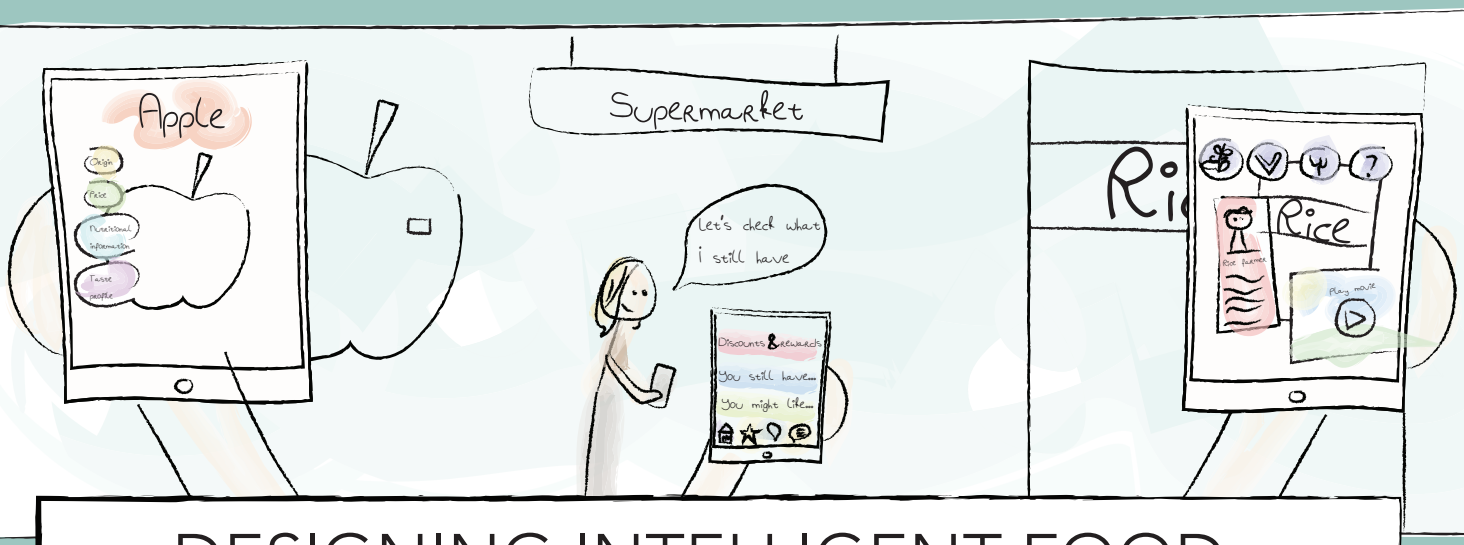

DESIGNING INTELLIGENT FOOD PACKAGING CONCEPTS FOR THE CONSUMER END OF THE FOOD SUPPLY CHAIN

A CONSUMER ORIENTED DESIGN APPROACH
FOR THE DUTCH FOOD PACKAGING MARKET

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ABSTRACT

Background: The basic function of food packaging is to hold and protect the food inside. New opportunities lie in innovative advanced packaging technologies that can extend shelf life, increase food safety, inform and perform intelligent functions. Intelligent packaging is increasingly implemented, and both challenges and opportunities arise from the *CONSUMER END OF THE FOOD SUPPLY CHAIN*.

Objective: The aim of this research is to find out how intelligent packaging concepts for the *CONSUMER END OF THE FOOD SUPPLY CHAIN* can be developed by using a *CONSUMER ORIENTED APPROACH*.

Methods: An understanding of the consumers' perspective is created by analysing consumer behaviour in a supermarket and their thoughts on intelligent packaging; by creating *URBAN SONGLINES* and conducting a *FOCUS GROUP*. The results will be used to develop new concepts by combining several design methods, that increase creative thinking and innovation development, into a concept development process.

Results: The results show that *DUTCH CONSUMERS* aged 25-30 are interested in intelligent packaging if it is something that benefits them in their lives. They are interested in intelligent packaging that can increase convenience and inform them about the food the packaging holds. The price of intelligent packaging should not be too high, additionally, there should be no added packaging waste. The concept development phase showed that new intelligent packaging concepts can be developed by using a *CONSUMER ORIENTED APPROACH* and a combination of design methods can be used.

Conclusion: As a result, three intelligent packaging concepts have been developed that can be implemented in the *CONSUMER END OF THE FOOD SUPPLY CHAIN*. The functions of these systems add convenience and inform the users about the food inside.

Key words: *Intelligent packaging, intelligent systems, packaging technologies, innovation, concept development, consumer end of the food supply chain*

DELIMITATIONS

The following section will give an explanation on how and why it has been chosen to narrow down certain areas of the research field. Additionally, this chapter contains a word and abbreviation list explaining some of the terms used in this report.

CONSUMER ORIENTED APPROACH

During this research, a *CONSUMER ORIENTED APPROACH* is used and describes the orientation of the research. Consumer oriented thinking in concept development means that the consumer needs to be understood before starting the concept development phase. The outcome derives from an understanding of the target group, the market and the subject (Cagan & Vogel, 2008).

DUTCH CONSUMERS

This research limits itself by focussing only on *DUTCH CONSUMERS*. The main reason is that the data collection has been conducted with Dutch participants.

HEAD PURCHASER

The participants needed to be the *HEAD PURCHASER* of their household, which is defined in this research as the person who is the main person to make a purchase.

25-30 YEAR OLD PARTICIPANTS

The research focusses on consumers in the 25-30 year old age group. This age group is expected to have an open mind towards new technology, is well informed and tolerant (Lobo, 2014).

WORDS AND ABBRIVIATIONS

COCD

Centrum voor de Ontwikkeling van het Creatief Denken; Centre for the Development of Creative thinking

CONSUMER END OF THE FOOD SUPPLY CHAIN

The food supply chain refers to the process of how food travels from farm to table. The process includes different steps in the food supply chain. For a simple food supply chain model the steps are: farmer; processor; distributor, retailer and finally the consumer (Harvard, No Date). The *CONSUMER END OF THE FOOD SUPPLY CHAIN* describes the final step in the chain.

FIFO

First In First Out

FOODSCAPE

The term *FOODSCAPE* is used during the *URBAN SONGLINES* to represent the temporary food world in which the participants travel. *FOODSCAPES* can be used to understand and explain the interaction of different actors in an environment and its effects (Mikkelsen, 2011).

FOCUS GROUP

The method of a *FOCUS GROUP* is used in this research to understand the opinions of intelligent packaging of *DUTCH CONSUMERS*. This method will be further explained in chapter 5.3 *FOCUS GROUP* interviews.

KISS

Keep It Simple Stupid

PMO

Plus, Min en Ontwikkelen; Plus, Minus and Develop

THE INTERNET OF THINGS

THE INTERNET OF THINGS is the concept in which home appliances and devices are interconnected with each other and can communicate reciprocally (Morgan, 2014).

SPATIO TEMPORAL PERSPECTIVE

The *URBAN SONGLINES* have been created with a *SPATIO TEMPORAL PERSPECTIVE*. Meaning that the data that is processed is organised by time and space. Time being the moment from starting the walkthrough until it finished and space, that showed the road the participants travelled.

TOUCHPOINTS

TOUCHPOINTS are defined in this report as a point of interaction between the participant and its surroundings.

URBAN SONGLINES

The method of *URBAN SONGLINES* is used in this research to understand the participants' temporary world. This method will be further explained in chapter 5.2 Urban Songlines.

4WHE

Four W-questions (where, why, who, what), How and evaluate.

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Lastly, thank you to all the participants from the *URBAN SONGLINES* and the participants from the *FOCUS GROUP.* Thank you for letting me follow you during your shopping trip, taking the time to answer all my questions and being so open in sharing your thoughts.

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1. INTRODUCTION

Food packaging is an essential aspect of the food industry. 99,7% of food products are packaged during transportation, handling, storage and/or use (Restuccia, et al., 2010). In 2003, Ahvenainen (2003) predicted that the packaging industry will grow in volume and relevance from an already sizable amount of 2% of the Gross National Product of the developed countries, valued at around 345 million dollars worldwide, of which the food packaging industry made up 50%.

The basic function of packaging is to protect the food it holds from the outer environment. However, food packaging is much more than covering of the product alone; it is created to be convenient for the end user, as well as a communication tool to portray messages about the product, the ingredients and the nutrients within (Wells, et al., 2007; Han, 2013). Food packaging is a major influence factor for a consumer to choose and purchase a food product (Foxall, 1980). It is therefore not surprisingly that a great deal of energy is put into the field of packaging design to create new packaging to get the consumer to choose their product (Ahvenainen, 2003).

This led to a high demand for new innovative packaging solutions that is not met by the traditional packaging sector. Therefore, advanced packaging technologies are being developed to meet these needs (Ahvenainen, 2003; Dainelli, et al., 2008; Han, 2013). Advanced packaging technologies, otherwise known as intelligent packaging systems are systems with technological improvements added to traditional food packaging to improve shelf life, food safety, quality and perform communicative and informative tasks(Yam, et al., 2005; Otles & Yalcin, 2008; Yam & Lee, 2012; Han, 2013). Aside from passive functions, intelligent food packaging has an active role in protecting and enhancing the food (Ahvenainen, 2003). The benefits of added technology that can extend shelf life, help improve food choices or simply benefit the consumer in any way, can add value to the food product.

Intelligent packaging innovation has been expanding, reflecting the need for new ways to solve food packaging issues in the food supply chain (Vanderroost, et al., 2014). Intelligent packaging could benefit the consumer as well by adding a new factor of convenience to a packaging (Han, 2013). The field of intelligent packaging is growing, since new technology in radio frequency and scan-code electronics are available

(Restuccia, et al., 2010). However, food packaging innovation should not only be focussed on the technological possibilities, but contribute to a more sustainable world, the demand of the food industry and the regulatory requirements. Food producers, food processors, logistic operators, retailers and consumers are demanding new packaging development that can guarantee food safety, food quality and traceability of products (Vanderroost, et al., 2014). Several studies have been devoted to intelligent packaging. And the rapid increase in research since 2009, compared to before, shows a trend in emerging intelligent food packaging systems (Vanderroost, et al., 2014). However, *THE CONSUMER END OF THE FOOD SUPPLY CHAIN* has not been fully benefitted compared to other segments of the food supply chain (Restuccia, et al., 2010).

There are some reasons for not fully implementing new intelligent packaging systems on *THE CONSUMER END OF THE FOOD SUPPLY CHAIN*. Such as high costs, regulation issues and unknown acceptance by consumers. Consumers might not be ready to pay the extra costs of intelligent packaging, since they need to be convinced of the benefits first. And many consumers might think that traditional packaging already meets their needs. However, the latest Actipack project showed that European consumers are open to intelligent packaging systems as long as the material is safe and all information regarding the system is transparent for the consumer (Restuccia, et al., 2010).

Most research done in this area focusses on the usage of intelligent packaging today. It is evident that, while there is a lot of products and technology developed to create better packaging solutions for food until it reaches the supermarket, there are still many new ideas to be developed to create intelligent packaging that benefit the consumers' needs.

This study will research how new intelligent packaging systems can be developed for the *CONSUMER END OF THE FOOD SUPPLY CHAIN* that will be accepted by *DUTCH CONSUMERS*.

To meet the challenges that, researchers must think of other ways to develop this technology further, by thinking outside the box and using non-traditional packaging approaches (Yam & Lee, 2012). This increases the focus on a design process, and how it could be applied in the area of intelligent packaging development. Design thinking and concept development has been an important innovation tool and the concept development process is something that can be applied in research as well as design (McElheron & Pilgaard Harsaae, 2015).

2. PROBLEM STATEMENT

Intelligent packaging is emerging further into the food supply chain. It is used to create better food safety and extend shelf life of food products. There is an opportunity for the food industry to develop new intelligent packaging concepts for *THE CONSUMER END OF THE FOOD SUPPLY CHAIN*. However, it is necessary to research what kind of intelligent implementations would be used by consumers and are seen as useful or helpful before implementing these new systems. This study will therefore focus on the question:

"How can intelligent food packaging concepts be developed, with a CONSUMER ORIENTED APPROACH, for the CONSUMER END OF THE FOOD SUPPLY CHAIN?".

The study will first focus on understanding the intelligent packaging market by answering the questions: "What is intelligent packaging?"; "What kinds of intelligent packaging possibilities are on the market?"; "What are the concerns for intelligent packaging?"; "What are the future trends in intelligent packaging?" and; "What are the rules and regulations regarding intelligent packaging?". This understanding of intelligent packaging will be the starting point for a *CONSUMER ORIENTED APPROACH* in developing new intelligent packaging concepts. The consumers' point of view on new intelligent implementations for packaging will be researched by creating maps of their temporary *FOODSCAPES* from supermarket to kitchen and conducting a *FOCUS GROUP* to answer the question: "*What does the consumer want to see/use regarding intelligent packaging?*". The understanding of the subject of intelligent packaging and the consumer will be the base of a concept development process.

3. STATE OF THE ART

There have been several studies and books devoted to intelligent food packaging and the use of technology to change the food supply chain.

The research by Yam et al. (2005) concluded that intelligent packaging is a new way of using packaging to enhance food safety, quality and convenience. The research suggests that interdisciplinary research is the answer to develop breakthrough technology that can be added to packaging (Yam, et al., 2005). The research introduces intelligent packaging as a framework that can be used in developing new intelligent packaging systems.

Vanderoost et al. (2014) have studied the emerging technological systems in the food packaging industry. From this study, it is concluded that new technology is emerging that could meet the needs of the food supply chain. However, new technologies are still immature and the next generation of intelligent food packaging systems will help to further improve all factors of the food supply chain (Vanderroost, et al., 2014).

In last few years intelligent packaging has been integrated in packaging materials to improve food packaging. Biji et al. (2015) research showed reasons for improving and adding smart technology to food packaging: to extend shelf life of food products; improve food quality; food safety and; to give the user more information about the product inside. According to the research of Biji et al. (2015) the future opportunities lie in consumer benefits and convenience and more research on the subject will led to further improvement of intelligent packaging.

The packaging industry has been focussed on researching new ways of packaging food, either to ensure better food quality, to extend shelf life, create better control over the food chain or to make packaging more convenient to its consumers. New innovative solutions, such as intelligent packaging, show a great potential to improve areas in the food supply chain. Brody et al. (2008) concluded that most intelligent packaging concepts have been developed based on changing consumer preferences.

The reason why most intelligent packaging has been developed is to improve the food supply chain, though intelligent systems are lacking technological developments that directly benefits consumers. A reason for this could, according to Ahvenainen (2003), be that there is less knowledge concerning consumer acceptance, the economic aspects and the environmental impact of intelligent packaging technologies (Ahvenainen, 2003).

Yam (2000) suggested a way to integrate intelligent packaging into a smart kitchen. In his proposal, food packaging had an active role of communicating and sending messages to the appliances in the kitchen, containing information about food and preparation. The research used an integrated approach to food science, packaging technology and information technology to create a smart kitchen. The primary use of the smart kitchen is food preparation; however, it could be used to monitor food inventory, online grocery shopping and use the internet for a variety of things. This approach is also known as *THE INTERNET OF THINGS*. The problems that arose during the case study, were that different foods had different cooking times, as well as ovens and microwaves have differences in their heating abilities. The system was found to be most helpful to people that have trouble reading the preparation printed on food packaging (Yam, 2000).

The Actipack project researched if European consumers were open to new intelligent packaging systems by measuring their attitude towards new innovations in the food packaging industry. The results showed that most European consumers are open towards innovations if the materials used for the intelligent packaging systems are safe and information about the system is explicit. European consumers also have interest in food packaging materials that are recyclable and biodegradable (Restuccia, et al., 2010).

The research by Dobrucka and Cierpiszewski (2014) concludes that changes in consumer preferences are the reasons for developing new innovative packaging technology. It is a dynamic industry which is creating technology that can improve the quality of human life. Overall the implementation of intelligent packaging will simultaneously improve food quality, food safety and security, and the improved packaging will lower the number of consumer complaints (Dobrucka & Cierpiszewski, 2014).

4. THEORETICAL AND CONCEPTUAL FRAMEWORK

In this chapter, the overall theories and concepts used throughout the research are presented and elaborated on.

Firstly, the theory behind consumer behaviour is presented. This theory is used to understand the reasoning behind why a consumer acts a certain way and how this is applicable to this study. Secondly, hermeneutics and the philosophy of constructivism are presented, which is used to interpret the consumers' language and actions during the *URBAN SONGLINES* and the *FOCUS GROUP*. Lastly, creative thinking and sensemaking are introduced to explain the theory behind innovation and concept development.

4.1 CONSUMER BEHAVIOUR

Consumer behaviour is the theory behind why a consumer chooses or behaves in a certain way. Behaviour can be influenced by many interacting forces and it is challenging to attempt to understand the factors behind it. However, the understanding of its complexity is the reason why consumer researchers know that there is not just one major factor that determines choice, but a wide range of stimulus and responds (Foxall, 1980). It is necessary to understand that the behaviour of a consumer is not influenced by one single factor, but many different stimuli when making a choice. In this research consumer behaviour is one of the main elements in understanding the consumer.

The wide range of stimulus and responses that determine consumer behaviour is studied widely across different fields. It derives from the field of psychology but has been incorporated into numerous marketing studies as well. The concepts and techniques that are frequently used in consumer behaviour are:

- The perception including absolute threshold; which is the baseline a response can be detected.

- The perceptual defence; where a consumer blocks out stimuli that they perceive as threatening from the environment, even though exposure has already occurred.
- Cognitive dissonance; when a person changes its perception or attitude towards something to avoid dissonance of its attitudes and beliefs.
- Learning including reinforcement; where a subject learns from trial and error.
- Stochastic models; in which the value of the range of stimuli is measured (Foxall, 1980; McLeod, 2008; Noronha, 2009; Businessdictionary, 2016).

However, this list is not complete traits, social class, attitude and motivation are also considered to be variables of consumer choice (Foxall, 1980).

The complexity of consumer behaviour has led some researchers to construct models of the buying process, which indicate stages a consumer goes through from the first stimulus to the time of purchase, in some cases including the evaluation process. Such models show the social and psychological actions a buyer has in that stage of the process (Foxall, 1980).

The basic representation model of the buying process can be seen in the figure below (Figure 1). The first stage, the development and perception of a want or need, is the stage where the consumer becomes aware of their want or need. Stage two refers to the planning and choosing of a certain product and the reasons behind that. The third stage is the purchase act itself. This stage defines the actions a consumer goes through when purchasing a product or service. The last stage refers to the post-purchase behaviour, and can be seen as an evaluation. This stage may lead to repeat buying (Foxall, 1980).

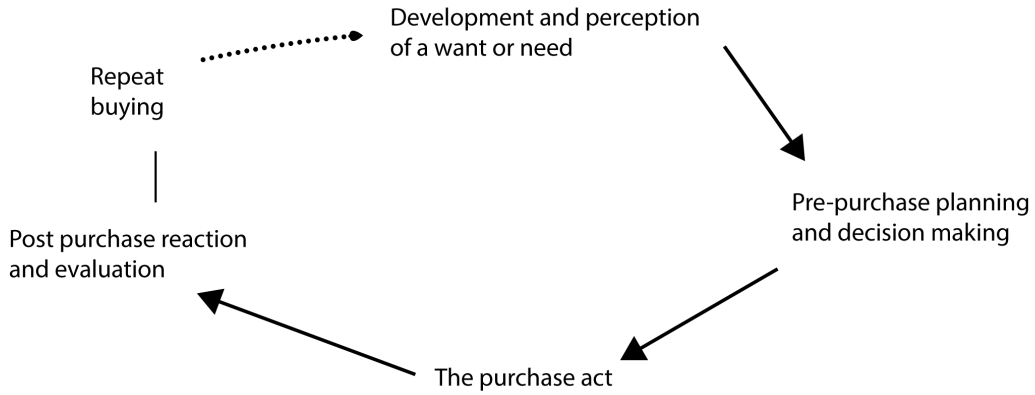

FIGURE 1 BASIC REPRESENTATION OF THE BUYING PROCESS AS PRESENTED BY FOXALL (1980) (LANDMAN, 2017)

Consumer behaviour is driven by individual needs, taste, attitude and situation. The reasons for purchasing or consuming is not just one factor, but is a combination of many different factors that motivate the consumer into buying. Since every action can be derived from personal motivation, motivated behaviour is directed to achieve an objective a person has. Two important aspects of motivation are that there must be a goal, and that there is a reason why a motivated person would act (e.g. a social need or a physiological drive). Identification of these reasons is difficult, because they derive from several influences, and people may not be aware of their reason for motivation or might not want to present the precise reasons to an interviewer. Therefore, behaviour is mostly studied by observation, since, it comes from an external goal and the drive that stimulates a consumer to act (Foxall, 1980).

Attitude is an internal human trait evaluating ideas, objects, people or events and can be positive, negative or neutral. It is a psychological tendency that is expressed by an individual (Foxall, 1980; Eagly, 1992; Eagly & Chaiken, 1993). Attitude is one of the most important factors of consumer behaviour and gives an understanding in the process when a consumer behaves in a certain way (Foxall, 1980). It is a key factor in understanding the attitude of a consumer has towards different type of products, and why certain choices are made by consumers.

Responses can be distinguished in different ways (Eagly, 1992), however, according to Foxall, attitude responses can be divided into three dimensions: cognitive (knowing), conative (impulse) and affective (emotion) (Foxall, 1980). Attitude is related to liking and preference. Both liking and preference are very closely related. Liking is a state of feeling that occurs within an immediate situation and as a reflection of a stimuli after the situation occurred. The immediate situation in which a feeling occurs is linked to the context and timeframe. The reflection of a feeling is, however, linked to situation, other attitudes, beliefs and expectations. These evaluations are not always similar (Mela, 2000). Preference is more a consideration between different stimuli. A product might not be liked but is preferred over another. This can also mean that even when a product is liked less, other reasons can occur for a consumer to prefer another product, i.e. health reasons, lower in price or packaging (Rozin & Vollmecke, 1986; Mela, 2000). Preference is sometimes used to cover liking, together with choice of a product, but preference is always based on an evaluation of alternatives. Liking can be a factor that influences preference, but preference is not always the same as liking (Rozin & Vollmecke, 1986).

4.2 HERMENEUTICS AND CONSTRUCTIVISM

For this research, the philosophy of hermeneutics and constructivism are used to interpreted the results from *THE URBAN SONGLINES* and the *FOCUS GROUP*. Dahlager and Fredslund (2008) define the concept of hermeneutics as the pre-understanding and understanding of a subject.

During the research, the researcher develops knowledge about the subject, as understanding is developed throughout the process of creation. This leads to a deeper understanding of the topic that is investigated (Dahlager & Fredslund, 2008). The concept of hermeneutics is often used in literary texts. However, it can be used for interpreting human actions and language as well, which happen mostly unconscious (Mantzavinos, 2016). It is crucial that the researcher remains objective in the interpretation and analysis of the *URBAN SONGLINES* and the *FOCUS GROUP*. The stories that are collected through the methods must be detached from the researchers understanding of the topic.

According to the philosophy of constructivism there are different truths, shaped by personal views of the world. The conducted interviews focus on how the participant sees

their own reality and how it is constructed. Constructivists believe that there are multiple realities. Each reality is subjective and is created by social and cultural influences that surround the individual. meaning that there is no true right or wrong, and it is the participants' view of how the world is constructed that needs to be understood (Nygaard, 2011). An understanding of hermeneutics and constructivism will help the researcher be aware to detach their own truth and understanding from the participants' answers and actions and to correctly interpret them.

4.3 CREATIVE THINKING & SENSEMAKING

In this research, creative thinking and sensemaking are used to develop innovative new concepts by using different design techniques to understand problems, create ideas and develop new concepts. The concept of creative thinking is about forming new thought patterns when being faced with an occurrence. The theory behind sensemaking can be applied to the creative process and involves interpreting the whole and making sense of chaos.

Byttebier and van Blokland (2002) define thinking as the way to process the information and stimuli a person faces. Our brain faces many different stimuli and we observe and progress all this information in some way. There is a difference between simple tasks; looking at the weather and deciding what to wear, and complex tasks; solve a mathematical problem. The thought process can process new stimuli quickly by recognising, combining and, sometimes, changing old thought patterns (Byttebier & van Blokland, 2002).

Thought patterns are clusters of information that our brain stored, because it leads to a successful result. If the brain recognises a similar situation, it can use these patterns and apply this to the current situation. Thought patterns are habits of thinking, and explain why some situations are simple; tasks that have repeatedly been done before and others are more complex. Thought patterns are connections in the brain that are stored and reused in similar situations. Every time a thought pattern is successfully reused the connection becomes stronger until it becomes a habit; actions that the brain does automatically (Byttebier & van Blokland, 2002). 'Habitus' is a form of 'modus operandi'. It is an abstract term, which in a very basic way structures our social orientation. Habitus

contains social elements and our individual values, and it sets a framework for peoples' opinion, standards, interpretations and actions (Bourdieu, 1984). A habit is a way people behave and think and makes it easy to respond in comfortable situations (Byttebier & van Blokland, 2002).

This efficient way of thinking is quick and the brain tries to create thought patterns and habits for all situations. However, a downside is that thought patterns are hard to break, and creative thinking is precisely the opposite of habitual thinking. The emphasis of creative thinking is creating new solutions by making original connections. With different techniques, creative and thought pattern breaking thinking can be learned (Byttebier & van Blokland, 2002).

There are a few creative skills that are presented by Byttebier and van Blokland (2002), that can be adopted to strengthen creative thinking;

Creative observation is one of them. It explains that how we see the world, and is shaped by our own observation and our thoughts are directly shaped by it. Creative observation is recognizing the prevailing visions that you and others have of the world and detaching yourself from it (Byttebier & van Blokland, 2002).

New ideas have the problem that they do not fit existing thought patterns. It takes time for a new thought pattern or connection to appear, and this is a reason for new ideas to be rejected before they are understood and have the space to be developed in another persons' thought pattern. It is important to be aware of this when forming new ideas and presenting them to others. Deferral of judgement is an important part of creative thinking; the idea needs to get a opportunity to form and the thought patterns need a chance to connect and be understood before judging an idea (Byttebier & van Blokland, 2002).

The brain is constantly connecting thoughts. Therefore, association sometimes goes automatically. It is an impulse that can take 1000 different routes, but some connections are more dominant than others (Milk - Cow or Milk - White). Connections will grow stronger when they are made more often and can create a quick and efficient way of thinking, however, this creates a smaller chance for another association to happen in the future. Dissociation and re-association are two ways to create new associations and

patterns by escaping a thought pattern by dissociation or by creating a new connection towards the thought pattern by re-association.

The brain will try to find a solution to solve an occurring problem, and stops after finding an acceptable one. However, this stops the creative thinking process. Diverging is a way to go beyond the first solution or idea and think about other ways that can solve the problem. The first solution or idea is not always the only solution or the best (Byttebier & van Blokland, 2002).

Creative thinking is used to develop new ideas and create innovative concepts. The design process organizes complexity and chaos. Sensemaking is a way for designers to understand data by organisation, pruning and filtering. Eventually information and knowledge is produced as the end result. Sensemaking is a process that is done privately. The outcome can be seen on paper but the process is, unlike other design aspects, not visual. It is not always understood, since it is hidden from view. As Jon Kolko mentions:

"Typically, a designer will observe four or five users as those individuals conduct their work. The designer will ask questions of each user about their jobs and record details of their responses. The designer might also take screenshots or photographs of the tools being used, and probe for details about each item. The designer will then return to the design studio. In the privacy of his or her natural work place, the designer will attempt to make sense of what he or she has learned" (Kolko, 2010).

The designer will try to find relationships or themes between the collected data and 'make sense' of the data. This can be done by using different design methods, thoughts and ideas change from mess to understanding. A newcomer to the process might not be able to see this. Yet, the process of sensemaking can be documented, it is just a lack of understandable material. Synthesis is sometimes seen as an informal and unimportant step in the process of design, since the benefits of going through the design process is sometimes unclear to the outsider; outsiders see no visible relationship between research and design ideas. The abduction process of synthesis is in a way the logic of what might be, the argument for the best explanation. What makes most sense when looking at the observed subject. When designing abductive thinking is used as intuition and logic. By using synthesis and naming it in the design process of a research, the importance of it becomes clearer (Kolko, 2010).

Sensemaking is fluid, it is a way to 'make sense' of a problem and eventually understand the data. The process is made up by different methods and techniques that a designer can use to develop ideas. Design is a bridge between science and art. There is no 'magic' to the design process, and what occurs during the design stages. Synthesis can be better understood and made visible. The process of design is a way to draw connections between hidden and seemingly unrelated ideas. Synthesis can be used to communicate the fluid process of sensemaking (Kolko, 2007).

It is possible to distinguish between each other in writing and to understand the theory behind each skill. However, in practise, creative and sensemaking skills are integrated with each other and fluid throughout the design process (Byttebier & van Blokland, 2002).

5. METHODOLOGY

In the following chapter the methods used to answer the research questions are presented.

First, a literature search was done to gain a better knowledge about intelligent packaging. Secondly, the *URBAN SONGLINE* method is presented, this method is used to create a better understanding of how *DUTCH CONSUMERS* act and think while grocery shopping. Thirdly, the *FOCUS GROUP* method is presented. The *FOCUS GROUP* method is used to get a better understanding of how *DUTCH CONSUMERS* view intelligent packaging. Lastly, concept development is presented as a framework of different methods that can be used to develop new intelligent packaging concepts.

5.1 LITERATURE SEARCH

The literature search will answer the following research questions:

What is intelligent packaging?

What kinds of intelligent packaging possibilities are on the market?

What are the concerns for intelligent packaging?

What are the future trends in intelligent packaging?

What are the rules and regulations regarding intelligent packaging?

5.1.1 LITERATURE REVIEW

For this project, a literature search was conducted to find relevant literature and information about intelligent packaging and its uses. The literature that was used were articles and books that could answer the research questions. All articles regarding intelligent packaging could be used; they were screened on language and relevance by reading the titles and abstracts. Articles and books regarding rules, regulations, acceptance and trends had to be recent and have a European perspective.

The AAU online library was used for the initial search of documents. A reading list was made after searching for the keywords: intelligent packaging, smart packaging, intelligent food packaging, trends in intelligent food packaging, packaging industry, Intelligent packaging consumer perspective, trends intelligent food packaging, *THE INTERNET OF THINGS*, intelligent packaging consumer benefits and intelligent packaging consumer acceptance. On several databases including Elsevier, PubMed, Scopus, Google Scholar and the AAU online library. Additionally, references from the collected material were used to find more research in the field of intelligent packaging.

Furthermore, books on the subject have been found through Google scholar, the AAU library and the Danish library system.

The concept development phase used different methods to develop intelligent packaging concepts. The methods used for this phase have been found by using literature provided during the master course Integrated Food Studies at Aalborg University (DK) and the bachelor course Food Design & Innovation at HAS University of Applied Sciences in Den Bosch (NL).

5.1.2 INTELLIGENT PACKAGING

Food packaging was traditionally used to make the distribution of food easier; the development of food packaging has led to more tasks, such as protection of food, an informative function and proper convenience (Ahvenainen, 2003). Because of the growing needs for more safety and information about food products, novel food packaging techniques with active roles in fulfilling these functions are developed (Yam, 2000; Han, 2013). Food packaging with these advanced packaging technologies are collectively called smart packaging. Smart packaging is a collective name for both active and intelligent packaging.

There are many definitions for intelligent packaging and it has a broad spectrum of technology that falls into the intelligent packaging category. Intelligent packaging is the science and technology behind communicative functions that are added to packaging

(Yam & Lee, 2012). The systems are added or printed to the packaging material and can perform intelligent action to improve shelf life, food safety, quality, and to inform (Yam, et al., 2005; Otles & Yalcin, 2008; Han, 2013). Intelligent packaging can do this by monitoring the food item internally and externally and communicate the collected data to an external program (De Jong, et al., 2005). The system could be capable to sense, detect, trace, record and/or communicate information about the food product (Otles & Yalcin, 2008). The added technology that can communicate and inform the consumer, manufacturer and retailer about the food inside is a key part in defining intelligent packaging, and it is the part that differentiates itself from traditional packaging (Restuccia, et al., 2010). Intelligent packaging systems can be embedded in the packaging as labels, or be incorporated in or printed onto the food packaging (Dainelli, et al., 2008). By adding a type of technology to a packaging in any way provides the user with reliable and correct information about the food product. Informing the consumer about the food has always been a function of packaging, which can be expanded even more by creating intelligent packaging (Vanderroost, et al., 2014).

As mentioned earlier in this chapter, intelligent packaging falls under the category of smart packaging. There is a difference between intelligent and active packaging. Active packaging is described as an extension of the protection function of traditional packaging and is a material or component added to a food product to improve shelf life, safety or the food itself. The added component releases or absorbs substances in or out the packaged food or the environment surrounding it to protect the food product (Ahvenainen, 2003; Han, 2013; Vanderroost, et al., 2014). Intelligent packaging and active packaging do not have to be exclusive from each other, it is possible to implement both systems into one food packaging (Vanderroost, et al., 2014).

The use of intelligent packaging started in Japan, in the 1970s, and was picked up in Europe and the United states around mid 1990. Since then the global market for intelligent packaging has grown and it is predicted that the demand for intelligent packaging in the United States alone will grow with 3.5 million US dollars in 2017 (Han, 2013; Lingle, 2014). Especially in intelligent packaging new and affordable types of technologies are being developed. Some examples of intelligent packaging are:

- Tampering evidence and/or a packaging discontinuity
- Opened packaging

- Quality indicators
- Time-temperature indicators
- Microbiological indicators
- Traceability devices
- Gas sensing devices
- Radio frequency identification (RFID)
- Chips/tags
- Product authenticity
- Holographic images, such as logos or hidden design elements

(Otles & Yalcin, 2008; Han, 2013)

The greatest market for intelligent packaging is the food and beverage industry and it is predicted that future development for intelligent packaging will focus even more on the commercial usage of intelligent packaging (Han, 2013; Lingle, 2014). The continuing growth in this industry is because of the current global trends. The consumer wants to know about health and food safety and is willing to spend more on it. There is also a great consumer acceptance for newly added technologies in food packaging (Han, 2013).

Intelligent packaging can be divided between external and internal use. One system is created to measure the condition of the packaging from the outside, while the other measures the quality of the food directly from inside the packaging. When intelligent packaging systems measure the food from inside the packaging, there might be direct contact with the food or the headspace (Ahvenainen, 2003; Restuccia, et al., 2010). Intelligent packaging can further be divided, depending on the different types of technology used; indicators, sensors or data carriers. Indicators show the environment, and possible changes of it, inside the packaging through a visual change on the outside of the food packaging. Sensors communicate through computerised chips embedded in the packaging to a receiver that translate the message. Data carriers store information about a product, sometimes in the form of letters and/or numbers or embedded in a chip, which can be read by an external device and translated into a message (Han, 2013; Vanderroost, et al., 2014). The most common types of these different systems and their functions are further explained in the table (Table 1). Most intelligent packaging is used to monitor food safety, storage conditions, package leaks or to monitor the

microbiological quality of food. Additionally, intelligent food packaging technologies can be used to provide information about the origin of the food product, authenticity, contents, use consumption-date expiration and track a product through the supply chain (Ahvenainen, 2003). The difference between the three systems are not just hardware, the possible usages differ from each other. There is major growth in the development and interest in these systems to develop, implement, commercialise and standardise these new technologies (Vanderroost, et al., 2014).

TABLE 1 EXAMPLES OF DIFFERENT INTELLIGENT PACKAGING SYSTEMS

Intelligent packaging systems	Possible usages of intelligent packaging systems	Explanation of intelligent packaging systems
Indicators		
	Time temperature	The best before date on food packaging is an indication when a food will expire, however a time temperature indicator can take possible changes in temperature into account and give information on how the variation in temperature affected the food. This type of indicator is mostly used in transportation and storage (Otles & Yalcin, 2008; Pereira de Abreu, et al., 2012)
	Seal and leak	Within the packaging there is possibility that the gas composition changes, this could be because of leaks, changes in the food, the package material, or its surroundings. A seal and leak indicator is used to give information if leakage occurred (Otles & Yalcin, 2008; Pereira de Abreu, et al., 2012)
	Freshness and/or ripening	Freshness and/or ripening indicators are used to identify the freshness of a packaged food. This done by measuring the microbial quality of the product by reacting to metabolites (such as; diacetyl, amines, carbon dioxide, ammonia and hydrogen) (Otles & Yalcin, 2008; Pereira de Abreu, et al., 2012)
Sensors		
	Biosensors	Biosensors are compact devices able to detect, record and transmit any information it measures about the biological reactions (Otles & Yalcin, 2008; Pereira de Abreu, et al., 2012; Yam & Lee, 2012)

	Gas sensors	Gas sensors respond to any changes within the properties of a gaseous analyte inside the packaging (Otles & Yalcin, 2008)
Data carriers		
	RFID	RFID tags use wireless connection technology to store data and can transfer it data to its reader. RFID tags can be passive; a simple short range tag that is powered by the reader, or active; a long-range tag, with its own battery. The latter can store more information (Otles & Yalcin, 2008; Yam & Lee, 2012)
	Barcode	Barcodes are less expensive, and most used. The barcode was introduced in the 1970s and is used in grocery stores for inventory, reordering and checkout. Any device with a function to read barcodes can be used to scan barcodes (Yam & Lee, 2012; Sankara Narayanan, 2012)
	QR Code	QR codes have been developed to answer the demand for barcodes to store more information. QR codes are 2D and have the possibility to store more information. QR codes are stacked barcodes (Sankara Narayanan, 2012)

5.1.3 THE INTELLIGENT PACKAGING MARKET

There are only a few different systems used in intelligent food packaging on the market. Even with active research devoted to the intelligent packaging area, such systems are mostly limited to seal and leak indicators and time temperature indicators. These systems are implemented in food packaging on the Japanese, Australian and US market. As a result of the European regulations for food contact materials, not many systems are implemented on European food packaging yet. Furthermore, reasons can be high costs and the acceptance of technology in food packaging (Ahvenainen, 2003; Dainelli, et al., 2008). However, the global market is experiencing a continuous growth in intelligent packaging, due to an increasing awareness in health knowledge and improved consumer acceptance. Consumers are also more willing to spend money on products that are safer, healthier and better for them and the environment (Han, 2013). As mentioned in the previous chapter, there are many possible ways to implement technology into food

packaging. The following cases are examples of intelligent food packaging on the market (Table 2).

TABLE 2 EXAMPLES OF INTELLIGENT FOOD PACKAGING ON THE MARKET

Intelligent packaging	Explanation of the system
RFID tags for restaurants	There is a pilot for fast food restaurants, such as McDonalds, to try RFID based packaging. RFID technology is often used in items such as fresh produce and pharmaceuticals. The Norwegian company, TAG Sensors, created an RFID printable that can be used by restaurants to see were the products are located and see the temperatures the food has been exposed to (RFID Journal, 2016).
Izon 3D film	DuPont Advanced Printing announced a new anti-counterfeit film for packaging. The 3D security film can be directly printed onto the packaging and, unlike holographic films, are difficult to copy. It can be used to create an image that can only be seen from a certain angle (Dupont.com, 2016).
Thinfilm	Thinfilm is a company that prints low cost, small electronic labels for packaging and products. Their printables can be used in food packaging, for example in craft beers. In this case thinfilm used NFC tags printed on craft beer to connect with the consumers through their smartphones. The NFC tags made it possible for craft beer brands to share their authenticity with their consumers (Thinfilm, 2016).
InTact	Another example of NFC printables is made by Amcor Capsules, in this case the company used NFC printables to create a capsule that can be fitted over a corked bottle. The NFC printable stores a unique ID number, and that can be used to ensure authenticity of the wine, and proof there has not been tampered with. And additional app can be used to promote the wine, get information about the product and confirm that the bottle has not yet been opened (Aipia, 2016).
Amazon Go	Recently Amazon announced that a new kind of supermarket will open in 2017 in Seattle. The supermarket will have no checkout and customers can directly put their groceries in their bag and leave. Consumers use an app to enter the store and

	different technology inside the store recognises the products the consumer takes and directly charges their account when they leave the Amazon Go supermarket (Amazon.com, 2016). Amazon is planning to open Amazon Go stores in the UK and the European Union (Wokke, 2017).

5.1.4 CONCERNS FOR INTELLIGENT PACKAGING AND SOLUTIONS

There are some concerns regarding the acceptance of added components to food packaging, even though there has been an increase in intelligent packaging in Europe, it did not match the expected growth. The food industry is reluctant to invest money in smart packaging concepts (Dainelli, et al., 2008). Reasons could be high costs, legislation issues and effectiveness of the packaging systems (Ahvenainen, 2003; De Jong, et al., 2005).

The evaluation of new material is costly and complex, not just the implementation is costly; there could be risks in the materials that are encountering food. (Restuccia, et al., 2010). The usage of intelligent materials will add to the price of the product. Normally packaging costs will hardly go over 10% of the cost of the product, while intelligent materials could (Dainelli, et al., 2008). The most encountered problems and concerns according to Ahvenainen are:

“Consumer attitude, doubts about performance, increased packaging costs and a false sense of security, ignorance of date markings” (Ahvenainen, 2003)

It is unclear if consumers see the benefit in intelligent packaging. For example, the consumer often perceives products with a short shelf life as fresh, and might not be interested in materials that can extend a products expiration date (Dainelli, et al., 2008). These problems are something that needs to be solved before intelligent packaging will be accepted by consumers, and to its full potential implemented by the food packaging industry. This can be achieved by researching the consumers’ acceptance towards an intelligent packaging component, and educate or inform the consumer if necessary (Ahvenainen, 2003). Since there is a lack of a clear regulation there is another concern from the food industry to implement technology in their packaging. Additionally, tests

need to be done on all newly added components before implementation to ensure that the added technology works properly (Ahvenainen, 2003; Dainelli, et al., 2008).

Finally, it is necessary to keep in mind that there is need for reduction of the environmental impact of food distribution (carbon footprint) especially in the food industry. Since supermarkets and retailers should try to find more locally produced food, there might not be a need to develop technology for long transport of food (Dainelli, et al., 2008).

Nevertheless, there are great potentials for the food industry to implement intelligent packaging for ready to eat meals, to increase convenience or create knowledge about the product (Dainelli, et al., 2008). De Jong et al. (2005) mention that because of the potential for a better control of the food production chain and a transparent communication with the consumers the problems concerning intelligent packaging will be overcome. The high potential of intelligent packaging weighs out the hurdles. Ahvenainen (2003) predicts that in the future, intelligent packaging will be so advanced that food products do not need any additives and the technology will protect the food product completely; it will guide itself through the supply chain and communicate product quality, usage and properties of the food.

5.1.5 FUTURE TRENDS IN INTELLIGENT PACKAGING

At this moment, most intelligent packaging components are measuring time and temperature inside food packaging, it is expected that future developments will ensure that more information about the food inside can be communicated through added components. This can be in the form of new printing technology and advanced chips. These tags can give information about use and the health of the food product, that can be of convenience for the end user (Ahvenainen, 2003). Research and development in the packaging industry is developing together with a growing demand for environment friendly packaging solutions as well (Dainelli, et al., 2008).

Intelligent packaging technology and development will be focussed on ensuring the freshness and safety of food products, increase traceability of food products through the food chain, monitor critical points in the supply chain to create better product quality and

will be developed to answer the demands from the consumer (Ahvenainen, 2003; Dainelli, et al., 2008). An opportunity for the smart packaging market is to improve consumer convenience with intelligent packaging, because packaging is not just protection for the food product anymore. Communication and convenience are equally important. And new packaging technology to improve production, traceability, display qualities easy opening and easier preparation methods should be developed (Han, 2013).

Whilst looking at the development of packaging solutions there are a few things that show the direction that intelligent packaging will take in the future. During the European Football championships, for example. Unilever used a visual recognition system for Heartbrand (frisko). It made it possible to scan the product with an app and gave Heartbrand the opportunity to communicate with their consumers (PUB, 2017). Another emerging concept is *THE INTERNET OF THINGS*. It is expected that packaging will play a key role in smart kitchens for households that have incorporated *THE INTERNET OF THINGS*. The Ecole Polytechnique fédérale de lausanne have created a device that can speed up the communication between appliances (Verpakkingsprofs., 2017). Further opportunities for intelligent packaging is the use of augmented reality. Augmented reality is a technology that makes it possible to place digital images in 3D models and project them into the 'real world' by using a smartphone, tablet, PC or virtual glasses. Augmented reality can be used to integrate text and images, and add new dimensions to food packaging (Verpakkingsprofs., 2016).

The intelligent packaging sector is expected to have the biggest growth, compared the active packaging sector, mainly because of the use of temperature indicators, and by using intelligent packaging for traceability of food, inexpensive interactive features and to make a product more unique to the consumers (Han, 2013). Indicators may be replaced by sensors, and are promising and as game-changing technology for intelligent packaging systems (Vanderroost, et al., 2014). Technological research development would also be in the field of nanotechnology, creating sensors, indicators and even data carriers on a much smaller scale (Dainelli, et al., 2008). Data carriers, in the form of RFID tags, are expected to grow as well, especially for flexible and printed electronics (Vanderroost, et al., 2014).

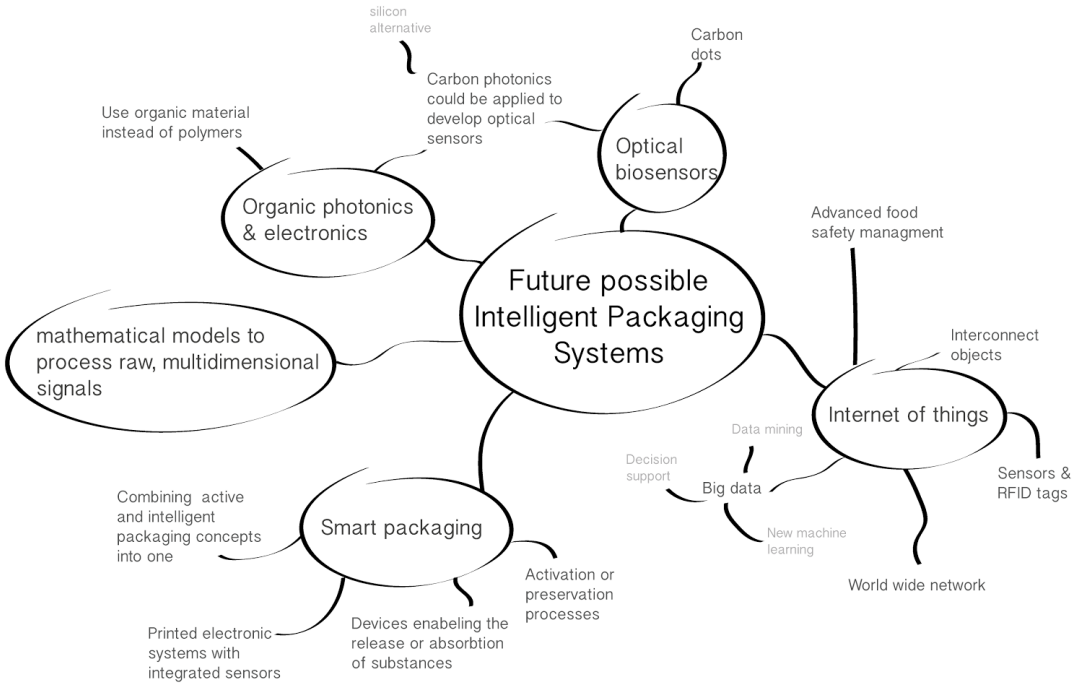

FIGURE 2 VISUALISATION OF FUTURE POSSIBLE INTELLIGENT PACKAGING SYSTEMS BASED ON THE RESEARCH BY VANDERROOST ET AL. (LANDMAN, 2017)

Vanderroost et al. (2014) considered the possibilities and technology that is expected to appear on the market in the future. This shows the possible directions intelligent packaging could take. Vanderroost (2014) predictions have been visualised in Figure 2. The technological possibilities described by Vanderroost are future predictions, based on research and development around intelligent packaging.

5.1.6 INTELLIGENT PACKAGING RULES AND REGULATIONS

Intelligent packaging has materials added inside or on food packaging. These intelligent systems interact with the food inside. This can lead to possible migration of substances into the food. Therefore, any new material used in intelligent systems might be unsafe, and needs to be tested and evaluated before it is possible to know how it affects food. Intelligent packaging could also be wrongly labelled or used, making it ineffective. As a result; many countries are creating rules and regulations for added material to food

packaging (Dainelli, et al., 2008; Han, 2013). In Europe, the implementation of intelligent packaging has been limited, especially compared to Japan, the United States and Australia. The main reason for intelligent packaging to have a slower rise on the European market is blamed upon less flexible and inadequate regulations that could not keep up with the technological possibilities and inventions for intelligent packaging systems. In 2004, the regulation in Europe changed with a new FCM Framework Regulation (1935/2004). Further reasons for a slower implementation on the European market are because of unknown consumer and industry acceptance regarding intelligent packaging (Dainelli, et al., 2008).

Japan has been one of the first countries that started creating smart packaging over 50 years ago. In Japan, new material added to packaging should be approved and listed by the ministry of health and welfare. New components, not yet listed, must first be registered as chemicals according to the guidelines for screening toxicity testing of chemicals (Ahvenainen, 2003). Australia follows its A12 food standards code which sets a maximum level of metal, monomers and additives from food packaging for externally added components. Internally added components need to follow the A13 standards code, which contains regulations about materials that can be in contact with food (Ahvenainen, 2003). In the United States of America, the legislation for adding components to packaging containing food states that any material directly added to food is a food additive. This means that all internally added components need to be toxicologically tested before use. Externally added components should follow the same legislations for migration of monomers and polymer components (Ahvenainen, 2003).

There is a fundamental difference between the legislation in Europe and the United States. The European legislation is based on the principle that all materials must be safe, while the United States legislation states that when there is only little exposure from the material to the food, there is no need for toxicology reports (Restuccia, et al., 2010). Consequently, even if an intelligent material is approved in another country, it might not be approved by the European Union (Han, 2013). The European Union has specific legislations for food contact materials, included in these legislations are the use of intelligent packaging components. Intelligent components internally and externally added to a packaging are authorised if it can be shown that this component enhances safety, quality or shelf life of the food. Additionally, all components are subject to already existing regulations about food and packaging and new components and materials need to be approved by the European Food Safety Authority (De Jong, et al., 2005).

To be approved on the European market, each intelligent packaging system needs to comply with the current EU legislation. All materials that are inactive fall under the Framework Regulation (EC 1935/2004). This regulation has directives for different materials used in packaging, such as the plastic directive, however, most materials used for intelligent packaging are not made from plastic, and do not fall under any directive, and should therefore comply to the regulation itself. Some countries in the European Union have specific regulations for all materials that do not fall under the plastic directive, and are approved in any other country in the European Union (Dainelli, et al., 2008). The intelligent component of intelligent packaging systems also fall under the Framework Regulation. Article 3, 4 and 15 of this regulation are important for intelligent components. Article 3 states that all food contact material should not transfer onto food in quantities that can: endanger human health, change the composition of the food, or change the characteristics of the food. Article 4 states the special requirements for intelligent material. The intelligent technology cannot mislead the consumer by giving false information about the food, and it should be clear which parts are inedible and/or intelligent. Article 15 states that the consumer should be informed about how to use the intelligent packaging appropriately (Dainelli, et al., 2008). New intelligent packaging requirements have been added in the new regulation (450/2009/EC). This regulation states that there should be no possible way for intelligent packaging systems to release chemicals into the food. Intelligent packaging can be added to the outside of the packaging and separated by a functional barrier (Restuccia, et al., 2010).

Restuccia et al. (2010) have created a framework that shows all European regulations around active and intelligent packaging. This framework can be seen in the appendices (Appendix 1.).

5.2 URBAN SONGLINES

The songlines method created by Marling will be used to collect qualitative data from the experience of ordinary people. This method is used to map and visualise the experiences of ordinary people in their day to day life, and makes it possible for the researcher to step outside of the expert role and understand the world from the point of view of the participant (Marling, 2012).

The *URBAN SONGLINE* method of Gitte Marling is inspired by the book "The Songlines" written by Bruce Chatwin. The book studied nomads traveling through their day to day lives in the form of dream lines. The songlines in this sense are a guide, but are in reality much more than that. The Aboriginal idea of a songline is the musical road left behind by their ancestors, singing songs, attaching stories and giving names to important places. Some of these songlines have been visualised by the Aboriginals into maps and art (Chatwin, 1990). Modern *URBAN SONGLINES* take their inspiration from the Aboriginals as well as the approach of Kevin Lynch. 'The sense of the whole' is a method that shows the relationship between different elements and bring the cities sense to life. A difference in the method of Kevin Lynch and Gitte Marling is the diversity of the participants and that *URBAN SONGLINES* set a framework for peoples' actions, experiences and values (Marling, 2012).

URBAN SONGLINES show the movement in a daily life, social behaviour, mental memories and their connections. They are created by mapping, photo safaris, interviews and visiting the places of meaning with the participants. The results are collected and analysed to develop an understanding of the respondents' lifestyle and values. The method has been used to design new meeting places and public domains, understand where social exchange takes place, but also to show urban live in a different context. This method has been used to study temporary places as well, in the case of the Roskilde festival study (Marling, 2012).

The purpose for this method in this research is to map a temporary world, the *FOODSCAPE* of a supermarket. The method, developed by Gitte Marling, follows daily movement from one place of meaning to the next. The method will be adapted slightly to show a temporary world, the experiences and point of view from supermarket to kitchen, a temporary foodscape. This method is used to understand the connections and the world of the participant (Marling, 2012). The results will give the researcher the option to view the experiences and *TOUCHPOINTS* in a supermarket *FOODSCAPE* and can be used to understand the consumers' perspective at the end of the food supply chain.

During this research, three different people will be given a voice and will be followed through their own local supermarket; their temporary *FOODSCAPE*. The participants will present their accustomed approach to finding food by documenting their way through their *FOODSCAPE*, while pointing out, photographing and documenting moments and

places that have meaning to them. All participants will be interviewed afterwards to discuss the journey.

The *URBAN SONGLINES* is created with the Ramblr application. The Ramblr application is a mobile software that can be used on a smartphone. It is normally used to trace outdoor adventures and share the story behind it with more than just one picture. The Ramblr application lets the creator see the route on a map, together with geotagged photos and notes (Bientus Inc., 2011).

5.3 FOCUS GROUP INTERVIEWS

A *FOCUS GROUP* is a small group of people that comes together to have a focused discussion. Some of the characteristics of the participants could be similar, but their opinions create a detailed understanding of the topic (Krueger & Casey, 2015).

FOCUS GROUP discussions are used in many marketing and therapeutic studies. However, social scientists have adapted this method as well, mostly, since this method is more cost effective compared to other methods, and adaptable to different research approaches, such as: patient/consumer satisfaction and education but also the development of promotional materials and sensitive issues (Parker & Tritter, 2006; Krueger & Casey, 2015). The purpose of a *FOCUS GROUP* can be anything from suggesting ideas, recommendations, a decision-making process to measuring reactions to new ideas. A clear purpose, as well as a good process are the most important factors for a good *FOCUS GROUP* (Krueger & Casey, 2015).

Nevertheless, not only a clear purpose and a good process are reasons that a *FOCUS GROUP* will work. The participants need to be comfortable enough to share their honest and real opinions without being judged (Krueger & Casey, 2015). Self-disclosing creates synergy and in an ideal situation, all participants share their opinions and contribute to the discussion (Parker & Tritter, 2006). Some people are more prone to self-disclose than others but there have been several studies done to help create synergy between participants. Most people are more likely to share when they perceive that they are alike in some way; age, gender, occupation, social status or when they hold the same opinion on the topic (Krueger & Casey, 2015). Alternatively, participants can be probed by the

moderator by encouraging the participant to fully explain their answer (Duke, 2005). The moderator is responsible for the discussion and should make sure that all participants have a chance to share their opinion (Krueger & Casey, 2015).

A *FOCUS GROUP* is a composed group of five to eight people (Krueger & Casey, 2015). Small enough so that all participants have a chance to share their opinion, and not too large, since some participants might be left out in a sizeable group (Duke, 2005). Participants are invited to participate in a *FOCUS GROUP* discussion. There are different kind of methods to recruit participants; nomination, random selection, all members of the same group, same role/job title or volunteering. It depends on the purpose of the study what the most feasible recruitment method is (Duke, 2005; Krueger & Casey, 2015). In the case of this research, the selection criteria are broad enough to use the volunteering method; participants are recruited through digital flyers.

In this research, the *FOCUS GROUP* is used to collect information on intelligent packaging and the opinion of consumers. It is a needs assessment, and the researcher will collect enough opinions and answers to discover the need for intelligent packaging. Needs assessment is a complex task, however *FOCUS GROUPS* have been proven to be a helpful tool, being that it enables participants to reflect and listen to experiences of others, which helps people to compare their personal reality with others (Krueger & Casey, 2015).

5.4 CONCEPT DEVELOPMENT

Creative thinking and concept development is a well know term in the creative arts. Yet, creative thinking can be applied in other fields of research as well (Lawson, 2006). Concept development is a creative process made up by different methods to create an innovative result. These methods help to understand reality and thoughts that are too complex at the beginning of the process (Byttebier & van Blokland, 2002; Kolko, 2010). The creative process of concept development can be divided into three parts; the start-up phase, the diverging phase and the converging phase (Byttebier & van Blokland, 2002; Lawson, 2006).

The start-up phase is the moment the creative process starts. This can be because of a problem, or because there is need for change. Solving problems is often associated with

the creative process, however, in some cases there is an opportunity for change, without a defined problem. This is defined as the problem of no problem; without discontent, the tendency to change is very small (Byttebier & van Blokland, 2002). During the diverging phase, many new ideas are generated. The methods used during this phase, help to break traditional thought patterns, increase imagination and trust intuition (Byttebier & van Blokland, 2002). The converging phase is necessary to go from an abundance of ideas, towards a final concept. Converging methods help the creative process to go from many solutions and ideas to the best one and the visualisation of it (Byttebier & van Blokland, 2002).

5.4.1 DESIGN METHODS START-UP PHASE

It is important that the problem area is understood and defined before starting the creative process. This can be done by creating an exploration circle, this circle defines the subject from three different sides; the feeling, thinking and wanting sides (Byttebier & van Blokland, 2002).

The feeling towards a subject is an important factor of the creative process that is sometimes forgotten. It is about the relationship between the researcher and the subject. If there is a disinterest, it is not a good time to start a creative process. The thinking side of the circle defines what is known about the subject itself by analysing the subject. The wanting side shows the desired result of the concept development process (Byttebier & van Blokland, 2002).

The start-up phase is finished when the design area can be defined in one sentence. This sentence defines the end goal of the creative process with a concrete focus.

The start-up focus will be visualised into a moodboard. Moodboards are visualisations created by a collection of images that visualise the atmosphere of the subject. The process is divided into three steps. The first step is image browsing, which is the process of finding images that help visualize the story. The second step is called image piling; the process of categorising the images and creating an overview. The third step is called building moodboards. This is the process of creating the moodboard from the different images and categories (Byttebier & van Blokland, 2002; Lucero, et al., 2007).

5.4.2 DESIGN METHODS DIVERGING PHASE

The diverging phase starts when the start-up phase is finished. The first method is called First round. It is important to get rid of already existing ideas, since these ideas tend to be the obvious solutions to a problem. The mind tends to fall back on existing ideas and thought patterns, and simply ignoring them blocks the creative process. This method is carried out by writing down all ideas that come to mind (Byttebier & van Blokland, 2002).

The diverging process continues with the next method, called Preconceptions. Preconceptions are thought patterns. This method is used to find the visible and invisible preconceptions around the subject. By identifying the existing preconceptions there is more possibility for new associations. This method is performed by using the ideas from the first round and identifying their common features. Every one of these common features are turned around or made invalid (Byttebier & van Blokland, 2002).

The next method is called the Personal analogy. This method is originated from the idea that a designer is so close to the subject they can imagine the personality of it. The researcher to imagine themselves as the object from the start-up phase and imagine themselves in various situations. From this perspective, the researcher must re-associate back to an idea (Byttebier & van Blokland, 2002).

The last method is about letting coincidence take over. This method is called Lucky shots. The method is originated from the belief that everything can be associated with anything and it is possible to associate from any random beginning back to the problem area. First the researcher picks a random word and associates back to the problem (Byttebier & van Blokland, 2002).

5.4.3 DESIGN METHODS CONVERGING PHASE

This phase is divided into three separate parts; choosing, developing and activating. It starts by finding the focus of the creative process again. Important factors to keep in mind are ratio and feeling; new ideas need to possess both rational aspects and need to ‘feel

right'. It is important to be able to let go of certain ideas as well (Byttebier & van Blokland, 2002).

The *COCD*-box method is created by Mark Raison for the Belgian company *COCD*. The *COCD*-box is developed to help the researcher label and choose concepts to develop further. This method helps the researcher to avoid relying on old thought patterns and choosing ideas that are obvious (Byttebier & van Blokland, 2002; *COCD*, 2017). The method helps sort the ideas and grade them on innovation strength and feasibility. Based on the criteria the concepts will be assessed into a three-squared model. The figure (Figure 3) shows an example of the *COCD*-box model and its corresponding colours (Byttebier & van Blokland, 2002).

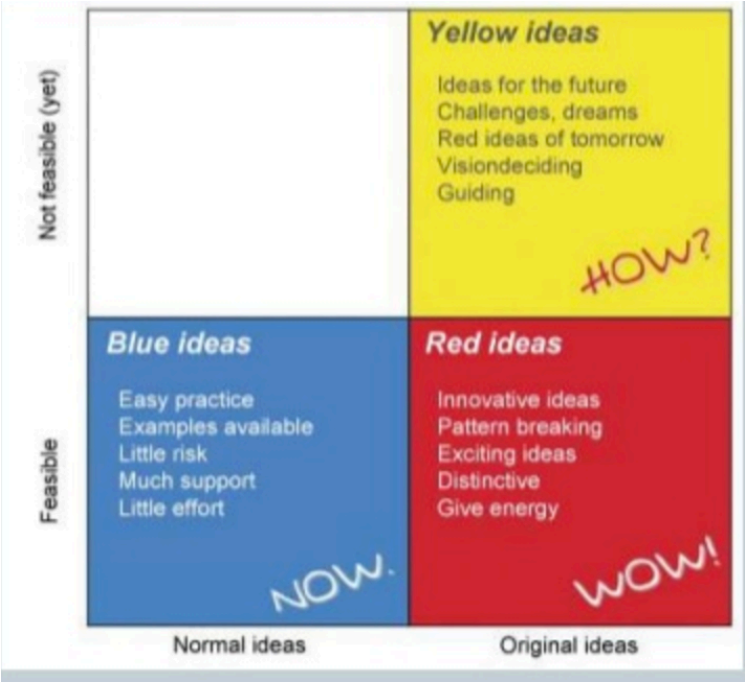

FIGURE 3 COCD-BOX (VAN DEN BOOMEN, NO DATE)

The blue colour represents ordinary ideas that are feasible. These are the concepts that many people will think of, might already exists and are easy to achieve in a short amount of time. The red ideas are the most interesting, red ideas are both innovative and feasible. The yellow ideas are concepts that are very innovative, yet they are not feasible right now. Yellow ideas are ideas for the future and are not ready to be implemented (Byttebier & van Blokland, 2002; COCD, 2017). The ideas will be sorted into the different categories by the researcher and an electrical engineer. The electrical engineer has knowledge of

the technological possibilities for intelligent packaging systems and will help sort the ideas into the *COCD*-box model.

After sorting the ideas, the researcher will be able to choose the most promising ideas and continue to develop the ideas in the converging phase. The V3-circle is a method that can further develop an idea into a concept. The three steps are visualising, verdict and enrich. The first step; visualising, helps to create stronger image (Byttebier & van Blokland, 2002). In this research, the ideaform method will be used to further develop the idea, additionally the ideas will be visualized into a cartoon. The first method of visualisation is related to storytelling. Stories are told every day, to communicate or to inspire or persuade. They are part of human evolution. Stories are important to understand a message (Fog, et al., 2005). The ideaform uses storytelling to describe the ideas and give structure to their diversity. The cartoon helps built an image and strengthen the idea (Byttebier & van Blokland, 2002).

The second step is the verdict. The verdict is an important and difficult part in the design process and the PREFer method is used to include different factors to help make decisions. Ideas are scored in the four different factors; Potential, Risk, Effort and Feeling. All ideas get scored ranging from 1 to 10. With 10 being the highest and 1 the lowest. The average of this score will be the final score of the ideas and will show the ideas with the best potential (Byttebier & van Blokland, 2002).

The last part of the 3V-circle is the enrich part, that strengthens the ideas. Some ideas might turn out stronger than others. In the end the strong ideas are the ones that can be implemented into society (Byttebier & van Blokland, 2002). It is important to keep ideas simple, by using the *KISS*-principle. It is easy to enhance ideas into something far too complex (Tvedebrink, 2015). The method to enhance ideas, without adding too much complexity to them, is called the *PMO*-method and it is a quick way to judge ideas and develop ideas by changing the negative parts about the idea into something positive. For each idea one or two positive points and three or four negative points are written down. Each idea then gets five minutes where the researcher must think of a way to strengthen the idea by changing the negative points into something positive (Byttebier & van Blokland, 2002).

The last step in the converging phase is to combine, choose and form the ideas into a concept that answers the focus defined in the start-up phase (Byttebier & van Blokland, 2002).

6. RESULTS

6.1 FLOW OF THE RESEARCH

This research was conducted to develop intelligent packaging concepts from a consumers' perspective. To do so different steps have been taken. Firstly, intelligent packaging needed to be researched by conducting a literature search and developing an understanding in the field of intelligent packaging. Afterwards the research continued with a focus on understanding the consumer. This was done by conducting *URBAN SONGLINES* and a *FOCUS GROUP*. This data, together with the existing knowledge on intelligent packaging, defined the frame for the concept development phase of the project. The concept development phase exists of different methods and tools to define the problem, develop ideas and create an innovative result. This study has been visualised in a flowchart that can be seen in the appendices (Appendix 2.)

6.2 URBAN SONGLINES

URBAN SONGLINES have been created to develop a better understanding of the consumer and their *TOUCHPOINTS* with food, products and packaging from supermarket to kitchen. The maps have been created from a *SPATIO TEMPORAL PERSPECTIVE*, together with the participants, while asking about different points that have meaning, value or are problematic for the participant. Afterwards a descriptive interview has been made with the participants about the *TOUCHPOINTS*. The visualization of this method can be seen in the appendices (Appendix 3.).

6.2.1 FINDING PARTICIPANTS

The first step was to find participants to create an *URBAN SONGLINE* with. *DUTCH CONSUMERS* aged 25-30 with different social situations (single, relationship, living together, married) could be asked to participate. The participants had to be the *HEAD PURCHASER* in their household. The participants needed to be followed and documented on a usual grocery

shop trip at the place they normally do groceries. *DUTCH CONSUMERS* were asked if it was possible to follow them from home to supermarket to their kitchen. The documentation ended when the participant was finished with grocery shopping. The inclusion and exclusion criteria are presented in Table 3. Participants were found by directly asking *DUTCH CONSUMERS* if they wanted to be followed and interviewed. Three participants were interviewed.

TABLE 3 INCLUSION AND EXCLUSION CRITERIA, URBAN SONGLINE

Inclusion criteria	Exclusion criteria
People (aged 25-30 years)	Unable to provide consent
DUTCH CONSUMERS	Unwilling to be followed through the supermarket
HEAD PURCHASERS of their household	Unwilling to give an interview

6.2.2 CREATING AN URBAN SONGLINE

The researcher met the participants in front of their home or inside their home. The participant was followed to the supermarket and all points of interest were photographed by the researcher with the Ramblr app. The participant was part of the photography process and could check if the picture showed what they experienced. The walkthrough finished when the participant had stored away their groceries how they would normally do it. Any comments made during the walkthrough where saved by using the Ramblr application and brought up again during the interview in addition to the photographs. The interview was held immediately after the walkthrough to ensure that the participant still remembered all the details of the trip. The *URBAN SONGLINE* was created with the Ramblr app. Even though the app does not show the roads inside the supermarket, the Ramblr app was still beneficial to remember the order of the pictures and when it occurred.

Afterwards the participants were interviewed by using the photographs from the Ramblr app. The interview was set up in a descriptive way. The first question asked the participant about their usual supermarket habits and the rest of the questions were built upon the photographs of the walkthrough and the answers the participants gave. The participant was free to share anything they wanted to tell. The focus of the interview was

to understand the consumer and their experience inside the supermarket. All the *URBAN SONGLINES* have been visualised (Appendix 6.) to show the experience of the participant.

6.2.3 THEMATIC CONTENT ANALYSIS

The responses from the interview were analysed. The first step was transcribing the data and translating the interviews from Dutch into English. This can be seen in appendix 4. The transcribed data was then cleaned of nonessential words and the quotes were colour coded into different categories. The categories were defined after all data was transcribed to be able to get a sense of the comments that have been made. Code-based analysing was used to reduce the text data. No software has been used to analyse the responses. Additional categories could be added if necessary after the responses were coded (Weber, 1990; SAGE, 2013). The responses were checked if they were all placed into the right category. The different categories are visible in Table 4. Afterwards all categories where arranged from the largest group to the smallest group, this can be seen in the appendix (Appendix 5.)

TABLE 4 COLOUR CODED CATEGORIES SONGLINES

Category	Responses
Habit	37 Quotes
Food Choice	21 Quotes
Food/product knowledge	18 Quotes
Convenience	17 Quotes
Obstacles	13 Quotes
Discount	11 Quotes
Placement	11 Quotes
Waste	4 Quotes

Additionally, maps have been created to visualise the *URBAN SONGLINES* of the participants. The maps can be seen in appendix 6. The maps have been created with Adobe Illustrator CC. Adobe illustrator CC is a vector graphics software used to create digital visuals for various types of media (Adobe, 2017).

6.2.4 RESULTS

From the defined categories, habit was the biggest one with 37 responses. Many of the actions from the participants are defined by habit, which is logical, since grocery shopping is a recurring event and many of the actions are similar to their previous experiences. Responses such as: “I always take this kind of bread. It is cheap and, I do not bother looking for any other kind if it is in stock.”, “[Even though I cook it right away I still put it away first]”, and “I go [to the bread aisle on Sunday] to get some nice bread, but during the week I make my own. I never buy bread.” show very habitual behaviour, just in a few cases the participants broke their habits; “I found a snack. The salty sticks. [buying] it was very spontaneous.”.

In some cases, the habitual behaviour of the participants was the reason for a negative experience; “I think a [personal stash with food at home] is good, the *FIFO* method is not really good but we do it anyway.”, “The order of [my grocery list] is based on the dishes that I want to make, so they are listed by dish and not how I would encounter them in the supermarket. That is probably the reason why I looked at it so often, because they are not in a logical order. That is how I do groceries, I start with taking fruits and then I go to vegetables”, “I do not [check expiration dates]. I had a bell pepper once that had mold on it though, but I just went back [to the store] … to exchange it.”.

The second biggest category is called food choice, the responses within this category show reasons for choosing, or not choosing a food product. In many cases a cheap price was a big factor influencing the participants’ choice; “I needed [coconut milk] for two different recipes and it was cheaper than buying two cans”, “I thought that [the salty sticks] were very, very cheap!”, “[I chose this type of carrots] because they were cheaper.”, and “I love mozzarella! This [type of mozzarella] is pretty cheap compared to normal mozzarella, and you get 150% more!”.

However, liking, appearance and preference were influential factors for the participants to choose a product; “I dislike green tea and I like spiced tea the most. I think herbal tea is very bland. I mean the diversity did not go up that much, but [the new flavours are] still different.”, “I considered taking a different type of bean as well, it was not on the list, but I thought it would be a good addition.”, “Yes I had to check if [the cilantro] looked healthy enough for a week and if it was not squashed before buying it.”, “[I got UHT milk] because

when you make lasagne you do not need an entire litre of milk. So, we make chocolate milk with it the next days or normal milk, and with fresh milk I think that you lose the fresh flavour really soon, and UHT milk already tastes bad, so then it does not matter. And for lasagne the flavour does not matter.", "I try not to take a big [courgette], because a courgette lasts for two days for us. So even though they are all the same price I take a small one. And I do not take an ugly looking one. … I would like them [to be sold by weight]"

The category food/product knowledge showed that the participants were unsure of the products in their home, when they were inside the grocery store; "I was putting away the canned corn, and I saw that I still had two cans, and I bought three more. I thought I did not have any left, so I did not check and in the end I still had some. … It would be easier if you could check what you still have when you are in the store. But I could have checked it when I was making the list.", "[I was] getting milk, but then later I went back [to take one more milk], after already taking other products. … I was not sure how much milk we had, but I knew we still had muesli. And I like to eat that. I remembered that we did still have a carton of milk, but that it was expired. It was actually still good to drink, I checked when I came home. And I will eat it tomorrow morning.", and "When I got home I noticed that the [brand of muesli] I currently have is a different brand. … I have to try [the muesli] before I know [if I find it annoying].".

The participants expressed that they have a good knowledge of products that are familiar to them; "I have worked at this supermarket when I was a student, and I know that this [Little thumb label] is the truth. I have not seen one that is not true.", "[I do not look at labels] with chocolate, but I know that some of the chocolate bars I buy are fair trade", and "I looked at the freshness of the twigs [of the grapes], I saw a video about that. [The grapes] looked fine.".

The convenience category showed that participants cared about convenience during their grocery trip. The participants familiar with the self-scan option expressed that this option was easier; "[The self-scanner] allows you to scan the products yourself. It is usually easier and quicker than going through a cashiers' stand.", "[The self-scanner] is quicker and easier, because you scan the products while you place them in your card. And if you are not picked as a random check, you already have everything in your basket and you can pay right away and put it away.", and "I think [the self-checkout] makes my

shopping trip easier. Maybe it is less social, because you do not have any interaction with a cashier, but for me, someone that is not that talkative, it makes it a better experience.".

In some cases, convenience was the reason for taking a certain product; "This [brand of bread mix] is cheap and good, you can also take another brand, they are even cheaper, but this one is tasty. It is also easy to take with me.", "I do not really think about [the type of milk], I just see milk and take it. I know where I can find the other milk, in this shop, but I do not think about it.", and "[The comfiture I took] was the closest to my reach. … Not really a reason to take [the comfiture].". For storing the food products after the supermarket trip, convenience was important as well; "I put everything in the fridge. … Because it is easier. It is better to store them in the fridge.", and "I guess the tea needs to be opened in put into a tea box, but I did not think it would fit so I just left it next to it.".

The category obstacles defined the experiences of the participants while they encountered something that hindered their process. The obstacles that occurred were diverse, some of them occurred with the self-scanner "[Shopping with the self-scanner] might be more difficult, because you do not have enough hands, because you need three [hands] to hold the list, the self-scanner and the pen.", and "Most of the vegetables are scannable with the self-scan, because they are sold by piece. I did not expect the broccoli to be sold by weight so I was looking for the barcode. Apparently, I had to weigh them myself, like the bananas, and print out a barcode. [I had to find a supermarket employee to help me].", while other occurred during the cashiers' check out; "The person in front of me did not put the divider after putting the groceries on the band, and I always have to do that. I find that really annoying. And then they just look at you, and look back at the groceries and just ignore it. And it is not that much trouble to put the little divider there, I find that annoying.", and "I had to pack and pay but the person in front of me was not quick, so all the stuff was still there and that was annoying. Normally I am very fast!". Some of the obstacles occurred because the participants forgot to take a product; "I realised I forgot to take sweet potatoes, they are placed at the entrance near the fruit so we had to walk back.", and "I thought I was finished, but then I remembered that I needed to get meat toppings for my partner.".

None of the participants actively looked at the discounts before entering the grocery store; "[I look at the discounts when I am in the store], but not before, so my meals were not determined on the discounts. I would switch if a vegetable [was cheaper if it] is similar

to the one I needed.", "I do not think it would have been influenced by any discounts", and "It depends [if I get convinced by discounts], if there is a really good one, but when I already took other stuff I do not want to switch dinner [plans].".

Even though the participants were not aware of the discounts before, all of them bought items with a discount; "I already wanted to get tea, but the discount convinced me to get another one.", "I noticed the toilet cleaner had a discount, which reminded me to buy it.". One of the participants mentioned that the discounts would be difficult to remember; "[Knowing the discounts before] would help, but it would be hard to remember all of [the discounts]", while another participant expressed forgetting about discounts; "Normally I go all the way to the back to take courgettes, and I already decided I wanted courgette for my lasagne, and then I saw that the courgette had a discount, so I took that one. ... I must have missed [that the courgette had a discount], I looked through [the discount magazine] quickly. But I actually knew [the courgette] had a discount, because I saw [the discount] on Sunday already.".

The placement category shows that the participants had troubles with finding products in the supermarket; "I was looking for a certain type [of rice], but I could not find it, so I picked another one. … I am familiar with [the other type of rice], and I kinda like it.", "I found [the sweet potatoes] after a lot of time. … There is only a little display of potatoes and the colour is the same as the other potato bags, so I thought they were normal potatoes.", and "[The other type of beans was not easy to find], I was looking for a can of white beans, but I only found them with tomato sauce. But I found them in a glass jar, a little higher on the shelf so I took those.".

The placement of products in the supermarket was not always in line with what the participants wanted; "I really wanted to have that kind of tomato. … But they are very high up on the shelf.", and "I think potatoes are more vegetables than fruits. So they are placed wrong in the supermarket. In my mind.". However, the placement of certain products were a factor in purchasing new items; "[The Easter display] was new … , I have not seen it before. I is almost Easter, because valentine's day is over, so then it is Easter time. … [The display was the reason to buy Easter chocolate from a different, cheaper brand than displayed] I wanted to get chocolate, when I saw the Easter display, I decided I wanted them.".

The smallest category was waste. The participants did not want to purchase unnecessary products when the expiry date was short; “For food that can spoil quickly, if I do not need it I do not look at [discounts].”, and “I know [the bigger meat packaging] are a little cheaper, but it is a waste. I do not throw it away or anything, but I do not finish it.”. This mattered less for the participants for products with a longer expiration date; “*We have 20 pots of pasta sauce, and they are only good for half a year.*”

The table (Table 5) shows the categories followed by a paragraph that explains the key points from each category.

TABLE 5 COLOR CODED CATEGORIES SONGLINES

Habit	Many of the activities performed during a grocery trip are habitual behaviour from the participants. All the participants have had moment where they expressed themselves negatively about a situation that had occurred because of their own habits.
Food Choice	The participants had different reasons for choosing or not choosing different products. In many cases the price was the determining factor, but liking, appearance and preference were all reasons why the participant choose certain products.
Food/product knowledge	In most cases the participants showed that they did not completely remembered what was left in their kitchen, this resulted in them purchasing unnecessary products or a different type. The participants also showed that they were sure of their own knowledge of the food products familiar to them.
Convenience	Convenience has a big role in the participants’ grocery trip. The participant who was familiar with the self-scan option preferred the method because it was a quicker and easier way to grocery shop. Some of the products were chosen because of convenience. Additionally, convenience was important when storing the food in the participants’ kitchen.
Obstacles	All of the participants had obstacles during their grocery trip. Some of the obstacles occurred with the self-scanner, and others with the cashiers’ check out. Some of the participants forgot they needed certain food products.
Discount	None of the participant were aware or looked at the discounts before entering the grocery store. Some said that the discounts would not influence their choices, however, all the participants purchased a product that had some sort of discount. One of the participants mentioned that it would be hard to remember all the discounts.

Placement	The participants mentioned that some of the products were hard to find, or placed 'wrong' in their mind. They did not always know where to find certain products. The placement was sometimes a factor in purchasing new items.
Waste	Waste was a factor that the participants thought about when making decisions. Some participants did not want to look at products that had a short expiration date if they did not need it. For products with a long expiry date this mattered less.

6.3 FOCUS GROUP

6.3.1 RECRUITING PARTICIPANTS

For the convenience of the participants, only people living in and around Eindhoven (The Netherlands) were asked to join the *FOCUS GROUP*. The participants were recruited with the volunteering method. The selection criteria were broad, the participants could be recruited with the help of electronic flyers. The selection criteria were that; the participants had to be interested in cooking or food, the participants needed to be between 25 and 30 years old and the participants needed to be the *HEAD PURCHASER* of their household. The table (Table 6) shows the inclusion and exclusion criteria for the *FOCUS GROUP*.

TABLE 6 INCLUSION AND EXCLUSION CRITERIA, FOCUS GROUP

Inclusion criteria	Exclusion criteria
People (aged 25-30 years)	Unwilling to provide consent
DUTCH CONSUMERS	Unwilling to participate in a group discussion
HEAD PURCHASERS of their household	Unwilling to be voice recorded
	Unable to participate on planned date and time
	Unwilling to participate in Dutch

Participants were found by using Facebook. By posting in groups that are mostly used by students and young adults and asking for their participation in a *FOCUS GROUP* about new packaging technology.

The message posted (translated from Dutch:

> "Do you like to cook and talk about what you miss when you are doing groceries, or cooking? Then I am looking for you!
>
> I am looking for people (25 -30 y old) to join a ***FOCUS GROUP*** on:
> Thursday 9th march from 20:00-22:00
> In Eindhoven
>
> I want to talk with you about new food packaging technologies that could change the way you go to the supermarket, the way you cook, or even something completely different! I promise that there will be tasty cake, and tea and coffee! And you will get a chance to share your opinion on the subject! Just write on this post that you are interested, or send me a private message and I will get back to you. It would help me out a lot, so thank you so much!"

It was followed by a figure (Figure 4) to make the post stand out more and give a visual representation of the event.

FIGURE 4 LOOKING FOR PARTICIPANTS FOR A FOCUS GROUP (LANDMAN, 2017)

The participants were screened, to check if they fit into the selection criteria. It they did, they got an email with a link to a Facebook event, where the participants got this information (translated from Dutch):

"Hello everybody!

Thank you for your willingness to participate and I am looking forward to hearing your opinions about smart food packaging and technology that could improve your shopping and kitchen experiences.

You will be in a group together with 6 other participants, and your responses to the questions will be kept anonymous.

I have a few subjects that I would like to hear your opinion about and I will present the subjects during the meeting.

Please arrive before 20:00"

As an incentive, the participants were offered tea, coffee and cake during the event. The participant form containing their details can be seen in Appendix 7. The names of the participants are replaced by codes to ensure anonymity.

6.3.2 FOCUS GROUP QUESTIONS

The *FOCUS GROUP* had eight different questions that will be discussed. Eight questions are the ideal length for any group (Duke, 2005). It is important that the questions are short, focussed on one dimension, unambiguously, open-ended and not embarrassing for the participants. It is important to define the questions before hand and the participants will not see the questions before the *FOCUS GROUP* starts. There are engagement questions, exploration questions and exit questions. The engagement questions are there to make the participants more comfortable with the topic and to open the discussion. The exploration questions are there to get to explore the main topic, in this case; intelligent packaging. The exit question is in place to make sure nothing was missed during the discussion (Duke, 2005).

The different topics of discussion are based on four different factors; food waste, food choice, convenience and health. The questions for the *FOCUS GROUP* have been defined and are listed here:

Engagement questions:

1. What do you already know about intelligent packaging?

After this round the participants get a briefing on what intelligent packaging is. This will be explained by the researcher.

2. How can intelligent packaging help you when it comes to food, grocery shopping and cooking?

Exploration questions:

3. How do you think intelligent packaging can help against food waste?
4. How can intelligent packaging influence your choice of products?
5. In what way, do you think, can intelligent packaging make your life more convenient?
6. What do you think intelligent packaging can do to help people eat healthier?
7. What kind of intelligent packaging solution would you like to see?

Exit question:

8. Is there anything else you would like to say about intelligent packaging and if they could improve your life?

After the first questions the participants get more information about intelligent packaging:

"Intelligent packaging is normal food packaging, but with added technology to improve the product or the environment around it. So how does that work?

In many cases, intelligent packaging is used to improve the shelf life of a product before it reaches the supermarket or to measure the environment inside the food packaging to make sure it is not spoiled. However, intelligent packaging can be used after the food reaches the supermarket and in your kitchens too.

Think for example about a simple QR code, that can be added to a packaging. This way you can scan the product and get more information about preparation, recipes or the product itself. You can also add a little chip to food packaging that can measure temperature and this chip can tell your smartphone or laptop when your food is about to spoil. This little chip can be used to scan all the products in your fridge or pantry, so you can check your supply, while you are not home, for example when you are in the supermarket. Another option is to use artificial

intelligence; it knows the products you are normally buying, and it can give you recommendations of new products the artificial intelligence thinks you might like.

There are many different options for intelligent packaging. Of course, I would like to invite you to give your opinion and share experiences, but also not to judge other opinions."

6.3.3 CONDUCTING THE FOCUS GROUP

The researcher will also take up the role as moderator. According to the Guidelines for Conducting a *FOCUS GROUP* (Duke, 2005) an ideal *FOCUS GROUP* monitor:

"Can listen attentively with sensitivity and empathy

Can listen and think at the same time

Believes that all group participants have something to offer no matter what their education, experience, or background

Has adequate knowledge of the topic

Can keep personal views and ego out of the facilitation

Is someone the group can relate to but also give authority to

Can appropriately manage challenging group dynamics" (Duke, 2005).

The moderator had the task of making sure all participants felt comfortable sharing their opinion, making sure that all participants are participating in the *FOCUS GROUP* and the direction of the topic was not diverted to much. After entering the room all participants filled out a consent form. This form can be seen in the appendices (Appendix 8.). General information about the participants (age, name, gender, occupation) was already collected during the selection of participants.

The script used by the moderator is placed in appendix 9. The script made sure that all information was told to the participants. The script also allowed the moderator the tell the participants about the ground rules of the *FOCUS GROUP.* After the ground rules were

explained, the *FOCUS GROUP* began. To make sure that all the participants felt comfortable with each other and ice breaker question was asked before starting the documentation:

"*What country would you like to travel to and why?".*

6.3.4 ANALYSING THE DATA

To understand the opinions of the participants the results need to be analysed. First, the data was transcribed and translated to English. This can be seen in appendix 10. The transcribed data was cleaned of nonessential words.

The data was compiled into a Microsoft Excel file. Responses were labelled per *FOCUS GROUP* question. Analysing the data was done by looking for common categories or themes. For each question, different categories were chosen. All responses were sorted into the categories, and responses that did not seem to match the category were sorted again. This can be seen in appendix 11.

6.3.5 RESULTS

The first two questions were engagement questions about the subject of intelligent packaging. The participants were first asked what they already knew about intelligent packaging. Most of the participants were unsure and did not know what intelligent packaging were; "I have never seen one.", "Are not they those things with special labels and codes?", and "But would not intelligent packaging also be the labels on packaging". However, the participants had ideas about intelligent packaging; "What about those fruit stickers that change colour when ripe ... for people who do not know when it is ripe?", "Edible barcodes, which slowly degrade when the temperature is too high, so when you have your product, that should be in the refrigerator, and it has not for more than 10 hours, then the barcode degrades and cannot be read anymore", and "I mean you can put a label on the packaging, but I would like a packaging that already knows the ingredients are inside, and you could check these things with a phone!".

Even if the participants were not sure what intelligent packaging were, it was understood some sort of technology was involved; “I am assuming that all the packages that are simply, and nothing else, packaging without anything added, that these are not intelligent packaging”, and “The technology does not necessarily have to be a phone, maybe you have a refrigerator that know what products are inside”.

The second question explored if the participants thought intelligent packaging could help them in some way. Many participants wanted a database that helped them remember what they had to buy and what they had at home; “A database at home would be useful”, and “Combined with something that knows what you would normally have at home and did not buy. It can tell me that I forgot to buy butter, that always happens”. However, some participants did not think a database would be useful for them; “But why do not you just make a list?”, and “I feel that many of these solutions are very complicated, and you will have to insert chips and use apps just to remember to buy something”. The participants also thought that the supermarket could benefit from an improved database; “I would see it more as a database that the supermarket can use itself, so they can know how much to stock and perhaps buy less?”. One of the participants mentioned that some consumers might not want to share their databases online or want it stored were other people can access it; “But then you collect information and these people need to agree with that, that seems difficult”.

Another idea from the participants was a system that helped them remember the expiry date of products; “For me, it would be very useful to be able to know what I have at home, and to know when it is about to expire. It happens too often that I clean my refrigerator after two weeks and then I see all kinds of products that expired and I have to throw them away”, and “When you code the expiration date into the QR code, you can create a system that, knows what you have and what the expiry date is”. One participant disagreed; “Personally, I would not like to get messages from my phone every time my food is about to expire… I do not want the things that I buy to be stored online, I find that unnecessary”. One participant was concerned about adding extra material to the packaging; “I think that there is already so much waste produced, should we add more plastic? And the metal in a chip does not seem very good for the earth?”.

The following five questions were exploratory about intelligent packaging. The third question asked the participants if they thought intelligent packaging could help against food waste. Some of the participants believed that some sort of alarm could help them

remember to consume items close to the expiry date; “For me it would help if I get an alert when my food is about the expire”, and “An alarm bell when food is almost expired”. One participant pointed out that the expiration date could be measured more precise when using intelligent packaging; “[Expiration dates] can be measured much more accurately with intelligent packaging ..., instead of having to go and smell your milk”.

The participants also mentioned that supermarkets could use a new system to lower their food waste; “I think that if a supermarket know what you have in your kitchen, it would be easier for them to estimate what you are going to buy. But you would have to give permission”, and “Normally the cash register only scans the product, but it could also scan the expiration date. Then the supermarket will know that the milk left in the supermarket has a shorter expiry date”.

The participants are most interested in knowing more about the products they are buying and creating awareness about this. For example, one participant mentioned; “What I think would be useful is that I could get additional information about the products. I would like to know if a product is sustainable, and what are the conditions for a product to be sustainable. You might not want to put all of that information on the packaging, and with intelligent packaging you will still get the detail”.

The participants thought that creating awareness was a good way of influencing their choice of products; “You can check whether something is fair trade, and immediately see what that means”, “I think it would help to show how many animals you have eaten that week [to lower meat intake]”, and “I would like to get back to the labels, because some of them are paid, and might not be so good for you after all, I would like to know more about that as well”. However, some people did not think making your buying habits public would help; “I am not sure if [showing how many animals you have eaten] works for everybody, you might get collectors that want to beat a high score”, and “I do not think [publicly showing the score] will work. You need to have a more positive approach. I would consider a bonus system, and when you have shopped very green, you get a little gift. That would be more pleasant and you will get more people to join”.

The next question asked the participants if intelligent packaging could make their lives more convenient. Some of the participants believe that recyclability could improve their convenience; “I would find it convenient that I get more information about the packaging

and how to recycle it. I sometimes reuse packaging as well, but sometimes I am not sure if it is that good… It would make my life easier… It would help me to know more about this", and "I would also like to know more about the environmental impact of the packaging itself".

The visible expiration date on packaging could also be improved according to the participants; "I do think it is a good idea to have a better best before date on the packaging", and "Or instead of a date, have a counter". One participant mentioned that intelligent packaging could perhaps help him to consume less; "I would like a packaging that motivates me to eat less".

When asked if the participants thought intelligent packaging could help them eat healthier, some participants thought feedback could be a good way to motivate them; "I would not mind a packaging that gives feedback when I have eaten unhealthy again", and "I would prefer, … healthy recommendations and recipes, and tell me what vegetables I can add". One of the participants thought a database would help; "I would like the smart refrigerator then, that know what you have at home", however, other participants did not think a database alone would help; "I would simply start to hide the unhealthy products from my fridge, or do not put them in the system"

The following question asked the participants what kind of intelligent packaging they would use. Many of the participants would like to get more information about the product in some way; "I think the thing that I would want to use are the labels and the information behind it. I would really pay attention to them. Or stickers that change colour when fruits and vegetables are ripe", and "Myself I would like to be able to get more information about the product, that is not normally printed on the packaging. I want to eat good and make well informed choices, but most labels are unclear".

A system that helps consumers remember what they have at home and help them remember it, is something some of the participants would like to use, although participants are not open to share personal information about their eating habits and storage; "I think I would use the database myself, but understand the feeling about sharing this information online. I also forget to buy certain products or to check at home, and it would be nice to have some sort of app tell me about this, or to have the ability to check what I still have at home. I do not want to share this with other people".

Reducing food waste is another reason to use intelligent packaging, recipe suggestions for food products are something participants would use; “For me it would help if I knew what is in my fridge. And that I get recipe suggestions for what I buy and when I have some leftover produce. In many cases I do not know what to do with it”, another participant would like to be motivated to take products with a shorter shelf life; “I actually always take products with the longest shelf life, it would motivate me not to do that if there was a discount on the other ones”.

The last question wanted to know if the participants had any last comments. Most of the participants would like to see some sort of returnable deposit on packaging that includes chips, and would feel that this would make intelligent packaging more sustainable; “And it would be so wasteful if people just threw away chips, I think if there was a returnable deposit I would like to use the chips”, and “That there is some sort of returnable deposit”. One participant mentioned that the design aspect of barcodes and QR codes could be improved and would like to see this; “Designing barcodes, but they do not look like barcodes. In that way you can create beautiful designs, while it is still possible to scan them. I think that is beautiful”.

The categories were written up into small heading titles and the responses were summarised into one paragraph per title. This can be seen in Table 7.

TABLE 7 SUMMARISED RESPONSES FOCUS GROUP

Knowledge of intelligent packaging	Most of the participants were not certain what intelligent packaging are. However, the participants had several ideas of what intelligent packaging could be or do for them. It was also mentioned by some of the participants that added technology was part of intelligent packaging, and that this did not necessarily had to be from a smartphone.
Benefits of intelligent packaging	Some of the participants wanted a way to check what they had at home while they were in the supermarket, or even a program that reminded them to buy products. However, some of the participants opposed this idea. The participants thought supermarkets could benefit from an improved database as well. A system that helps consumers remember the expiration date of food was another idea that participants thought that could benefit them, however one of the participants did not want to receive

	notifications if their food was about to expire. One participants expressed concerns about the use of chips and metal in packaging.
Intelligent packaging and food waste	The participants thought an alarm when their own food was about to expire could help them reduce food waste, and expressed that the measurement of food could be more precise with intelligent packaging. The participants believed that supermarkets could reduce food waste as well with help of intelligent packaging.
Intelligent packaging and food choice	The participants are most interested in getting more information about the product, and creating a better awareness of the products they purchase. While some participants mention high scores when purchasing food products, one participant thinks that a reward system would be better. The participants think that scanners and screens in the supermarket would be the most convenient, and one participant suggested screens instead of a label. Sound was mentioned as well, however scannable products are preferred by most people.
Intelligent packaging and convenience	The participants think that recycling and the impact a packaging has would help them. Another convenience mentioned by the participant is to have a clearer best before date on the packaging, or a counter. One participant expresses that intelligent packaging can help with consuming less food.
Intelligent packaging and health	The participants agree that intelligent packaging could help them eat healthier. Some of the participants would like to have feedback and tips on their habits. One participant thinks that a database would help them eat less unhealthy, however, some other participants disagree that this would work.
Usable intelligent packaging	The participants would use intelligent packaging if they are beneficial to them. Most of the participants are interested in getting more knowledge about the products. Some of the participants are interested in a database and knowing what they have at home, however, they are unsure if this is information they would want to share online. Recipe suggestions are something participants would be interested in and one participants mentions that they would like to be motivated to take packaging with a shorter shelf life.
Other comments	Some of the participant's belief that there should be a sort of returnable deposit on intelligent packaging, that uses chips, and they feel that would be more sustainable. One participant mentions the design aspect of barcodes and QR codes and would like to see more of that.

6.4 CONCEPT DEVELOPMENT

To develop new concepts a concept development process was shaped by combining different methods that have been developed to help the creative thinking process and innovation building. The visualisation of the methods in the concept development process can be seen in appendix 12.

6.4.1 START-UP PHASE

The problem area needed to be defined by creating an exploration circle. The circle was created by collecting the information from the interviews and the literature search. The exploration circle is visualised in appendix 13. A moodboard was created as well and can be seen in appendix 14. After creating the exploration circle and the moodboard the focus for the creative process has been defined to the following sentence:

> Design intelligent food packaging concepts, to be implemented in *THE CONSUMER END OF THE FOOD SUPPLY CHAIN*, that *DUTCH CONSUMERS* would want to use and has added value for them.

This sentence will be the starting point of the concept development process.

6.4.2 DIVERGING PHASE

The diverging phase started by writing down all initial ideas. The table (Table 8) below contains all ideas that originated from the first-round method.

TABLE 8 THE FIRST ROUND, IDEAS

Idea	Explanation
Intelligent recommendation system	A system that recognises your purchasing habits and gives recommendations for products that you can buy in the supermarket. It can tell you when products you might be

	interested in, have a discount or recommend products that fit your buying style.
Scan all the food you buy	Something that simply scans the products you buy and remembers the best before date. You will get notifications when the products are about the expire to remember that you need to consume them. You will also be able to manually add products and delete them after you have used them.
Colour changing packaging	Packaging that changes its colour the moment something happens to the food it holds or the environment that surrounds it.
Screens instead of labels	Start to use small foldable screens instead of labels on packaging. This means more interaction and possibilities on the packaging itself.
Know what you have at home	Scan your food packaging, and know what you still have at home from another location.
Chip on the shelves of the supermarket	Place a measurement chip on the shelves of the supermarket to measure the environment to see if the expiration date can be prolonged. This chip can stay in place, and communicate with a computer.
Food miles	Give people insight in the food miles their products have travelled; will that change their purchasing habits?
Smart logos	The labels that contain information about the product are designed QR codes. They look like a picture but are scannable and show the information about the label. Either with scannable software in the supermarket or a smartphone.
Expiration date labels	Create labels that can somehow change the expiry date on the packaging.
Background information scanner	Add an element to the food packaging that makes it possible to be scanned. Include background information about the food.
Allergy/diet checker	Include an element so the person who picks up the food packaging can check if this food fits into their diet without having to look at the ingredient list and finding it themselves.
Non-packaging scanner	Create a scanner that can understand what a product is without having to add anything to the packaging. Use recognition software so there is no need for packaging waste, or extra printing.
Recipe suggestions	Add a database behind different food packaging that contains different recipes that could be created with the food that was just scanned.
Self-heating packaging	Packaging that contains an element that can be used to heat the food inside. Could be used for ready to eat meals mostly.

Self-cooling packaging	Add a self-cooling element to the packaging. Can be used for ready to eat meals, or to ensure better food safety for food that needs to stay cold.
Give the consumer more transparency	Add an element that consumers can use to find out more about the food they would like to consume.
Novel food help	The packaging of novel food can contain a system that is scannable and brings the consumer to a place with more background information. E.g. about the food, preparation methods, recipes.
Supermarket inventory	Help the supermarket get a better understanding of the products and their best before dates in the supermarket, and help them battle food waste.

The diverging process continues with the preconceptions method. All ideas from the first round have been used and common features between them have been identified. This is visible in Figure 5. The preconceptions that have been identified are presented in the table below (Table 9).

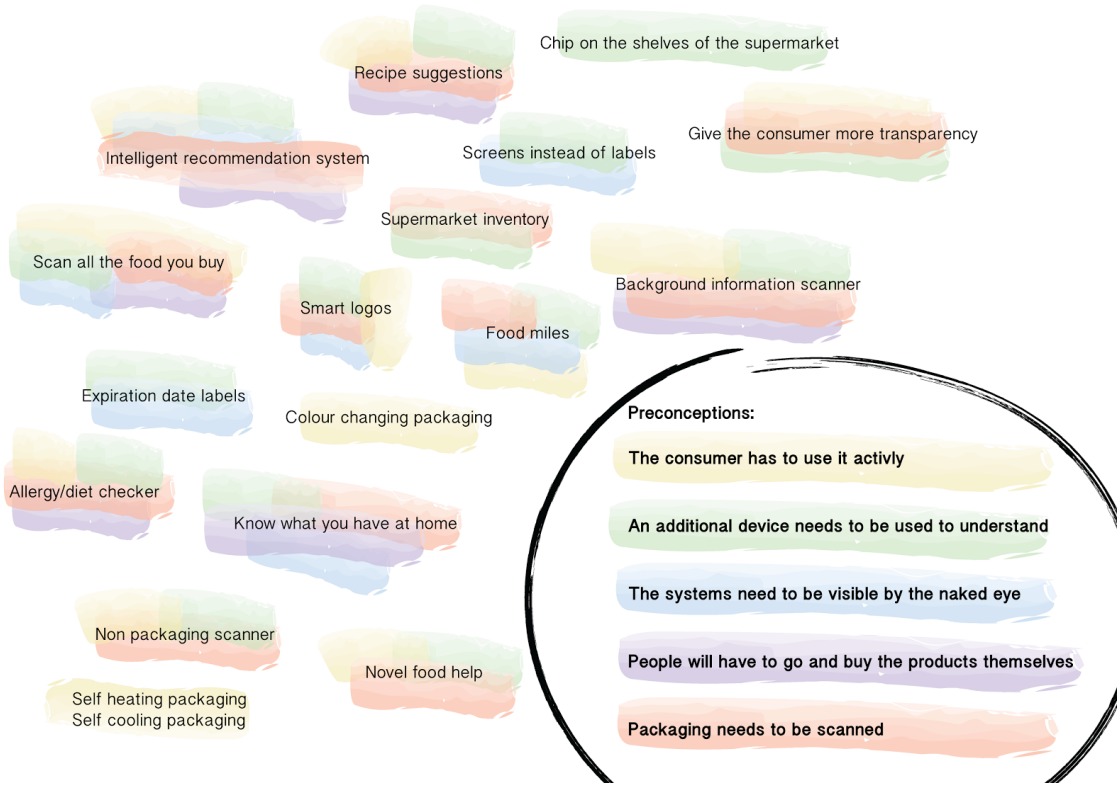

FIGURE 5 PRECONCEPTIONS COLOUR CODED (LANDMAN, 2017)

TABLE 9 PRECONCEPTIONS

Preconceptions	Turned around
The consumer has to use it actively	The consumer does not need to do anything for the system to work
An additional device needs to be used to understand	No additional device is needed to understand/use the intelligent packaging system
The systems are visible by the naked eye	The systems have to be invisible to the naked eye
Consumers will have to go and purchase the products themselves	Consumers do not have to purchase the product themselves
The packaging needs to be scanned	The packaging does not need to be scanned

All the preconceptions were made invalid and new ideas developed from this process. The process is visualised in appendix 15. All new ideas are described in the table below (Table 10).

TABLE 10 IDEAS FROM PRECONCEPTIONS METHOD

Idea	Explanation
Lights up	Packaging that lights up when you need it. Could be used in the supermarket when searching for a product
Colour	Packaging that changes colour when something happens to it. Each colour could represent a different thing (e.g. expired, opened, almost empty)
Sound effects	Sounds effects could be embedded in packaging to create an extra dimension of interest for the consumer. Could be used for marketing purposes
Expiration date talks	The packaging could simply tell you when it is about to expire
Face recognition	Supermarkets could use face and product recognition software. The consumer does not need to pay at checkout in the traditional sense, because the system already knows who took what product from the shelf
Test if the food is for you	Packaging could test if the product is healthy for your body and give serving size recommendations accordingly (male/female/kid or look at diseases/allergies/diets)
Kitchen of things	The kitchen of things (internet of things) can use intelligent packaging to create a smart home for the user
Smart trash	The trash knows which food packages are thrown away, and adds them to the grocery list

Screens	The appliances have screens and the consumer can use the kitchen of things without tablet, laptop of smartphone as well
What's at home	You will always know what you have at home because your kitchen scanned all the products and you can access this database
Automated buying system	The food packaging communicates with the kitchen that it is almost empty. The product is added to the list and groceries are ordered automatically
Screens as packaging	Traditional packaging is replaced by digital screens that show the information of the food it holds. It can show more information or play movies
Touchscreen	The traditional packaging is replaced by a touchscreen, when the consumer wants to know more about a specific thing he can use the touchscreen to go further into the label (e.g. click on the ingredient list or a specific ingredient, click on the labels, name of the product)
Temperature sensor	Temperature sensors are added to supermarket shelves and measure the environment and control it to extend shelf life for the food on the shelves.
Shelves with intelligent packaging systems	The shelves in the supermarket can be equipped with intelligent packaging systems, and communicate with the supermarket about the products they hold
Measures and regulates the temperature	Food packaging that measures and regulates the temperature of the food inside, containing a cooling system if necessary to cool the product to keep the product fresh longer
Map of the product	The food packaging can contain holographic images, hidden from direct view that shows additional information about the product
Background movie	Consumers can get access to exclusive background movies about the products they purchased. Can be used for marketing purposes
Designed codes	No more traditional barcodes or QR codes. The new codes could be embedded into the packaging design. By using a recognition software.
Supermarket map	Use augmented reality to show the consumer how to walk through the supermarket. It will be similar to a shopping list, but by scanning the area you can see where to go and find the products you need.
Game	Use an augmented reality game to make grocery shopping more fun
Learn about food	By using a smartphone to create an augmented view of the product, it shows more information about the product and visualizes this in augmented reality for the consumer

Floating veggies	By scanning the product, the augmented reality will add recipes and suggestions what could fit with the chosen product
Cookbooks	The packaging will have more recipe suggestions embedded in them they could come from a database of people that have cooked this product before
Expiration date alarm & menu suggestions	A few days before a food item is about to expire, it will give a suggestion and alarm to help consumers battle food waste
Scale	The food packaging can be equipped with an internal scale that measures how much of the product has been used and is necessary (portion size). Could be used for products such as rice, so the consumer knows how much rice to cook.
Make packaging more usable	Add something to the packaging to make it usable after the food has been consumed
No-label packaging	The packaging does not need to have labels anymore, just a small chip/scannable and all the information can be read on smartphone or on screens in the supermarket. This way there is no need for so much packaging material anymore
Automatic connection	Your smartphone could make automatic connections to food nearby, look in the database if you need something and you can see where it is
Use augmented reality to show price/labels	Instead of printing labels or price tags augmented reality can be used to show this when looking through a smartphone at the product

The following method in the diverging phase was the personal analogy. The object from the start-up sentence is food packaging and has been imaged in three different situations. The first situation is that the food inside the packaging is about the spoil, the second situation is that the consumer did not like the food inside the food packaging and the third situation is that the packaging would like to help the consumer more. The following boxes show the personal analogy method from situation to idea.

The food that I am holding is about to spoil

Oh no! I am starting to feel spoiled and gross. My insides do not feel good anymore!

I feel so sick if I do not get picked up soon I might throw up and need to be thrown away.

I need to make sure this does not happen by making sure I get recognised and let people know to eat me fast! I am turning green already so they must hurry.

Green packaging

The food packaging in the supermarket turns green when it is about to expire, this way the consumers know that they should buy this product and eat it fast. The green colour means that there is a discount on this product.

The consumer does not like the food I have

It makes me so sad, I have travelled so far to get this to the consumer, and now he is disappointed.

I wish the consumer knew I was not the right choice before buying, and that it will not happen again. I would like to warn the consumer about the food he might dislike or is allergic to. Maybe then this will never happen again.

Personal profile

Use food packaging to create personal flavour/product/preference profiles which shows preferences, products that are similar in flavour or good to combine and knows when a consumer does not like, want to, or is allergic to something.

I would like to help the consumer better

I am so frustrated! I cannot let the consumer know enough, they have so many questions for me and I know the answer, but I cannot communicate it.

I know so much, I mean I have travelled with this food for a long time, and I want to share this.

Journey database

A food database could contain information about the journey of the food, has it been handled well and how far did it travel.

The last diverging method is called lucky shots. Different words have been chosen and associated back to the word intelligent packaging. The words were randomly generated by using the online word generator tool. This tool can be used to generate words and used for brainstorming (TextFixer, No Date). Five words have been generated: Folding, Gasmask, Humble, Piece and Zombie. The Lucky shots associations method is visualised in Figure 6.

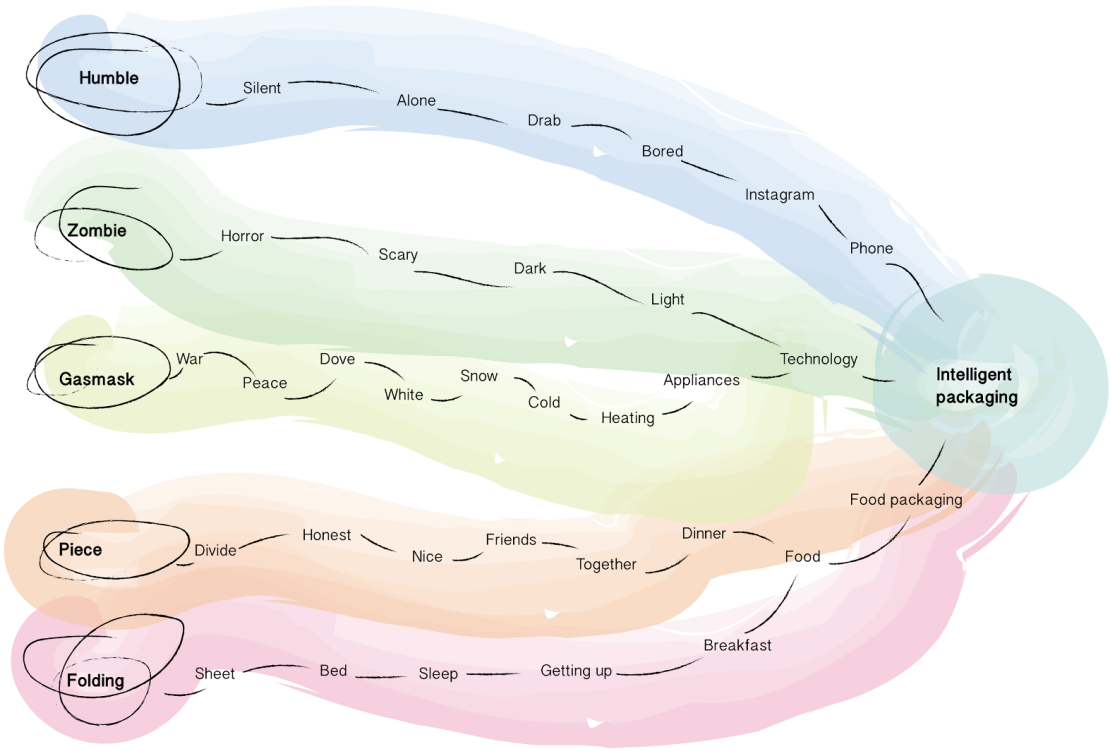

FIGURE 6 LUCKY SHOTS ASSOCIATIONS (LANDMAN, 2017)

New ideas have been formed by using the association words from the lucky shots method. These ideas can be seen in the table (Table 11).

TABLE 11 LUCKY SHOT IDEAS

Idea	Explanation
Social packaging	By scanning the packaging, you can get in touch with other people who like the same product and meet new people who like the same food as you
Eat with friends	A database that you share with friends/roommates that shows who bought what product for an event or just for this month
Intelligent game	Scan the packaging and open a secret game. There could be a game that can be played on a smartphone that is in theme with the food packaging that is scanned

6.4.3 CONVERGING PHASE

The converging phase started by dividing all ideas generated with the methods from the diverging phase into the *COCD*-box. All ideas have been scored on innovation strength and feasibility, by the researcher together with an electrical engineer, who has knowledge of the possibilities for new technological systems. The scoring of the ideas can be seen in appendix 16. Afterwards the researcher and the electrical engineer both chose 10 ideas that sounded the most interesting, the ideas chosen were sorted into the *COCD*-box and can be seen in the figure below (Figure 7).

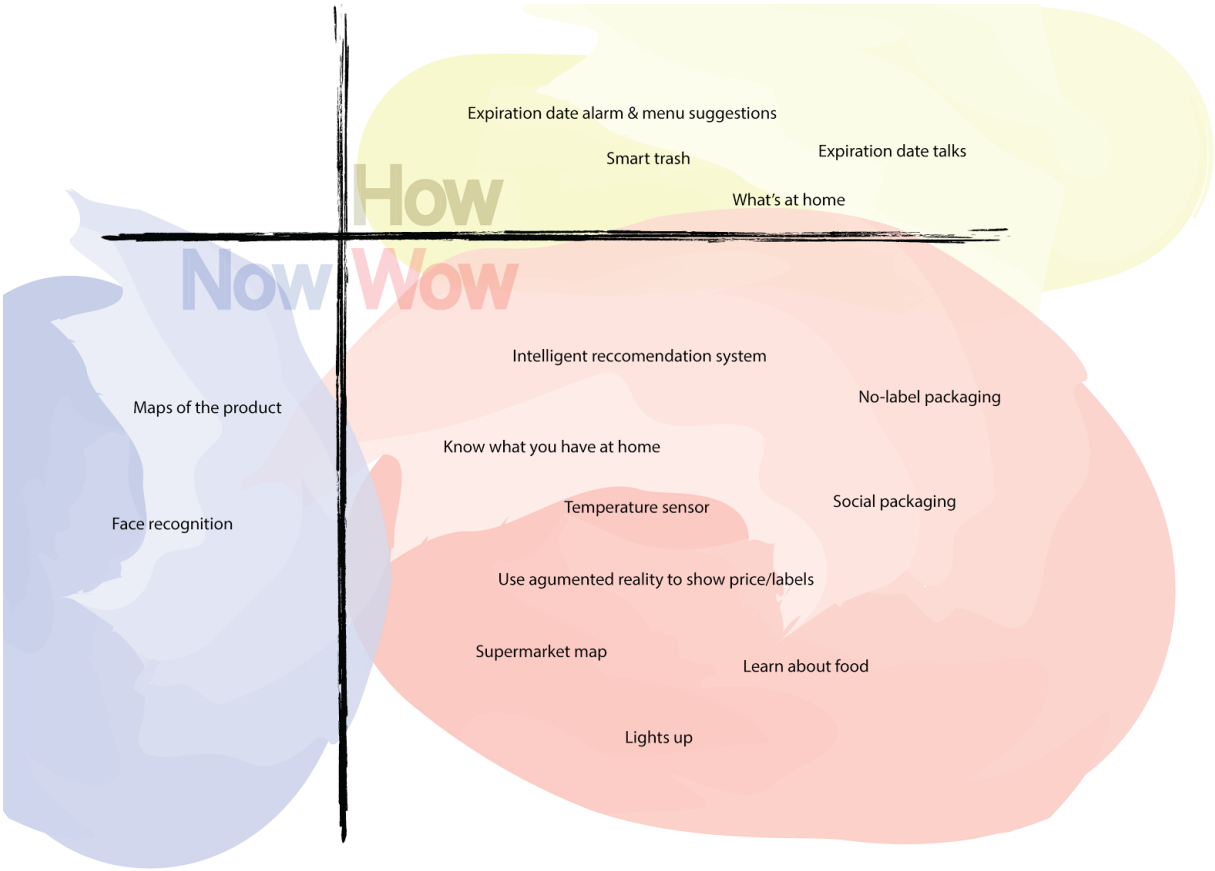

FIGURE 7 CODC BOX INTELLIGENT PACKAGING IDEAS (LANDMAN, 2017)

The *COCD*-box method narrowed the ideas down to fifteen. These ideas were visualised in an ideaform and cartoon. The fifteen ideaforms and cartoons can be found in the appendices (Appendix 17.). The visualisation of the ideas helped to further develop them, which was necessary for the next step of the converging phase; the verdict. The ideas have been scored on potential, risk, effort and feeling (Table 12). The scores ranging from 1 to 10 (1 lowest and 10 highest). The idea numbers in the table are corresponding to the idea numbers in the ideaform (Appendix 17.)

TABLE 12 PREFER SCORES

Idea number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Potential	7	5	8	6	9	6	9	8	8	8	9	7	9	6	9
Risk	9	5	6	2	2	4	7	8	8	4	6	2	7	7	3
Effort	6	9	2	3	2	3	5	6	5	4	6	4	5	3	5
Feeling	3	6	7	6	8	5	8	7	7	8	8	5	9	5	9
Total	25	25	23	17	21	18	**29**	**29**	**28**	24	**29**	18	**30**	21	**26**

The PREFer method shows that the idea with the most potential is: learn about food. This is followed closely by the intelligent recommendation system; know what you have at home and; the supermarket map. The six ideas with the most potential are:

- (7) Intelligent recommendation system
- (8) Know what you have at home
- (9) Temperature sensor
- (11) Supermarket map
- (13) Learn about food
- (15) No-label packaging

And were chosen to be enriched with the *PMO*-method, the last step of the V3-circle (Table 13).

TABLE 13 PMO METHOD IDEAS INTELLIGENT PACKAGING

	7. Intelligent recommendation system
Pro	• More inspiration • Convenience • Knowledge in the purchasing habits of consumers
Con	• Only for smartphone users • System does not know if the consumer likes the product • Consumer might not want to share personal purchasing behaviour with the program
Enrich	• Add a rating system so consumers can send feedback on how they liked the products, which is good for companies as well, since they will get consumer feedback about their products. This will get them to print a QR code/scannable on their packaging. • Give personal rewards to people, such as a personal discount for products the consumers will like. • Create an online version for laptops so non-smartphone users could use the program as well.
	8. Know what you have at home
Pro	• Convenience • Battle household food waste by helping consumers not to purchase too much
Con	• All packaging needs be included for this to work. • The consumer might not want to share personal data in a database. • Need a smartphone.

Enrich	• Feedback from the consumer, who buys the product, is a benefit for the food industry and can convince them to implement the intelligent packaging system. • Give consumers a reward for sharing their feedback, and ask if they want private settings. • Incorporate the intelligent system with the check out, use a personal profile when paying.
	9. Temperature sensor
Pro	• Helps extends shelf life • Easier temperature regulation management for supermarkets
Con	• Not important for dry food • Products with a different preferred storing temperature cannot be on the same shelf • Needs to be tested to see if it makes a difference in shelf life
Enrich	• Only implement the system on products that need such a system. • Re organise the shelves in the supermarket. • Pilot test the system to see if there is a difference in shelf life for the products.
	11. Supermarket map
Pro	• Convenience • Easy shopping experience • Marketing tool for supermarkets
Con	• The supermarket needs to implement this system • All supermarkets have a different lay-out • Sometimes products and shelves are moved around for promotions
Enrich	• Great marketing tool, a supermarket would want to invest money to get more customers in their supermarket. • Use GPS tracking to find the products in the shelves. • Pilot one supermarket and see if there are real results before adding more supermarkets.
	13. Learn about food
Pro	• Increase communication with the consumer • Lower the amount of packaging material necessary to inform the consumer
Con	• Consumers needs a smartphone • Location bound • Mostly visuals, not too much text possibilities
Enrich	• Create self-scanners with augmented reality programs embedded in them to scan the products. • Create a scannable system, that is not location bound and the product can be scanned at all times (even at home).

	• Add clickable links to a webpage with more information and text for the consumer to read.
	15. No-Label packaging
Pro	• Decrease packaging waste • More possible ways of communicating through digital media
Con	• When consumers do not have a smartphone and have purchased the product it is not possible to read the information again without going to the screens in the supermarket • Hard to catch consumers interest before scanning • Difficult to find the product
Enrich	• Still use simple traditional packaging design, either on the shelf or on the packaging itself, depending on the product. • Database of external digital information is accessible through smartphone, tablet, laptop and screens in the supermarket.

The last step was to combine and choose from the six ideas and create intelligent packaging concepts. Firstly, idea seven (intelligent recommendation system) and eight (know what you have at home) can easily be combined into one concept, since both ideas use a database of products to work. Idea nine (temperature sensor) and eleven (supermarket map) need to be tested thoroughly before knowing if the benefits are worth the risks before implementing the systems. Idea thirteen (learn about food) and fifteen (no-label packaging) have a higher success factor, since there is a lower implementation risk

6.4.4 CONCEPTS

Different concepts have been developed that could be implemented into the intelligent packaging sector. The three concepts chosen from the converging phase are; intelligent recommendation system & database (Table 14), learn about food (Table 15), and no-label packaging (table 16).

TABLE 14 INTELLIGENT RECOMMENDATION SYSTEM & DATABASE CONCEPT

Intelligent recommendation system & database
The food packaging has a scannable system embedded in the packaging design. This can be scanned by the consumers' smartphone, through an app, and/or directly at checkout. The information is send to a database that can be checked by the consumer at any time. The consumer can receive notifications of products they might like and personal discounts. The consumers have an option to share feedback about the products, to keep their recommendations as current as possible, and there is an option to send this data back to the manufacturer of the product as well. The program can be used with a smartphone and tablet, and can also be accessed with a laptop or computer (Figure 8).

FIGURE 8 INTELLIGENT RECOMMENDATION SYSTEM & DATABASE (LANDMAN, 2017)

TABLE 15 LEARN ABOUT FOOD CONCEPT

Learn about food
By using a self-scanner or a smartphone, the consumer can scan a product and see, on the screen, the digital world around the food packaging. Using augmented reality, the product can be enhanced with digital visuals and links for the consumer to click and gain more knowledge about the food inside (Figure 9).

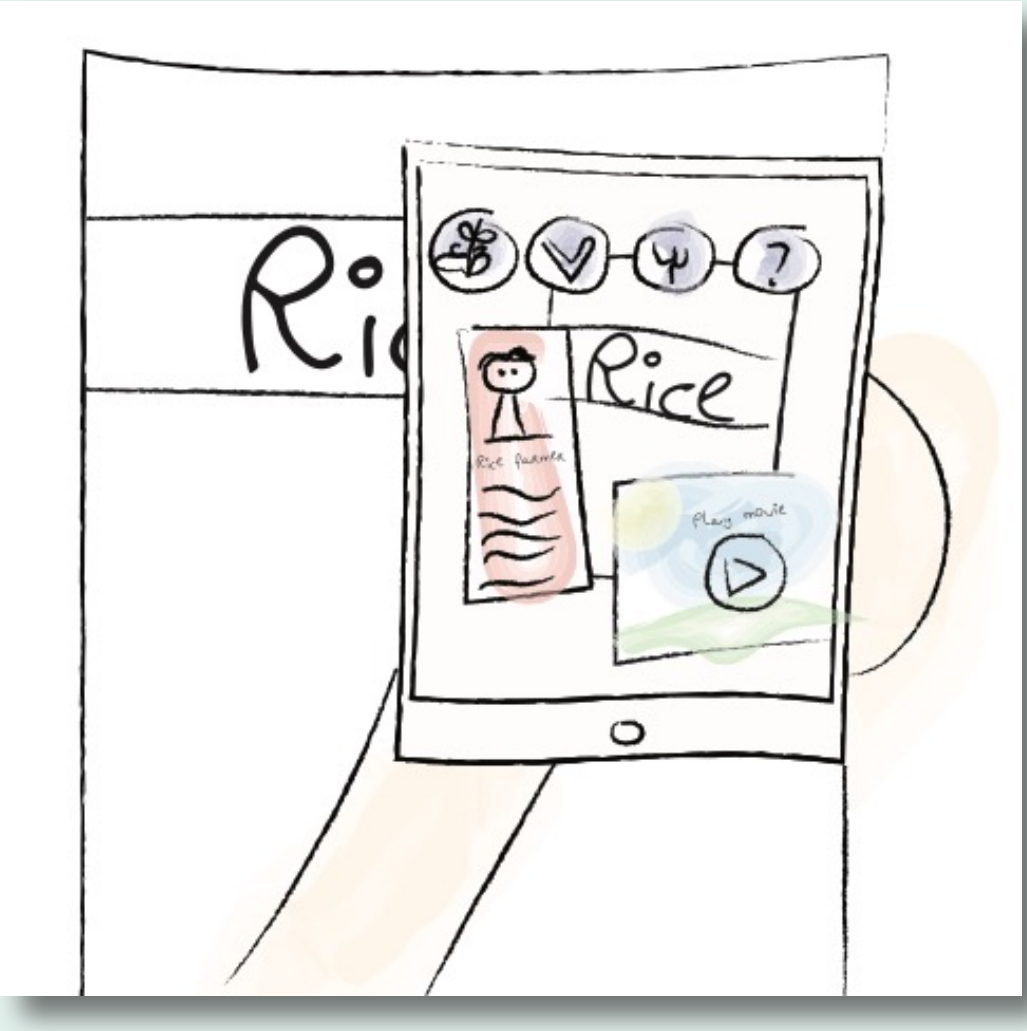

FIGURE 9 LEARN ABOUT FOOD (LANDMAN, 2017)

TABLE 16 NO LABEL PACKAGING

No-Label packaging
Food packaging is embedded with a small chip, all the information that is normally printed on packaging can be read digitally with a smartphone, or on screens in the supermarket. Packaging design can be kept simple and it is not necessary to print as much on the food packaging. In some cases, packaging would not be necessary eg. fruit and vegetables (Figure 10).

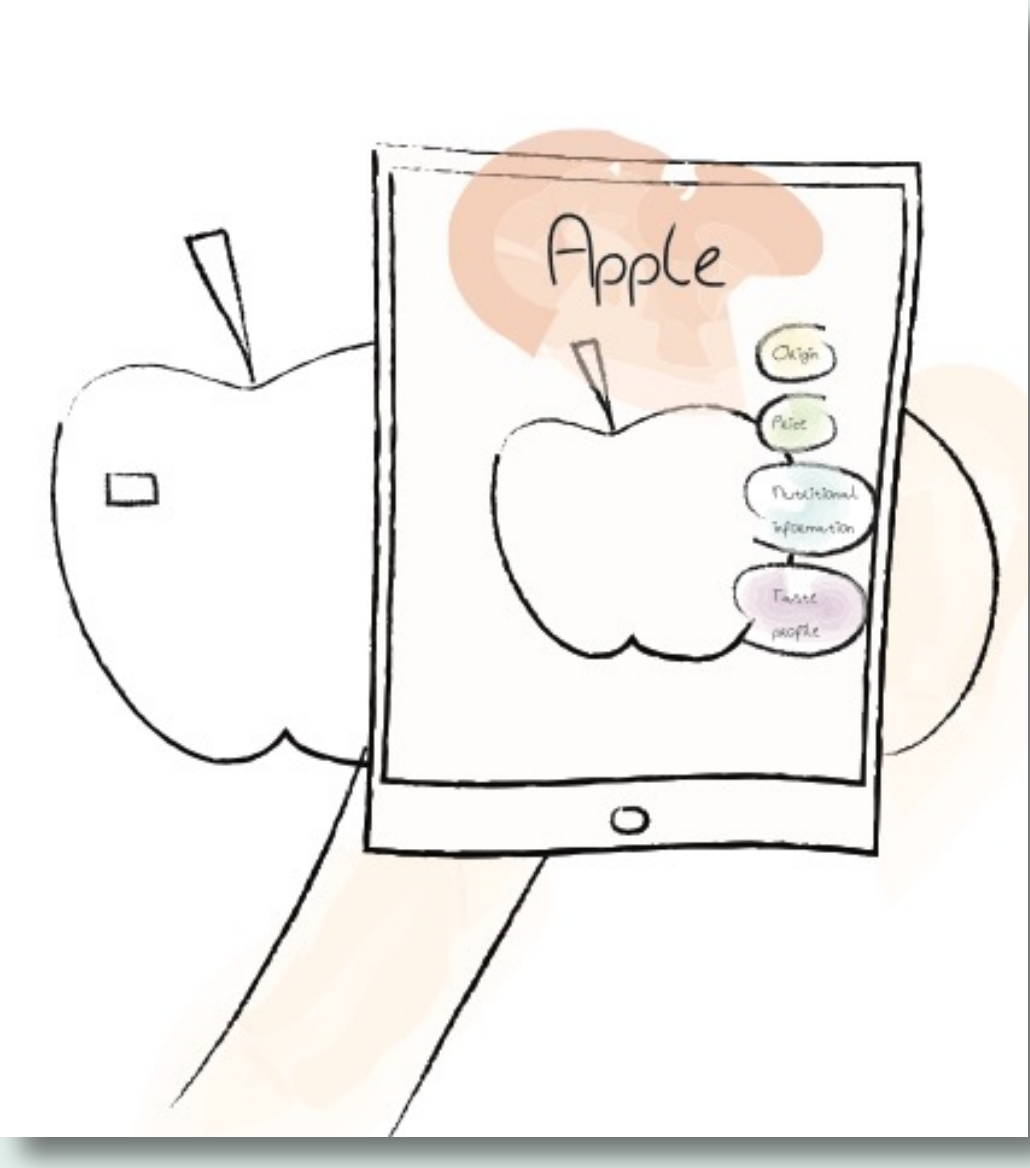

FIGURE 10 NO-LABEL PACKAGING (LANDMAN, 2017)

7. DISCUSSION

The aim of this research is to understand in which way intelligent food packaging concepts can be developed with a *CONSUMER ORIENTED APPROACH* for *THE CONSUMER END OF THE FOOD SUPPLY CHAIN*. Intelligent food packaging systems have been emerging on the European market since the legislation change in 2004 and many researchers have said that there are both challenges and opportunities for developing food packaging systems for *THE CONSUMER END OF THE FOOD SUPPLY CHAIN*. A *CONSUMER ORIENTED APPROACH* and out of the box thinking can help the researcher develop new concepts that have a higher consumer acceptance than innovations created from a technological point of departure. This study was made to answer the question

"How can intelligent food packaging concepts be developed, with a *CONSUMER ORIENTED APPROACH*, for *THE CONSUMER END OF THE FOOD SUPPLY CHAIN*?".

The researcher tried to understand the world of *DUTCH CONSUMERS* before designing and developing new intelligent food packaging concepts. The role of the researcher in this study is important, since many of the choices made are done because of the researchers pre-understanding and understanding of the subject. It was important to have a good understanding of the *DUTCH CONSUMERS* before starting the concept development phase, to ensure that the concepts were not developed by the researchers' preferences of intelligent packaging systems. However, everyone has their own view of the world, it can be questioned if understanding the consumers is enough. By introducing an electrical engineer, with a different world view on the subject, it has hopefully given a more nuanced input in the concept development phase. The researcher will always have a high influence in a concept development study.

7.1 DISCUSSION OF CONTEXT

Several studies have been dedicated to the field of intelligent packaging and new developments in the food supply chain. Many existing intelligent food packaging have been created to extend shelf life and improve food safety (Vanderroost, et al., 2014).

Research suggests that there are opportunities in consumer benefits and convenience (Brody, et al., 2008; Biji, et al., 2015).

The *URBAN SONGLINES* showed the consumers' behaviour during their supermarket trip. Convenience was one of the important determining factors for a consumer to choose a product. However, price, liking, appearance and preference played a role in the participants' behaviour as well. This could mean that even if a food is more convenient, it might still not be preferred, the price of the packaged food product should not be much higher than the alternative. The participants from the *FOCUS GROUP* expressed interest in being better informed about the food they purchase, increased convenience while shopping and an interest in added technology. These benefits can be determining factors for a consumer to prefer a product over another.

There has not been much development of intelligent packaging systems in the *CONSUMER END OF THE FOOD SUPPLY CHAIN* in Europe. One of the reasons is according to Ahvenainen an unknown consumer acceptance of intelligent packaging (Ahvenainen, 2003). It could be that the reason for an unknown consumer acceptance is that consumers are not yet sure what intelligent packaging is. During the *FOCUS GROUP* discussion, the participants of this study were not sure about the definition of intelligent packaging. There was a general idea that technology was added. During the *FOCUS GROUP* interview the participants mentioned that they would use intelligent packaging if the intelligent packaging systems added something they are interested in; added convenience or more information about the product inside. The Actipack project researched consumer acceptance towards new innovations in the food packaging industry. The project concluded that European consumers where open towards new intelligent innovations if the material used was safe. This research showed that consumers prefer food packaging materials to be recyclable and biodegradable (Restuccia, et al., 2010). The participants from the *URBAN SONGLINE* found it important not to create much food waste, and it was one of the determining factors when making decisions. During the *FOCUS GROUP* the participants mentioned that a benefit of intelligent packaging could be knowledge of products at home, programs that helped them remember what they had to purchase, or an expiry date alarm to help them reduce their own waste. Some participants disliked the idea of added packaging waste, such as chips and metal, that might be added to some of the intelligent packaging systems. The participants would be more interested in using intelligent packaging systems when there is a returnable deposit on intelligent packaging, so they can be reused, or by using data carriers that do not require extra waste.

Most reasons for changes in the food packaging industry are linked to consumer preferences, which is why, according to the research of Dobrucka and Cieszewski (2014), the implementation of novel packaging systems should be done from a consumer perspective to ensure the end user will use it. The participants from the *FOCUS GROUP* expressed that they mostly wanted to be informed about the food, but wanted to be able to scan the packaging themselves, and use the intelligent packaging system whenever they wanted to. Additionally, the participants from the *FOCUS GROUP* found that supermarkets could benefit from an invention that could battle food waste by using intelligent packaging.

7.2 DISCUSSION OF METHODS

7.2.1 DATA COLLECTION METHODS

The understanding of *DUTCH CONSUMERS* prior to starting the concept development phase came from three *URBAN SONGLINES* and a *FOCUS GROUP*. Consumer behaviour is mostly studied by observation (Foxall, 1980). The *URBAN SONGLINE* method created a better understanding of *DUTCH CONSUMERS* and their behaviour from supermarket to kitchen. This is an alternate method to personas, a method frequently used in concept development. Personas are fictional characters, created by the researcher, that can be used to understand the reality and assumptions of a target group (Grudin & Pruitt, 2002). However, the *URBAN SONGLINES* method gives a more detailed understanding, it also shows places of meaning and the road that is travelled by the participants. The *URBAN SONGLINE* method derives from the field of architecture and urban city planning. In this case, it has been used to create a temporary world and is seen in this research as a method that can be used to understand how people travel through *FOODSCAPES*, instead of landscapes. The songline in this research is less about the physical road the participants took, it is about understanding the moments of meaning, disturbances and experiences that the participants had as a Dutch consumer.

To create the *URBAN SONGLINES* the researcher was responsible to take photographs and conducting a descriptive interview. During the interview the questions were based upon

the photographs and comments that were made during the trip. Another option would have been to conduct semi structured interviews, with key points to give all interviews a coherent direction. However, the use of a semi structure might have prevented answers that the researcher did not account for. It could also have been possible to use a different collection method while conducting the *URBAN SONGLINES.* The Ramblr app was used to collect data, and while this app is feasible to map long distance tracks, it was not possible to create a real-life map of a supermarket, since the Ramblr maps do not include indoor roads. This meant the GPS function was insignificant. Other technology could make it possible for the participants to create an *URBAN SONGLINE* without having a researcher present. One tool could be the ebutton. The ebutton is a wearable computer that the participant can pin on their chest. The ebutton is programmed to take pictures every 1 to 5 seconds (Sun, et al., 2012). The participant does not need to be accompanied by the researcher, resulting in less time spend on data collection. However, there is a difference between manual and automatic photographs. Only the photographs that show points of interest from the participants are needed for the descriptive interviews, and the ebutton takes automatic pictures every 1 to 5 seconds. The possibilities of the ebutton needs to be studied before it is possible to draw a conclusion if the ebutton is a sufficient tool to create *URBAN SONGLINES*.

The *FOCUS GROUP* was conducted to understand the thoughts and interests of *DUTCH CONSUMERS* on intelligent packaging. Normally when *FOCUS GROUPS* are conducted there will be two or three *FOCUS GROUPS* with different participants, to make sure that the answers from the participants are not influenced by the other people in the group. One *FOCUS GROUP* might not be enough to reach a conclusion on how the *DUTCH CONSUMERS* view intelligent packaging. Additionally, *FOCUS GROUPS* are challenging to manage, since there are several factors that can change the outcome. Participants might make up answers when they do not want to share their honest opinion or dominant participants could influence other participants (Krueger & Casey, 2015). As a safeguard, the researcher fulfilled the role of moderator, ensuring that the participants felt safe to share their thoughts. Furthermore, the answers from this *FOCUS GROUP* were used as a starting point of the concept development phase, as a *FOCUS GROUP* is a great method to explore new ideas and discuss themes. The results of the *FOCUS GROUP* cannot be used later in the concept development process to make design decisions. The *FOCUS GROUP* has been held over a limited period, and the moderator was responsible for introducing the themes and questions when the discussion had found its saturation point. Instead of a *FOCUS GROUP* discussion, all participants could have been interviewed separately. However, by using a

FOCUS GROUP the participants got a chance to comment on other participants' answers, expanding or expressing a difference of opinion.

7.2.2 DESIGN METHODS

By using several design methods three new concepts have been developed. If other methods would have been used the results of the concept development phase might have been different. Likewise, if another researcher carried out the concept development process. This can be explained by the personal component of concept development, and why feeling is an important part of the start-up phase, as well as the converging phase.

The exploration circle and a moodboard have been used during the start-up phase. The goal of both methods is to introduce the subject and give the researcher the sense of starting (Byttebier & van Blokland, 2002). It is an important part, since focus is necessary to get good results. Additionally, the moodboard gives the researcher a visual understanding of the subject. Both are methods are used to start the creative process and acquire the right mind-set. Other methods could also have been used for the start up phase. The start sentence is the basis of the concept development session. The start-up sentence shows the direction of the concept development process and the focus. If the start-up sentence was different, the focus and the result would have been different.

The diverging phase is used to develop many new ideas by using a collection of different methods. The preassociation method lets the researcher think about their own thought patterns. This might be difficult at first, but as a result many new ideas have been created. This method is mostly done by an individual, and not in a group setting. If the research would be repeated with more persons, it might be better to use a different method that works better with multiple people. The personal analogy asks the researcher to use their imagination. This method might not work for everybody, since it needs a great deal of imagination to work. However, it is a way to break traditional thinking styles. The lucky shots method is a good method to finish the diverging phase, since it is a quick method to find and create more ideas. The concepts that eventually have been chosen, have all been developed with the preassociation method. As a result, it might seem that only this method is necessary to develop new ideas. However, the process of sensemaking and creative thinking is integrated and fluid. Therefore, a combination of different methods is best for the creative process.

The converging phase started by using the *COCD*-box method to sort and choose the ideas. This was executed by the researcher in collaboration with an electrical engineer that has knowledge about the technological possibilities of the ideas. This method was suitable to sort and choose the ideas and worked well with two people. When working with a bigger group, other methods for choosing ideas could work, however, the *COCD*-box method sorted the ideas simultaneously, other possible methods do not. The ideas that were chosen from the *COCD*-box were visualised with a cartoon and shaped into ideaforms. A moodboard could have been an alternative visualisation method, however, a moodboard portrays the feeling of an idea, while a cartoon, accompanied by an ideaform, gives a better understanding of the idea. Additionally, it helps shape the ideas while working on them. During the diverging phase, most ideas are sentences and words, and have not been formed completely yet (Byttebier & van Blokland, 2002). An additional method that could have been used is the mirror. This method is used by a researcher to develop the idea further by talking to another person, while this person asks how and why questions (Byttebier & van Blokland, 2002). The mirror could be a good expansion to further develop the ideas, when working with multiple people.

The PREFer method was used to score and choose ideas. Other methods could have been used, but most scoring methods are only successful in group settings, when there are more people that can give scores to the ideas. The PREFer method divides the scoring in different subsections, consequently there is no biased result (Byttebier & van Blokland, 2002). The *PMO*-method has been used to enrich the ideas. There are many different methods that can be used to complete a concept development process and it depends on the circumstances which methods are best. The *PMO*-method fit well with the time limit of 5 minutes and the *KISS*-principle, which is the reason why this method was deemed the most appropriate. The results from using this combination of design methods are three intelligent packaging concepts that could be implemented in the Dutch market, and it is therefore recommended to use these methods again when this type of research development is repeated.

7.3 DISCUSSION OF RESULTS

As a result, three different intelligent packaging concepts have been developed that could be implemented into the traditional food packaging industry on the Dutch market. These

concepts are; ‘the intelligent recommendation system & database”, “learn about food” and “no-label packaging”.

The first concept is the intelligent recommendation system & database. This system falls under the category of data carriers. And the implementation of the system does not require added packaging waste since it can be printed on the packaging by the manufacturer. The main purpose of this system would be added convenience to the consumer by sending notifications to the consumer about food that is interesting to them and by creating a database of the food the consumer has that can be checked. The need for a database can be seen in the results from the *URBAN SONGLINES* and the *FOCUS GROUP*. The participants mention being interested in a database and most are willing to use it. Problems that can arise is that consumers might not be open towards sharing their personal information online. This was mentioned in the *FOCUS GROUP* as well. By adding a reward system, such as personal discounts and recommendation consumers might be more prone to sharing their food choices. An important factor should be that the consumers know who has access to their database, thus the information that is send is transparent to them. This system can be implemented by a supermarket and all food packaging can be added to the database. Food producers can be convinced of adding a scannable to their food packaging because they will receive feedback on their products, which is assumed valuable to them.

The second concept is the learn about food system. This intelligent food packaging system uses augmented reality to add a new dimension to food packaging. The concept falls under the category of data carriers, the costs of implementing a scannable system on the packaging is low, however the development of augmented reality packaging would require effort from the food industry. The main function of this system is to inform the consumer about the food and to use new technology to let the food industry communicate with their consumers. The implementation of this system can come from the food producers and this system can be used as a marketing tool to change consumer preferences.

The third concept is called the no-label packaging. This system falls under the category of data carriers and works by adding an RFID chips to the packaging. The system could be used to lower packaging waste by either replacing the need for printed packaging on certain food products; such as vegetables and fruit, or lowering the amount of printed material that is necessary on packaging. Furthermore, it could also be used in

supermarkets that offer bulk products to replace labels. The implementation of this product can be done through the supermarket to lower their packaging waste or through the food manufacturers. For this system to fully replace packaging, it would be necessary to have all scannable information available to all consumers. A solution can be that screens, that can scan the packaging, are placed in the supermarket, for people without a smart phone.

8. CONCLUSION

Prior research shows that intelligent packaging systems are emerging in the food packaging industry. There are multiple uses for intelligent systems implemented on food packaging, and there is an opportunity to create intelligent packaging concepts for food packaging for *THE CONSUMER END OF THE FOOD SUPPLY CHAIN*. However, challenges emerge, as is is unknown how the consumer will react to these new technologies. Therefore, it has been researched how intelligent food packaging concepts can be developed, with a *CONSUMER ORIENTED APPROACH*, for *THE CONSUMER END OF THE FOOD SUPPLY CHAIN*.

One of the major challenges for intelligent packaging is that it is unknown what consumers will use, which is why, to further develop intelligent systems in *THE CONSUMER END OF THE FOOD SUPPLY CHAIN*, new approaches must be used to think outside the box. An increased design focus can be the answer to develop new intelligent packaging systems. This research has taken the departure point to create new concepts from a consumers' perspective by using different qualitative methods to understand the consumers' thoughts on intelligent packaging. From this data, and the knowledge from other research done in the field of intelligent packaging, new concepts have been developed by combining concept development methods into three separate phases (start-up, diverging, converging). The results showed that by using a *CONSUMER ORIENTED APPROACH* and design thinking, it is possible to create intelligent packaging concepts that can be implemented in *THE CONSUMER END OF THE FOOD SUPPLY CHAIN*.

The results showed that design thinking can be combined with other fields of research to create new possibilities. The results from the *FOCUS GROUP* and *URBAN SONGLINES* created a profile of Dutch 25-30 year old consumers and showed that for intelligent packaging they were mostly interested in being informed and added convenience, and did not want to increase packaging waste. This is represented in the three intelligent packaging concepts that have been developed.

A combination of consumer oriented research and concept development methods have been used to develop three different intelligent food packaging concepts that can be implemented in the end of the food supply chain. The three concepts are the intelligent recommendation system & database, learn about food and no-label packaging. This study shows that design thinking can be combined with other fields of science to develop new

ideas and concepts. Furthermore, a combination of qualitative methods and design thinking can be used to solve consumer based challenges in the food packaging industry.

It is recommended that the strength of the three intelligent packaging concepts are research further before implementing them, as will be elaborated on in chapter 9. Recommendations.

9. RECOMMENDATIONS

Following the conclusion of this study three concepts were selected and the question that arises is: What happens now?

The concepts that are developed in this study are recommended to be tested by *DUTCH CONSUMERS*, before being further developed into actual intelligent systems used on food packaging. To control this project, it is recommended that a project proposal is made based on the *4WHE* question approach. The project proposal will include the four W-questions (where, why, who, what), a how question and an evaluation proposal that tests the impact is the change (Mikkelsen, 2016).

The strength of the concepts could then be assessed by *DUTCH CONSUMERS* through an assumption test. This experiment uses questions to research if a concept adds value, if consumers will appreciate it and the economic possibilities. By involving consumers in this study there is a sense of co-creation that is developed by involving consumers. Finally, a trail launch on the marketplace could test if the concept works and will be used by the consumers (McElheron & Pilgaard Harsaae, 2015).

During the testing phase, it is important to keep in mind how new innovations are accepted by the public. This can be predicted by using the diffusion of innovation theory (Figure 11). This theory explains the science behind how an idea (or concept) diffuses through social systems and populations and divides the public into five separate adopter stages: innovators, early adopters, early majority, late majority and laggards (Rogers, 2005).

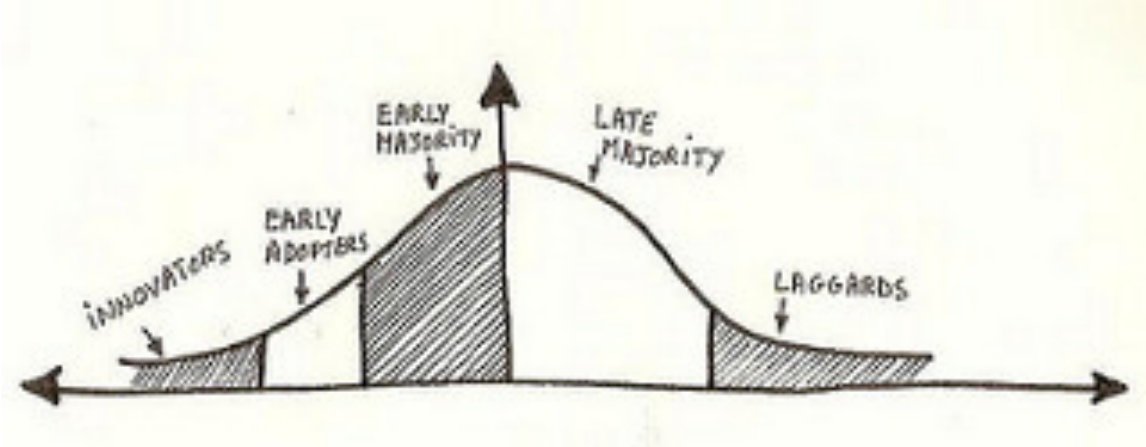

FIGURE 11 THE DIFFUSION OF INNOVATION THEORY (GALOPPIN, 2010)

An additional recommendation is that the combination of methods used during the concept development phase can be used as a guide for further implementing design thinking in the field of science. It would also be possible to recreate this study with a different target group or conduct a cross cultural study by repeating this study with different nationalities.

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APPENDICES