

# Fresh on-the-go snacks, a market-orientated research

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# Table of content

<b>1. Preface.....</b>	<b>5</b>
<b>2. Abstract.....</b>	<b>6</b>
<b>3. Management summary .....</b>	<b>7</b>
<b>4. Introduction.....</b>	<b>9</b>
<b>5. Theoretical framework.....</b>	<b>11</b>
5.1 Means-end chain.....	11
5.2 Lead user method .....	12
5.3 Technical aspects yoghurt vending machine .....	15
5.3.1 Yoghurt.....	15
5.3.2 Fruit .....	18
5.3.3 Materials.....	23
5.4 Managerial aspects.....	28
<b>6. Methodology.....</b>	<b>32</b>
6.1 Quantitative research .....	32
<b>7. Results.....</b>	<b>35</b>
7.1 Discussion focus group .....	35
7.2. Means-end chain laddering interview.....	39
7.3. Observation.....	43
7.4 The lead user method .....	45
7.4.1 Phase two: Identifying trends and key customer needs .....	45
7.4.2 Phase three: Collection of needs and solution information from lead users.....	48
<b>8. Conclusion.....</b>	<b>55</b>
<b>9. Discussion .....</b>	<b>58</b>
<b>10. Recommendations.....</b>	<b>59</b>
<b>11. References.....</b>	<b>60</b>
<b>Appendices.....</b>	<b>68</b>
<b>Appendix 1.....</b>	<b>69</b>
1.1 Process chart for yoghurt making .....	69
<b>Appendix 2.....</b>	<b>70</b>
2.1 Process chart for producing cut fruit.....	70
<b>Appendix 3.....</b>	<b>71</b>
3.1 Small whole fruit assortment additions for yoghurt vending machine .....	71
<b>Appendix 4 .....</b>	<b>72</b>
4.1 Topic list.....	72
<b>Appendix 5.....</b>	<b>73</b>
5.1 Results of statistical tests .....	73
<b>Appendix 6.....</b>	<b>74</b>
6.1 Definitions words used in hierarchical value map .....	74

6.2 Hierarchical value map scores.....	75
<b>Appendix 7.....</b>	<b>76</b>
7.1 Drawings concept 1 .....	76
7.2 Drawings concept 2 .....	77
7.3 Drawings concept 3 .....	78

# **1. Preface**

When starting as a food technology student I was very interested in developing new food products. Not only in the technological aspects that are important for making a food product, but also the managerial side of developing and innovating food products. This is why I choose to follow the master food innovation management, with the master the thesis is executed at management department of the Wageningen University. This thesis really suits me; it contains both the managerial aspects as the technological aspects of food product development. And with this thesis there is tried to link the food technology knowledge with the managerial knowledge. When executing this research, I got better insights in the importance of cooperation between both disciplines.

For their help and advice in the last seven months I would like to thank my supervisors: Professor Omta and Dr. Ir Linnemann for their advice, time and effort they putt in to help me with the formation of this thesis.

Furthermore I would like to thank the company Welldesign and especially I would like to thank Ir. van Dijk, to give me the opportunity and trust to use one of the ideas of the company as a case study for this thesis.

Mitchel van de Hoven  
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## **2. Abstract**

This thesis research is done to find out if there is a future for vending machines that can dispense healthy freshly made on-the-go food and more specifically, the future need for a yoghurt vending machine with fresh and healthy ingredients is investigated. In this thesis two aspects of developing a vending machine were researched; the food technology side and the managerial side. For the food technology aspects there was researched which ingredients can best be used for the machine with respect to shelf life of the ingredients. For the managerial aspects first there was researched if there was a need for healthy on-the-go snacks with the help of a focus group. Second, with the focus group members a hierarchical value map was made. Subsequently this information was used to develop three product concepts for yoghurt vending machines and a profile of a lead user of such a machine. In the second part of the research lead users give their opinion about the three product concepts. Furthermore in a Delphi method lead users were asked to give their vision on the future of the yoghurt vending machines. From the research is concluded that lead users of a yoghurt vending machine with fresh and healthy ingredients are high educated women. Furthermore in the future it is important for the yoghurt vending machines that the ingredients are natural, the portion size can be determined by the consumers themselves and digital technology should be used to make the machines more modern. For the technological aspects the shelf life is the most diminished by the fresh fruit, therefore it is important to use small whole Modified Atmosphere Packed fruit.

### 3. Management summary

Nowadays still a lot of companies do not involve consumers when developing new food products. This results in a lot of product failures, because companies are more technology orientated instead of market oriented.

The subject of this thesis is the development of a fresh and healthy on-the-go snack vending machine and more specifically, the future need for a yoghurt vending machine is investigated. The company Welldesign had an idea for a yoghurt vending machine which can dispense different fresh ingredients like yoghurt, fruits and cereals. Welldesign would like to know whether there is a market for such a machine and if the consumer wants healthy on the go snacks. The research question that therefore is proposed is: *Can a machine which dispenses healthy, freshly made on-the-go snacks be a commercial success in the next five years?*

In this research first a more broad view is used to see if there is a need for healthy on-the-go snacks from a vending machine. This is done with help of a focus group. The focus group members were asked to make ladders and with these answers a hierarchal value map could be made. This hierarchal value map gives insight in what the consumer finds important in the product and what the life values of the consumer are. Next to the laddering questions also general questions were asked about the consumers need for healthy on-the-go food.

Statistical tests showed that there was a high relation between high educated females and buying healthy on-the-go food and also a relation was found between women and willingness to pay. Women were willing to pay between the 2 and 3 euro for such a snack. Because there was need for healthy-on-the-go snacks, the research was more focussed on the design of a vending machine that can dispense healthy on-the-go yoghurt snacks as proposed by Welldesign. The answers given during the focus group were used to make a more specific profile of the lead user of yoghurt vending machines. The profile stated that especially high educated women want to buy health fresh on-the-go. The lead users therefore were high educated women.

In the second part of the research the lead users are used in a Delphi method. With the Delphi method the future trends and technologies of the yoghurt vending machine will be predicted with the help of answers of the lead users.

The lead users were asked to give their opinion about three product concepts for yoghurt vending machines that were made according to a literature research which specifically focuses on new vending machines trends and on the hierarchal value map.

The results of the Delphi method were that in the next 5 years, pure, fresh and natural food is becoming more popular. This means that the consumer would like to have products where no other ingredients are added to change the flavour for example.

Furthermore the lead users of the yoghurt vending machine would like to see that it would be possible to compose a meal that contains all the different food groups and they want to determine the amount of the snack they are going to eat. For the technology that will be important in the yoghurt vending machines, the lead users predicted that especially computer electronics will be important. It will make it easier to order and will help to give the machines the needed modern look.

Next to the managerial aspects research is done for food technological aspects of developing a yoghurt vending machine which can dispense healthy fresh ingredients like fresh fruit, yoghurt and cereals at once.

For this part special attention will be paid to the microbial safety and packaging of the ingredients.

The shelf life limiting factor for the yoghurt vending machine is cut fruit. The cereals when stored dry can be stored for a few weeks, the storing of the yoghurt also will not be a problem because of the acid environment. The yoghurt therefore can be stored for three weeks.

The limiting factor in the machine is the fruit, cut fruit has a shelf life of one or two days. Nowadays cut fruit can be bought in the supermarket but this is Modified Atmosphere Packed (MAP). When using cut fruit, the fruit is more susceptible for microorganisms. The

best results therefore can be achieved when using small fruit that does not have to be cut, like blueberry and grapes.

As said above the packaging of the fruit is also important. The best way to extend the shelf life will be with Modified Atmosphere Packaging. Fruits still respire and when different gas compositions are used the respiration of the fruit is influenced. In this way the shelf life of the fruit can be increased.

No packaging interactions will occur because of the short time the ingredients will be in contact with the packaging.

In conclusion there is a need for a yoghurt vending machine which can dispense a healthy fresh on-the-go snack. The target group will be high educated women. The machine would be a commercial success if natural and healthy ingredients will be used, the amount of the snack can be determined by the consumer themselves and digital technologies will be used to make the machine more modern.

From the technological perspective the cut fruit limits the shelf life, therefore the best solution is to use small whole fruits which are Modified Atmosphere Packed.



## 4. Introduction

Innovating is a difficult and complex project. It depends on trends and therefore succeeding in the market is hard (Smith, 2006). Often in companies there are no concrete guidelines for implementation of product development. The innovation process misses a structural approach and there is insufficient integration between the marketing department and research and development department. The effectiveness and efficiency of the innovation process should be better (Fortuin & Omta, 2009). The absence of a structure is especially seen in the beginning phases of the process. These phases are also called the fuzzy front end (Verworn, 2009 & Costa & Jongen, 2006). What is difficult in the beginning phases is that there should be room for creativity but there is also a need for a structured efficient process (Backman, Börjesson & Setterberg, 2007). This accounts especially for radical innovations (Sandberg, 2007). This beginning phase is critical because here the idea for a product is born. It is therefore important that the product idea with the most potential is obtained, but how to determine if the idea has potential?

Especially in the food industry innovating is hard. This sector is a mature and slowly growing industry. Furthermore the budget for research and development is low and when companies are innovating, the innovation is often conservative. One of the reasons for this is that consumers fear trying out new foods and the food habits of the consumers are very conservative. The consumer does not want to switch to another product unless it has a relative advantage on the current product (Moskowitz & Hartmann, 2008). So, it is difficult to successfully place new products on the market. In the European food industry only 2.2% of the total product launches are radical products. However the incremental innovations, like a new flavour or a new ingredient are 77% of the total launches (Costa & Jongen, 2006). Even though the introduction of new products on the market is high, these are mostly incremental innovations. The incremental innovations keep the costs for research and development low and also have low risk. Still also a lot of these innovations fail. New products have a high failure rate; 60-80% of the products are not on the shelves anymore after a year (Grunert & Valli, 2001). Nevertheless food companies still innovate, this can have different reasons (Luning, Marcelis & Jongen, 2002),

- The product life cycle decreases. The time between introduction of a product and the decline of a product decreases.
- The market conditions change very fast, there are constantly changing requirements which a company has to fulfil.
- Technological developments are following up rapidly, these are new opportunities to develop new products and incorporate this new technology.
- The strategy of the company can change or set goals have to be met, this stimulates the innovation process.
- External sources can have an influence, like changing legislation.

For food companies innovating is necessary rather than an option. Because innovating is important for the food companies other ways of innovating have to be used in the fuzzy front end. In this way the failure rate of products will decrease and the product ideas with the most potential are continued with.

Consumers have more choice in products nowadays. They change more often to other products which better fulfil the current need and have become heterogeneous consumers, all this makes it harder to predict how a consumer will react on a product (Linnemann, Meerdink, Meulenberg & Jongen, 1999). In this way the consumer has taken the power and has become the driving element of the food chain. This phenomenon is called chain reversal. To follow this trend the food companies have to change from a supply-based approach to a demand-based approach (Jongen, Linnemann & Dekker, 1996, Jongen, 1995).

Food companies have to better understand the market and should be more market-oriented, to make a product a success. They have to acknowledge that not all the consumers are the same and do not share the same taste and preference. Market-orientation means that the whole process of making a new product, from idea to launch, should be related to the input of

the consumer market. It is suggested that new product development and market-orientation could benefit each other (Grunert et al., 2007). One of the ways to execute the vision of market-orientation is to involve consumers in the beginning phase of new product development. This is done for example with the 'Lays create your flavour' and 'Mona dessert of the month'. The market-orientation is used to find out the consumer needs. The results of such market-oriented research can give the designers insights in what the consumer finds important. Subsequently it can be a starting point for developing new products.

But it is difficult for consumers to express their needs for a product in the future. This is because the consumers cannot give their needs about a product or technology that is unknown to them (Ciccantelli & Magidson, 1993). To find out what will be the future developments for the product there is searched for people who are ahead of the market and already spotted a technological trend that can be important for product design in the future. In this way there is the consumer input on one sight and a vision of what the future technology will be in the product on the other side.

This research will be performed with the help from the company Welldesign. Welldesign is an industrial design company for innovation, design and realisation. They spotted a trend in consumer behaviour. Nowadays people have a busy life and still want to have a meal that is according to the guidelines of the food pyramid. The food pyramid is a guide to inform the consumers about their daily nutritional intake of fruit and vegetables, dairy, fat proteins and carbohydrates (USDA, 2010). In The Netherlands the food pyramid is known as the 'schijf van vijf' (Voedingscentrum, 2009). Because of their busy life style consumers do not have a lot of time to prepare a meal and therefore often buy pre-made foods. A problem with the pre-made foods is that most of the time they do not contain enough nutrients as prescribed by the food pyramid (Consumentenbond, 2008, Sloan, 2005, Voedingscentrum, 2008, VWA, 2007). It is hard for the consumer to find a convenient on-the-go meal which is healthy and nutritious. Next to this, another trend was spotted, namely the popularity of yoghurt (Sloan, 2005). This is due to the introduction of functional yoghurt, and the healthy image this dairy product has. With the help of product designers these trends were combined and resulted in an idea for a yoghurt vending machine which can dispense an on-the-go snack with yoghurt and healthy ingredients like fresh fruit and cereals. The market for yoghurt vending machine is already growing, the first vending machines with yoghurt can be found on the market like the MyActivia and the yoghurt shake machine both from Danone.

Welldesign would like to see if it is possible to bring the idea of a yoghurt vending machine with fresh fruit to the market. To make the product into a success, it is important to first find out if consumers would buy a healthy on-the-go snack. Subsequently, it can be investigated how this demand can be fulfilled. Does the on-the-go snack have to be freshly made or is pre-packed healthy food also an option? Furthermore there is researched if it is feasible to make yoghurt with fresh fruits and cereals from a food technology point of view. It is also important to find out what the newest technologies are that could be used for a vending machine for healthy products.

In summary, the aim of this thesis is to execute a marketing-orientation research. Where there is researched whether or not consumers have a need for healthy on-the-go snacks and if consumers have a need for a vending machine that uses fresh ingredients. From a food technology point of view, there is researched if the idea of a yoghurt vending machine is feasible. Furthermore to find out what the future technologic trends will be in the field of food vending machines.

Therefore the following research question is proposed.

*Research question:*

*Can a machine which dispense healthy, freshly made on-the-go snacks be a commercial success in the next five years?*

## **5. Theoretical framework**

The theoretical framework can be divided into two parts, namely a marketing and management part and a food technology part. In the marketing and management part different approaches for market-oriented design are considered, namely a means-end chain theory perspective and a lead user perspective. Furthermore, the applicability of the method in the food industry will be discussed. The technological part assesses the ingredients that can be used. The microbial, physical, nutritional characteristics of the ingredients will be discussed. Finally also the packaging of the ingredients will be discussed.

### **5.1 Means-end chain**

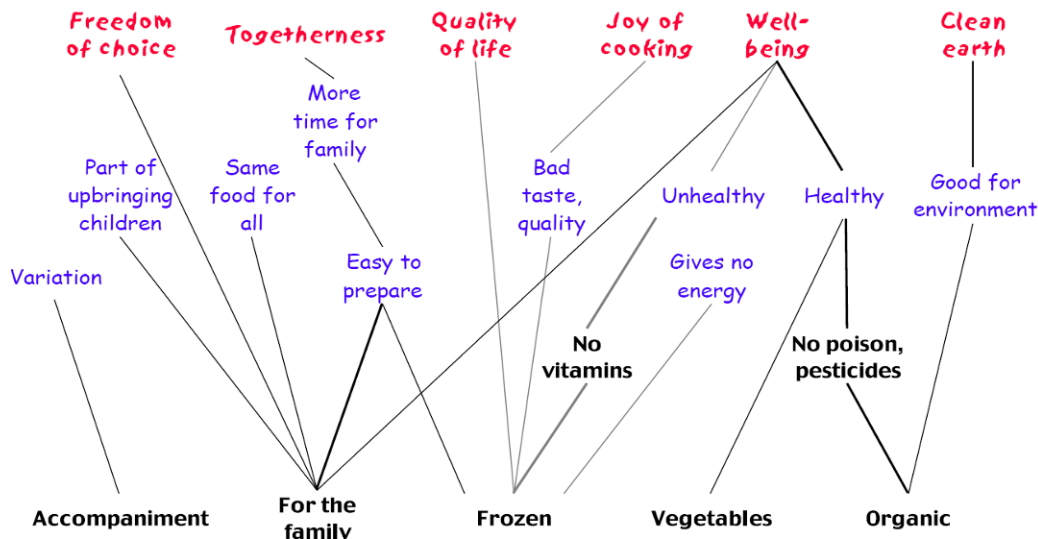
There are different theories for pursuing a market-orientation. This can help the company to get insight in what the potential consumer wants are and to translate these potential wants into characteristics of the product. These theories provide structure and creativity in the beginning of the new product development process. An approach that is developed in view of market-orientation is the consumer-led new product development. Here the consumer will be the starting point of new product development. Furthermore, the focus of the new product development has to be fulfilling the needs and wants of the consumer instead of just developing products or applying new technologies. The means-end chain theory is a method that is used to find out what the motives of the consumers are. With the means-end theory it is assumed that the consumer does not want a product for its own sake, but because of the consequences that consuming this product will have on them. There is a relationship between the product attributes and the higher order benefits and values they must satisfy (Walker & Olson, 1991). The knowledge the consumer has is organized in hierarchical levels (Costa, Dekker & Jongen, 2004). The means-end chain is constructed by a qualitative interview technique called laddering. As a result of this laddering interview a sequence of attributes-consequences-values will come forward. There are two methods of laddering, namely soft and hard laddering (Grunert & Grunert, 1995). When using the soft laddering approach the natural speech of respondents' is encouraged and afterwards the sequence is made. Hard laddering is an interview technique in which it is more compelled to generate subjects and associate between the different elements in the ladder (Costa et al., 2004). Additionally for hard laddering often a questionnaire or survey is used. A disadvantage of this can be that the value levels can be too abstract for the respondent (Phillips & Reynolds, 2009).

An example of such a laddering interview can be: a consumer wants a low fat product (product attribute), the consequence is a healthy life style, and the value is security/safety (consumer requirements). When combining all the personal ladders, a hierarchical value map can be made. This map shows the direct linkages between the consumers' values. In figure 1 an example is given of the outcome of this method (Grunert & Valli, 2001).

The results that are obtained can help the company in different ways.

- It can give a better insight in consumers' cognitive position towards existing products.
- It improves understanding of the relevant consumer needs and which product attributes delivers those needs.
- It provides a better focus for product improvement processes, by showing which current or potential product attributes are valued by consumers and which are not.
- It ensures a better development of positioning strategies for new products.
- It results in a better focus on marketing communication strategies, by highlighting the relevant links between product knowledge and self-knowledge of the consumer.

The means-end chain can give the company the necessary knowledge to deliver the consumer products with the desired consequence of using the product and in this way obtain their life value (Søndergaard, 2005).



**Figure 1: Example of the sequence of attributes that will lead to consumers' values, shown in a hierarchal value map (Søndergaard, 2005).**

Furthermore there are some assumptions made when performing a laddering interview (Phillips & Reynolds 2009):

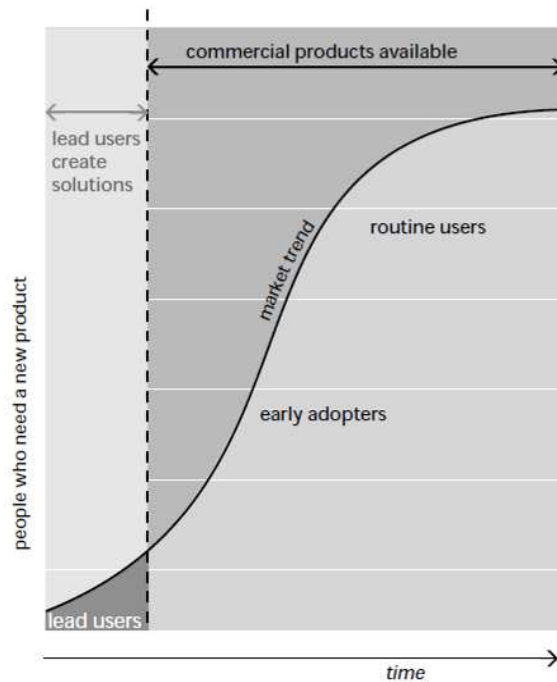
- The ladders are obtained from personal and preference distinctions, which result in a hierarchal value map.
- The respondent has to carefully think of the given answers, this can be achieved by tailoring the respondent questions '*why is that important to you?*' to the prior given answer.
- The obtained answers will be reflected in a ladder which contains all the three levels of attribute, consequence and value.
- Appropriate terms have to be thought of to place similar answers under the same term.
- The names of the terms will reflect the level of meaning.

The means-end theory has been used in the food sector for many different products like wine (Fotopoulos, Krystallis & Ness, 2003), home-made meals (Costa, Schoolmeester, Dekker & Jongen, 2005), pork (Westerlund Lind, 2007) and functional foods (Krystallis, Maglaras & Mamalis, 2008).

## **5.2 Lead user method**

Von Hippel (1986) describes another theory that can be used when innovating, namely the lead users approach. The theory is based on individuals who are ahead of the market. These individuals have needs which will become general in the market in the next months or years. These individuals are leading a new trend, and therefore they are called lead users. The lead users are fulfilling a need that they have and this can give insight and provide information for new product concepts and designs.

Sometimes lead users also already tried to solve the problem themselves by manufacturing their own product. The advantage of lead users is that they illustrated their need in a product and also give a solution to the problem on how they want to see the product. It gives the company insights and a starting point for concept development and in this way the lead users help the company. Furthermore there is a difference in driving force for innovating between a company and a lead user. The reason for innovating for a lead user is to fulfil a need, the need of the company is in the end to make profit (Schreier & Prügel, 2008). Figure 2 shows that lead users have a need that overtime will be present with more consumers.



**Figure 2: lead-users curve, it can be seen that when time increases more people have the same need for a product as the lead-user (Von Hippel, 1999).**

Research has shown that when using the lead user approach instead of the traditional marketing methods, concept developing is much faster. This is because of the cooperation between the marketing and the technical department. The information is shared better and new concepts need less development because the technical department has easy access to the prototype that the lead user already made (Churchill, Von Hippel & Sonnack, 2009). In the industry, the lead user method is often used. It is found that users are often the developers of products that are a commercial success (Urban & Von Hippel, 1988). It is even found that most of the initial products are thought of by users instead of the companies themselves (Von Hippel, Thomke & Sonnack, 1999, Lüthje & Herstatt, 2004). The lead user approach has proven its success in multiple industries. Products that were made with the lead user method are: mountain bikes, Gatorade, granola and skateboards (Churchill et al., 2009). Furthermore, the rate of new products increased for companies that used the lead user method (Gruner & Homburg, 2000).

There are three types of lead users that can be distinguished (Churchill et al., 2009):

- Lead users in the target application and market
- Lead users of similar applications in advanced markets. These are users in a more demanding but other market.
- Lead users with respect to important attributes of needs faced by users of the target market. This can include pattern recognition specialists in other industries.

The lead user approach exists of four stages (Churchill et al., 2009), namely:

- 1) Selection of the project focus and scope
- 2) Identification of trends and needs
- 3) Collection of needs and solution information from lead users
- 4) Concept development

#### *Selection of the project focus and scope*

In this first phase the homework for the project will be done. There are multiple decision points that the management team has to discuss. What will be the targeted market and in what kind of product category will the innovation be? What will be the wanted level of innovation? Will this be a breakthrough innovation or an incremental innovation? And what

are the goals and restrictions for the company? Important is to keep in mind the vision of the company and the resources and technology available. Next to this a planning has to be made for the whole project and the management has to form an innovation team with members from the marketing and research and development departments.

#### *Identifications of trends and needs*

In the second phase the innovation team does research on trends and upcoming needs in the market. The goal of this phase is to select a specific need which will be addressed in the project. The information about the trends can be gathered in different ways, first a literature research will be executed, and next interviews can be held with the experts in the field. They can also give information about the trends in the sector. With this information the needs of the consumer can be framed.

#### *Collection of needs and solution information from lead users*

The goal of this phase is to generate concepts that fulfil the need that was framed in the second phase. To gain information to develop a concept lead users will be interviewed. Phase three ends with the question if there is a business potential for this product, and if the products fit the company's current business.

#### *Concept development*

In this final phase a workshop is held with the lead-users and a proposal is written for the new product. This proposal should include the specific design, have results and facts that support the potential of the product and it should give an insight in how the product should be produced.

#### *Sub-questions*

- *Is there currently a need for fresh made on-the-go snacks?*
- *What is the customer value that according to the means-end chain method has to be fulfilled when thinking about a vending machine for healthy snacks?*
- *What is -according to the lead user method- a trend that in the future will become important in the vending machine industry?*

### **5.3 Technical aspects yoghurt vending machine**

The idea for the yoghurt vending machine is that it contains yoghurt, fresh fruit and cereals. In the next paragraphs there is researched if it is feasible to develop such a machine. This is done by discussing the ingredients and determination the optimal way of storage of these ingredients. In this way the quality and safety of the ingredients can be guaranteed. Furthermore there is focused on the best way to pack the ingredients.

#### **5.3.1 Yoghurt**

The main ingredient of the vending machine is yoghurt. Yoghurt is fermented milk. Fermentation is the process where microorganisms are used to create desirable effects in food. In the process of fermentation microbial enzymes breakdown carbohydrates, lipids and proteins. As a result of the breakdown several microbial substances can be found in the food, like ethanol, aldehydes and esters. The main metabolite for yoghurt will be lactic acid, next also volatile metabolites are important for the taste development of the yoghurt with acetylaldehyde as first metabolite and diacetyl as second metabolite (Nout & Schoustra, 2002).

Yoghurt is defined by the Codex Alimentarius (2003) as follows:

‘A milk product obtained by fermentation of milk, which milk may have been manufactured from products obtained from milk with or without compositional modification. By the action of symbiotic cultures of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* and resulting in reduction of pH with or without coagulation (iso-electric precipitation). These starter microorganisms shall be viable, active and abundant in the product to the date of minimum durability. If the product is heat treated after fermentation the requirement for viable microorganisms does not apply.’

##### *Types of yoghurt*

There are different types of yoghurt available on the market, there is set yoghurt, stirred yoghurt and yoghurt drink (Tamime & Robinson, 1991). Set yoghurt is the oldest method of making yoghurt, with this process the milk is inoculated with the yoghurt bacteria and the fermentation takes place in the retail container. Set yoghurt is always very firm and thick yoghurt. Stirred yoghurt and yoghurt drink are made in a slightly different way. In these processes the yoghurt is stirred after the fermentation process. This is done to disrupt the gel that has been formed and to incorporate the whey that has drained off. After stirring full fat yoghurt is a smooth and relatively thick but still pourable. Low fat yoghurt is very thin after stirring. This can be prevented by adding milk powder to the milk before the fermentation. With yoghurt drink a stabilizer is added to prevent aggregation and sedimentation of the particles. (Hooydonk, Valenberg & Hettinga, 2009). Next the general process of making yoghurt will be explained in detail.

##### *The process of yoghurt making*

In appendix 1 a scheme of the manufacturing of set and stirred yoghurt is shown (Nout & Schoustra, 2002). First the fat of the milk has to be adjusted to standard values. The reason for this is that there could be differences in the milk composition and when this milk is used also the yoghurt that is made of this milk will differ in composition. It is only allowed to standardize the fat content. Additionally stabilizers can be added, this is done to change the water binding and in this way the viscosity of the yoghurt is increased. Milk powder for example is added to the low fat milk before the fermentation (Ranken & Kill, 1997).

When the milk is standardized the milk is homogenized. Homogenization is done to decrease the size of the fat particles and in this way slow down the creaming of the yoghurt. The next step in the process is the pasteurization, this is done to make the yoghurt microbiological safe and to cause protein denaturation. An often used time/temperature

profile in the yoghurt industry for pasteurization is 72°C for 20 seconds (Tamime & Robinson, 1991, Ranken et al., 1997).

After the pasteurization the fermentation will take place. The milk is inoculated with the starter cultures as defined by the Codex Alimentarius of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*. For stirred yoghurt the milk is incubated for 16 hours at 31°C. Set yoghurt is fermented at higher temperatures for a shorter time, few hours at 40-42°C.

The bacteria that are used for the fermentation of the milk are lactic acid bacteria, these bacteria produce lactic acid by the fermentation of the sugar lactose which is naturally present in the milk. The bacteria are inoculated in the ratio (1:1); this is done because both cultures should be equally present to obtain the preferred taste. Furthermore, the cultures stimulate each other's growth (Nout & Schoustra, 2002). *Lactobacilli* stimulate the growth of *Streptococcus* by decreasing the pH and by forming small peptides and amino acids. The *Streptococci* stimulate the growth by forming formic acid out of pyruvic acid. Due to this cooperation between the two bacteria, lactic acid is produced much faster than when the cultures work independent of each other. The lactose is converted into galactose and glucose and the glucose is converted into L-lactic acid by *Streptococcus thermophilus* and into D-lactic acid by *Lactobacillus bulgaricus* (Tamime & Robinson, 1991). Because lactic acid is produced the pH of the yoghurt decreases. The pH decreases from 6.7 to  $\leq 4.6$  (Lee & Lucey, 2010). The pH of the yoghurt that is consumed will be around 4.5. The growth of the *Streptococci* is inhibited at a pH value around 4.4-4.2 while *Lactobacillus* can grow until the pH reaches values around 3.8-3.5 (Hooydonk et al., 2009). To make sure the lactobacillus will not continue to grow, it is important that the yoghurt is cooled in a good way so the acidification process is slowed down. As a result of the decrease in pH, aggregation of casein micelles occurs, a protein matrix will be formed consisting of micellar chains and micellar clusters. The iso-electric point of the casein micelle is 4.6, this means that the net charge between the micelles is zero. This leads to a decrease in electrostatic repulsion between the casein molecules. Also a casein network is formed in which the denatured whey proteins are also taken up. As a result of these reactions a gel is formed and this explains the thickness of the yoghurt (Lee & Lucey, 2010).

After the incubation the yoghurt is cooled to 15°C to further slow down the acid development. At this point the yoghurt network has just been formed. When making stirred yoghurt there is gently stirred to obtain a smooth, thick stable yoghurt (Nout & Schoustra, 2002). After this is done the yoghurt is packed in cartons and transported to the cooled storage.

### Physics

Important physical characteristics of the stirred yoghurt are viscosity, smoothness, ropiness and stability against wheying-off (Hooydonk et al., 2009). Wheying-off is the phenomenon that the watery phase will be expelled from the casein network. Stirred yoghurt is classified as a non-Newtonian visco-elastic fluid, showing a yield stress and shear thinning. Yield stress means a minimum stress is needed before the yoghurt starts flowing. The shear thinning rate of yoghurt is high; this means that when the rate of shear increases the viscosity decreases (Linden & Sagis, 2007).

One of the causes of wheying can be syneresis. In yoghurt syneresis is a rearrangement in the network of the yoghurt, which increases the particle-particle junctions. As a result of this the network will shrink and hereby liquid what was previous between the particles is expelled (Nout & Schoustra, 2002). In set yoghurt during gel formation a fracture could arise due to shaking the package, resulting in syneresis (Nout & Schoustra, 2002). In stirred yoghurt when the pH is above 5.3 and there is started with the formation of the gel, the gel could easily break by vibrations or fluctuations in temperature. These lumps can show syneresis. When stirring at the end of the fermentation process the lumps will break down, but a side effect of too much stirring will be that the yoghurt will be too thin (shear thinning).



### *Storage*

A big problem for the storage of yoghurt is the continuing of acidification of the yoghurt after production (Ranken et al., 1997). As a result of this the yoghurt can be too acidic for the consumer to eat it. The yoghurt is cooled after the manufacturing to slow down the acidification. Nevertheless it is difficult to cool fast enough. Even at refrigerator temperatures the acidification slowly continues. Also bitter off flavours will be produced, which will be more limiting to the shelf life than the continued acidification. Spoilage bacteria and pathogens will not grow in the yoghurt. This is because the milk is pasteurized, a low pH is present in yoghurt and there is a dense population of starter bacteria present (Kilcast & Subramaniam, 2003, Adams & Moss, 2000). The only microbial contaminants that are able to grow in yoghurt are yeasts and moulds. They can cause off-flavours. The growth of these microorganisms is mainly determined by the amount of oxygen available in the headspace of the package and the air permeability of the package (Hooydonk et al., 2009). Syneresis can occur during the storage of yoghurt, this can be avoided by not vibrating or shaking with the package and during manufacturing incubation at a low temperature, (Hooydonk et al., 2009). When yoghurt is stored around 5 °C it can be stored for three weeks. After the yoghurt is opened the yoghurt can be stored for around one week (Adams & Moss, 2000).

### *Nutritional value*

There are different kinds of yoghurt that can be bought like full fat yoghurt, low fat yoghurt, yoghurt with probiotics and yoghurts with prebiotics.

Nutrition wise yoghurt has the same composition as milk, this means that yoghurt is a good source for proteins, calcium, phosphorus, vitamin B1 and vitamin B2. The protein contains essential amino acids for the body. Furthermore, vitamins and minerals that are present in the yoghurt are bioavailable (McKinley, 2005). With bioavailability is meant the degree to which a compound which is ingested is free for up-take in the body (Ball, 1998).

Consumers who suffer from lactose-intolerance can eat yoghurt. The most of the lactose that is present in the milk is during the fermentation converted into lactic acid (Nout & Schoustra, 2002). The remaining lactose does not cause problems for lactose-intolerant consumers. In this way the consumer can still obtain the other nutrients that are present in the yoghurt.

Nowadays the consumers are more health conscious and have a lifestyle which focuses more on healthy food. The low fat yoghurt is a product which has grown because of this trend (Khurana & Kanawjia, 2007). Low fat yoghurt only contains 0.1 grams of fat per 100 gram yoghurt in comparison to full fat yoghurt which has a fat content of 3.0 gram per 100 gram of yoghurt (Voorlichtingsbureau voor de voeding, 1996). Also yoghurt provides a lot of important nutrients in comparison with the energy and fat intake (McKinley, 2005).

Some yoghurt contains next to the yoghurt bacteria, *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*, other bacteria. These yoghurts are called probiotics yoghurts. Probiotics are living microorganisms which when added in the right amount may have a beneficial health effect for the consumer (Shah, 2007, McKinley, 2005). They should withstand the low pH of the stomach and the bile acids in the intestine, and should stick to the intestinal epithelium. A probiotic should reach a certain minimum level before it can affect the intestinal environment (Hooydonk et al., 2009). Prebiotics yoghurts are yoghurts that contain non-digestible ingredients. These prebiotics can selective stimulate the growth of bacteria and in this way improve the health of the host. Most of the prebiotics are oligosaccharides and dietary fibers (Shah, 2007). The probiotics and prebiotics are the main reason for the growth for the dairy demand nowadays (Khurana & Kanawjia 2007).

### 5.3.2 Fruit

The most bought flavours of yoghurt are strawberry, raspberry and blueberry. Could it be a possibility to use these fruits for the yoghurt vending machine? A disadvantage of this will be that these fruits are only available in the summer (Gough, 1994, Liebrecht, Wagner & Wendland, 2009, Hancock, 1999). An option can be to use refrigerated fruit, but this often contains more sugar. Sugar is added when refrigerating the fruit (Hui, 2006), to extract the water from the fruit. This also conflicts with the healthy and natural image of the yoghurt vending machine. Another option is to use Modified Atmosphere Packaging, with this method the fruit is gas packed. A complete explanation of MAP is given in paragraph 5.3.3. To make sure that throughout the whole year fresh fruit is present in the yoghurt vending machine, other fruits have to be examined. Other fruits which could be a good addition to the fruit assortment in the vending machine are apples and pears. These are the one of the most eaten fruits in The Netherlands (Voedingscentrum, 2008). These fruits are also cheaper because they are harvested on large scale. It is not advised to use pineapple, kiwi and papaya as a fruit for the yoghurt. These fruits contain proteases or active protein-degrading enzymes. The result of this is that the structure of the yoghurt is broken down and the yoghurt becomes more liquid like. Also the taste becomes bitterer. This is due to presence of more peptides, which have a bitter taste. This problem can be solved by inactivating the enzymes with a heat step. But then the fruit cannot be sold as fresh fruit anymore (Foodinfo, 2008).

#### *Production process*

The processing of fruit increases the physiological deterioration, biochemical changes and the microbial decay of the fruit. Before the fruits are being packed for consumption some light process steps are executed. These are washing, peeling and cutting, second washing step, dipping treatments and packaging. Each step during the processing could have an effect on the nutritional value and quality of the fruit. A critical step in the process is the cutting and the peeling this is because this will cause cell rupture with the result of liberating intercellular fluid like oxidizing enzymes. Next to this the surface of the fruit is exposed to the air and possible contamination with yeast and moulds could occur. Furthermore cutting and peeling is influenced by the maturity of the fruit. Research showed that riper fruit is more susceptible for wounding during processing (Gorny, Cifuentes, Hess-Pierce & Kader, 2000).

During the process the washing steps are the most important steps that influence the quality and the shelf life of the fruit. The first washing step is done with the whole fruit to remove any contaminants like pesticides or plant remains. The second washing step is done after the peeling and cutting of the fruit, this washing is done to remove microbes and tissue fluid. The temperature of the washing water is below 5 °C. The shelf life of the processed fruit can be prolonged with a 2 to 3 days, when the fruit is washed carefully. After the second washing step the fruit is often subjected to a dipping step. This dipping is done in a sanitizing solution which contains chlorine and antimicrobial compounds. The dipping step is the only step in the production process where a reduction of spoilage organisms and potential pathogens can be achieved. After this is done the fruit is packed. In appendix 2 the fruit processing steps are shown (Corbo, Speranza, Campaniello, Amato & Sinigaglia, 2010).

### Strawberry

Strawberry (*Fragaria x ananassa*) is a popular fruit among the consumers. This is because of the delicate flavours and the high vitamin content (Hancock, 1999).

The strawberry can be cultivated in The Netherlands. Strawberries that are grown in a glasshouse have a bigger period to ripe, the fruit ripens in April until June. When they are cultivated in the open field the strawberries can be harvested from June first until mid July (Darrow, 1966, Hancock, 1999).

It is advised that the strawberries are picked when they are three-quarters ripe, when the strawberry is stored the ripening continues and at this point the strawberry is at his best for selling (Ohlsson, Bengtsson, 2002). The shelf life of the strawberries will be around 5 to 10 days, when they are cooled immediately after harvesting and stored below 5 °C. (Hancock, 1999). The main problem for spoilage of the strawberry is the presence of the fungus *Botrytis cinerea* (Schouten, Kessler, Orcaray & van Kooten, 2001). The fungus influences the deterioration of the strawberry tissue and resulting in softening of the tissue. (Hertog, Boerrigter, van den Boogaard, Tijskens & van Schaik, 1998). Pathogens do not grow on the strawberries because of the high acidity of the strawberry (Siro, Devlieghere, Jacxsens, Uyttendaele & Debevere, 2006). When storing cut strawberries at 5 °C, the strawberry can be stored for 6 days. The cutting of the strawberry has an influence on the firmness, a 40% decrease in firmness was measured in comparison with whole strawberry. Next to this the visual quality of the cut strawberry decreases fast. After three days the visual appearance decreased with 25% (Gil, Aguayo & Kader, 2006). Modified Atmosphere Packaging can be used to increase the shelf life and to limit the growth of fungi. When using MAP the storage life of the whole strawberry can be increased with 3 to 5 days (Hancock, 1999). Strawberries are healthy, they contain different compounds that are good for the human body. First they contain a high content of vitamin C (Garrow, James & Ralph, 2005). Second, there are fibers present in the strawberries which can have a beneficial effect on the digestion (Marlett & Vollendorf, 1993). Finally also high levels of antioxidants have been found in the strawberry. Antioxidants have been related with the decreased risk of chronic diseases (Meyers, Watkins, Pritts & Lui, 2003).

### Raspberry

Raspberries (*Rubus ideaus L*) are only available around the summer and have a short shelf life (Beekwilder, Hall & de Vos, 2005). The short shelf life is caused by the high metabolic activity and the growth of moulds (Steen, Jacxsens, Devlieghere & Debevere, 2001).

Just like with strawberries also here the grey mould *Botryotinia cinerea* is the most common post harvest disease (Tournas & Katsoudas, 2005). Because the raspberry is very perishable they can only be stored for two to three days at 5°C (Nunes, Emond & Brecht, 2003). When using MAP the shelf life could be extended to 7 days (Siro et al., 2005). Another advantage of the raspberry is the small size and therefore it does not need to be cut in smaller pieces. The raspberry also contains healthy compounds, the most important is the high antioxidant level of the raspberries (Bleekwilder et al., 2005).

### Blueberry

Blueberry (*Vaccinium sp*) is harvest from June till mid September (Hanson & Hancock, 1998). The best way to store fresh blueberries is around 0°C, in this way they can be stored for around 3 weeks (Schotsmans, Molan & MacKay, 2007). When the blueberries are MAP and stored lower than 5°C, the blueberries can be stored for 6 weeks (Schotmans, et al., 2007). An advantage of using blueberries is that they do not have to be cut, in this way the shelf life is longer in comparison with the fresh cut fruits. It is important that the outside (skin) of the blueberry stays intact in this way microorganisms have less chance to grow. The skin works like a shield for the blueberry, it makes sure the microorganisms stay outside.

Blueberries are healthy food, this is because of the high fiber, vitamin C and potassium content (Carew, Florkowski & He, 2006). The blueberry can spoil by a fungus, but also physical spoilage can occur. Physical spoilage of blueberries can be the loss of moisture, loss of firmness and mat colour appearance (Gough, 1994).

### Apple

Apples (*Malus domestica*) have a long storage life and therefore can be found on the shelf in the supermarket throughout the whole year. After harvesting they are stored at -4°C with a high humidity and they can stay at this temperature for 8 months (Kilcast & Subramaniam, 2003).

The apple has to be cut when used for the yoghurt vending machine. This can cause problems because the cutting of the apples sets off different reactions in the apple which result in a loss of quality. The cutting increases the respiration rate, oxidation of phenols and microbial development (Rocha & Morais, 2002). Also enzymatic browning can occur because of the cutting (Jongen, 2002). The enzymatic browning reaction is caused by polyphenol oxidase which reacts with phenolic compounds and is facilitated by the diffusion of O<sub>2</sub> into the cut tissue. The compound that is formed as a result of this oxidation reaction condenses to a brown pigment (Beldman, Gruppen, Linssen, Schols, Vincken & Voragen, 2007). Next to the fact that enzymatic browning can occur the apple can also spoil because of microorganisms. Although the fact of the high water activity, the spoilage is dominated by fungi this is because of the low pH of the apple. The *Penicillium expansum* causes a soft rot of the apple, and looks like a ring with numbers of blue conidiospores. The conidiospores can be seen as the seeds of the fungi that are needed for reproduction (Adam et al., 2000). On fresh cut apples also other microorganisms can be present. The pathogens *E. coli* O157:H7, *Salmonella* and *Listeria monocytogenes* can grow on the fresh-cut apple. But this is only at temperatures of and above 10°C. It is therefore very important that during the processing of the apple no contamination occurs and throughout the whole supply chain the ingredient is cooled (Alegre, Abadias, Anguera, Oliveira & Vinas, 2010). Physical spoilage of the apple will be loss of moisture and weight loss. As soon as the slices of apple are in contact with oxygen the browning reaction will occur. Because of this a cut apple can be stored for only 3 days (Rocha, & Morais, 2002).

When applying MAP to package the apple parts they can be stored for 7 days at 4°C before the consumer finds the product unacceptable (Torrieri, Di Monaco, Cavella & Masi, 2007). Map packed apple parts are made on large scale nowadays (ZNEK, 2007).

Apples contain vitamin C but they do not have as much vitamin C present as the citrus fruits have (Garrow et al., 2005). An orange contains per 100 gram 49 mg of vitamin C, and an apple contains 4 mg of vitamin C per 100 gram (Voorlichtingsbureau voor de voeding, 1996). Apples do contain high levels of fibers, one apple can provide around 20% of the daily recommended level of fibers (Ronizo, 2003).

### Pear

Pears (*Pyrus*) are available in every season this is because they have a long storage period. Pears can be stored for 6 months when they are stored around -1°C (Kilcast & Subramaniam, 2003).

Cutting the pear increases tissue respiration, browning, texture breakdown and off-flavour development (Raybaudi-Massilia, Mosqueda-Melgar, Sobrino-lopez & Martin-Belloso, 2008). Furthermore it is difficult to choose the best ripening phase of the pear. When the pear is too ripe, moisture loss and softness will be the result. When a pear is used which is not yet ripe the pear will be too firm and not all the flavours will be developed (Bai, Wu, Manthey, Goodner & Baldwin, 2008).

The shelf life of cut pear is short, the variety *Anjou*, can be stored for only 2 days at 10°C and the varieties *Bosch* and *Bartlett* for 3 to 4 days (Gorny et al., 2000). When using MAP the winter variety *Flor de Invierno* can be stored for around 10 days. (Oms-Oliu, Aguilo-Aguayo, Soliva-Fortuny & Martin-Belloso, 2007). Nowadays Modified Atmosphere Packed pear can be bought at the retailer and in vending machines (ZNEK, 2007). The pear can spoil due to the spoilage bacteria, also moulds and fungi could grow on pears the most found fungi is *Erwinia*. Pears are a good source of fibers and have a high content of potassium (Brickling, 1993).

It is not possible to use cut fruits. The shelf life of these fruits is very short because cut fruit is more susceptible for microorganisms and chemical and physical change (browning and moisture loss). Therefore the best solution is to choose fruits that do not have to be cut because they are small enough. Like the mentioned blueberry, raspberry and for example grapes which have shelf life of one week and when using MAP 70 days (Costa et al., 2011). Only using whole small fruit is not a limiting factor for the yoghurt vending machine. In appendix 3 a table is shown with possibilities for whole small fruits that can be used in the vending machine. A berry that is very popular in foods nowadays is the açai berry but is not mentioned in the list. This berry is so popular because there is claimed that this berry has a high antioxidant level and therefore has health benefits (Heinrich, Dhanji & Casselman, 2011). Unfortunately the açai berry is not an option as berry for the yoghurt vending machine. This is because the açai berry is a very perishable berry and this restricts the export of the fresh berries (Janick & Paull, 2008). The açai berry is grown in South America and therefore fresh açai berries cannot be bought in the supermarket in Europe. Moreover after harvesting the berries are frozen and transported to the rest of the world (Pacheco-palencia, Hawken & Talcott, 2007).

### *Cereal*

The cereals that are present in the yoghurt vending machine will be rolled oats, whole grain wheat, cornflakes and dried figs and dried plums.

The advantage of all these ingredients is that they all have low moisture content around 0.15 (Hui, 2006, Muller & Tobin, 1980). When the ingredients have a moisture content lower than 0.6 no microbial spoilage can occur, because the ingredient is too dry. Problems that can occur are physical and chemical related. The two most important processes that can occur are lipid oxidation and moisture transfer into the ingredients (Jensen & Risbo, 2005). Lipid oxidation is a chemical reaction which results in rancidity. The moisture transfer results in a decrease in crispiness. Lipid oxidation is no problem for dried cereals. The fat content of the cereals is around 2 to 7 %, the lipid oxidation will not go very fast at these low rates (Voorlichtingsbureau voor de voeding, 1996). The dry cereal can be stored for 6 to 12 months at room temperatures when the package is not opened yet (Brown, 2007). Furthermore for the nutritional value accounts that they are all very high on fibers. Table 1 shows the fiber content of the cereals. The effect of the cereals on the consumer is that it increases the chewing of the consumer. This decreases the intake because of the promoting secretion of saliva and gastric juice. This results in an expansion of the stomach and an increased satiety feeling (Slavin, Klosterbuer & Willis, 2008).

**Table 1: Fiber content of the different cereals that will be used for the yoghurt vending machine (Voedingscentrum, 2010).**

Ingredient	Fiber content/ 100 gram
Cornflakes	4
Dried figs	19
Dried plums	16
Rolled oats	8
Whole grain wheat	16

Another aspect to keep in mind is that people can be allergic to all kinds of food products like peanuts, shellfish and wheat (Food allergy, 2009). It is important that information is given to the consumer about which ingredients are present in the machine. Sometimes extra information is mentioned like the ingredient is produced in a factory where also peanuts are produced. The Dutch food-law says that the package should mention the food products which can lead to an allergic reaction or intolerance. In this case only the possible presence of peanuts has to be mentioned (Rijksoverheid, 2010).

A lot of research is done to find other minimal processing techniques. There is searched for techniques where no heating step is needed. Where first the safety of the fruit can be guaranteed and second the fresh character of the fruit is maintained. One of the methods that is found is non-ionizing, artificial ultraviolet-c radiation. This technique is used as an antimicrobial application for water, air and food preparation surfaces. The ultraviolet light acts as an antimicrobial agent because it directly damages the DNA. A disadvantage can be the damage to the tissue of the treated area. This method can best be used with other methods because using only the ultraviolet light does not result in a complete sterilization (Allende, Tomás-Berberán & Gil, 2008).

Another technique that can be applicable is the use of freeze drying. Freeze drying is the sublimation of ice fraction when water passes from solid to gaseous state. Because of the low temperature the deterioration and the microbial activity are stopped. This delivers a better quality product than when the product is just frozen (Sagar & Suresh Kumar, 2010). Disadvantages of using this method are the high operation costs and the long drying time (Marques, Silveira & Freire, 2006). The freeze drying technique is used in the food industry to make for example freeze dried coffee.

### 5.3.3 Materials

Packaging of ingredients has different functions, it should protect and stabilize the ingredients. Furthermore it should be easy for transportation and distribution so the package should be easy to stack and make optimal use of the space in the boxes. Finally the package should be the right portion size, convenient, give information and can provide the product with a desired image (Linnemann & van Boekel, 2007). What is important for the package of the on-the-go yoghurt snack is that it should be big enough to contain the different ingredients, but small enough to be easy to use.

The main problem for packaging cereals is the moisture transfer into the package. Therefore the fruit and the cereals cannot be packed into one compartment in the package. The cereals will absorb the moisture from the fruit and become soft. To prevent moisture transfer into the cereals a package material is needed with a high moisture barrier. Cereals are normally packed in laminated bags of polyester, aluminum and low density polyethylene. These bags are packed in duplex printed carton. A new way of packaging cereals nowadays is with biaxially oriented polypropylene film (BOPP). This has multiple advantages. It is stronger than polypropylene, it has an excellent moisture barrier, has a high transparency and gloss (Gabric, Galic & Curcic, 2010). A possible disadvantage of using this material is the low resistance for oxygen permeation.

Yoghurt can be packed in a lot of different ways. In some countries the yoghurt is packed in glass bottles. This has the advantage of recycling of the glass and glass has the best barriers compared to other package options. A disadvantage of glass is that it is expensive, it can break easily and it is heavy. Other options for packaging are plastic containers, sometimes other plastic are added so the properties of the container are improved. For yoghurt it is important that the container must be acid resistant, prevent the loss of flavour volatiles and for a lesser extent be impermeable to oxygen. Currently the yoghurt is packed in carton which is laminated with polyethylene which is not a good oxygen barrier, but enough for a shelf life of a few weeks. The presence of oxygen can encourage the growth of moulds and yeasts. An advantage of plastic packages is that a lot of shapes and forms are possible, it is light weighted and has low costs. Yoghurt can also be packed in paperboard cartons. Paperboard is not a good moisture and oxygen barrier and therefore the paperboard is made of different layers of materials often it is coated with plastic. Advantages are the shape, it is easy to package for transport, it is cheap and does not break easily. Disadvantages are that you cannot see the product and that size large volumes are not available (Chandan, 2006). Another way of packing yoghurt is in plastic pouches, these are bags made of low density polyethylene. They have good moisture and water vapor barrier but a poor oxygen barrier. They are very flexible and are used in a lot of countries. The pouch is made with a flexible tube. The pouch is placed in a box and the box can fit right into a refrigerator with a simple tap. The tube is fed around the tap and cut off to open the pouch and allow the dispensing of the yoghurt (Giles, 1999). Other food products are also packed in pouches like ketchup, soups and baby food.

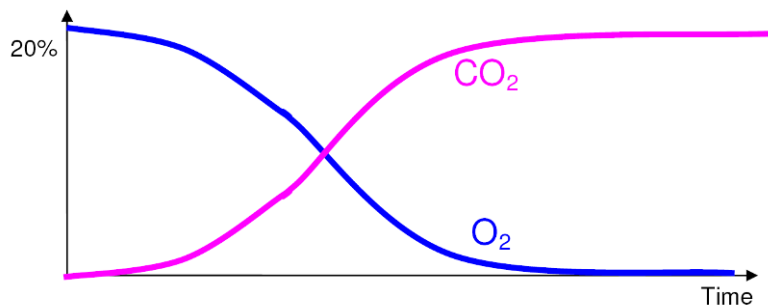
Packaging for whole fruit and vegetables has as main goal, to prevent the product from bruising during transport and storage. For sliced fruits it is different, the quality will decrease fast when not packed properly. The main aim of MAP is the extension of the shelf life of the ingredient. Fresh fruit and vegetables are still alive after harvesting and respire. The rate of respiration of the fruit or vegetables is inversely proportional to the shelf life of the product, so a higher respiration rate results in a shorter shelf life (Farber et al., 2003).

There are two types of MAP: active MAP and passive MAP. With active MAP in the package a slight vacuum is made and the desired gas mixture is put in the package. With passive MAP the effect is derived from respiration of the ingredient and gas permeability of the package, this results in the establishing of a passive steady state after a some time, passive MAP is therefore also called equilibrium MAP (Charles, Guillaume & Gontard, 2007). The active MAP is mostly used for products which are not physiologically active like meat or fish. Passive MAP is used for fresh fruits and vegetables, which are physiologically active (Linnemann & van Boekel, 2007).

When fruits or vegetables are cut they have a higher respiration rate, which will decrease the shelf life. When cut the internal tissue of the fruit is exposed to the environment, the fruit responds to this by increasing its respiration rate to survive and repair the damage (Blakistone, 1998). The MAP should decrease the respiration of the fruit or vegetable.

Figure 3 shows the conversion of oxygen into carbon dioxide in the package, under atmospheric conditions due to respiration. When an ingredient is packed with normal gas composition after a while the O<sub>2</sub> will deplete and anaerobic conditions will occur.

When the package is permeable oxygen can be transferred into the package so no anaerobic conditions occur and carbon dioxide can be transported out.



**Figure 3: The change of gas composition in a package under atmospheric conditions.**

The gas that is used in MAP is composed from oxygen, carbon dioxide and nitrogen.

Nitrogen is used for three reasons, first it will replace a part of the oxygen in the package and therefore reduces the oxidation process. Second, slowing down the growth of aerobic spoilage bacteria and third, as filler gas so the package keeps the same shape (Faber et al., 2003, Adams & Moss 2000).

The oxygen level in the package is very low around 1 to 5%. This is done so the respiration of the fruit or vegetable is reduced. Also at these low oxygen levels the production of ethylene, an important compound in the ripening process, is reduced. By limiting the oxygen the oxidation processes are suppressed, but to low oxygen levels lower than 1% will result in the growth of anaerobic bacteria which can cause off-flavours and off-odors. Also foodborne pathogens which are anaerobic like *Clostridium botulinum* can grow now. (Faber et al., 2003, Brody, 2003).

The carbon dioxide has a direct antimicrobial effect. At carbon dioxide levels of 10 to 20% aerobic spoilage bacteria like *Pseudomonas* are inhibited. A too high level of carbon dioxide can inhibit the growth of spoilage bacteria, but not the growth of pathogens. Because of the suppressed growth of the spoilage bacteria the pathogens have less competition and it is easier for them to grow. As a result of this the consumer thinks that the product is edible but instead it is not safe anymore (Faber et al., 2003).

When using passive MAP it is important that there are no big fluctuations in the surrounding temperature, this can influence the respiration rate of the ingredients. The respiration rate is more affected by the temperature changes than the permeability of the package is. Therefore it is important to keep the temperature lower than 7°C during handling, transportation and storage. This way the microbial and sensorial quality are maintained (Jacxsens, Devlieghere & Debevere, 2001)

In general the gas composition for fresh fruit and vegetables will be around the values 10-20% CO<sub>2</sub>, 2-10% O<sub>2</sub> and 84-96% N<sub>2</sub> (Blakistone, 1998). The actual optimal gas composition depends on cultivar, storage time before processing and the type of permeability of the package (Gorny, 1997). In table 2 recommendations are given for the gas composition of the different fruits.



**Table 2: Recommendations for gas compositions MAP of fruit**

	Temperature	Humidity	CO <sub>2</sub>	O <sub>2</sub>
Apple	0-5	90	1-3	1-3
Blueberry	0-5	90-95	15-20	5-10
Pear	0-5	90-95	1-2	2-3
Raspberry	0-5	90-95	15-20	5-10
Strawberry	0-5	90-95	15-20	4-10

The rate at which the gases are transferred depends on the type of plastic, thickness of the package, temperature and the partial pressure of the gas inside and outside the package (Blakistone, 1998).

There are different plastics available on the market with different permeability. First, there are the plastic films that can be used for low and medium respiration, then there are plastic films with a high respiration rate and there are plastic films using micro-perforation to obtain very high rates of respiration.

Low-density polyethylene (LDPE) and polypropylene (PP) are the main plastics used nowadays to package fruit and vegetables. Micro-perforation can be used to increase their permeability and make the plastic applicable for fruit packaging (Kader, Watkins, 2000). The perforations are made with help of laser techniques and the diameter of the wholes that are made are between the 40 and 200  $\mu\text{m}$ , depending on the desired steady state of the gas in the package (Sandhya, 2010).

What is important for the ingredients is that they cannot contaminate each other in the package. To avoid this from happening, the best solution is to pack the ingredients separately. Another reason to package the ingredients separately is that the ingredients can be packed per portion size. In this way it is easier to stock the yoghurt vending machine and the ingredients will not get squeezed and flatten when packed in smaller portions. The one-portion package can also be used as the cup where the consumer can eat from. The fruit or the yoghurt can already be present in the cup and the other ingredients can be added. In this way the cup has multiple functions and less equipment is used to assemble the snack.

### *Food packaging interactions*

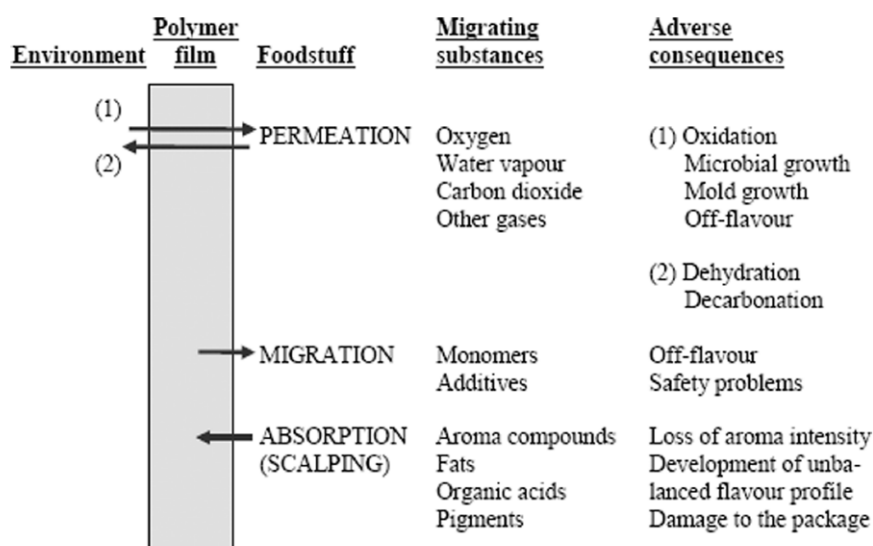
During the storage of the product the ingredients undergo a lot of different reactions such as oxidation. These changes can be affected by the package, the ingredient or interaction of the ingredient with the packaging. The interaction of food with the package can be divided in three types of reactions: migration, permeation and absorption.

Migration is the transfer of packaging components, like residual monomers and polymerization aids, into the food and in this way contaminate the food.

Permeation is the transfer of a gas through the package, which negatively affects the ingredients. This for example accounts for oxygen and water vapor.

Absorption is the third process that can influence the quality of the product. This is the absorption of food compounds into the package, for instance pigments, fats and aroma compounds (Linssen, 1992, Sajilata, Savitha, Singhal & Kanetkar, 2007). In figure 4 the previously discussed interaction between food and the packaging are shown.

Factors that can influence the migration of packaging compounds in yoghurt are the filling and storage temperature, fat content, moisture content and pH. The migration of styrene, one of the most used monomers in packaging, from polystyrene to the yoghurt does not affect the colour of the yoghurt. The level of styrene found in yoghurt is in The Netherlands around 3-4  $\mu\text{g kg}^{-1}$  (Tamime & Robinson, 1991). The daily tolerable intake of styrene is 7.7  $\mu\text{g kg}^{-1}$  per body weight day<sup>-1</sup> (WHO, 1996). Migration of packaging material in strawberries has been researched and less than 3  $\mu\text{g kg}^{-1}$  styrene in the strawberries was found. Research was also done for prepared cut salad and this contained 10  $\mu\text{g kg}^{-1}$  (Gilbert & Startin, 1983).



**Figure 4: Summary food packaging interactions (Sajilata et al., 2007)**

The level of flavour absorption depends on the properties of the polymer, the size of the molecules and external conditions. Furthermore also the chemical composition, chain length and the polarity of the polymer are important (Sajilata et al., 2007).

To determine the absorption of fruit compounds into the package often limonene is used. Limonene is an aroma and flavour compound which can be found in high levels in citrus fruits. Also the molecular weight of limonene is lower than most of the additives used. Low molecular weight means that the smaller structure hence it is easier to transfer through the package material. In this way limonene can translate the 'worst-case' scenario in the package (Begley, Brandsch, Limm, Siebert & Piringer, 2008).

A study was done with squashed fruit and citrus fruit beverages in polypropylene and polyethylene packages to see how much limonene will be absorbed by the package. With beverages the complete package is exposed to ingredient, instead of partial touching the package when using cut pieces of fruit. The conclusion was that after storage of 3 weeks at 4.5°C a 50% decrease of limonene concentration was detected but no taste difference was noticed by the test panel. A similar research was done with orange juice in low density polyethylene (LDPE), polyethylene terephthalate (PET) and polycarbonate (PC). In this research the samples were stored at 4.5°C for 3 weeks, also here no significant taste difference was found (Duncan & Webster, 2009). Because the fruit will not be in contact with the package for such a long time the absorption will not have an effect on the package or the taste of the ingredient.

The permeability of a package is influenced by the permeability coefficient and the solubility coefficient of the packaging material and by the thickness and area of the package. Furthermore, also the temperature, permeant size, shape and polymer morphology have an effect. A polymer with a high permeability for gasses is low density polyethylene, a polymer with low permeability is polyvinylchloride and with an average permeability polypropylene and polycarbonate (Ahvenainen, 2003).

Currently in the food industry a lot of fruits and vegetables do not have a brand. Fruit is placed on the market as commodity item. When putting a brand on the fruit it can help the consumer to recognize a specific product. Branding of the fruit has more advantages. When buying fresh products not everything can be told about the quality when consuming. The brand can work as an extrinsic cue for the consumer and thereby communicate the quality. Cues are signs that are present on the package which the consumer uses to determine the quality of the product. The cues help the consumer to determine the quality of the product. In food often colours are used as cues to say something about the taste and flavour of the product (Grunert, 2006).

It is difficult for fresh products to have the same consistent quality. Sometimes this is resolved by adding words like 'genetic variations' or 'due to climate'. Another way to control the differences in quality is to make sure that one actor in the supply chain takes all the control (Nijssen & Trijp, 1998). Sometimes companies do not mention the specific fruit but just call the flavour 'fruit of the season' or 'red fruit flavour'.

- *Cleaning*

Cleaning of the vending machine is also an important item. It depends on how the vending machine will look like what would be the best way of cleaning. When all the ingredients are packed separately in one-portion-packages and only yoghurt will be added in the machine. The cleaning will consist mainly of drips of yoghurt that during adding went out of the package. Also the tube where through the yoghurt is added should be cleaned. But when also fruit will be added with the help of equipment and the portion is completely made in the machine more equipment has to be cleaned. When using equipment extra potential hazards will be created. It is better that the machine is placed near a cleaning place where the equipment can be cleaned properly. In a canteen this is often possible. Another possibility is that the equipment is replaced with new equipment everyday and the used equipment can be taken to the company to get cleaned. It is important the machine is cleaned everyday with disinfectant to make sure no microorganisms will grow. When this is not done, leftovers of the made snack can be present on the equipment. It is not only important to clean this from a microbial hazard point of view. The ingredients can also dry out and change colour. The consumer can see these leftovers and could think the machine is not cleaned. Furthermore it is possible that the leftovers fall in the next on-the-go snack. This can influence the taste and appearance of the snack. When the machine is held at 5°C and the machine is cleaned daily the growth of microorganisms is decreased and will not be a problem. This is because at these low temperature most of the bacteria do not multiply and the ones that do will only be present in small amounts. Due to the short time they will be present on the equipment (Davies & Board, 1999). When less equipment is used, the machine will be easier to clean and it will increase the flexibility of the machine. Next to this it is important to control the temperature in the vending machine and record and document this information. It can be important for traceability (Adams & Moss, 2000).

As stated above the machine has to be stocked and cleaned everyday. But the stocking and the cleaning will be done by the company who is the owner of the machine. Also the revenues that are made with the machine are for the owner of the machine not the company who provides the location. The offices are only a provider of a location and want to give the employees the possibility to choose fresh and healthy food.

## 5.4 Managerial aspects

In this paragraph the focus lays on the managerial side of the fresh ingredient vending machine which can dispense a healthy freshly made on-the-go snack.

### ▪ *Product category*

The company Welldesign has an idea for a machine that will help consumers to consume fresh on-the-go food. The snack should be freshly made from healthy ingredients. And the snack should be made on the spot. The fresh ingredient vending machine should be a product that is completely new in the current segment and should have relative advantage to other on-the-go snacks on the market. It should make a change in the current market. The fresh on-the-go snack segment is a relatively new segment that can still be explored. The healthy-on-the-go snack is competing with the healthy food that consumers bring from home like an apple, banana or cucumber and with the not fresh unhealthy on-the-go snacks that can be found in vending machines at different public places. Furthermore the machine should have something like an eye catcher/wow-effect that will attract the consumer. The aim is to develop a machine that can be handled by the consumers them selves, in this way no employees are needed. This makes the machine more flexible and more selling locations are possible. Next to this the vending machine should be a machine that only will dispense fresh on-the-go snacks and no other products. In this way a clear image is created for the machine.

### ▪ *Customers of interest*

The target consumers of the fresh ingredient vending machine are high educated health conscious people, who often buy on-the-go snacks. They have enough money to spend on on-the-go snacks and are willing to pay a bit more for a healthy snack. Furthermore these people want something else in the current assortment. The customer of the fresh ingredient vending machine will be companies with highly educated employees. For example a law firm, a big multi national, universities. The fresh ingredient vending machine can be placed in the canteen or in the hallway next to the coffee machine. Next to the assumption that consumers have a need for a fresh ingredient vending machine, the company can also be actively involved with their employees' health and maybe have a work side health-promoting program. When a fresh ingredient vending machine is placed this can contribute to the health of the employees. The company in the end financially benefits from employees who have healthy lifestyle (Goetzel, Ozminkowski, 2008, Baker et al., 2008).

### ▪ *Business goals & constraints*

The information that is obtained with this research can help the design company to get insights in whether or not their idea fits the needs of the consumer. Furthermore new technological trends that can be found with the lead user method can be an input for new insight in how the fresh ingredient vending machine should look like.

The experts can give insights in new technologies for vending machines that possibly can be the dominant design for the future. With both information sources a new type of vending machine can be designed. This way the designing company can set a new standard in the



vending machine world. There are already competitors on the market of the fresh ingredient vending machines but the designs of the machines of the competitors are not that different of the already available vending machines (figure 5). This machine dispenses yoghurt when pushing the arm. Next the consumer has to add fruit and cereals themselves. When setting the standard for a new vending machine the company can build barriers for entry with their gained experience in the field. Next there are more advantages of becoming the dominant design.

A patent for the specific technology which can be used to make sure that it is difficult for other competitors to enter the market.

**Figure 5: The yoghurt dispenser of Activia (Danone, 2008).**

### ▪ Costs

Another aspect that is important for fresh ingredient vending machine are the costs.

It is important to keep in mind that the turnover of the healthy freshly made on-the-go snack should be fast, this is because perishable ingredients are used. Otherwise the ingredients have to be thrown away and it will only result in losses for the company. To make sure that spoiled products are not sold, the machine should be checked everyday. Therefore the fruit has to have a 'use by date'. This date indicates that when the date on the package has expired the products safety and/or quality is not guaranteed (Voedingscentrum, 2008). When the machine is checked for quality of the ingredients also the machine can be stocked again. When the machine contains computer equipment, the company knows exactly how much is sold and can fine tune the supply. An option that can be used for the fresh ingredient vending machine is changing prices. When some ingredients are almost out of date, the price can be lowered. So people are persuaded to buy the flavour which is almost at its expiration date (AFG, 2010). In this way the loss of stock which has to be thrown away can be reduced. A disadvantage of this technique is that it can influence the image of the machine as a selling spot of healthy, fresh products with a high quality. When the price is lowered the consumer can link this to lower quality and a reduced freshness (East, Wright & Vanhuele, 2008).

The most expensive ingredient for the yoghurt vending machine will be the fresh fruit. The technique used to produce the fresh cut fruit is relatively new and more steps have to be taken in producing than with the other ingredients. Next to this fruits can be used which have a lower supply and a high demand this will influence the price of these scarce fruits. Subsequently yoghurt and cereals are easier to produce. This is because the products are produced already for many years and the process is less complicated (Tamime et al., 1991, Hui, 2006). In table 3 the retail prices are shown of the ingredients. The prices for strawberry, blueberry and raspberry are high this is because this not the harvesting period for these fruits in The Netherlands. Therefore these fruits have to be imported from other countries which make it more expensive. Furthermore it can be seen that the small fruits are the most expensive ingredients and these fruits are not even Modified Atmosphere Packed.

**Table 3: Cost for ingredients according to the retail price (AH, 2010, ZNEK, 2010)**

Ingredient	Price in Euro's
Low-fat yoghurt	0.65 (per 1000 ml)
Strawberry	1.08 (per 100 gram)
Raspberry	1.99 (per 100 gram)
Blueberry	1.66 (per 100 gram)
Apple parts (MAP)	0.42 (per 100 gram)
Fresh fruit salad (MAP)	0.80 (per 100 gram)
Cereals (Quaker cereal multifruit)	0.47 (per 100 gram)

The price of the on-the-go yoghurt snack can be determined in two different ways. One way is to let the consumer pay per ingredient. This way a more expensive ingredient will make the snack more expensive. Another way to determine the price is to pay a pre-determined price for a size and then it does not matter what kind of ingredients the consumer chooses.

To indicate how much a healthy-on-the-go yoghurt snack costs nowadays the prices of different shops offering fresh yoghurt with fruit are compared. At the LaPlace and the Shakies different sizes of cups can be chosen. There can be chosen for small, medium or large cups. The amount was not mentioned. In these shops the fruit is blended with the yoghurt. This blending is done by the staff. At the Laplace the smoothies are already poured into the cups. The consumer cannot see that the smoothie is freshly made. At the Shakies the smoothie is hand made and blended. This has the disadvantage that every time a new clean blender has to be used and it is more time consuming. In table 4 the prices are mentioned of a medium size yoghurt fruit snack. A product that looks the most on the product idea of WellDesign is MyActivia. The MyActivia has to be handled by the consumer themselves, at this machine the consumers themselves have to do different steps to make their meal. Next to this

there are only one size cups available. The difference is that this machine mainly focuses on breakfast. Furthermore yoghurt with probiotics is used (Danone, 2010).

**Table 4: Price of medium size yoghurt snacks of different shops**

Company	Price in Euro's
La place	3.50
Shakies	3.50

The prices mentioned above give an indication of what the prices of the competitors are. Next the cost of a yoghurt snack will be determined by calculating the costs price. The costs of the yoghurt vending machine are the electricity, depreciation, salary of the personnel, the cost of the ingredients and the spoons. For determining the cost price it is assumed that the sales are 150 beakers per day, this is based on research that was done about the sales of a healthy vending machine in an office (Gorton, Carter, Cvjetan & Mhurchu, 2010).

Electricity: 1 Kwh= 0.36 euro cents. A vending machine with 50 beakers uses per day 3 Kwh (US department of energy, 2010).  $3 \times 0.36 = 1.8$ .  $1.8/150 = 0.012$  euro.

Salary: Minimum salary of an adult is 8.65 euro per hour, when working 38 hours per week. (Rijksoverheid, 2011). Assumed is that it takes 20 minutes to clean the machine.  $8.65/3 = 2.89$ .  $2.88/150 = 0.019$  euro.

An assumption is made that the depreciation of the machine will be done in 5 years and the cost price will be 10.000 euro. That will be 2000 per year.  $2000/365 = 5.48$  euro.  $5.48/150 = 0.04$  euro

Ingredients: The prices for fruit per kg will differ between the 3.50 and 6.00 euro per kilogram (FruitPack B.V, 2011). Furthermore when the fruit have to be packaged in smaller sizes 30% has to be added to the costs of the fruit. It is assumed that one beaker will consist of 100 gram fruit. The maximum price for the fruit is taken per 100 gram that is 0.60 cent, 30% packaging costs are added. The cost for the fruit will be 0.76 euro.

For the yoghurt and the cereals the prices obtained from the supermarket (table 3) will be taken. It is assumed that 200 ml of yoghurt is needed and 50 grams of cereals. The costs of the yoghurt will be 0.13 euro and for the costs for the cereals will be 0.24 euro.

Then there is the cost of the spoon which is 0.10 euro (Time-Out, 2011).

In the end the cost price of a beaker with fruit, yoghurt and cereals will be:  
 $0.012 + 0.019 + 0.04 + 0.76 + 0.13 + 0.24 + 0.10 = 1.30$  euro.

#### ▪ *Supply chain*

In this part there is researched if the stocking of a fresh ingredient vending machine is feasible.

For explaining the supply chain, the idea of the yoghurt vending machine is used as a case study.

Looking at the complete supply chain of the yoghurt vending machine in figure 6. There are different actors involved. First the ingredients have to be supplied from the producer of the ingredients. The customer of the ingredients will be the company who places the yoghurt vending machine at different locations. The bought ingredients will be transported to the distribution centre. This is a central point where all the ingredients will come together and from this place the ingredients will be distributed to the yoghurt machines at the different locations. When an on-the-go snack is bought the product is consumed by the end-customer. When the supply is delivered to the distribution centre it is important that this supply is controlled. The employees have to control this and have to compare the incoming supply to standards that have been set up. For example the supply could be controlled on the packaging date of the ingredients. Furthermore the delivery of the supply to the distribution should be fast, reliable and consistently. This reduces the order cycle time and it will eliminated big variances in the variability (Fawcett, Ellram & Ogden, 2007).

The stocking of a vending machine can be done in different ways. For a candy vending machine this is done by different companies who all have their own product in the vending machine. For the yoghurt vending machine this is not an option. It is important that every ingredient is present in the machine. Otherwise when an order is made the on-the-go snack is not complete. To make sure this will not happen, the power in the supply chain should be with one actor.

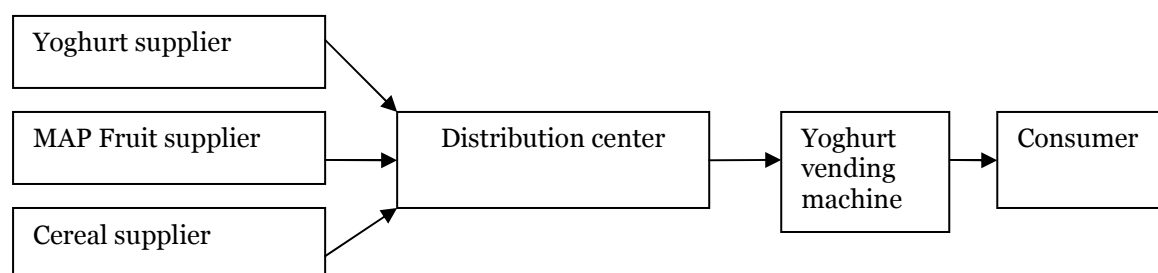
For the yoghurt vending machine the distributor is the best actor. The distributor is in the middle of the chain and can communicate up and down the supply chain. And is responsible for the ordering, stocking, cleaning and quality assurance of the machine. In this way one actor will have the responsibility. When the stocking of the yoghurt vending machine will be done by the supplier of the ingredients. First, multiple companies have to stock the machine. Logistic wise this is not the best way. Second, every actor has their own task and only fills the machine but nobody feels responsible for the complete machine.

What is important for the complete supply chain is that it is a cooled supply chain, around 5°C. This is because perishable ingredients are used. The quality and shelf life will decrease if the temperature becomes too high. The shelf life of the fruits which are Modified Atmosphere Packed is around one week. The supply chain should be as short as possible when the shelf life is too long the fruit could be spoiled even before it reaches the yoghurt vending machine.

Communication and cooperation between the different actors on the chain is important for the success of the machine. The different actors have to communicate about how much stock is needed and when this can be delivered. It is not possible to keep stock in the warehouse for the MAP fruit. Therefore the on time ordering and the delivery of the ingredients are crucial. And when this is not the case, the machine does not have all the ingredients and the on-the-go snack cannot be made. Next to that also feed-back has to be given to the suppliers about the quality and shelf life of the fruit, in this way the suppliers can improve their product.

These aspects involve therefore a good supplier relationship. In this case a good supplier relationship is when there is a long-term relationship between the actors, there is a mutual benefit in supplying the machine and there is shared risk (Fawcett, Ellram & Ogden, 2007).

Setting-up a supply chain for the yoghurt vending machine is difficult but possible. The importance is that one actor in the chain takes the power and the responsibility (Fawcett, Ellram & Ogden, 2007). When one actor has the power and makes a fitting personalized communication system for the ordering of the ingredients it should be manageable. Furthermore the relationship with the supplier should be close so communication and trust can be built up.



**Figure 6: Supply chain of the yoghurt vending machine**

#### *Sub-questions*

- Which ingredients are most suitable for the yoghurt vending machine from the viewpoint of food safety?
- Which material can be used for the yoghurt vending machine?
- Is it from a food technological point of view feasible to make a yoghurt vending machine?

## 6. Methodology

### 6.1 Quantitative research

In this part of the research a quantitative research will be executed. The data that is obtained with this research can help to give more insights in how lead users currently and in the future see a yoghurt vending machine. This can help to design a yoghurt vending machine that can fulfill the upcoming needs of consumers.

#### *Research design*

To find out what will be important in the future for vending machines focus groups will be executed to gain consumers' opinion. A focus group is a group discussion where respondents are brought together to discuss the research topic as a group. Most focus groups consist of four to ten respondents (Ritchie & Lewis, 2003). The aim is to make three groups of ten people to extract information from. First general information from the respondents about buying on the go food is obtained like the price, frequency of buying and type (healthy or unhealthy) of on-the-go snack.

Also there will be asked what the group members think are places where the snack should be sold.

Finally the focus group members are asked to name attributes, requirements and values that they think are important for a healthy vending machine. After this the members are asked to explain with examples why they wrote down these ladders and a discussion in the group is started. This information will be used as input for the design of three concepts of the yoghurt vending machine.

With the obtained information is tried to find a specific type of person who is interested in buying healthy on-the go snacks, called the lead user. With the focus group members who fit the made profile according to the extracted information from the first focus group meeting a Delphi method is executed. In the Delphi method the lead users are asked to answer three questions about the how they see the future of health on the go snacks. The Delphi method will be executed in two rounds.

With the extracted information of the hierarchical value map three product concepts will be made and will be shown to the lead users to comment on.

Next to this 150 observations will be done at a company restaurant where high educated people work. In this case the observation is done at Utrecht Medical Centre. This is a place where well educated people work and they are easy to recognize when observing, because it is assumed that they wear white coats. The observation is done to see if the answers that were given during the focus group match the reality.

A list is made to help make a distinction between healthy and unhealthy on-the go snacks.

Unhealthy on-the-go snacks are: candy bars, chips, donuts, cookies, pastry snacks, chocolate bars and ice-cream. Healthy on-the -go snacks: fruit, salads, smoothies, milk and juices. When an unhealthy and a healthy snack are bought the observation will not be used. There will be focused only on people who buy one food product.

#### *Respondents*

The respondents for the focus group will be consumers who buy on-the-go snacks. Lead users in this research are consumers who fit the made profile which is based on the information obtained from the focus group, the hierarchical value map and the observations.

The composition of the focus group will be both high educated men and women (HBO or university). This based on the assumption of the company Welldesign. They assumed that the target group for the yoghurt vending machine will be high educated women. This is based on the research that woman are more health conscious than men and find it more important to eat healthy food (Wardle, Haase, Steptoe, Nillapun, Jonwutiwes & Bellisle, 2004). To see if it is true that women are more inclined to buy a healthy on-the-go snack a focus group will be held with high educated men and women. There is searched for focus group members on the



university of Wageningen and especially students. First, because there are a lot of high educated people present at the university, second they do not have a commercial benefit in the product idea, third it is easier to compose a focus group because there are a lot of students who can be asked and fourth it is easier to bring a group together. To find if it is possible to sell such a product in The Netherlands, Dutch students will be interviewed. The respondents will be found eating an on-the-go snack bought at the canteen of the Forum building of the University of Wageningen and they are asked to cooperate in a focus group later that week.

### *Procedure*

First the respondent will be asked whether they want to participate in a focus group later that week. Then an appointment is made with the respondent to come to the focus group. In the focus group first six general questions are asked at the lead users. This information is used to make a profile of the lead user of a yoghurt vending machine. In appendix 4 the list of questions are shown which will be asked at the focus group members. Next the members of the focus group are asked to make ladders. The ladders will be about attribute, requirements and values that they currently would like to see in a vending machine. This information will be put in a hierarchical value map and can be used as input for three product concepts. After the focus group the obtained information about from the general questions will be processed with the statistical program SPSS and a with the obtained information from the statistical tests the lead user of a yoghurt vending machine will be determined.

With help of the hierarchical value map and the literature obtained about the trends in the vending machine world, three preliminary product concepts for a yoghurt vending machine will be made. There is chosen to make three preliminary products concepts to present the lead user with a wide range of possibilities and options for the design of a yoghurt vending machine. In this way different options will be evaluated and there can be researched which aspects in the designs the lead users like and dislike. Next to this the Delphi method will be done with ten of the focus group members who fit in the profile and the research will be done via email. There is chosen to execute the Delphi method with ten lead users because literature states that good results can already obtained with a small group of ten persons (Adler & Ziglio, 1996). In this way the members do not know who is involved and everybody can be anonymous. Furthermore the email contact can help the lead users to be more honest about the designs.

The Delphi research (as described in chapter 5.2) will consists of two rounds.

#### Round 1.0

- Ask to give their own vision on the questions that are proposed.
- The answers will be sent back and will be analyzed.
- Conclusions will be made of the statements.

#### Round 2.0

- The concluded statement will be send back with the first vision of the respondent. The respondent is asked if they want to change their prior vision.
- The received answers will be combined and a final conclusion will be made.
- 

Every round will take one week and in this way the whole Delphi research will take two weeks.

Three questions will be asked:

1. What do you think will be the dominated trend in the food market the next 5 years?
2. What will be the most important technique that will be leading in vending machines in the next 5 years?
3. Which consumer need for on-the-go food will be emerging the next 5 years?

What is important for the Delphi method is that the lead users look critical to the statement and that they give their own opinion. That is why the people who participate in the research are anonymous so they cannot influence each other. All the data that is collected is used to give more insights in what the lead users thinks is important in the vending machines. Furthermore the information can be compared with the trends that are found in literature.

#### *Data analysis*

The general information will be processed with the help of the statistical program SPSS.

There are three types of tests that will be used. The chi-square test, the independent T-test and the one-way ANOVA test.

The chi-square test is used to explore the relationship between two categorical variables. The test does not need the assumption that the data is normal distributed. Furthermore the assumption has to be met that expected frequency in any cell should be 5 or more

An independent t-test is used when you want to compare two different groups of subjects on some continuous variable. But therefore a criteria has to be met, the dependent variable has to have normal distribution. An one-way ANOVA test will be used when there is one independent variable which has three or more levels (answer categories) and one dependent continuous variable. The one-way ANOVA test also has to meet the assumption of normal distribution (Pallant, 2007).

The data obtained from the soft laddering interview will be putt in more general terms and with these terms hierarchical value map will be made. In this hierarchical value map the most important ladders will be highlighted.

#### *Validity*

The research is reliable when it reproducible (Ritchie & Lewis, 2003). This means that when the research will be done for the second time the same results have to come out. For the Delphi method it is difficult to reproduce the research because when other people are involved they have other opinions and they can come to other conclusions. Furthermore when the same people are involved they can in the mean time be influenced by other research that has been done in this field and other insights that they have obtained. For the means end chain the same accounts. The research not reproducible and the results be generalized for another group then high educated people (Crowther & Lancaster, 2008).

The generalization of the case study is difficult. For the laddering the group of respondents is small and is not a representation of the Dutch society. Only high educated people were interviewed. When the vending machine with healthy and fresh ingredients is placed at different locations where more people with a different background have access to the vending machine more research should be done. So the research can not be generalized.

## 7. Results

In this paragraph the results of the general discussion with the focus group members, the means-end chain laddering with the focus group members, the observations, the feedback of the lead users on the three product concepts and the results of Delphi research with the lead users will be shown. First the information obtained from the focus group will be shown. Next the results of the laddering will be discussed in the end the observation will explained. For the lead-user research the second phase *identifying trends and key customer needs* and the third phase *collection of needs and solution information from lead user experts* will be discussed.

### 7.1 Discussion focus group

For the focus group 30 respondents were asked to cooperate. There was aimed at a fair division of the genders. In the end women were more willing to cooperate. The composition of the focus group was 17 women and 13 were men. All the focus group members had a university education level (100%), this matches with the aimed target group stated in the methodology. In the end it was difficult to find people who bought their snack at canteen of the Forum building and wanted to cooperate and therefore not only people who bought snacks at the canteen of the Forum building but also people who brought their snack from home were asked to cooperate.

In the focus group first the need for healthy on-the-go was researched. Next there was examined if a difference between gender and healthy on-the-go could be found.

Furthermore there is researched

- If there is a relation between gender and the preferred price
- If there is a relation between gender and the frequency of buying at a vending machine

The statistical tests were executed with a confidence interval of 95% and an  $\alpha$  level of 0.05.

#### Consumer and buying healthy on-the go snacks

Do consumers buy a healthy on-the-go snack? The first question that was asked was: when I can choose between an unhealthy and a healthy on-the-go snack I prefer a healthy on-the-go snack. The results show that of the 30 focus group members, 16 said they would want to buy a healthy on-the-go snack. This was 53.3% of the respondents. Of the 17 women who participated in the interview 76.5% would buy a healthy snack instead of an unhealthy snack. Of the 13 men who participated 23.1% would buy a healthy on-the-go snack. This can be seen in table 5.

**Table 5: Cross tabulation of the variables gender and would buy healthy on-the-go snack**

			Would buy healthy		Total
			Yes	No	
Gender of respondent	male	Count	3	10	13
		% within Gender of respondent	23,1%	76,9%	100,0%
		% within Would buy healthy	18,8%	71,4%	43,3%
		% of Total	10,0%	33,3%	43,3%
	female	Count	13	4	17
		% within Gender of respondent	76,5%	23,5%	100,0%
		% within Would buy healthy	81,3%	28,6%	56,7%
		% of Total	43,3%	13,3%	56,7%
Total	Count		16	14	30
	% within Gender of respondent		53,3%	46,7%	100,0%
	% within Would buy healthy		100,0%	100,0%	100,0%
	% of Total		53,3%	46,7%	100,0%

### Gender versus buying healthier on-the-go snacks

In this part it is analyzed whether there is a significant difference between men and woman and buying healthy-on-the-go food. With other words can a difference be found between men and women based on coincidence or is there really a relation between the variables. A chi-square test for independence will be used to get more insight. Two categorical variables, which both have 2 answer are used:

- Gender: male/female (categorical)
- Would you prefer to buy an healthy on-the-go snack over a unhealthy on-the-go snack: yes/no (categorical)

The follow hypotheses were made:

$H_0$ = There is no relation between gender and choosing healthy on-the-go snacks.

$H_1$ = There is a relation between gender and choosing healthy on-the-go snacks.

In table 6 the results of the test is shown.

**Table 6: Results of the chi-square test with the variables gender and would buy healthy on-the-go snack**

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8,438 <sup>a</sup>	1	,004		
Continuity Correction <sup>b</sup>	6,429	1	,011		
Likelihood Ratio	8,860	1	,003		
Fisher's Exact Test				,009	,005
Linear-by-Linear Association	8,157	1	,004		
N of Valid Cases	30				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6,07.

b. Computed only for a 2x2 table

The table shows that the minimum expected count is 6.07, the assumption for the chi-square test is met. To find the significance level there has to be looked at the Pearson chi-square value. This has a significance level of 0.004, circled in table 6. To be significant the value should be equal or lower than the  $\alpha=0.05$ . This is the case. Therefore  $H_0$  is rejected and  $H_1$  is accepted. So, there is a relation between gender and buying a healthy on-the-go snack. Furthermore the Phi constant (table 7) is used to see what the association level is between the two variables. The association between the two variables is 0.53. According to the criteria that are set-up to understand this effect. A value of 0.1 is seen as a small effect, 0.3 as a medium effect and 0.5 as a large effect. The value of 0.53 indicates a larger effect (Pallant, 2007).

**Table 7: Results that indicate association level of the variables**

	Value	Approx. Sig.
Nominal by Nominal Phi	,530	,004
Cramer's V	,530	,004
N of Valid Cases	30	

Due to the significant difference calculated with the chi-square test, differences in percentage is not based on coincidence but on a relation between gender and the buying of healthy on-the-go food.

### Gender versus preferred price

Here is researched if there is a relation between gender and the preferred price for a healthy on-the-go snack. For this test two variables are used.

- Price: different answers possible (continuous)
- Gender: male/ female (categorical)

To perform a T-test, it should be determined whether or not the sample is normally distributed. To determine this a test of normality is performed. In appendix 5 the result of this test can be seen. The result of this test was positive and this means that the T-test can be executed.

To test if there is a relation between gender and preferred price the following hypotheses were made:

$H_0$ = There is no relation between gender and preferred price for a healthy on-the-go snack.

$H_1$ = There is a relation between gender and preferred price for a healthy on-the-go snack.

First there has to be looked at the Levene's test to see if there is equality of variance. There is equality of variance when the value of the test is higher than 0.05. In table 8 can be seen that this is the case. The value is 0.208. Next there has to be looked at the significance level, this is 0.001. This value is lower than the  $\alpha$  of 0.05. This means that the  $H_0$  is rejected and  $H_1$  is accepted.

This means that there is a difference in preferred price for a healthy on-the-go snack between men and woman.

**Table 8: results of the independent t-test with the variables price and gender**

		Levene's Test for Equality of Variances		t-test for Equality of Means						
										95% Confidence Interval of the Difference
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Price	Equal variances assumed	1,661	,208	-3,742	28	,001	-,62330	,16658	-,96452	-,28209
	Equal variances not assumed			-3,832	27,702	,001	-,62330	,16266	-,95665	-,28996

In table 9 the percentages are shown of the given answers. Here can be seen that 76.5% of the women is willing to pay 2 euro or more for the on-the-go snack versus 15.4% of the men. Because of the significant difference, which is shown with the T-test, it can be said that the difference between gender and preferred price is not based on coincidence.

**Table 9: Cross tabulation of the variables gender and preferred price**

			What is the respondent willing to pay for an fresh on-the-go snack?									Total
			1,00	1,25	1,50	1,75	2,00	2,25	2,50	2,75	3,00	
Gender of respondent	male	Count	2	2	5	2	1	0	1	0	0	13
		% within Gender of respondent	15,4%	15,4%	38,5%	15,4%	7,7%	,0%	7,7%	,0%	,0%	100,0%
	female	Count	0	0	4	0	4	4	4	2	1	17
		% within Gender of respondent	,0%	,0%	23,5%	,0%	29,4%	5,9%	23,5%	11,8%	5,9%	100,0%
Total		Count	2	2	9	2	6	1	5	2	1	30
		% within Gender of respondent	6,7%	6,7%	30,0%	6,7%	20,0%	3,3%	16,7%	6,7%	3,3%	100,0%

### *Gender versus frequency of buying*

Is gender related to the frequency of buying a snack? For this test two categorical variables are used. One with 2 answer possibilities and the other one with 8 possible answers.

- Gender: male/female (categorical)
- Frequency of buying an on-the-go snack (categorical)

The follow hypotheses were made:

$H_0$ = There is no relation between gender and frequency of buying a snack

$H_1$ = There is a relation between gender and frequency of buying snacks

A chi-square test was executed. For the chi-square the assumption has to be met that the lowest expected frequency in any cell should be 5 or more. This assumption is not met. Therefore there has to be looked at Fisher's Exact test. The result of this test has a significant level of 0.100. This is not lower than the  $\alpha$  of 0.05. This means that  $H_0$  is accepted. Therefore there is no relation between gender and the frequency of buying. In table 10 the results of test are shown.

**Table 10: Results of the chi-square test with the variables gender and frequency of buying**

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	10,826 <sup>a</sup>	6	,094	,077		
Likelihood Ratio	13,328	6	,038	,081		
Fisher's Exact Test	9,661			<b>,100</b>		
Linear-by-Linear Association	1,800 <sup>b</sup>	1	,180	,200	,107	,031
N of Valid Cases	30					

a. 14 cells (100,0%) have expected count less than 5. The minimum expected count is ,43.

b. The standardized statistic is 1,342.

## **7.2. Means-end chain laddering interview**

This research is done to find out what consumers want in a vending machine which can dispense healthy ingredients and how the consumers would like to see such a machine. When using a focus group to develop such a machine, insights can be given in what the consumer finds important for vending machines with healthy ingredients. With this research there can be seen whether or not the consumer does want a freshly made on-the-go snack. To obtain this information a soft laddering research was used.

The main question asked was: 'if you could design a vending machine which dispenses healthy ingredients, what are the most important attributes this machine has to have to fulfill your needs?' The group members did not need a long time to think about what they would like to see in such a vending machine. The researcher only had to help the group members to come to the level of the values.

The result of this was that each member wrote down three attributes which led to three ladders per group member. In the end 90 ladders with a wide range of answers for the attributes, the consequences and the requirements were made. These answers are categorized and placed under more general terms. The answers which were given more than 5 times in a category will be mentioned. The cut-off level therefore is 5. When using a lower cut-off level, the terms that are used will be based on answers only two or three members had given. The *n* next to the general term indicates the times the term is mentioned by the focus group members. The hierarchical value map is shown in figure 7. The most mentioned ladders are:

- Nutritional value (attribute) -> Maintaining health (consequence) -> Quality of life (value)
- Easy to use (attribute) -> Convenience (consequence) -> Performance (value) -> Achievement (value).

In the hierarchical value map these two ladders are made bold. In appendix 6.1 a list of definitions that are used in the hierarchical value map can be found.

Next the ladders will be explained in more detail with the help of explanations and examples the focus group gave. The attribute that a lot of group members wrote down as the first attribute of three was the attribute 'nutritional value'. Examples of answers that were given are: no extra sugars should be added, it should deliver enough energy and at the same time it should not contain a lot of calories. The attribute nutritional value was linked by the group to maintaining health and nutritional intake. These two consequences are linked to the values: quality of life, satisfaction and peace of mind. When having food with a high nutritional value this benefits health and members of the group link eating food with high nutritional value to maintain their health. They do this because a good health influences the quality of life. Other group members answered that they do not have to worry about what their next meal is because they already had a healthy meal that day, which gives them piece of mind. Furthermore sometimes when you are eating unhealthy food like French fries and you are eating this in the train, other passengers look at you because it smells and they could think of you that you are living an unhealthy life. Choosing for a healthy snack can give you more piece of mind, because you will not think about what other people think of you. And for some group members eating healthy gives satisfaction, they are fulfilled that they have eaten healthy that day.

The attribute 'freshness of ingredients' is linked to enjoyment, nutritional intake and maintaining health. With respect to the enjoyment the group indicated that they prefer eating fresh foods because of the appearance and taste of the ingredients. Examples that were given were the white rash on chocolate that some focus group members noticed and the possible presence of additives in the products when they are not fresh. Some group members perceive fresh products as products which are more natural and this gives enjoyment. Furthermore the focus group said that fresh ingredients are healthier than ingredients that can be stored for a longer time. Some group members stated that they would want to buy a fresh and healthy on-the-go snack, but it will depend on the price and on what kind of product it will be.

The attribute ingredient variation is linked to consequences 'choice' and 'enjoyment'. Everybody said that they would like to have a broad assortment. This way they have the possibility to choose. Not every day they feel like eating the same and there is a difference in how much hunger the consumer has. Therefore they would like to choose a product that fits the craving of that day. The variation in the ingredients decreases the sameness of the product. The choice that the consumer has is important according to the group. The consumer wants to decide for themselves what they. This influences the enjoyment of the product.

One of the two ladders which is mentioned most of the time starts with the attribute easy in use. A snack is a food product which people eat in between the main meals, and often when people have a craving. It should not take a long time to prepare because they quickly want to fulfill the need of craving. It should be easy to use so it can be done in between tasks. The easiness to use will increase the convenience of the consumer. When the machine is really convenient group members would want to try it another time. Also the way of paying when using a vending machine was a point of attention. The group thinks that both cash and bankcard should be an option. One member even mentioned the possibility of paying with the mobile phone. In this way the consumer can always buy the product independent of having your wallet on you. When a machine is convenient to use, the consumer finds it easy to use the machine and time can be saved. The consumer does not want to waste time and energy on ordering and waiting on the snack being made. In the end convenience is linked to the value performance and achievement. Because of the convenience time and energy is saved. This is important because now this time and energy can be used to perform better at the task that they are doing for example running to the train or working at their desk. In the end this is important because this is linked to achievement. Successfully accomplishing the task, like catching the train or get the job done at work.

Taste was another important attribute mentioned in the group. A flavour that is attractive gives enjoyment, which is linked to the value pleasure. Answers that were given that were placed under the term taste were words that also described the texture of the ingredients. The different textures can give different dimensions to the mouth feel and as a result of this it can give enjoyment. Next to this the taste can be an indicator for the quality of the products. The group mentioned that in this way there can be checked if the product fulfills the expected quality. This in the end can give the consumer piece of mind.

The package of the product was mentioned by some group members. The main thing that was mentioned about the package was the design. The package should be easy to hold and should be easy to eat from. The snacks are most of the time for on-the-go. The design of the package therefore should be fine tuned to this demand. Eating and doing other tasks at the same time. When this is possible this will increase the convenience of the product and will leave time to do other things. Next to this the amount of food they would get should not be too big. Furthermore the ingredients should not be too small, the group said that they clearly want to see what they eat. Next to this focus group members mentioned that sometimes you have to buy a package that is too large. For example a Twix can only be bought in with two bars in one package and for drinks you always have to buy an half a liter bottle.

Only five group members mentioned the safety and the hygiene of the machine. This indicates that most of the group members do not really think about the hygiene of the product and the machine. They take this for granted. The members that did mention the hygiene of the machine, said that the appearance (does the machine look clean and is nothing broken) of the machine is an indicator of the quality of the food that is in the machine. The hygiene of the machine works as an extrinsic cue for products. The hygiene of the machine is linked to the consequence control. The group mentioned that they wanted to see a clean machine and in this way check if everything is ok with the product. This checking of the hygiene of the machine is linked to the piece of mind. They can eat the snack with no worries about becoming sick.



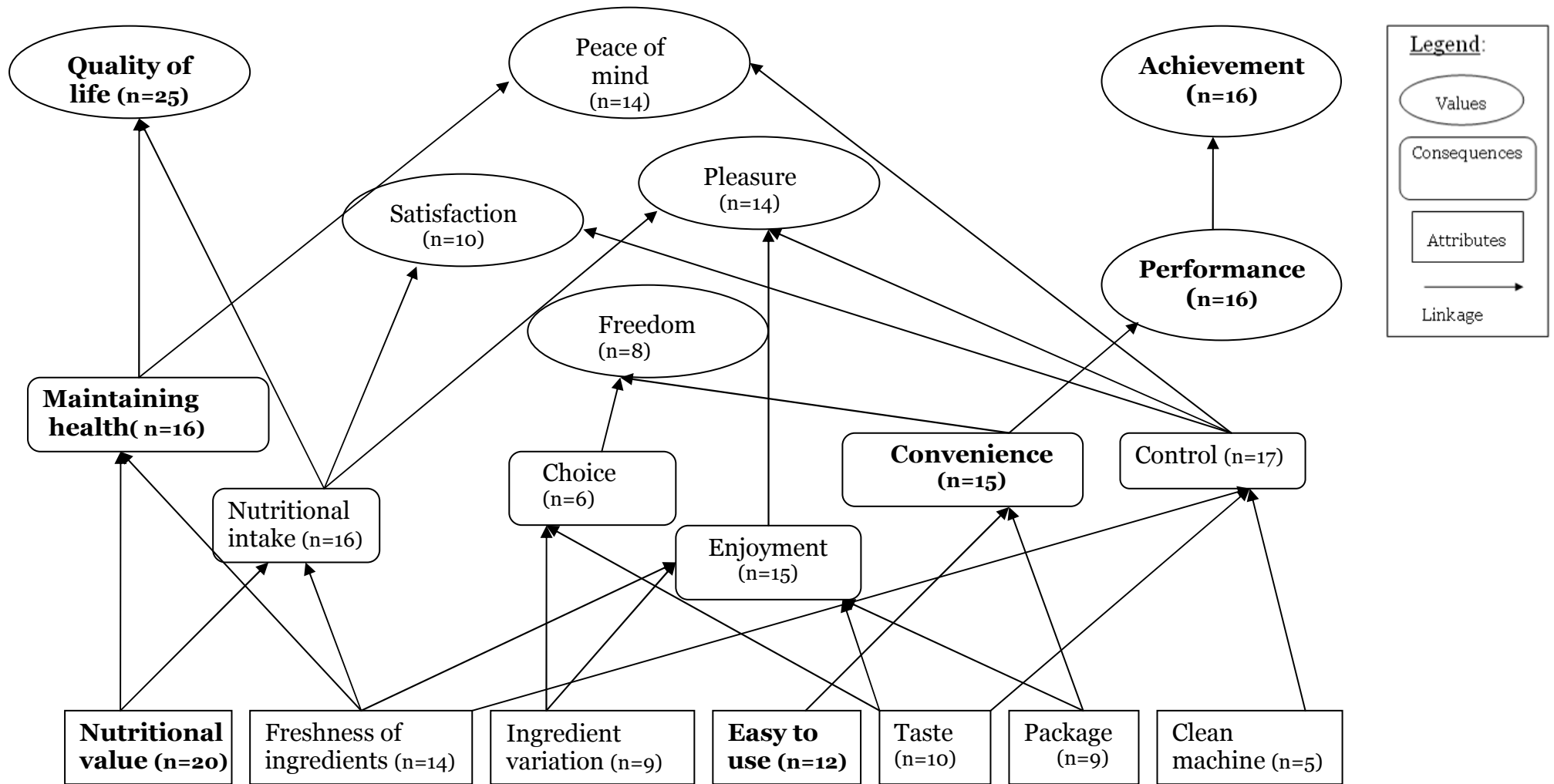


Figure 7: The hierarchical value map of a healthy vending machine

To make a better distinction between the genders in figures 8 and 9 the hierarchical value maps are shown made only for the genders. Furthermore in appendix 6.2 tables are shown which converted the values into percentages to make a comparison between the hierarchical value maps of the genders. What can be concluded from the hierarchical value maps that for three of the six made ladders there are no big differences between men and women. But for some men and women have a different vision on how they would design a vending machine with healthy ingredients.

It is shown that women find the quality of the ingredients the most important attribute and relate this to their health and in the end quality of life. The men find the usefulness and the consequence convenience of the machine the most important because in the end it can help them to perform better and this influences how they will achieve their goal.

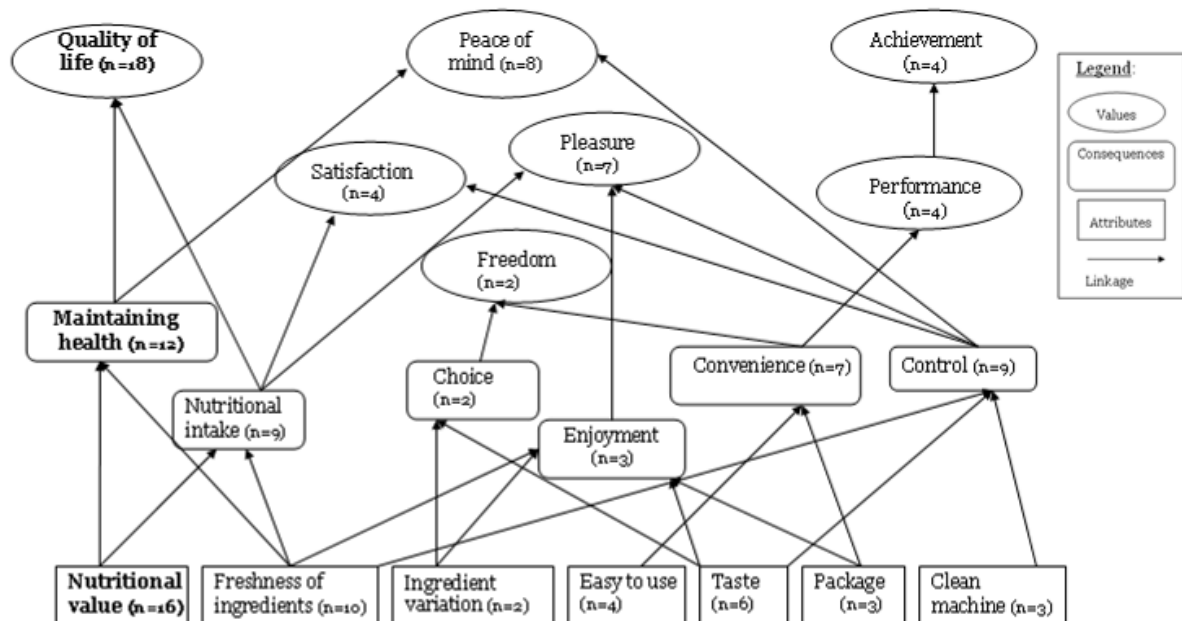


Figure 8: Hierarchical value map made only with answers of female focus group members

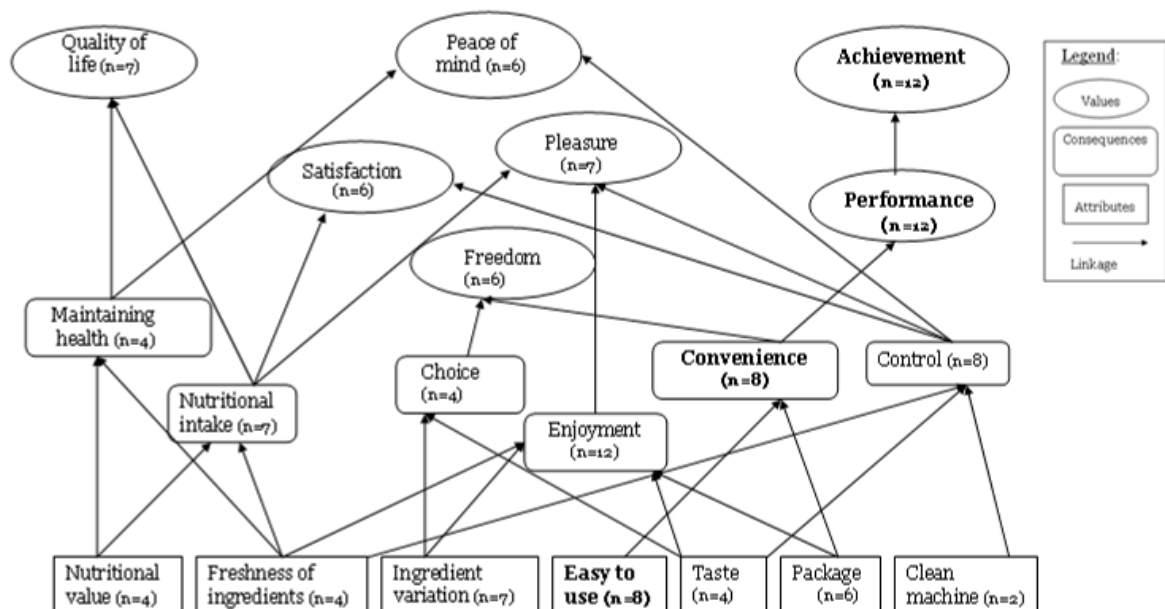


Figure 9: Hierarchical value map made only with answers of male focus group members

### 7.3. Observation

After the focus group interviews were done an observation was held. This observation was done to see if the answers that were given in the focus group match with the reality.

The observation was held at the Utrecht Medical Centre, at the moment of observation there was a special offer for fresh fruit. The observation was done from 14:30 until 16:00. There is chosen for this time because the yoghurt snack is seen as a snack for in between meals. The late afternoon is seen as that time of the day when the most cravings and the need for snacks occur (McGuire & Beerman, 2009).

In total 153 people were observed and 45.8% bought a healthy on-the-go snack (table 11).

**Table 11: Cross tabulation of the variables gender and bought healthy on-the-go snack**

			Observation bought healthy food?		Total
			yes	no	
Observation what is the gender of the buyer	male	Count	22	63	85
		% within Observation what is the gender of the buyer	25,9%	74,1%	100,0%
		% within Observation bought healthy food?	31,4%	75,9%	55,6%
		% of Total	14,4%	41,2%	55,6%
	female	Count	48	20	68
		% within Observation what is the gender of the buyer	70,6%	29,4%	100,0%
		% within Observation bought healthy food?	68,6%	24,1%	44,4%
		% of Total	31,4%	13,1%	44,4%
Total	Count		70	83	153
	% within Observation what is the gender of the buyer		45,8%	54,2%	100,0%
	% within Observation bought healthy food?		100,0%	100,0%	100,0%
	% of Total		45,8%	54,2%	100,0%

From the table above can be seen that there is a difference between men and women and buying a healthy on-the-go snack. Of the 85 observed men 25.9% bought a healthy on-the-go snack. Of the 68 observed women this was 70.6%. In total from the observed persons that bought healthy on-the-go (70 people) were 68.6% women.

In the end more then half of the observed people bought an unhealthy on-the-go snack.

To find out if the difference between men and women is based on coincidence or if there is a relation between the variables, a chi-square test for independence will be used to get more insight. The two categorical variables, which both have 2 answer options are:

- Gender: male/female (categorical)
- Bought a healthy on-the-go snack?: yes/no (categorical)

The follow hypotheses were made:

H<sub>0</sub>= There is no relation between gender and buying a healthy on-the-go snack.

H<sub>1</sub>= There is a relation between gender and buying a healthy on-the-go snack.

In table 12 the results of the test is shown.

**Table 12: Results of the chi-square test with the variables gender and bought a healthy on-the-go snack**

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	30,421 <sup>a</sup>	1	,000		
Continuity Correction <sup>b</sup>	28,646	1	,000		
Likelihood Ratio	31,399	1	,000		
Fisher's Exact Test				,000	,000
Linear-by-Linear Association	30,222	1	,000		
N of Valid Cases	153				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 31,11.

b. Computed only for a 2x2 table

The table shows that the minimum expected count is 31, 11, the assumption for the chi-square test is met. To find the significance level there has to be looked at the Pearson chi-square value. This has a significance level of 0.000, circled in the table. To be significant the value should be equal or lower than the  $\alpha$  of 0.05. This is the case. Therefore  $H_0$  is rejected and  $H_1$  is accepted. So, there is a relation between gender and buying a healthy on-the-go snack. Furthermore the Phi constant (table 13) is used to see what the association level is between the two variables. The association between the two variables is 0.45. According to the criteria that are set-up to understand this effect, a value of 0.1 is seen as a small effect, 0.3 as a medium and 0.5 as a large effect. The value of 0.45 indicates a larger effect (Pallant, 2007).

**Table 13: Results that indicate association level of the variables**

	Value	Approx. Sig.
Nominal by Nominal Phi	-,446	,000
Cramer's V	,446	,000
N of Valid Cases	153	

When the data obtained from the observations is compared with the results from the answers from the focus group members. Some slight differences can be seen. From the focus group came forward that 53.3% of the respondents would buy a healthy on-the-go snack. In reality this value is lower namely 45.8%. In the end also the observations showed that there was a relation between women and eating healthy on-the-go food. The association level is a bit lower but can still be large effect.

Next to this there are some small differences in the ratio of consumers who buy on-the-go food. From the interview with the focus group came forward that 23.1% of the males and 76,5% of the females would buy a healthy on-the-go snack. In reality this ration is a bit different during the observation 25.9% of the men and 70.6% of the women bought a healthy on-the-go snack. There is a small difference between the answers of the focus group members and the observation. Still a significant difference is found in both cases.

From the hierarchical value map which made a differentiation between the genders can be seen that especially women find the nutritional value and freshness of the ingredients important for maintaining their health and their quality of life. From these results can be concluded that high educated women are the target group of the yoghurt vending machine and are seen as the lead user of a yoghurt vending machine.

In chapter 5.4 an estimation of the costs for the yoghurt snack is made (approximately 1.30 euro). From the interview with the focus group members became clear that women are willing to pay between 2 and the 3 euro for a healthy on-the go snack. When comparing these two values with each other it becomes clear that the price the women are willing to pay is possible.

## 7.4 The lead user method

As described in the theoretical framework the lead user method consists of four phases. The first phase is already discussed in the chapter 5.4. The second and the third phase will be executed.

### 7.4.1 Phase two: Identifying trends and key customer needs

In phase two there is focussed on the current trends in different sectors that have a link with vending machines which can dispense healthy ingredients. This research will give insights in what could be trends in the future. Furthermore there will be looked at the current alternatives on the market for vending machines with fresh ingredients.

- Food trends

There are different trends to distinguish in the food sector nowadays. First there is the trend of the *healthy consumer* (Sloan, 2007). The consumer buys healthy products to reduce the risk of developing health conditions. These products often contain, for example, fibres, extra calcium or antioxidants. Second, there is a trend for more *healthy snacks* in the vending machines. This means that a consumer will go to the vending machine and more often chooses for a healthy snack instead of an unhealthy snack (Sloan, 2005). Thirdly, because of the grab-and-go lifestyle of the current consumers, *new distribution channels* arise. Therefore the convenience stores are becoming a more important place for selling on-the-go food. It is easy and time saving to buy your food on-the-go (Sloan, 2008).

Other trends in the food sector are the *quick fix* trend, the consumer takes less time to prepare a meal and does not want a lot of side dishes. One of the reasons for this is the limited cooking skills of the consumer and lack of interest for cooking by the young adults. A trend that is related to this is the trend of *prepared meals*. World wide there is an increase of convenience and ready-to-(h)eat meals. The package is becoming more important for this product because it has multiple functions. It is not only for protecting the ingredients, it also needed to help the eating possibilities (IFT, 2005).

When the consumer takes time to eat, they often choose for premium food products that are really a treat for the consumer. These are often products that the consumer buys to pamper themselves. This can be products like chocolate with special species and coffee with a special blend. This *soul food* trend can also be found in on-the-go shops, for example Starbucks coffee can be bought in different special blends.

In the last years the popularity of yoghurt increased, this is due to the introduction of functional yoghurt, and the healthy image this dairy product has. Functional yoghurt is yoghurt which is enriched with ingredients that provide a health benefit next to the traditional nutrient requirements. Examples are yoghurts which are fortified with vitamins or calcium (Gibson, Williams, 2003). The popularity of yoghurt as an on-the-go snack can be illustrated by the growth of 45% of dairy packet products in vending machine in the United States of America in 2004 (Sloan, 2005). Another reason for the growth of yoghurt sales is that yoghurt is marketed more as an all day snack instead of a dessert (Adwan, 2003). This can also be seen by the success of the introduction of the breaker in the Netherlands, breaker is a yoghurt drink, which is placed on the market as a snack which can be eaten at every moment of the day. The introduction of the breaker in 2001 was a success, more flavours were developed and breaker nowadays can still be found at the retailer and in convenience stores (Friesche vlag, 2010).

- Economic trends

Consumers have less money to spend nowadays due to the economic crisis, they do not spend a lot of money outside the house anymore as they did (CBS, 2010). The price has always been an important factor for buying a product but currently also the quality and the service has become more important factors when buying a product. Furthermore the private labels are

becoming more popular in the supermarkets. These brands have the best price/quality ratio according to the consumer (Euro RSCG Worldwide, 2008, Deliott, 2010). The consumer really wants, now more than ever, value for money. The consumer wants to buy a product that they trust and therefore the consumer does not buy a product immediately but will browse and see if there are other products that have a better price/quality ratio or that they trust more. Another trend that is related to this is the fact that consumers will exchange information via the internet and in this way the internet is becoming much more important element in the decision pattern to buy a product (Livecom, 2009).

#### ▪ Technological trends

In the vending machine world also new trends are occurring. One of the biggest new trends is the use of touchscreens instead of the regular buttons. This is a new and interactive way of ordering and it is easy to use. The consumer only has to press on the screen what they want. Another advantage of using a touchscreen is that it can change easily. When an option or flavour it is not available anymore this can be removed from the screen so the consumer cannot press that button anymore or the screen can say that that option is not available. Additionally the vending machine can be equipped with computer equipment so when there are no ingredients available anymore, the supplier knows the machine has to be filled. In the multi-media sector this touchscreen trend is also spotted, examples of these trends in other industries are the ipad and smart phones. A new way of paying that is just in the pilot phase can be found in Japan. Here the hand is scanned and the machine recognizes the customer. The fingertips are linked to a credit card and a postal address. The machine has a screen which gives advises about other products. The customer can choose to send a sample these advised products to their address (Hitachi's, 2010).



Co-designing of your own product is a trend that is already present in the food industry. A new dimension is given to this with the Coca-Cola freestyle dispenser. With this vending machine every consumer can design their own coke. It has 100 flavours present in the machine so that a lot of combinations are possible. Next to this the Coca-Cola freestyle dispenser also has a touchscreen as can be seen in figure 10 (Fastcompany, 2009).

**Figure 10: Touchscreen of the freestyle Coca-Cola dispenser**

Another trend that is beginning to become more mainstream is the trend of frozen food and the ability to prepare the snack in the vending machines. There is a vending machine on the market for fresh French frites (Foodcube, 2008) but also for fresh made pizza. The complete pizza is being made in three minutes and uses infrared rays which reach a temperature of 300 °C. The price for one pizza is around the 5 euro. Furthermore the machine offers the possibility to watch the pizza being made, by placing a window in the machine to see the preparing section. In figure 11 the pizza vending machine is shown (Let's pizza, 2010). It is



**Figure 11: The front view of the pizza vending machine**

not only possible with heat also ice snack are an option. There is an ice cream vending machine which can make a tailor made ice cream in 40 seconds. The consumer only has to take three steps and the ice cream is being made. The ingredients are not frozen but with a special flash freezing technology the ingredients are frozen. The ice crystals are formed on the spot. There are 96 variations available also with this vending machine the consumer can tailor make their snack (Fastcompany, 2009). An evolving trend in the vending machine world is the trend of the solar vending machines. These machines do not need electricity but use green energy.

A major advantage of these machines is that they are good for the environment and that they can be placed everywhere. This has the advantage that completely new selling locations can be entered like the beach, the mountains and the golf court (Solarvending, 2008).

In the coffee vending machines also a new trend is occurring. It is called the Bemoved vending machine. The machine is equipped with motion sensitive cameras. When you are



moving up and down and to the side the camera sees this and in this way different ingredients can be dragged into the coffee see figure 12. Furthermore when the coffee is dispensed out of the vending machine, the consumer can check the weather forecast and the news. The personal made coffee can be saved in the profile, in this way the next time in one touch the personal coffee can be made (Fastcompany, 2009).

More research is done on this new technique. A similar technique is being researched for a tea vending machine. With this vending machine a mat is used. With this the feet have to be used to make preferred choice (Martello, 2010).

**Figure 12: Consumer using the Bemoved Vending machine from Douwe Egberts**

In the world of the healthy fresh-on-the-go snacks there are not a lot of products available. One of the products is the orange juice vending machine (figure 13). In 15 seconds a fresh juice is made. The machine can be placed everywhere and the juice company cleans and stocks the machine. The customer of the machine does not have to do anything. The machine is already placed at the University of Amsterdam (Orangejus, 2010). This type of machine is becoming popular there are multiple companies who offer such machines (Officejuice, 2010, Oranfresh, 2010)



**Figure 13: The fresh juice vending machine**



Danone is also introducing a new yoghurt vending machine. This machine produces yoghurt smoothies and can make a smoothie in 47 seconds. The temperature of the smoothie is  $-1^{\circ}\text{C}$ . The low temperature indicates that it could be possible that frozen fruit paste could be used, this is quickly defrosted and mixed with the yoghurt. The paste for example can be smoothie cubes, small cubes of frozen fruit which can be blended with milk to a smoothie in a few minutes (Creativegourmet, 2010). The process of the yoghurt being made can be followed via the flat screen on the machine. In figure 14 the test machine of Danone can be seen (Mars-online, 2011).

**Figure 14: Test machine to make the yoghurt shake of Danone.**

A new technological trend that can be spotted in the catering business is a different way of filling of cups. With the new technique the cup is filled from the bottom. The technique works with magnets that opens valve on the underside of the cup when it is placed on the dispenser.



The bottom of the cup is place over the dispenser. When the cup is filled the valve closes and the cup has to pop of the stand (figure 15). It is a much quicker way of filling the glasses.

Furthermore it reduces waste and now problems with the foaming of the beer (Bottoms up beer, 2010).

**Figure 15: The bottoms up beer dispenser mechanisms**

From the alternative vending machines that are currently present on the market can be concluded. That there is still no machine developed that combines dairy with fresh fruits and works completely automatic. The added value of the yoghurt vending machine therefore is that an on-the-go yoghurt snack with fresh fruit can be made when pushing one button. The ingredients are natural and fresh, no additives are added and no extra production step is done increase shelf life of the ingredients.

### **7.4.2 Phase three: Collection of needs and solution information from lead users**

With the help of the information obtained from the focus group, the hierarchical value map and from the observations a profile of the lead user for a yoghurt vending machine. It shows that especially high educated women are more inclined to buy healthy on-the-go from vending machines. Subsequently women are also willing to pay more for a healthy on-the-go snack. For the Delphi research 10 focus group members were searched which suited this profile of high educated female and they were asked if they wanted to cooperate in a Delphi method. In the end 8 focus group members wanted to cooperate in the Delphi method.

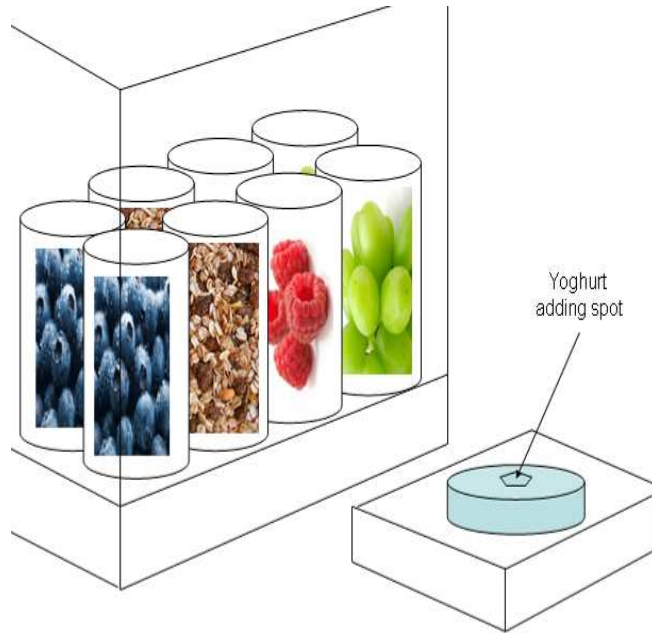
#### *Concept designs*

With the help of the theoretical framework that was executed in the previous paragraph, the hierarchical value map and the general information obtained from the discussion in the focus group three product concepts for vending machines which can dispense healthy and fresh ingredients were designed. The concepts will be described with according to the marketing mix tools the four Ps; Product, Place, Promotion and Price (Kotler & Keller). This is done to find out how the lead users prefer to see the machine. For every concept a different price, location and technology is used to see find out the lead users opinion. The product concepts were shown to the lead users and they were asked to give their opinion about the different concepts. In appendix 7 the sequence of making a yoghurt snack in different drawings is shown. For all the drawings four basic ingredients are used, this assortment can be expanded with different types of whole small fruits as mentioned in appendix 3. Also for the designs the spoons for the snack will be provided, but are not shown in the drawings. The prices that are mentioned for the snack are based on the answers that the female focus group members gave on the question about the price willingness to pay for a healthy snack. There is checked if the lead user has another opinion about the price when they see the design of the machine. The yoghurt vending machine will be placed on locations where a lot of high educated women come. To find out what the lead users think are the best suiting locations, for every machine locations are described. In this way there can be research what the lead users finds the most suitable place for the yoghurt machine.

#### *Concept 1 (figure 16)*

The idea of the first concept is based on the bottoms up-beer idea that was explained in the previous paragraph. Next to this, because of the two steps that have to be taken to make the snack, the consumer can see the product being made and can see that the product is completely fresh. Next this machine is easy to stock and is also easy to clean.





**Figure 16: Drawing concept 1**

A dispenser that can be placed on a table or a counter where the consumer also has to execute a step.

*Price:* 2, 75 euro per beaker

*Place:* The machine can best be used in a company canteen. Two steps are needed to make the yoghurt snack and more space is needed to make the snack.

*Promotion:* Healthy fresh snack, yoghurt is dispensed into the cup from the bottom. The yoghurt adding from the bottom would be the wow effect.

*Product:* The beakers are packed with fruit and are MAP packed. The beakers are cooled in a small table refrigerator. The consumer makes a choice for a preferred taste and picks the beaker from the refrigerator. Then the consumer removes the lid and places the beaker on the valve on the platform next to the refrigerator. Then the beaker is filled from the bottom.

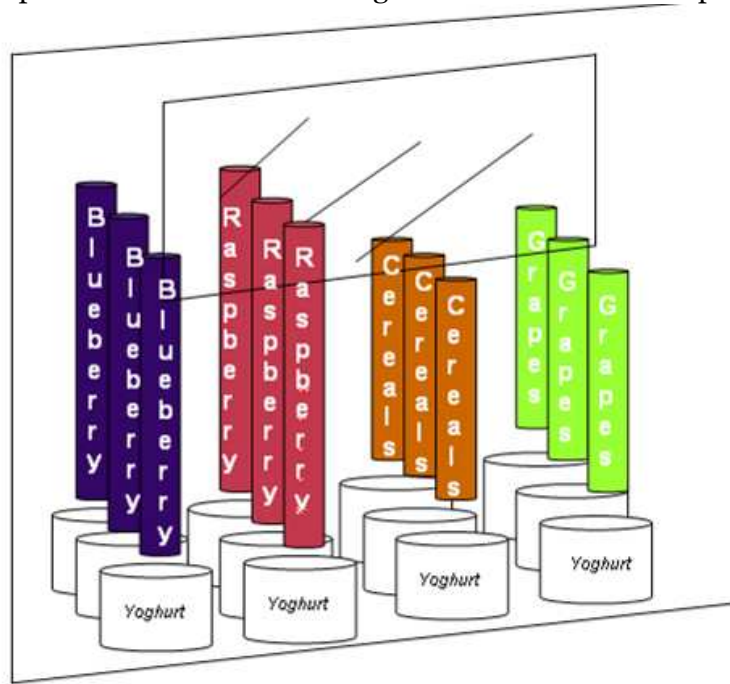
*Response lead users concept 1:*

The positive points of this concept were according to the lead users the price of the product. They also did not mind that two steps have to be taken to make the product; they gave the example that at IKEA the consumer also has to make the ice cream themselves. So, the two steps are not seen as slowing down or lowering the convenience of the process of making a yoghurt snack. The selling location was also appropriate for the machine, but it would be difficult to use this concept for example on a train station. Next to this the technology of adding the yoghurt from the bottom was a new technology that they think will attract consumers.

Negative aspects the lead users found are: that it is not possible to have three ingredients in one snack. It is only possible to have cereals with yoghurt or fruit with yoghurt, this limits the choice possibilities and therefore the variation possibilities. Another point that the lead users would like to see different is that in this concept it is not possible to determine your own portion size. Furthermore they think that mixing the ingredients will be difficult when yoghurt is added from the bottom. This is because no lid is provided and shaking therefore is difficult when yoghurt is only added from the bottom.

*Concept 2 (figure 17):*

The idea for the second concept is based on the hierarchical value map. This states that the consumers would like to have variety in their meals. Next to this in the focus group, members said that their cravings often differed. Therefore there is chosen for the possibility to buy the ingredients separately and for different cravings a snack can be bought. The package is resealable this is based on the hierarchical value map which stated that the package should have the right amount for a snack. This amount differs per consumer and when providing a resealable package the consumer can determine the right amount themselves and store the part that is not used. Next to this a touchscreen was introduced based on the literature research touchscreens will be the standard in the future. The promotion is based on the input from the focus group members that told that high nutritional value is important.



**Figure 17: Drawing concept 2**

Complete yoghurt snack can be bought but also separate compounds of the snack can be bought.

*Price:* 3,00 euro for one tube with 7 pieces of fruit and one cup of yoghurt.

*Place:* Gym, sport canteens, hospitals, Wi-Fi hotspots and events. There is chosen for this location because these can be places where there is a higher than normal need for healthy food in the assortment and a lot of people come together at these places.

*Promotion:* The promotion of this concept is that it is emphasized that the ingredients have a high nutritional value. For example high on fibres and vitamins. Furthermore it should be made clear that the ingredients can be bought separately and that the package is resealable.

*Product:* With this machine a touchscreen is used. Furthermore it is possible only to buy the fruit. The fruit is MAP in a long tube which in the end is a spoon, just like some straws have.

The consumer themselves have to add the two parts together or can buy only the fruit tube. There is chosen for this because the yoghurt snack is seen as a small snack in between two meals.

The machine is see trough except from the place where the touchscreen is positioned and will be the size of a small refrigerator.

The tubes will be in the colour of the fruit, the tube will still be see-through but the fruit will be less visible because of the colour used.

### *Response lead user concept 2*

The most positive reactions on this concept were about the resealability of the tubes with the fruit. The lead users said that this made it easier to determine the amount of the yoghurt snack because not every ingredient has to be used right away. Furthermore the lead users also liked the idea of buying the ingredients separate because sometimes you do not feel like eating yoghurt. The use of a touchscreen is seen as a good addition to the machine, it can help increasing the convenience in the machine. Subsequently the lead user liked the fact that there were a lot of possibilities to combine and to add ingredients. They like that they had the possibility to choose and combine.

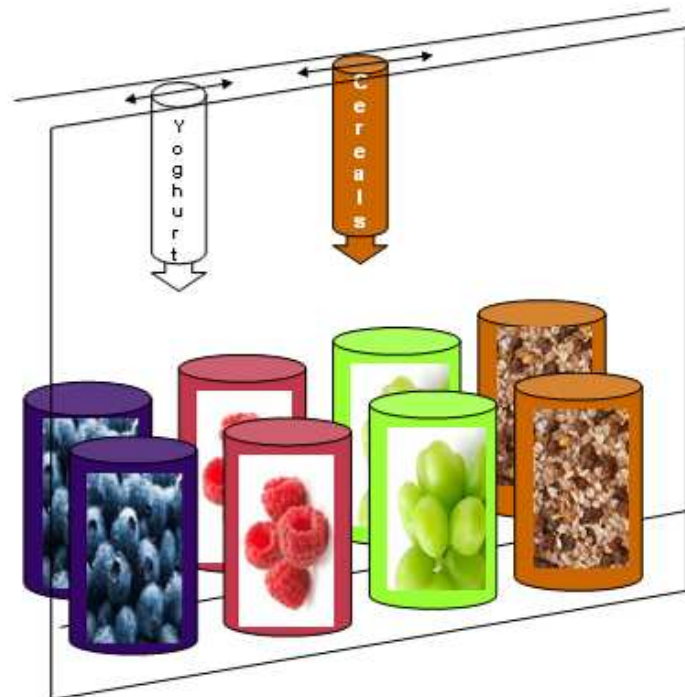
Some aspects that the lead users did not like about this concept were first the package of the ingredients. The colour on the tubes is not an improvement, the consumer would like to see the ingredients. They judge the freshness of the ingredients according to the colour of the ingredient. Not all the locations that were mentioned were seen as proper selling locations of the yoghurt snack. The lead users preferred the hospital and the gym.

The amount of fruit was also a point of improvement because the lead users found that the pieces of fruit in the tube are a bit low compared to the price you have to pay.

The last negative aspect of this concept is that the consumer has to mix the ingredients themselves. This is an extra step the consumer has to do that is more with concept 1 transferring the beaker to another spot.

### *Concept 3 (figure 18):*

The third concept is based on the found results that the consumer wants convenience. With this machine the consumer only has to push one button. With this machine it is also possible to have all the three ingredients in one snack. The promotion is based on emphasizing the healthiness of the product. Orders will be placed via the order manual with buttons next to the machine. Furthermore the front side of the machine will be see trough, so the consumer can see how the product is made.



**Figure 18: Drawing concept 3**

The complete snack is made in the machine.

*Price:* 3.50 euro for one ingredient with yoghurt.

*Place:* Cinemas, sport events and concerts.

*Promotion:* This product will be placed on the market as convenient, fast, easy product. It is a product that already contains a percentage of the daily needed nutrition.

*Product:* Beakers with MAP fruit and a one portion package with yoghurt or cereals hang above the beakers. This yoghurt package can move horizontally above the beakers. When an order is placed package will come down and will break the sealing and the yoghurt or cereals are added to the fruit in the beaker. Then the package is moved up and moved to the side, here the package will be removed and a new package will be putt on the rail.

### *Response lead user concept 3*

It is a very flexible machine, it can be placed at the described selling locations but the lead user thinks that the machine can easily be placed at other locations. Furthermore it is positive that all the three ingredient components are present in the yoghurt snack and that the cereals are added on top at the end because otherwise the crunchiness could be affected. Also seeing the product being made gives the machine something extra. Because you can see that the ingredients are fresh and it is really freshly made in front of your eyes.

A negative aspect was according to all lead users the price of the yoghurt, it was too high. The lead users also thought about the possibility that because of the technologies that are used the machine could break down easily and you then do not have a yoghurt snack. Furthermore the cleaning of the machine and the appearance that the machine is clean is an aspect that when it is not done properly is negative for this concept. The cinema was the only location that according to the lead users is a place where they would buy a yoghurt snack.

In summary according to the lead users a yoghurt vending machine should contain ingredients that are packed separately but the machine should also have to possibility to add the three ingredients (yoghurt, cereals and fruit) together in one package. This will increase the combinations that can be made and therefore the choice possibility of the consumer. The ingredients should be added on the spot because this shows the freshness of the products. The machine should be light and see trough so the consumer can see how the product is being made. The beakers should also be see trough so the consumer can see the ingredient and can determine the freshness of the ingredient. Next to this the beakers with the ingredients should be resealable and in different sizes, in this way the consumer can store the ingredient and can choose different yoghurt sizes. The price of one yoghurt snack should not be higher than 3.00 euro, which is in agreement with the results found during the focus group.

The locations that are preferred by the lead users are most of the time locations where you are not with a group but alone, like hospitals, company canteens and at the gym.

## *Delphi method*

Next to asking the lead users their opinion about the concept designs the Delphi method was executed to find out how the lead users see the future of yoghurt vending machines. Eight lead users were willing to participate in the Delphi method. Instead of the wanted ten lead users. As proposed in the methodology two rounds for the Delphi method were executed. The questions were sent to the lead users and they had one week to answer before they had to send their answers back. Sometimes the answers were not quite clear and the lead user was told to better explain their answer. With the answers on the questions a conclusion is made of the answers of all the lead users.

### *First round*

1. What do you think will be the dominated trend in the food market the next 5 years?

*Due the more information available consumers will become more conscious and educated about what they are eating. Therefore consumers will be more critical to the products that they will eat. Because of this trend the consumer will buy more products that are better produced and better for the lifestyle of the consumer. Next to this the labeling of food products will improve, in this way the consumers are also more informed about how the product is produced and where the ingredients come from. Furthermore the consumer will be more nostalgic and will look at products and meals that were eaten years ago. This will lead to an increase in buying ingredients that the current consumer forgot.*

*Next to this the consumer will share their opinion and experiences with food via social media like Facebook and twitter with other consumers.*

2. What will be the most important technique that will be leading in vending machines in the next 5 years?

*In the vending machine industry smaller, more modern and clearer machines will be introduced. This will help to get the vending machine out of the unhealthy snack dispenser category into the more modern, healthy on-the-go category. Furthermore it will be much easier to use such a machine and it will be more fun to use the machine.*

*The lead users also predict that the dispenser systems that are currently used for soda machines in restaurants will be more versatile and will have to opportunity to also dispense other ingredients. Next to this techniques will be introduced that have do not negatively influence the environment.*

3. Which consumer need for on-the-go food will be emerging the next 5 years?

*The need of the consumer will be that there will be variation in the portion sizes of meals. In this way the consumer can order a meal that completely fits their current hunger need. Next to this the consumer would like to see an on-the-go product that is a healthy alternative for the meal that they would otherwise bring from home. It should be a good alternative but it has to be something different that the consumer does not eat every day. So the alternative should also be special. Furthermore the consumers have the need to eat meals which have a higher quality, when they are buying something they want to have value for money.*

In the second round the lead users were asked if they would want to change their first answers when looking back at the general answers that were given. Furthermore they were asked to be more specific in the answers and give examples of technologies and trends.

### *Second round*

1. What do you think will be the dominated trend in the food market the next 5 years?

*Due to that consumers are more informed and educated about food. Food preferences will shift. Consumers want products that are ready to eat but are made with fewer additives. The need of the consumer will shift more to products that are natural, without any extra ingredients added to for example increase the sugar level. So, no other ingredients should be added to make the product better. The trend will be that the consumer will go back to basic and will appreciate the more natural ingredients more. The products furthermore will contribute to pursuing a healthy lifestyle. Food companies will meet the new demands of the consumer and will develop and innovate their current food products. The food companies will develop labels and logos to, in an easy way, inform the consumers about the production of the product and the origin of the product.*

2. What will be the most important technique that will be leading in vending machines in the next 5 years?

*The lead users predict that digital electronics like the introduction of a touchscreen on a machine will help to make the vending machine more modern and up-to-date. Next to this the location of the vending machine will change. The machine will be found where the people will be and the machine will be mobile and can be transported to different placed. Furthermore more emphasis will be on using 'green' sources for the machine. A possibility is to have the vending machine on the back of a bike, and by riding the bike power for the vending machine can be obtained. This can be added to make the machine more fun to use. The machine should have the possibility to pay per weight, in this way the consumer can add the amount of ingredients themselves and determine themselves the amount of the snack.*

3. Which consumer need for on-the-go food will be emerging the next 5 years?

*The lead users predict a growth in on-the-go food which contains all the ingredients that a meal should have carbohydrates, proteins and a fruit/vegetable source. Also in smaller package all these ingredients will be available. In the on-the-go industry the assortment therefore will increase the possibility to make different mixtures. Next to this the lead users predict that the consumer wants more on-the-go foods which have a better quality. With increased quality is meant that the food is produced in an environment friendly way and that the food is a good source for nutrients. Most of the on-the-go foods are small snacks that are eaten because of a craving. These on-the-go snacks need to have better ingredient composition, in this way the snacks will give enough energy for a longer time and the feeling of satiety after eating. In this way the craving will not return after half an hour. Even though it is a snack, and it will not take a long time to eat still has to fulfill the quality demands the current consumers sets for food products.*

## 8. Conclusion

### *Sub-questions*

- *Is there currently a need for fresh made on-the-go snacks?*

In the focus group 53% of the people said they would like to buy a healthy on-the-go snack. 81% of this group were women. From the statistical test can be concluded that there is strong relationship between women and buying healthy on-the-go food. The observations that were done were in line with the results found from the focus group. The observation showed that 70.6% of the high educated women bought a healthy snack. The hierarchical value map furthermore showed that women find eating healthy foods from a vending machine more important than men. Therefore when a yoghurt vending machine is developed women have to be the main target group. When the respondents were asked what they would pay for a healthy on-the-go snack, 76.5 % of the women were willing to pay 2 euro or more versus 15.4% of the men. Comparing this price to the cost price of the snack, 2 euro or more can be a possible price for the snack. Furthermore no relation could be found between gender and the frequency of buying on-the-go snacks.

In conclusion there is a need for fresh made on-the-go snacks especially in the group of high educated women.

- *What is the customer value that according to the means-end chain method has to be fulfilled when thinking about a vending machine for healthy snacks?*

From the hierarchical value map can be concluded that the two most important attributes of vending machine which dispense fresh ingredients according to the consumers are the nutritional value of the ingredients that are used in the machine. This is to the fact that the consumer finds it important to maintain their health and have a good quality of life. And the second attribute that the consumer finds important is the easiness to use the machine and this is linked to the life value performance and achievement. The consumer does not want to take a lot of time to prepare a meal and wants to use their time as sufficient as possible. The freshness of the ingredients is mentioned. The respondents did describe a need for a product that should be freshly made on the spot. They stated that fresh ingredients increase the enjoyment of eating and fresh ingredients have a better flavour.

For the consumer it is important to choose between different kinds of products, they want to have freedom to decide for themselves what they eat. With a fresh ingredient vending machine this can be a problem. Because of the limitation in ingredients that can be used due to shelf life problems the assortment is not very broad. This results in less choice for the consumer.

- *What is -according to the lead user method- a trend that in the future will become important in the vending machine industry*

The lead user predicted that because of the more informed consumer, the consumer will go back to basic and will focus more on natural ingredients. Furthermore they think that digital electronics like a touchscreen or an internet connection on the machine can help the vending machine to get a new look. The yoghurt vending machine can be placed on the market as a machine which is a modern and trendy. The need of the consumer that has to be fulfilled in the next five years will be that the on-the-go snacks should contain the three food components that also a complete meal contain and the meals should consist of higher quality foods. Furthermore the choice in ingredients should be wide because the consumer wants to have variety and make different combinations. A resemblance could be found between the reactions of the lead users on the Delphi method and on the product concepts. It became clear that the lead users find it important that it is possible to determine the portion size. Therefore it is advised to include different beaker sizes. The price that the lead user is willing to pay is not more than 3 euro.

- *Which ingredients are most suitable for the yoghurt vending machine from the viewpoint of food safety?*

The yoghurt vending machine will consist of yoghurt, fresh cut fruit and cereals. The main problem for the yoghurt vending machine is the use of fresh cut fruit. The cereals when stored dried can be stored for weeks; the only problem can be the softening of the cereal. The yoghurt when stored cooled and not contaminated with fungi that are present in the air can be stored for 2 to 3 weeks. For the yoghurt and the fresh cut fruit accounts that the temperature should be around 5 °C. Not all types of fruit can be used, because their shelf life is too short (açai berry ) and some fruits contain enzymes that can break up the yoghurt network, like pineapple and kiwi. Cut fruits are the ingredients which are the most perishable. Because of cutting, the fruit has more areas exposed and is more susceptible microorganisms. The average shelf life of the cut fruit is around 2 to 3 days. This is very short, when using Modified Atmosphere Packaging the shelf life of the fruit can be extended to one week. If small fruits are used the shelf life can (dependent on the type of small fruit) be extended to 2 or 3 weeks. Therefore small fruits are the best option for the yoghurt vending machine when Modified Atmosphere packed. Strawberry is a popular fruit that can be found in yoghurt but it is not the best fruit to use in vending machines. Due to the cutting moisture loss will occur, which influences the quality of the fruit and the visual appearance of the strawberry. This makes it more difficult to sell the product.

- *Which material can be used for the yoghurt vending machine?*

The different ingredients in the yoghurt vending machine all have different properties, the package needs to make sure that all these properties will last and diminish the decrease in quality of the products. All the ingredients should be packed separately, in this way no contamination can occur. There are different solutions to package the yoghurt. The best way is to have pre-packed yoghurt cups. This will decrease the cleaning because no equipment is needed for dispensing the yoghurt and in this way the fruit only has to be added and possibility for contamination is lower. The packaging of the cereals is not that difficult, the main thing is that the package should have a barrier to make sure that the cereals do not come in contact with moisture. The cereals do not have to be packed separately and can be present in the yoghurt vending machine in batch size.

The fruit package is the most defiant. Because the fruit should be fresh and the shelf life of fresh cut fruit is short Modified Atmosphere Packaging is a good solution to increase the shelf life of the fresh cut fruit. Modified Atmosphere Packaging is done with plastic; therefore plastic is the way to package the fruit. Currently MAP is already used to pack al different kinds of fresh cut fruits. Food packaging interactions will occur but in such a small amount that this will not have influence on the taste nor on the properties of the packaging. This is especially because of the short contact area the ingredients have with the package.

- *Is it from a food technological point of view feasible to make a yoghurt vending machine?*

What is characteristic of the yoghurt vending machine is that multiple fresh ingredients are used which have to be added together in the machine. With this idea different obstacles have to be overcome. The most important challenges to solve that are important for the yoghurt vending machine are the safety and quality of the ingredients, the cleaning and the stocking. The safety and quality is solved by cooling the machine to around 5°C and packaging small whole fruits with Modified Atmosphere Packaging. In this way the growth of microorganisms is stopped, which contributes to the safety and the quality. To make sure that the ingredients are not spoiled when they are in the machine it is important that the machine is checked every day. Next to this the equipment that is used to add all the ingredients in one package has to be cleaned every day. It can be concluded that is possible to make a yoghurt vending machine but it is important that a strict cleaning manual and stocking scheme is made to control and check the machine daily. Only when this is the case the yoghurt vending machine could be used.



*Research question:*

*Can a machine which dispense healthy, freshly made on-the-go snacks be a commercial success in the next five years?*

A healthy vending machine can be a commercial success in the next five years, if the focus will be on high educated women. Furthermore it is important that the machine will have modern appearance which can be done by using new technologies and designing the machine in such a way that it has a clear and bright appearance.

The machine should have the possibility to buy the ingredients separately but in the machine also the yoghurt snack should be made. The assortment of the machine should be wide, in this way the consumer has the possibility to each time make different combinations. The machine should also offer different portion sizes and natural ingredients.

In the future the consumer would like to see that the healthy on-the-go snacks contain the three major food components proteins, carbohydrates and vegetable/fruit source. The price of the yoghurt snack should be between the 2 and the 3 euro.

For the yoghurt vending machine it is possible to contain the ingredients that fulfill this need. The best solution is to use small intact fruit which is Modified Atmosphere packed, the average shelf life of this fruit will be around 2 to 3 weeks. The cereals and yoghurt can be stored for three weeks. Furthermore the interactions that occur between the package and the ingredients do not affect the taste of the snack.

## 9. Discussion

For the focus group some results can be discussed. No relation was found between gender and frequency of buying, in this case it could also be possible that the respondents gave desired answers instead of what their real behaviour is. This could be because they were ashamed for their frequency of buying.

The focus group was done with students. This can have an influence on the results because more often students have not as much money to spend on on-the-go snacks than people who have a fulltime job. This can have an influence on the opinion about willingness to pay for a snack from a healthy vending machine. Furthermore a difference between the observed buying behaviour of people and what was said in the focus group by the focus group members was found. It can be that during the focus group women did not want to admit that they did not bought healthy on-the-go food. And the men did not want to admit that eating healthy is important to them, because it is not good for their image.

Next to this the difference in results could be explained by the fact that the healthy on-the-go snack assortment in the company was small. Therefore the variety of healthy snacks is low and the buyers shifted to buying unhealthy on-the-go snacks to change to something different.

To make the hierarchical value map the focus group members were asked to write down three attributes for a vending machine which can dispense healthy ingredients. It could be that members could only come up with 2 attributes and just looked at the list of another group member just to fill the list to three attributes and maybe did not even find this attribute important. Also to make the hierarchical value map the answers that were given were put under general terms, this a subjective task. When somebody else did this task the answers could be placed under other general terms and it can be possible that other general terms could be chosen.

The observations were done at one location, it was done at a hospital and high educated people were observed. It was assumed that people in a white coat had a high education, it could be that also other people with a lower education also wore a white coat and were observed. Furthermore the observation was done in the afternoon this can also have an influence on the buying behaviour because in the afternoon people prefer a salty snack. Next to this during the observation there was an offer for a fruit salad more people could have bought this healthy snack because it was offer.

Furthermore the answers that are given in the Delphi research can be discussed. These are opinions of a small group of people and other lead users can have other visions on which will be important in the future. Because a small group of lead users are used the input of different ideas is small which limits the variety in the answers and the input of completely new ideas.

The cost price calculation that was done was only done for the most important factors that contribute to the costs. Furthermore assumptions are made about the amount of product sold and the price of the machine. The cost price therefore only gives an indication for the cost price of the snack and not the exact costs.

For the food technological aspects of the yoghurt vending machine it is important to tell that the conclusions are drawn from literature research. It can be that due to the circumstances the ingredients have to cope with other environments this can for example influence the shelf life. Next to this it has to be mentioned that the quality of the ingredients is not constant. There can be fluctuations between different batches of ingredients, due to different harvest and packaging conditions. This can also influence the shelf life and the quality of the ingredients. Improvements are still being made in the storage of fruit with Modified Atmosphere Packaging. It is possible that in the future the storage of fruit with the help of MAP is improved and the shelf life of the fruit can be increased.

## 10. Recommendations

In this last chapter recommendations are given for follow-up researches.

- In this thesis two consumer research methods are used. For both methods high educated people were used. For a follow-up research there can be focussed on another target groups to see if other groups also have a need for healthy fresh made on-the-go snacks. When there is a need the means-end chain could be used to find out what this target group finds important. These results can be combined to make a machine that has a broadened audience.
- In this research the focus was on Modified Atmosphere Packaging. In another research a closer look can be taken into the opportunities to use the other techniques that are under development and see if these techniques are an option for the yoghurt vending machine.
- In this research two methods of market-orientation are used. There are a lot of different methods that can be used to develop a product. In another research other market-oriented researches could be used to get insight in what the consumer wants.
- To make the yoghurt vending machine more flexible, different ingredients could be researched. There can be look at the possibility of using more tropical fruits or different types of yoghurt and cereals.
- When continuing with the concept the new product development process goes into the next phase. In this phase more aspects of developing a new product are important. The financial possibility and the feasibility of the technological aspects have to be researched.
- In this thesis the current need of the consumer is researched. In a follow up research the same research can be done but then to see if a shift has taken place in consumer needs and it can be analysed if more consumers have the need for a healthy freshly made on-the-go snack.
- For the observation the hospital was chosen as a location where are working with a high education. For a next research another location can be used where high educated people are present to see if the location influences the data. Furthermore observations can be done at different times. To see if there are difference in buying healthy on-the-go during the day.
- A different aspect of the machine that can be researched is how the machine can be made more environmental friendly and sustainable. In this way the machine can set an example in the market.

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# Appendices

## Appendix 1

### 1.1 Process chart for yoghurt making

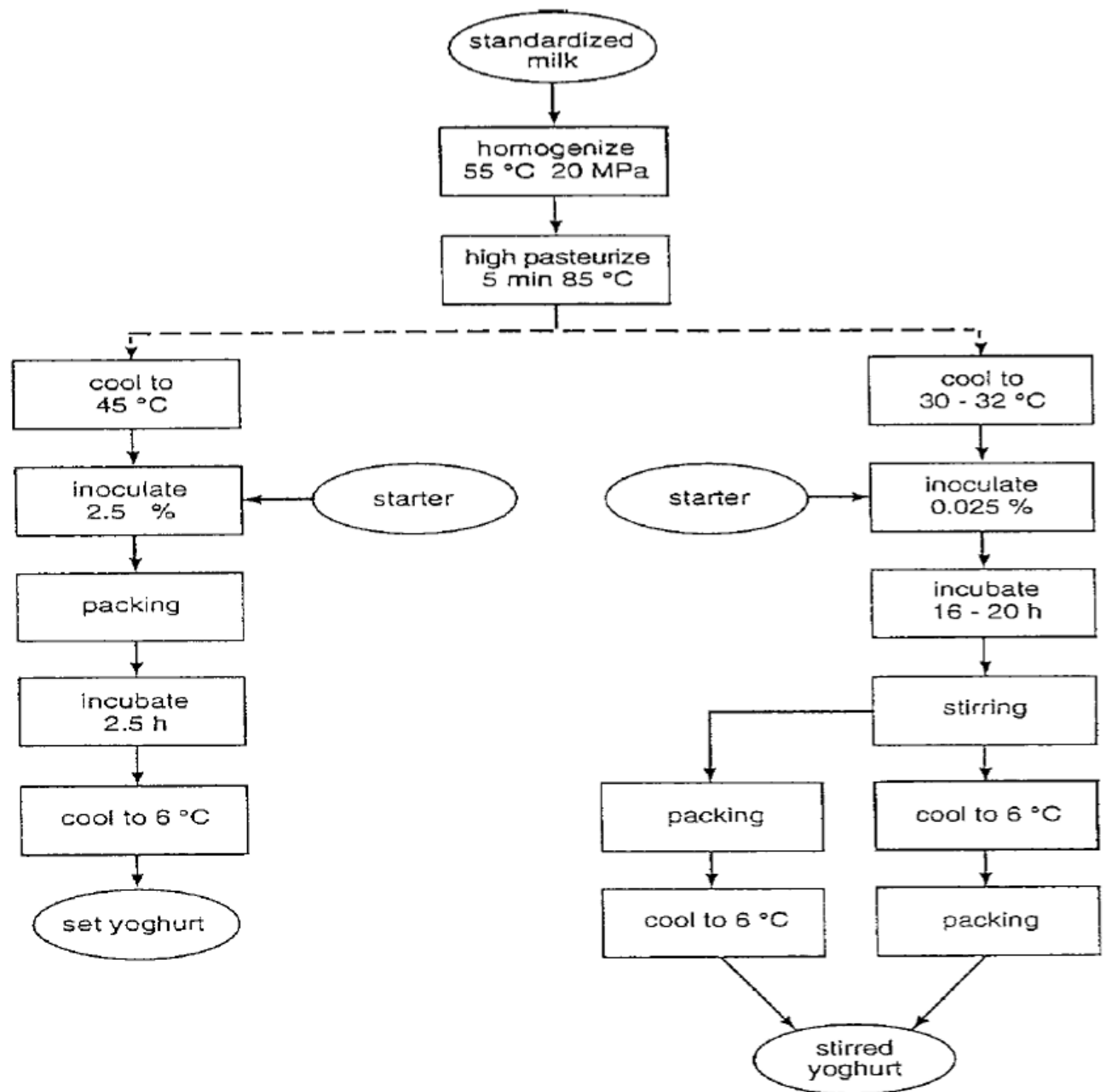


Figure 19: Schematic overview of manufacturing of set and stirred yoghurt (Nout & Schoustra, 2002)

## Appendix 2

### 2.1 Process chart for producing cut fruit

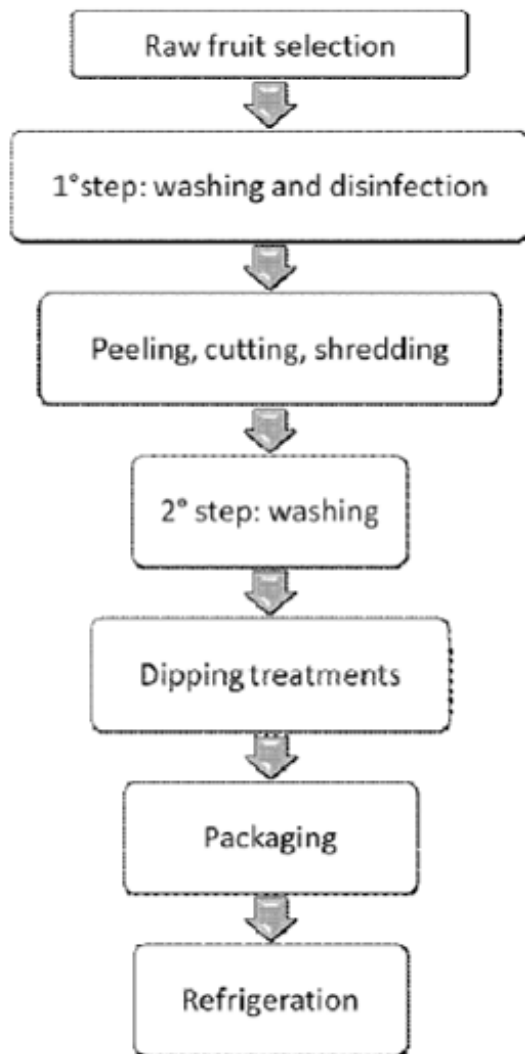


Figure 20: Schematic overview of manufacturing of processed fruit (Corbo et al., 2010)

## Appendix 3

### 3.1 Small whole fruit assortment additions for yoghurt vending machine

In the table below a list is shown of small fruits which do not have to cut. The shelf life of the small fruits is mentioned when stored cold and when using Modified Atmosphere Packaging.

**Table 14: List of whole small fruits that could be used in yoghurt vending machine**

Species	Cold Storage	Modified Atmosphere Packed
Cranberry ( <i>Vaccinium oxycoccus</i> )	60 to 120 days at 2.2 °C (Thompson, 2003)	No increase effect on shelf life (Snowdon, 2010)
Red currant and black currant ( <i>Ribes Rubrum</i> , <i>Ribes nigrum</i> )	4 weeks 0 °C (Prange, not dated, Nascimento Nunes, 2008)	8 weeks 1 °C (Prange, not dated)
Jostaberry ( <i>Ribes nidigrolaria</i> )	2 to 4 days at 2 to 7 °C (Sedlatschek, 2004)	6 to 8 weeks at 1 °C (Sedlatschek, 2004)
Wild strawberries ( <i>Fragaria vesca</i> )	2 to 3 days at room temperature (Almenar, Del Valle, Hernández- Muñoz, Lagáron, Catalá & Gavara, 2007)	10 days at 3 °C (Almenar, Del Valle, Hernández- Muñoz, Lagáron, Catalá & Gavara, 2006)
Gooseberry ( <i>Ribes uva-crispa</i> )	2 weeks at 2 °C (Calu, 2009)	5 to 7 weeks at 5 °C (Batzner & Helm, 1999)
Cowberry ( <i>Vaccinium vitis-idaea</i> )	2 weeks 5 °C (Saario, 2000)	2 to 3 weeks at 5 °C (Batzner & Helm, 1999)

## Appendix 4

### 4.1 Topic list

#### *Start:*

- Explanation research
- Confidentiality of results

#### *General information:*

- Education

#### *Buying behavior:*

- 1. Do you often buy on-the-go food?
  - Yes/No
- 2. How often?
  - A) Every day
  - B) Every week
  - C) Multiple times per week
  - D) Once per month
  - E) Multiple times per month
  - F) Once per six months
  - G) Once a year
  - H) Never
- 3. Where do you buy it?
  - A) Supermarket
  - B) On-the-go shop
  - C) Canteen
- 4. Do you have a need for a healthy vending machine?
  - Yes/No
- 5. Would you prefer to buy a healthier on-the-go snack?
  - Yes/No
- 6. What is the price you are willing to pay for a healthy on-the go snack?

For the questions 1 to 5 answer categories will be given.

#### *Reasoning for a healthy freshly made on-the-go snack:*

- 9. Could you name attributes of a healthy vending machine?
- 10. What do find the most important ones?
- 11. What will be the reason to buy a healthy on-the-go snack?
- 12. Why do you find these reasons so important (consequence)?
- 13. Why is this important -> consequence
- 14. What is the life value -> the requirement?



## Appendix 5

### 5.1 Results of statistical tests

#### *Test of normality*

Drawn hypotheses:

$H_0$ = The data is normal distributed

$H_1$ = The data is not normal distributed

The results are shown in table 15.

There has to be looked at the Shapiro-Wilk statistic. This value should not be significant, a value lower than 0.05 indicates that there is not a normal distribution. For this data accounts a significant level of 0.072. The level of significance was 0.072. This means that  $H_0$  can be assumed and the t-test can be executed.

**Table 15: Results of the test of normality for the dependent variable price**

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Price	,198	30	,004	,936	30	,072

## Appendix 6

### 6.1 Definitions words used in hierarchical value map

#### Attributes

*Nutritional value:* Nutrient level of a food product.

*Freshness of ingredients:* The ingredients should not have had a process step to extend the shelf life.

*Ingredient variation:* The possibility to switch to other ingredients.

*Easy to use:* The way the machine has to be handled.

*Taste:* The flavour, texture, temperature of the food product.

*Package:* The way the ingredients are packed.

*Clean machine:* Machine that is not dirty, has a clear appearance and is not broken.

#### Consequences

*Maintaining health:* Eating food products that help to maintain the health of the consumer.

*Nutritional intake:* Consuming of food with nutritional value to have a healthy diet.

*Choice:* The power and liberty of the consumer to pick a food product according to their liking.

*Enjoyment:* The level to which the consumer enjoys the food product.

*Convenience:* How easy it is for the consumers to eat and buy the product.

*Control:* The power the consumer has over their order.

#### Value

*Quality of life:* General well-being of the consumer

*Satisfaction:* Gratification of a need or desire.

*Peace of mind:* The mental state of no stress and tranquility.

*Pleasure:* A state of being amused.

*Freedom:* Being free from restrains and have the possibility to express own choice.

*Performance:* The act of carrying out a task.

*Achievement:* The act of successfully accomplishing a task.

## 6.2 Hierarchical value map scores

In the tables below the answers are shown which the focus group members gave. First the value is shown of how many times the definition is mentioned by the gender and next to this the answers that are given are converted into a percentage. This is done to compare the answers of the genders with each other.

**Table 16: Attributes scores from hierarchical value map in percentages and distinguished in to gender**

Attribute	Nutritional value	Freshness ingredients	Ingredient variation	Easy to use	Taste	Package	Clean machine
Men	4 (20%)	4 (29%)	7 (78%)	8 (57%)	4 (40%)	6 (57%)	2 (40%)
Women	16 (80%)	10 (71%)	2 (22%)	4 (43%)	6 (60%)	3 (43%)	3 (60%)

**Table 17: Consequence scores from hierarchical value map in percentages and distinguished in to gender**

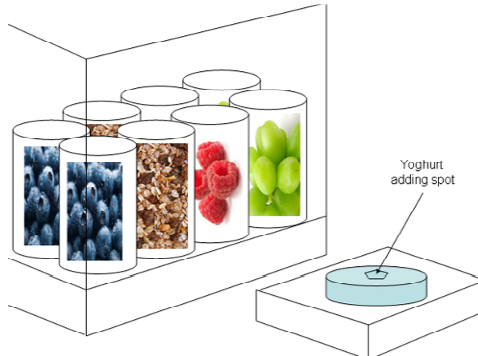
Consequences	Maintaining health	Nutritional intake	Choice	Enjoyment	Convenience	Control
Men	4 (25%)	7 (47%)	4 (57%)	12 (80%)	8 (53%)	8 (47%)
Women	12 (75%)	9 (53%)	2 (43%)	3 (20%)	7 (47%)	9 (53%)

**Table 18: Value scores from hierarchical value map in percentages and distinguished in to gender**

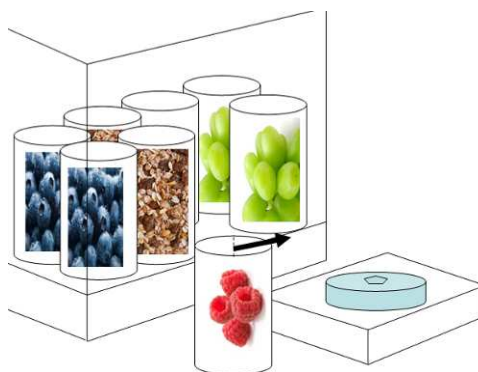
Value	Quality of life	Piece of mind	Satisfaction	Freedom	Pleasure	
Men	7 (28%)	6 (43%)	6 (60%)	6 (75%)	7 (50%)	12 (75%)
Women	18 (72 %)	8 (57%)	4 (40%)	2 (25%)	7 (50%)	4 (25%)

## Appendix 7

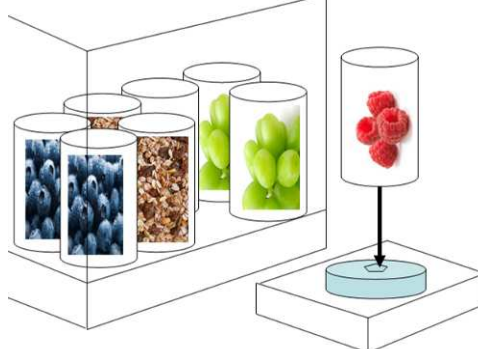
### 7.1 Drawings concept 1



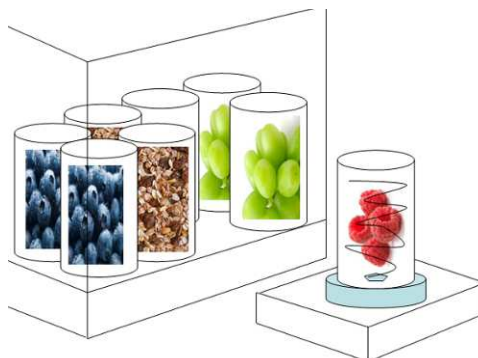
Step1: Choose a beaker with fruit



Step 2: Remove the sealing from the top of the beaker

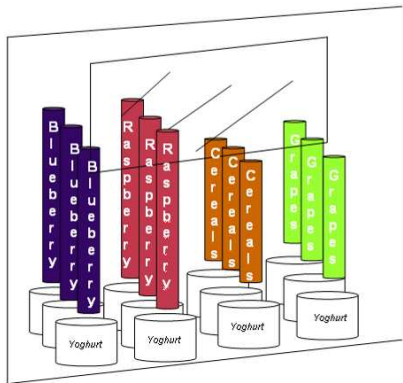


Step3: Place the beaker on the valve

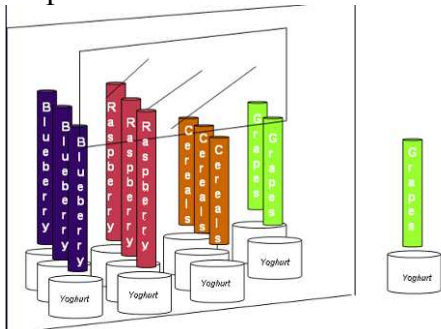


Step 4: Yoghurt is added to the ingredient in the beaker

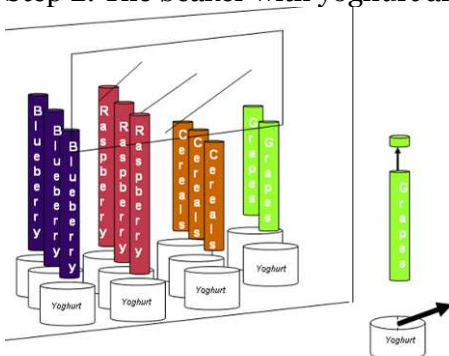
## 7.2 Drawings concept 2



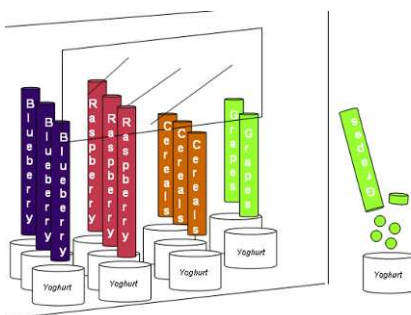
Step1: Make a choice for tube with ingredient



Step 2: The beaker with yoghurt and the ingredient tube are dispensed by the machine.

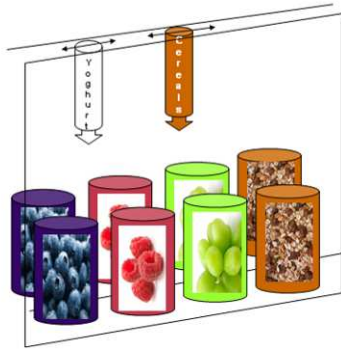


Step3: Remove sealing and lid from the yoghurt and the ingredient tube.

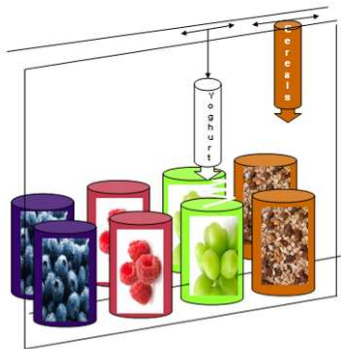


Step 4: The ingredient is added to the yoghurt

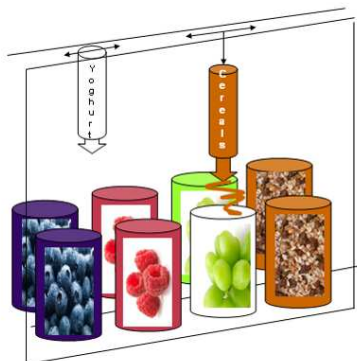
### 7.3 Drawings concept 3



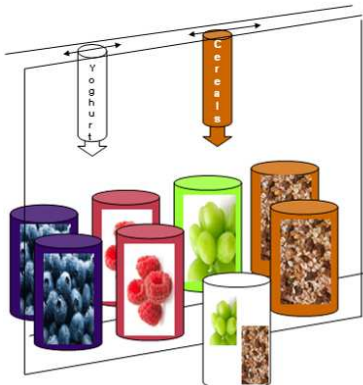
Step1: Choose a beaker with ingredient



Step 2: Yoghurt is added to the chosen beaker



Step3: Cereals are added to the chosen beaker



Step 4: Beaker with cereals, fruit and yoghurt are placed outside the machine.