Master Sustainable Business and Innovation

-Towards a green dairy industry-
Creating a sustainable *New Product Development* process

The case of FrieslandCampina

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Summary

This research focuses on the integration of sustainability in new product development (NPD) processes. Regarding the integration of sustainability requirements in NPD practices, different authors conclude that there is often a lack of knowledge on why and how firms should accomplish this. If firms have no clear scope or tangible sustainability targets, it is difficult to shape an NPD process with exact steps that help integrating sustainable practices in the NPD process. The dairy sector aims to define a clear scope and sustainability targets but there seems to be a misalignment between the company's environmental strategy and its sustainable NPD practices.

The objective of this thesis was to understand how a sustainable NPD process could be created in the dairy sector, more specifically at FrieslandCampina Domo (FC Domo). FC Domo, part of Royal FrieslandCampina N.V., is a leading producer of ingredients, base powders and total formulas for the infant and toddler markets and producer of ingredients for the medical and cell nutrition markets. FC Domo was chosen as case for this study because its current NPD process does not consider any sustainability actions. Nevertheless, according to route 2020, sustainability should be part of the product development process.

A new, synthesized NPD model was created for FC Domo combining literature on front-end innovation (FEI), NPD processes and design for environment (DfE). The proposed model was used as a theoretical basis for further research. Data was collected through internal and external interviews, and workshops with employees of FC Domo were organized. The synthesized NPD model was further developed by including important concepts and elements that help integrating sustainability in NPD processes at FC Domo. Factors such as awareness and obligatory goals were found to be specifically important to FrieslandCampina. It was found that the DfE strategies found in the workshops and interviews corresponded to six of the seven DfE strategies from the literature. The refined synthesized NPD model should be used and refined after every product launch. In this way sustainability will be integrated step by step in the NPD process of FC Domo.

Acknowledgements

I would like to express my special gratitude to two persons in particular, namely my academic supervisor dr. Jacco Farla and MSc Jan Bastiaans, my internship supervisor at FrieslandCampina.

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List of abbreviations

B2B	Business to business
B2C	Business to consumer
CH4	Methane
CO_2	Carbon dioxide
CP	Cleaner production
CSR	Corporate social responsibility
DE	Development expenses
DfE	Design for Environment
DLP	Delactosed permeate
FC Domo	FrieslandCampina Domo
FMCG	Fast moving consumer goods
DS	Development speed
EP	Environmental performance
FC	FrieslandCampina
FE	Front-end
FEI	Front-end innovation
FFE	Fuzzy front-end
GHG	Greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
KPI	Key performance indicator
LCA	Life cycle assessment
LiDS	Life cycle Design Strategy
NCD	New Concept Development
NGO	Non governmental organisation
NPD	New product development
NSC	New sustainable concept
N2O	Nitrous oxide
PC	Production cost
PLC	Product life cycle
PP	Product performance
3R	Reduce, reuse, recycle

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1. Introduction

1.1 Background

To meet the needs of the continuously growing population, natural resources are depleted and pressure on our planet is increasing. According to the Intergovernmental Panel on Climate Change (IPCC), climate change is caused by human activity and emissions of greenhouse gases are nowadays highest in history (IPCC, 2014).

A problem that comes with population growth is the increasing need for food security. Food security exists when 'all people at all times have access to enough food for an active, healthy life' (Mechlem, 2004). By 2050 we face the challenge of feeding ten billion people and at the same time aiming to reduce the impact of food production on the environment (Smith & Gregory, 2013). This approach of producing food in a sustainable manner is determined as one of the greater challenges in the future (Dewulf et al., 2012).

The dairy industry is a sector, which is working towards sustainable food production. In the Netherlands, the dairy sector is a modern sector and has become one of the biggest and most vital agricultural sectors in the Netherlands. The dairy factories in the Netherlands got an international orientation when the first dairy factories were set up around 1870. Between 1950 and 1980 the production doubled and increased by 40% per capita. Substantial international expansion took place especially after 1960, when farmers started using mechanical milking systems (ZuivelNL, 2016). It has been argued that adequate intake of nutrients from dairy foods reduces the chance of getting diseases such as obesity, type 2 diabetes, kidney stones, and some cancers (Elwood et al., 2007; McCarron & Heaney, 2004).

Next to the nutritional benefits, the dairy industry is also known as a polluting industry since greenhouse gas (GHG) emissions such as, methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2), which contribute to climate change, are linked to milk production (Vergé et al., 2007). Thereby, manure causes pollution of air, soil, and surface waters since this is the main source of nitrogen and phosphorous (Onegreenplanet, 2016).

1.2 Problem description

Sustainable development has been described as the 'ability of current generations to meet their needs without compromising the ability of future generations to meet their needs' (Brundtland et al., 1987). Reducing the environmental impact of activities is one approach a company can take to contribute to sustainable development. 'Environmental management refers to all the initiatives a company takes to reduce the environmental impact of its activities' (van Hemel, 1998). One approach to control the environmental effects of a company on the environment is to apply end-of-pipe solutions. Cleaning technology is one example of an end-of-pipe solution, whereby the waste is managed in such way that it has as little impact as possible on the environment. With the growing demand for sustainable products, it can be stated that environmental actions have changed from reactive 'end-of-pipe'

solutions to a more proactive attitude (Tingström et al., 2006). Waste management was replaced by the idea of cleaner production and cleaner product design. With these new approaches, the designing process of products changed as well; sustainability requirements became part of this design process and the idea of sustainable new product development (NPD) was born. According to the Business Dictionary (2015), an NPD process is the process of developing new products or services for the market (Business Dictionary, 2015).

Especially in relation to NPD, the definition of sustainable development remains vague (Petala et al., 2010). It is stated that if firms have no clear scope or tangible sustainability targets, it is difficult to decide what are the exact steps that companies need to take to integrate sustainable practices in NPD processes (Alblas et al., 2014). Although most large companies do have an overall environmental strategy, it is often not clear how this strategy should be translated into sustainability actions within an NPD process. It seems that there is often a misalignment between a company's environmental strategy and NPD practices (Hynds et al., 2014; Alblas et al., 2014). According to Tingström et al. (2006), this is due to the lack of knowledge of the design team. As such, 'the incorporation of sustainability into NPD remains challenging and is not a one-step change' (Petala et al., 2010).

Yet, several authors suggested new models for the integration of sustainability in NPD, some focus on organizational issues while others focus more on readily available eco-toolboxes that can help with the integration of sustainability in NPD. Although many of these frameworks exist, they do not meet the needs of NPD professionals since these frameworks focus broader than NPD and they do not provide comprehensive information. Thereby, 'the existing models are either difficult to use or generally not available' (Hynds et al., 2014).

1.3 Aim and research question

This thesis deals with the proactive response of companies in the dairy industry towards sustainable development by promoting an NPD process with integrated sustainability goals. This thesis deals with issues such as the determination of sustainability elements that can help NPD professionals to focus on sustainability in the product development process (Fang et al., 2007; Hynds et al., 2014). This study will be conducted with a focus on the food industry, in particular the dairy industry. Opportunities for integrating sustainability goals in the NPD process will be sought and it will be investigated how the integration in this complex process can be achieved. To come to an answer on these points, the following research question has been posed:

How can sustainability be incorporated in the new product development process in the dairy industry?

This study will comprise of a case study in a specific research and development department of Royal FrieslandCampina N.V.: the Domo ingredients group. Royal FrieslandCampina N.V. is an international dairy company that optimizes the value of milk by processing it into a wide assortment of dairy products and ingredients. The focus of FrieslandCampina Domo (FC Domo) lies with the production of base powders and total formulas for the infant and toddler

markets. Royal FrieslandCampina N.V. formulated its route2020 strategy for the period 2010–2020 (figure 1) (FrieslandCampinaCSR, 2016). Apart from maximizing the value of all the milk produced by the cooperative's member dairy farmers, the company strives to grow climate-neutral throughout the entire chain from cow to consumer (ibid). It is therefore of great importance that companies start thinking of sustainability while developing new products and choose a proactive instead of a reactive approach (Bonini & Görner, 2011).

Figure 1. CSR strategy house of FrieslandCampina (FrieslandCampinaCSR, 2016)

This research will examine how Domo can deal with sustainability issues more proactively within the process of NPD without compromising the quality of the product. The aim of this research is to deliver a sustainable NPD model to achieve a more sustainable NPD process and finally more sustainable products. The NPD model of FC Domo does currently not touch upon any sustainability issues and is shown in figure 2.

Figure 2. New product development stage/gate diagram Domo (DomoAboutUs, 2016)

1.4 Outline of the thesis

The structure of the thesis is as follows: chapter 2 gives an overview of the theory on environmental sustainability in relation to new product development and concludes with a conceptual model, which will be used in this thesis. Chapter 3 describes the methodology, which includes the research design, data collection and analysis. Chapter 4 includes results and analysis, followed by the conclusion and discussion in chapter 5 and 6. Finally, chapter 7 gives an advice to the business that was studied during this research.

2. Theory

In this chapter already existing concepts from theory are described. Concepts will touch upon NPD processes, the incorporation of sustainability in these processes and sustainable product design. The chapter concludes with a proposed synthesized NPD model, which will be further developed and refined specifically for the dairy industry.

2.1 Environmental concepts

'Environmental management refers to all the initiatives a company takes to reduce the environmental impact of its activities' (van Hemel, 1998). Examples of such initiatives are cleaning technology, cleaner production and the development of cleaner products. The relation between these initiatives is illustrated in figure 3 (ibid).

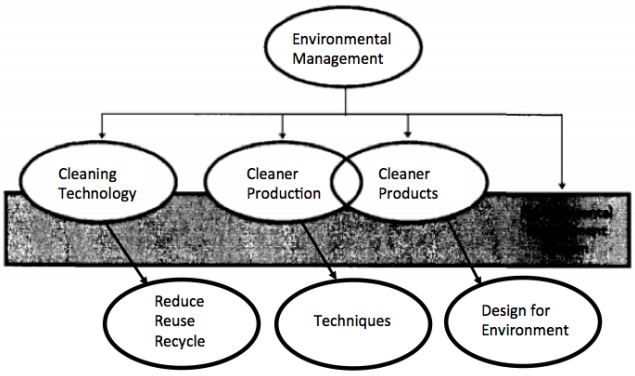

Figure 3. The relation between the topics 'cleaning technology', 'cleaner production' and 'cleaner products' (adapted from: van Hemel, 1998)

2.1.1 Cleaning technology

To control the environmental effects of a company on the environment, cleaning technology is an end-of-pipe solution that can be applied. The purpose of cleaning technology is to take care of environmental impact caused by activities of a firm (Hammar and Löfgren, 2010). The focus of this end-of-pipe solution lies with controlling and observing streams of solid waste and emissions to soil, water and air (van Hemel, 1998). Waste management is often mentioned as a cleaning technology and has been seen as an important approach to reduce the environmental impact of a product. There are different possible practices for waste

management, for example the 3R strategies: Reduce (Reduce the production of wastes in production-, circulation-, and consumption processes); Reuse (use waste directly after repair, renewal, or reproduction or use part or all waste as components of other products); Recycle (turning items considered to be waste into a valuable resources) (Barr et al., 2001).

2.1.2 Cleaner production and cleaner products

With the growing demand for sustainable products, it can be stated that environmental actions have changed from reactive 'end-of-pipe' solutions to a more proactive attitude such as the practice of cleaner production (CP) (Tingström et al., 2006; Pujari, 2006). The difference between end-of-pipe solutions and cleaner production is that the former does not affect the production process, while the latter focus just on improving production techniques to become cleaner (Hammar and Löfgren, 2010). The definition of CP is often used in a broad sense: as a concept that supports preventive actions to reduce and avoid waste and emissions in the first place by identifying by-products that can be used again (Fang et al., 2007; Berkel et al., 1997). In this thesis, CP refers to the development or implementation of cleaner production techniques (Frondel et al., 2004). Criticism on CP usually comes from scientists who believe that the existing product is taken as a starting point where cleaner production techniques are considered (Vergragt & van Grootveld, 1994). Real sustainability calls for more radical innovations such as the design of cleaner products. The development of cleaner products shows a certain amount of overlap with CP as they both devote attention to cleaner production techniques as well as cleaner product designs. As was outlined above, CP focuses on cleaner production techniques; however, some design elements might be considered as well (van Hemel, 1998). Moreover, the same applies to cleaner product design: While focusing on cleaner product designs, some cleaner production techniques are involved as well (ibid). It is argued that with the development of cleaner products, the process of developing new products should be changed (Vergragt & van Grootveld, 1994).

2.2 New product development

Cleaner products call for a design process where sustainability requirements are integrated in the process of NPD. According to the Business Dictionary (2015), an NPD process is the process of developing new products or services for the market. A number of steps should be completed before the new product is ready for market launch; the number of steps depends on the type of innovation and product. NPD may be done to develop an item to compete with a particular product/service or may be done to improve an already established product. NPD is essential to any business that must keep up with market trends and changes (Business Dictionary, 2015). Regarding the integration of sustainability requirements in NPD practices, different authors conclude that there is often a lack of knowledge on why and how firms should accomplish this (Dangelico and Pujari, 2010). Expectations from stakeholders and society, but also the business climate are changing rapidly and the size of green markets is growing. These developments make it imperative for businesses to integrate sustainability in NPD processes but rapidly changing markets make this difficult as well. It can be stated that adaptation of environmental strategies is going slower than the market change (ibid).

2.2.1 NPD and sustainability

According to Alblas et al. (2014), integrating sustainability in NPD is difficult if firms have no clear scope and concrete sustainability targets. To make the integration successful, different tools, databases and methods can be used and NPD personnel should be active in sustainability networks. Alblas et al. (2014) argue that, if these requirements are met, a mature form of NPD can be achieved. Moreover, if the sustainability scope and targets, its processes, methods, and tools, and the sustainable design expertise are lacking, one can speak of an immature form of NPD. Instead of two maturity levels the assessment tool, developed by the Industrial Research Institute (Hynds et al., 2014), works according to four maturity levels: beginning, improving, succeeding and leading. This online assessment tool can be used by 'individuals or teams to benchmark progress on the journey to integrate sustainability into NPD' (ibid). [1]

Several authors suggested new models for integrating sustainability in NPD processes. Kaebernick et al. (2003) argue that, throughout the entire NPD process, the Environmental Performance (EP) objective must be added to the four conventional objectives: Product performance (PP), Product Cost (PC), Development Expenses (DE) and Development Speed (DS). This generates a trade-off model that can be used in balancing the five objectives against each other (figure 4). The advantage here is that environmental requirements are fully integrated and enjoy the same importance rating as the other objectives.

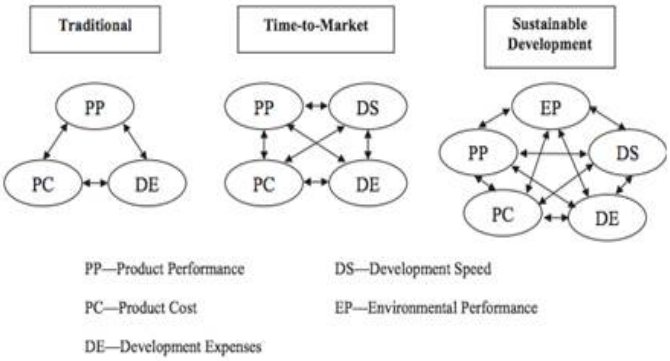

Figure 4. Trade-off model for sustainable design decision (Kaebernick et al., 2003)

Instead of focusing on the NPD process from beginning till end, it is claimed that sustainability should be integrated in the front-end of the NPD process (Dewulf, 2013). Figure 5 shows the stage-gate system of Cooper (1990): an NPD model where the first stages and gates form the front-end of the process. These stages include discovery of the design, scoping the design, and building a business case, which is the final stage prior to the product development stage. The entrance to each stage is a gate, which stand for an evaluation point and is characterized by a set of deliverables or inputs, a set of exit criteria, and an output (Cooper, 1990).

[1] www.iriweb.org/sustainabilitytool

Herstatt & Verworn (2004) use the term fuzzy front-end (FFE), which is synonym for front-end, to determine the stages of the NPD process where most decisions with a future environmental impact are made. The term 'fuzzy' implies that the FE is unknown and mysterious; accordingly, influence of designers on product design is high and costs from changes are relatively low (see figure 6) (Dewulf, 2013). This advantage is limited by the fact that the information available at this early stage is low compared to later stages of the process (Herstatt & Verworn, 2004).

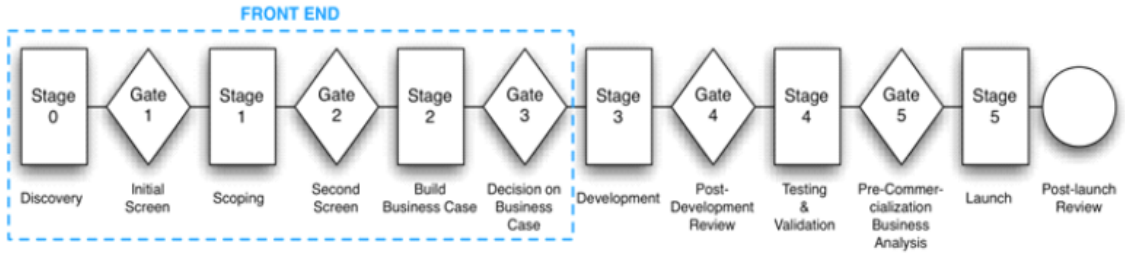

Figure 5. Stage-gate system and its front-end (Dewulf, 2013)

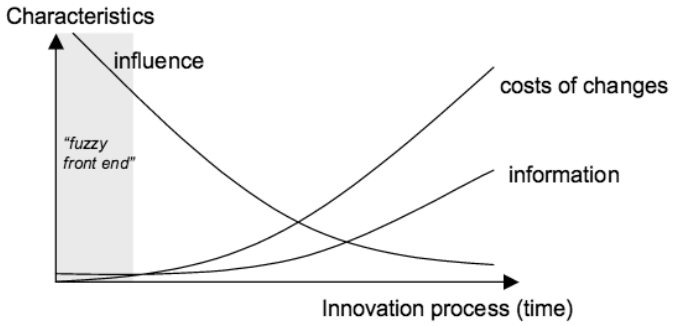

Figure 6. Evolution of influence cost of changes and information during the innovation process (Herstatt & Verworn, 2004)

2.2.2 New concept development model

Koen et al. (2002) state that the term 'fuzzy' implies that 'this stage lacks accountability and cannot be critically evaluated'; therefore the authors propose the New Concept Development (NCD) model to cover the main activities in the 'fuzzy front-end' (figure 7). According to Koen et al. (2001), the 'engine' stands for leadership (senior- and executive-level management support), culture, and business strategy of the organization. The engine drives the five controllable activity elements (opportunity analysis, opportunity identification, idea genesis, idea selection, and concept & technology development) (Dewulf, 2013). The influencing factors are relatively uncontrollable and consist of 'organizational capabilities, the outside world (distribution channels, law, government policy, customers, competitors, and political and economic climate), and the enabling sciences (internal and external) that may be involved' (Koen et al., 2002). The two arrows pointing into the model imply that the process either begins with idea genesis or opportunity analysis. The third arrow stands for the projects that exit the NCD model and enter the NPD process. The circular shape of the NCD model implies 'that ideas and concepts iterate across the five elements' (ibid).

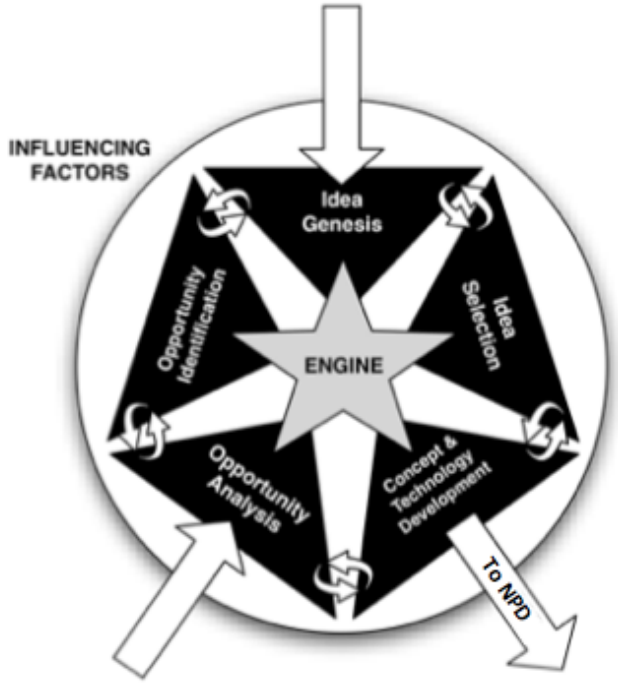

Figure 7. The new concept development (NCD) model for fuzzy front-end (FFE) activities (adapted from: Dewulf, 2013)

2.2.3 Design for environment

The front-end innovation (FEI) process is followed by the product development stage, where the idea of Design for Environment (DfE) can be implemented to develop cleaner products (Dewulf, 2013; van Hemel, 1998). DfE is often used to reduce the overall impact of a product on the environment and human health and takes place when companies explicitly incorporate environmental issues in their product development (van Hemel, 1998). DfE is a tool that can be used during the development of a product to take into account environmental aspects in the design decisions. Here, 'the environment has the same status as other conventional product values such as profit, functionality, aesthetics, ergonomics, image and overall quality' (van Hemel, 1998). Next to the product development stage, DfE helps to consider environmental aspects in every other stage of the NPD process as well. Consequently, products with the lowest possible environmental impact throughout their entire lifecycle are achieved, which ultimately leads to more sustainable products (Brezet & van Hemel, 1997; van Hemel, 1998). A wide range of different products has been subject to DfE, and many industries have developed their own schemes. The available methods and tools range from general to specific and focus on parts of the product life cycle (PLC) or on certain types of products or services. Some methods are aimed at decision support early in the design process while others are aimed at use during the detailed design phase (Hauschild et al., 2004).

2.2.4 Life cycle design strategy

One of the tools that have been developed to find optimized products, according to the idea of DfE, is the life cycle design strategy (LiDS) wheel. The LiDS wheel is based on the concept of cleaner product design and can be used to design more environmental friendly products.

The tool can be used while evaluating the new product by using the old design as benchmark, in this way it cannot be used to determine the actual environmental impact of a product, like an LCA does (Jones et al., 2001). The LiDS wheel is a graphical representation of seven possible DfE strategies. The seven possible strategies can be described as potential routes a company can follow if it wishes to apply the principles of DfE to one or more of its products. As shown in figure 8, a DfE strategy encompasses a set of DfE principles, which are described by van Hemel (1998) as potential means of operationalizing or realizing a DfE strategy.

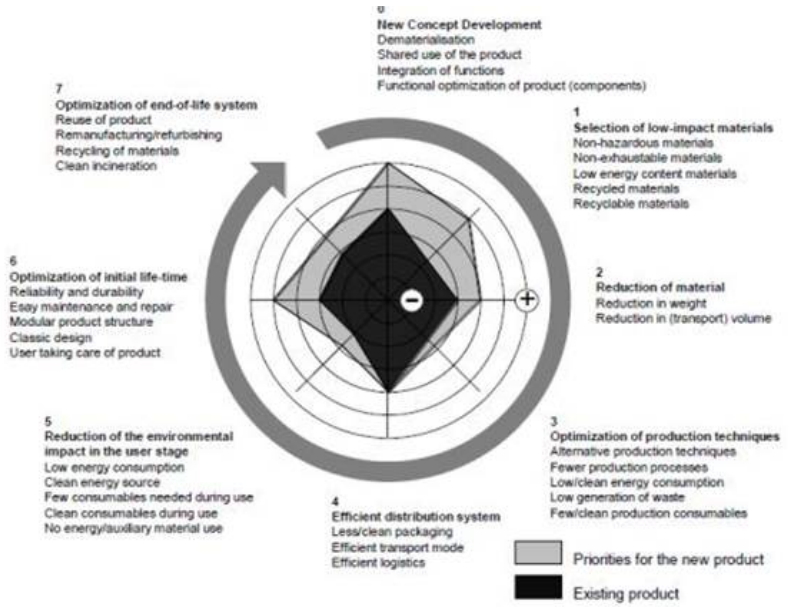

Figure 8. LiDS Wheel (Brezet et al., 1994; van Hemel & Keldmann, 1996)

2.3 Proposed synthesized NPD model

Derived from the synthesis of literature that was studied, the synthesized NPD model was proposed (figure 9). Several authors suggested new models for integrating sustainability in NPD processes; however, they often focus on a different part of the NPD process. Thereby, some models focus primarily on intangible elements such as organizational structure, while others focus on tangible targets such as CO_2 emissions. For that reason, it can be stated that a model combing different elements is needed to accomplish the best possible integration of sustainability in NPD.

It is argued that the integration of sustainability in NPD should take place in the first stages of the NPD process since, 'influence on the product is high and costs from changes are low' (Herstatt & Verworn, 2004). Therefore, this thesis includes the NCD model of Koen et al. (2001) in the NPD process, which means that the 'fuzzy' part of the front-end innovation process is included in the NPD model. Since the focus will be on the FFE of the NPD process, opportunity analysis & identification, idea genesis & selection, and concept & technology development, as well as their driving factors (leadership, culture, and business strategy of the organization) are important elements. Leaving the NCD model, the project enters the creation stage where one or more DfE strategies and principles (the tangible elements) can be applied.

The LiDS wheel is used as a tool during the creation stage but is kept in mind in all other stages of the NPD process as well; especially in the FFE since in this phase, the fundamentals of the LiDS wheel are set.

Thus, the NPD process starts with idea genesis or opportunity analysis, and ends with the implementation of a product. The proposed synthesized NPD model will focus on the first stages of the NPD model (the FFE) and the creation stage. It will give structure to the fuzzy stages of the NPD process, which makes it easier to determine which elements are lagging behind and which elements score best. The structure will also help to investigate which elements could be improved to deliver the best possible project to the implementation stage. Entering the implementation stage asks for tangible sustainability targets to meet. It is argued that the better the elements of the FFE are determined, the easier it is to integrate sustainability in the implementation phase. The product life cycle structure helps to give structure to the creation phase as well.

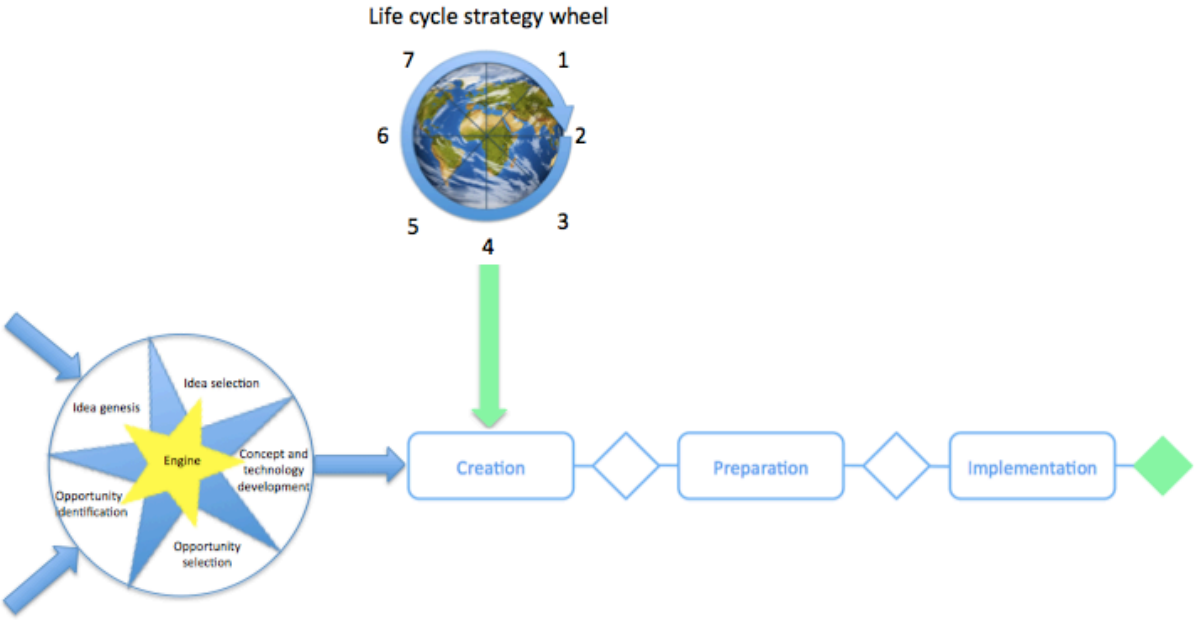

Figure 9. Proposed synthesized NPD model

3. Methodology

This section describes the methodology. First, section 3.1 outlines the research design and the case study that was chosen for this project. Second, section 3.2 explains how data was collected and from which sources the data was collected. Section 3.3 describes the data analysis and last, section 3.4 outlines the quality of the research.

3.1 Research design

The objective of this research was to understand how the integration of sustainability in NPD at FC Domo could be accomplished. To reach the objectives, exploratory research was applied, which is defined as the initial research into a hypothetical or theoretical idea (Study – exploratory research, 2016). This is where the researcher has an idea or has observed something and seeks to understand more about it. An exploratory research project is an attempt to lay the groundwork that will lead future studies (Bryman, 2016). This type of research comes often in two forms: in a new topic, or a new angle. A new topic is often unexpected and startling in its findings, while new angles can come from new ways of looking at things, either from a theoretical perspective or a new way of measuring something. The next step is descriptive research, which attempts to explore and explain while providing additional information about a topic (Study – exploratory research, 2016). Exploratory research helped to find important concepts that can assist with the integration of sustainability in NPD processes at FC Domo. Descriptive research helped to find concepts that were generated through open coding and were used as 'building blocks' for the development of new theory (Bryman, 2016). While analysing the data, it could be identified and described which aspects were completing the concept model and which aspects were less important for the dairy industry and could be removed (Silverman, 2006).

Semi-structured interviews were complemented by two different workshops on the integration of sustainability in the NPD process at FC Domo in the Netherlands. These workshops facilitated finding additional qualitative data on this subject and gave new insights in how the integration should be accomplished. The LiDS wheel was specified in advance of the data collection as theoretical framework to be tested by employees of FC Domo.

3.1.1 Case study: integrating sustainability in the NPD process of FC Domo

FC Domo was chosen as case for this study as Domo's current NPD process does not consider any sustainability actions (figure 2). Nevertheless, according to route 2020 (FrieslandCampinaRoute2020, 2016), sustainability should be part of the product development process. Royal FrieslandCampina is fully owned by Zuivelcoöperatie FrieslandCampina and with more than 19,000 member dairy farmers in the Netherlands, Germany and Belgium it is one of the world's largest dairy cooperatives. The dairy cooperation ensures that all the milk from every member is purchased at a guaranteed price. The value is optimized through processing the milk into a wide assortment of dairy products and ingredients in many European countries, Asia and Africa. The company has offices in 32 countries and employs over 22,000 people, its products find their way to more than 100 countries. FrieslandCampina's activities are divided into four market-oriented business

groups: Consumer Products Europe, Middle East & Africa; Consumer Products Asia; Cheese, Butter & Milkpowder; and Ingredients (FrieslandCampina Domo) (FrieslandCampinaCSR, 2016). With regards to the last group, FC Domo is a leading producer of ingredients, base powders and total formulas for the Infant and Toddler markets and ingredients for the Medical and Cell nutrition markets. In this case study, Wave3 and Phoenix were the chosen 'new product' projects to work with during the research.

Wave3 presents the results of a process development project where different whey demineralization technologies are investigated. The goal of this project is the experimental validation of the foreseen demineralization technologies that are required in order to develop and understand: the process knowledge; a proper factory design; data for change control; support demineralization as a core technology of Domo; understand technology used by the competition; and understand the impact of other demineralization technologies on the D90 products. The ultimate goal is to come to a robust process, including critical control parameters and well-known product properties by certain process configuration. According to the stage-gate model for NPD processes within Domo, Wave3 is currently in the second stage. Wave3 is at the moment in a creation phase, there is no consideration of changing directly to a preparation phase.

Phoenix is a project focusing on value added opportunities for Delactosed Permeate (DLP). Domo produces lactose from whey permeates, which generates a DLP co-product. DLP volumes will double in the coming years due to increasing lactose demand/production and planned investments. Although DLP contains 55% lactose, which represents potential value for FC, the high mineral content hinders the maintenance of the value/price of DLP (valorisation). Currently nutrifeed markets DLP volumes but cannot absorb increased volumes, resulting in a DLP contribution of about -/-0.25 €/kg^2. Cost are estimated to increase about €10 to 20m per year. Project Phoenix is initiated to eliminate cost of DLP through end-of-pipe conversion or application of DLP into added value products. This is done with the aim to shift projected negative contribution to a potential positive contribution of DLP. According to the stage-gate model for NPD processes within Domo, Phoenix is as total project in the creation phase. A part of the project is in the preparation phase.

3.2 Data collection

Multiple sources of data were studied and the case was approached from different angles, which ensures that the results and analysis is rich, valid and reliable. The data included scientific literature on NPD processes, data on how sustainability can be integrated in this process, data from semi-structured interviews and data from workshops.

First, desk research was conducted to gather background information on integrating sustainability in NPD processes. To find information on this topic, documents of FC Domo on NPD processes as well as documents of other companies were studied. Documents of FC Domo on existing projects in different stages of the NPD process were considered as well.

Other information came from existing literature on NPD processes and sustainability, as well as literature on existing tools for the integration of sustainability in NPD (see chapter 2).

The qualitative data were collected through in-depth face-to-face interviews. These semi-structured interviews provided the interviewer with the possibility to have a direct conversation whereby a set of prepared questions were used as a guideline for the interviews (see appendix B). Semi-structured interviews are suitable for exploratory research since the analysis of data can help to shape the concept model. Eleven interviewees were selected, which were divided into two categories: internal and external interviewees (see appendix A for the list of interviewees). Eight interviewees were employees of FrieslandCampina (internal) and three people worked for other companies (external). The eight interviewees of FrieslandCampina held different positions namely: sustainability manager, development manager, business development manager, senior scientist, researcher, supply chain trainee and sustainability intern. The interviews included topics such as reducing water use, energy use or the reduction of CO_2 emissions. Other questions touched upon defining important sustainability questions and the definition of sustainability specific to FC Domo. Some interviewees performed their job for many years within FrieslandCampina, while others just started their traineeship. This variety can give more objective information on sustainability in NPD processes since the variety of resources is greater. Parallel to these interviews, three relevant actors in other companies were interviewed to get an insight in how other companies handle sustainability issues within NPD processes. These companies were frontrunners or have been working for a longer time on this topic. It can be of great importance to know where predecessors experienced bottlenecks or success-stories with integrating sustainability in NPD. The interviews lasted between 40 minutes and 60 minutes and were recorded by the researcher. The order of the questions depended on the flow of the conversation since the focus was on exploring the context and therefore a flexible style of interviewing was required. Since the author was looking for categories in the text, a summary of the interviews provided the required information. The summaries of the interviews were sent to the interviewees and either accepted or adjusted if the interviewees disagreed on the content. In practice only minor details had to be changed. Job specifications are communicated in this thesis although names of the interviewees are not. Most of the interviews were taken in Dutch; however, quotes in this thesis were translated into English.

Information obtained from the desk research and interviews was used to set up two different workshops within FC Domo. Each workshop dealt with a different project namely: Wave3 and Phoenix. All participants were employees from Domo R&D since these people can share their knowledge about their practical NPD experiences within Domo R&D.

The purpose of workshop 1 was to investigate the maturity level of FC Domo regarding the progress on the journey to integrate sustainability into NPD. This workshop (see appendix C) was divided in three parts: first, a presentation to give a short introduction (see appendix E) second, a practical assignment based on the online assessment tool of the Industrial Research Institute (www.iriweb.org/sustainabilitytool) (see chapter 2) and last, a practical assignment based on the LiDS wheel. The IRI sustainability assessment tool enables companies to

benchmark their sustainability performance in NPD processes (Hynds et al., 2014). In this workshop, the participants considered the 'design tools' by answering the corresponding online questions with 'yes' or 'no'. The results were graphically visualized (figure 10). Also, the participants gave their opinion on which questions could not be applied to FC Domo or which questions should be altered to make them better fit for FC Domo. The LiDS Wheel formed the theoretical basis for the last part of the workshop, project Wave3 was used here as practical case. The theoretical framework was analysed by the participants in order to determine which elements of the framework Domo R&D can use. All elements of the LiDS wheel were handled by groups of two participants. They had to answer three questions:

i) Is this element relevant to bring sustainability under the attention of NPD professionals
ii) How would you adjust this element to make it better fit for the FC Domo NPD process?
iii) What would be the action within project Phoenix according to this element?

The purpose of workshop 2 was to investigate which parts of the LiDS wheel are applicable to the FC Domo R&D department and which part should be altered to make them better fit. This information can be used with the organization of future workshops to inform the employees. Considering strategies that are mentioned to be less useful can inform employees on less obvious strategies. The second workshop (see appendix D) consisted of two parts: first a presentation to give a short introduction (see appendix F), and second a practical assignment. The LiDS Wheel formed the theoretical basis for the assignment whereby project Phoenix was used as practical case. The theoretical framework was analysed by different representatives of FC Domo in order to determine which elements of the framework Domo R&D can use. All elements of the LiDS wheel were handled by groups of two participants. They answered the same three questions as in workshop 1 (stated above). The participants wrote down their answers on flip overs and the answers were discussed in the whole group afterwards. The workshop was partly of a 'what-if' nature in order to be able to evaluate the impact of the adapted LiDS Wheel. The goal of a what-if analysis is to inspect the behaviour of the complex system of product development processes under some given scenarios (Rizzi, 2009).

After the workshops, the LiDS wheel was adjusted to Domo standards, in this way a refined tool formed a basis for the proposed synthesized sustainable NPD model. See table 1 for an overview of the data collected.

Table 1. Overview of types of data related to different research aims

Type of data	Internal/ External	Source	Aim
Desk research	Internal	Documentation on the current NPD process of Domo R&D	To get background information on how the current NPD process of Domo R&D works
	External	Documentation and literature on NPD processes, DfE and practical examples	To collect background information on how sustainability was already implemented at other companies than FrieslandCampina
	External	Documentation on comparable transformations, their backgrounds, approaches and implementations	To find lessons-learned and best practices that can be useful for integrating sustainability in NPD processes at Domo R&D
Interviews	Internal	Employees of FrieslandCampina. E.g. project managers, business development managers, researchers and trainees who work on sustainability	To investigate the vision of employees other than Domo R&D at FrieslandCampina on the current sustainability practices in NPD and what can be improved
	External	Researchers from other companies in de food industry. These companies are preferably frontrunners regarding the integration of sustainability in NPD processes.	To investigate how the integration of sustainability in NPD is done at other companies than FrieslandCampina
Workshops 1&2	Internal	Employees of Domo R&D	To investigate which parts of the LiDS wheel are relevant for Domo R&D and how these parts would be implemented in a specific Domo project.
	Internal	Employees of Domo R&D	To investigate which parts of the iriweb tool are relevant at the moment and which parts could be relevant in the future

3.3 Data analysis

All the interviews were recorded and summarized in Word. NVivo was used for reviewing the data by 'giving labels to components parts that seem to be of potential theoretical significance and/or that appear to be particularly salient within the social worlds of those being studied' (Bryman, 2016, p 573). This practice of open coding includes the 'process of coding yields concepts, which are later to be grouped and turned into categories' (Bryman, 2016, p 574). Relevant pieces of text, which provided information about the proposed synthesized NPD model in any form, were coded. By doing this, the first distinction was made between the relevant and irrelevant pieces of text, which made the data more organized. To get a clearer overview of the amount of data, the data was then coded deductively by searching for emerging themes from the theory (Burnard et al., 2008). According to Beiske et al. (2007),

deductive research approach explores a known theory or phenomenon and tests if that theory is valid in given circumstances. A predetermined structure/framework, the DfE principles, was used to analyse the data. Essentially, predefined codes were imposed on the data gathered from the interviews and workshops. Since exploratory research is an iterative process whereby a case study is used to build theory, but where the case study is used to test the theory as well, next to predefined codes from literature on the NCD model and the DfE principles concepts derived from empirical data were added (Bryman, 2016). Elements determined from the interviews and workshops, which were found to be relevant for the integration of sustainability in NPD at FC Domo, but did not appear in the proposed synthesized NPD model yet, were added. Comparing the data obtained from interviews and workshops enabled the author to validate the empirical data.

In order to answer the research question, namely how to integrate sustainability in NPD processes in the dairy industry, the elements that were found were compared with the proposed synthesized NPD model in order to categorize them into existing concepts or to classify them in newly added concepts.

3.4 Quality of the research

To ensure the data was valid and reliable, different data collection methods were applied namely: literature review, internal and external interviews, and workshops. During the workshops, the focus was on two different projects, which made it possible to compare outcomes and conclude on this. All internal interviewees represented people working in their own way towards sustainable business; however, they came from different departments within FC. This variety increased the validity of the data since the subject was approached from different angles. Yet, validity issues of the collected data can arise since one person conducted the interviews.

4. Results and Analysis

This chapter describes the results and analysis. Section 4.1 gives the results and analysis on the external interviews; section 4.2 presents the results and analysis of the internal interviews. Here, gathered data was labelled and, if possible, categorized. For example, two different labels ‘business growth’ and ‘financial aspect’ were taken together and classified in the same category since these subjects touch upon each other. The results and analysis are outlined in section 4.2 per category. Section 4.3 gives the results and analysis of workshops 1; and section 4.4 presents the results and analysis of workshop 2.

4.1 External interviews

4.1.1 Interviewee 1

According to interviewee 1, sustainability means ensuring that the resources we use around us today do not cause any damage to our world in the future and are used in a way that there will

always be enough and they will not run out. However, sustainability also means to double the size of the business while reducing the environmental footprint and increasing the positive social impact. Another important thing is engaging in partnerships where you can help change things on a global scale: deforestation and climate change; water, sanitation and hygiene; and sustainable agriculture and smallholder farmers. Each R&D employee works to meet the company's sustainability goals in their own projects. For example, in packaging development they work towards designing packaging materials that are as light as possible (to save transport costs in fuel) and with materials that can be easily recycled. Within the laundry discovery team they search for how they can concentrate the detergent liquids to make packs smaller. Other R&D teams also search how to produce products in the factories in the most efficient way using less high temperatures and therefore less energy. Each site at the company has an interactive event approximately every quarter to engage employees to not only look at sustainability in their daily work but also be active in their personal life. The idea is that each employee is an ambassador for sustainability and inspires others to act responsibly to create a better world for tomorrow. All R&D employees also receive regular updates on the progress that the company has made towards their sustainability goals of 2020 (to double the size of the business but halve the environmental footprint). This is done in a personal way identifying the colleagues that have made these positive changes happen. From the first stages of the NPD process, innovations are considered with sustainability goals in mind. This works because all levels of management have set in their annual targets and goals to innovate, develop and produce products in a sustainable manner. Consideration to sustainability standards and indexes are also taken into account to ensure the company also gets recognition for its efforts.

4.1.2 Interviewee 2

Interviewee 2 defines sustainability as ‘actions you take to reduce the impact on the environment and by doing this making profit as well’. Interviewee 2 tries to find new solutions for existing products to reduce the environmental impact. Also the social aspect is of great importance since every human being should have access to healthy food. Recycling packaging material is another practice the company is trying to accomplish by working together with suppliers and customers. He stated that sustainability should be in our mind from the very beginning of the NPD process, ideally, it should be in our mind constantly so that it is a given fact and not something you have to be reminded about every time. It should be very helpful to learn more about the subject and see how other companies handle sustainability. The interviewee thinks that interesting examples help to start thinking of integrating sustainability in NPD, especially when these examples are very creative and include new ideas. A weekly mail from the sustainability department can be also of great importance. Regarding the integration of sustainability in NPD, interviewee 2 argues that at this moment, only CO_2 emission is a fixed target. This means that a new product should be at least 10% more efficient than the initial product regarding CO_2 emissions. Water and energy use will be targets soon.

4.1.3 Interviewee 3

According to interviewee 3, the definition of sustainability is, make use of renewable sources with as less as possible energy usage. Interviewee 3 states that for their company this means that as many recyclable resources as possible are used in the design. Possibilities to combine energy streams are considered, for example by using waste heat in gases and liquids for heating other parts of the process. Both renewable sources as well as the optimization of energy streams are of use. Awareness is created through internal training about possibilities to refine the design of machines in such way that it becomes more sustainable. From 'project proposal' and 'project definition' people should think of above stated points since these decisions are basic and have to be made in the first stages of NPD. To actually integrate sustainability in the NPD process, some basic targets are set such as the amount of energy and water used, and CO_2 emissions. Interviewee 3 states that other more sustainability targets will be set in the nearby future.

4.1.4 Wrap-up

The purpose of the external interviews was to investigate how other companies than FrieslandCampina accomplish the integration of sustainability in NPD. Using the obtained information in the case of this research can help answering the research question. To get high quality information, the interviewees worked at companies that are preferably frontrunners in integrating sustainability in product development. According to the interviewees, sustainability should go hand in hand with financial benefits; interviewee 1 even argues that the business should double in size. The interviewees argue that sustainability is taken into account from the beginning of the NPD process and awareness is created through workshops, and other interactive courses. It was stated that identifying the colleagues that have made positive changes happen, regarding sustainability in NPD, is a very effective approach since people feel personally responsible. Taking other companies as example could help identifying opportunities, but possible more effective is engaging in partnerships with other companies to help change things on a global scale: deforestation and climate change; water, sanitation and hygiene; and sustainable agriculture and smallholder farmers. To accomplish the integration of sustainability in NPD, annual targets and goals are set, important subjects are CO_2 emissions, water and energy use.

4.2 Internal interviews

The qualitative data were collected through in-depth face-to-face interviews with a sustainability manager, development manager, business development manager, senior scientist, researcher, supply chain trainee, and a sustainability intern. Besides their regular job, all interviewees spend time on side activities focussing on sustainability within FrieslandCampina.

4.2.1 Awareness & CSR tool

Considering the data gathered from the interviews, interviewee 1 stated that creating awareness should take place before the 'new project request' by organizing workshops, using

sustainability tools and by setting targets. Interviewee 7 designates 'new project request' itself as the best moment to start thinking of sustainability arguing that it is difficult to set targets in an earlier stage. The interviewee argues that after the start of a project it can be determined if the project has similarities with the overall CSR strategy of the company and if it can elaborate on this. Interviewee 5 endorses this argument by stating that sustainability should play a key role in the very beginning of the NPD process, however, the analysis should be done after the project definition. Although 'new project request' or the phase before the new project request' is often determined as the best place to start thinking of sustainability, interviewee 7 argues that along the whole NPD process people should keep sustainability in mind. It is argued that every gate should be a moment of evaluation and if the sustainability-target is not reached, the project should be rejected. According to interviewee 7, this is only possible if the project principal denotes this as a requirement of the deliverable. Going one step further, it is stated that sustainability should be a given fact. Interviewee 8 confirmed this by arguing that sustainability should play a role along the whole NPD process and it should be part of the DNA of all employees. According to interviewee 1, sustainability experts should be appointed and trained so that R&D has this knowledge in house. Interviewee 6 states that employees can be triggered by awards, but essential are targets and some checklists, which can be used as sustainability tool during the NPD process. Interviewee 7, 5 and 6 think that a specific sustainability tool can create awareness as well. The CSR taskforce tool is a tool developed to check whether a project scores well on one of the four sustainability pillars of FC (figure 1). Pillar 1 entails Nutrition & Health, Pillar 2 - Efficient and sustainable production chains, Pillar 3 - Dairy development in Asia and Africa, Pillar 4 - Sustainable dairy farming. If all the questions are answered correctly, there are four different outcomes visualized by a colour: dark red to dark green. For every pillar the project scores a colour whereas dark red means a bad score on the sustainability pillar and green means a very good score on this pillar. This toolbox however is not binding and it is just to check how a project scores regarding sustainability; it is a tool that identifies which CSR goal is achieved. Interviewee 4 argues that a disadvantage of this tool is that it is just used to monitor the project. He states that targets are only reached if the tool is binding and if there are restrictions.

Regarding the overall results, it can be stated that all interviewees state that sustainability should play a key role in the first stages of the NPD process. Here, the 'new product request' and the phase prior to this stage can be distinguished. Some interviewees argue that the phase prior to 'new product request' is the most important to create awareness, while others think that this is too early since there is no project definition yet and thus setting sustainability goals is difficult. Ways to draw attention for sustainability are mentioned by the interviewees, such as organizing workshops, supply tools, offer help in using these tools and setting fixed targets and sustainability goals. The CSR task force tool is an example of such a tool; the disadvantage of this tool is that it is just for monitoring sustainability practices, which means that the outcome is not binding.

4.2.2 Customer importance

According to interviewee 1, it is already known that the customer will be asking for more sustainable products in the future. He argues that FrieslandCampina has to work on this request beforehand instead of waiting for the request to come. He mentioned the R&D department as a factor with a key role in this. Interviewee 3 also states that the customer will be asking for more sustainable products so FrieslandCampina has to conform these upcoming requests.

To conclude, it is wise to start working and thinking of sustainability in advance rather than wait for the request from customers to come. According to the interviewees, it is un-doubtable the request will come from customers.

4.2.3 Organizational structure

Interviewee 4 mentioned the organizational structure to be an important factor in integrating sustainability in NPD. He argues that employees are on their own island trying to launch some sustainability initiatives, however, these initiatives are not working well. He states that the organizational structure plays a key role here since these different projects are not top-down centrally managed to avoid overlap or gaps. Thereby, it is stated that if sustainability is not a priority of the HQ, profit projects (low cost/high volume) will be preferable to sustainability projects. As long as there are no key performance indicators (KPI's) on sustainability, projects will not be done in the way you would expect. Moreover, the organizational structure has to be changed to structure the different sustainability projects. Thereby, a great deal of attention should be paid to the interconnection of these different projects. According to interviewee 4, the good news is that there are sustainability projects that were not supported 4 years ago, but are supported now. R&D is hiring an LCA specialist, a carbon footprint specialist and a 'manure treatment' specialist.

Overall, it can be stated that the organizational structure is an important influencing factor regarding the integration of sustainability in NPD. The organizational structure of FrieslandCampina has to be organized in such a way that there is one central management to structure small isolated sustainability projects. For example, sustainability projects at the farm, at the R&D department and other departments should be centrally organized to avoid overlap and regulate finance.

4.2.4 Financial aspect

Interviewee 4 states that money plays a key role in the integration of sustainability in NPD. The interviewee argues that the organizational structure is at the root of a financial gap since Domo R&D does not charge the head quarter in Amersfoort for sustainability projects. As long as there is no budget for these projects, they will not take place at all. Interviewee 1 confirms this by stating that as long as there is no money for these kinds of projects, they are not taking place. Interviewee 5 argues that projects should be financially favourable, which means low costs and high volumes. Interviewee 4 states that ideally the greenest option is also the most financially favourable option. If this is not the case, the management team has to

make a decision if the project should be continued or not. Interviewee 3 puts forward that specialists should calculate a case. Accordingly, a team of marketers have to look at the feasibility of the plans and see if it is a licence to operate.

To wrap up, money plays a key role in the integration of sustainability in NPD. As long as the HQ does not finance sustainability projects, there will be no time to carry them out.

4.2.5 Obligatory goals

According to interviewee 4, sustainability topics are not as binding as other financial topics. He states that the overall target is 20% reduction of energy, however, per project this is not a target yet. These fixed targets should be adopted in the future, on the other hand it is not as easy as it seems since, for example, salt reduction is a sustainability target but will cost more energy to achieve. In other words, there are different dimensions that come together here, which make decision making more complex. It can be stated that if a project scores badly on all dimensions it should be rejected, however, these requirements are still in their infancy. Another option is to look at portfolio scores; in total all projects together should score positively, instead of looking at scores per project. Another suggestion interviewee 4 comes up with is to develop 'shadow prices' for qualitative data to make calculations easier. Interviewee 7 states that targets will only be reached if it is in the interest of the project principal. A lot depends on whether the principal values sustainability intrinsically, since it is difficult to force this. The executive board should give more attention to goals and make them obligatory as well; these targets are based on FC's strategy and will flow through other parts of the company. The CSR tool, which was introduced by the R&D department, is one initiative but the point is that this tool is just to monitor and thus not binding. There are other initiatives as well within CA and supply chain but as long as they are not aligned, they will not work optimally. The executive board plays a key role: supporting these initiatives is the only way to make them really work. Another difficulty is how to set certain targets. Interviewee 3 argues that the overall strategy entails 20% reduction of energy use; the question remains how this can be translated in specific project targets. According to interviewee 3, this should be done by obligatory goals: 'it is not about what we can, but what we must do'. He states that a KPI is key in reaching targets; thereby this KPI should include a number so that calculations can be made. Interviewee 8 argues that only when goals and targets are obligatory, they will be reached. These targets should be set top down. She states that 20% reduction by 2020 is an ambitious target since real actions are not taken yet; 'as long as there are no targets and no money to reach the goals, we will never meet these targets'. If these targets are not set, cost efficiency will always win from energy efficiency.

Overall, the interviewees state that sustainability goals and targets should be binding and should be handed down from on high. A suggestion would be to set KPI's including specific numbers so that calculations can be made, for example by setting shadow prices. To integrate sustainability in NPD, a start would be to set targets for project portfolio's instead of setting targets for stand-alone projects. This enables NPD professionals to balance out opportunities.

4.2.6 Social aspect & Health

Interviewee 7 mentioned welfare, human rights and food availability as an important social aspect of sustainability for FrieslandCampina. Interviewee 6 defines the social aspect as dairy development in Asia and Africa. Interviewee 5 underpins the designation of milk as much as possible for food production, which means, produce as little waste as possible. Interviewee 1 highlights the availability of healthy food for people who cannot afford it. Interviewee 6 highlights this health aspect as well by stating that healthy food should be available for people all over the world. Interviewee 7 mentioned the availability of healthy food for generations now and for generations of tomorrow. The interviewee remarks that the production of food should happen in a sustainable manner so that generations of tomorrow are able to enjoy this healthy food as well. It is stated that there should be more attention for healthy food for people all over the world. Interviewee 5 mentioned one sustainability pillar of FrieslandCampina's overall strategy: the health and nutrition pillar. Interviewee 2 states that nutrition and health is the most important pillar at the moment. Today, a lower limit is set on how much protein a product should contain. Before, products were diluted so much that the product could not be called 'healthy' anymore.

At the moment, health and nutrition are the most important subjects regarding FrieslandCampina's sustainability strategy. At the same time the company tries to improve the quality, think of increasing the protein content of a product. Another dimension is the production of this nutrition; according to the CSR strategy house, this should be done in a sustainable manner so that future generations have access to this healthy nutrition as well. This relates to reducing the pressure on society by using all produced milk (no waste) and cost price reduction.

4.2.7 Efficiency & Environmental aspect

Interviewee 7 mentioned efficiency as an important subject. Interviewee 1 elaborates on this by stating that FrieslandCampina wants to grow climate neutral. This means that the company has to reduce its energy and water consumption with 20% since the company is estimated to grow 20% by 2020. Thus, the company has to become 20% more efficient by 2020 compared to 2010. Interviewee 1 explains that every NPD project should be 20% more efficient compared to the former project regarding energy, water use and waste production. If the project does not comply with this requirement, there will be no financial support. He appoints R&D as the key player in this process by saying that 'they have to puzzle as long as they need to, to reach this goal of 20%'. The NPD task should be very clear, namely 20% more efficient compared to the initial product. Interviewee 6 endorses the importance of efficiency by stating that efficiency also is in favour of competition, interviewee 5 mentions efficiency in relation to production chains. Interviewee 8 argues that fixed targets are very important regarding efficiency. She states that these targets have to be set; otherwise cost efficiency will take precedence over energy and water efficiency. She argues: 'of course, cost efficiency is important, but environmental efficiency should be reached as well'. Interviewee 5 states that regarding NPD processes, the environmental aspect of sustainability is important. According to interviewee 6, the R&D department has the most influence on the environmental aspect of

sustainability and should therefore focus on pillar three of FrieslandCampina's CSR strategy. She states that R&D should focus less on the financial and social aspect of sustainability since R&D has less influence on these aspects.

The majority of the interviewees mentioned the environmental aspect as a crucial factor. It can even be stated that, compared to the other sustainability aspects (financial and social), this aspect is often perceived as the most import one for R&D since the R&D department has the largest influence on the environmental aspect. 20% environmental efficiency is key to most interviewees and the sustainability manager goes one step further by saying that projects should be rejected if they do not meet these criteria.

4.2.8 Use of resources & Farm

Interviewee 2 states that for R&D it is interesting to look at what resources are used think of milk, soy and sugar. These resources should be used and treated in a conscious and responsible way to prevent depletion. Interviewee 1 adds to this that the scarcity of resources plays an important role regarding integrating sustainability in NPD. Interviewee 6 states that to her, sustainability means that people consider what resources they are using and that they are thriftily with these resources. She argues that sometimes alternatives can be found for resources that are scarce. Interviewee 8 touched the subject of sustainable farming when she stated that FrieslandCampina's strategy is in the first place to produce milk in a sustainable manner. This includes that cows should graze outside and the land is maintained in a sustainable way; sometimes farmers have solar cells on their rooftops. According to interviewee 4, the use of sustainable energy, preferably produced by member dairy farmers, contributes to the achievement of the climate-neutral growth ambition. FrieslandCampina is encouraging member dairy farmers to generate sustainable energy, for example by means of wind turbines, solar panels or biomass, and/or by issuing green certificates. However, with the focus on R&D, this topic is out of scope since milk is a given resource; how this milk is produced is not something R&D can decide upon. Since it is clear that the biggest impact can be made at the farm, some people argue that the farm should be in the scope as well.

Considering the use of natural resources, R&D should take into account the scarcity and depletion of their resources. Sustainable farming is included in this topic since FrieslandCampina tries to produce milk in a sustainable manner. Farmers are stimulated to generate green energy by solar panels or biomass. To really make a difference here, the farm is part of the production chain, however, R&D does not take into account the farm in the NPD process. To really make a difference, R&D has to take into account activities at the farm as well.

4.2.9 Water use & Energy sources

Interviewee 1 mentioned water as an important subject regarding the integration of sustainability in NPD. Interviewee 5 mentioned the reduction of water use in combination with pressure on society. Interviewee 3 also defines water as an important topic regarding sustainability and NPD, and interviewee 8 states that the use of water should be reduced since

society is under pressure for using water, especially in dry parts of the world. Interviewee 5 denotes energy use in relation to pressure on society. Interviewee 3 mentioned energy use by stating that the company should give up on fossil energy and make the transition towards sustainable energy sources. He suggests a new KPI: In five years the same product should be produced using 10 to 20 per cent less energy. Interviewee 8 gives examples of alternative energy sources such as wind energy, solar energy and tidal energy.

Water and energy are both resources that should be reduced in the production process, which has been decided on in the NPD process. Interviewee 3 suggests a new KPI to concretise this and make the target more tangible. It is stated that goals can be reached through the transition to alternative energy sources such as wind-, solar-, and tidal energy.

4.2.10 Circular economy & Production chain

Interviewee 1 mentioned circular economy in relation to biodiversity as an important approach. FrieslandCampina tries to keep the soil as diverse as possible by applying the thinking of circular economy. This person underpins that thought of circular economy is more difficult to apply to the food industry since the product cannot be broken down into different component to be used again or to be recycled. Interviewee 3 mentioned circular economy as well but did not explain how to apply this concept. Interviewee 8 suggested treating packaging waste according to the idea of circular economy. Interviewee 1 endorses this idea by stating that, for instance, a plastic lid of a bottle should be part of the production chain. He argues that FrieslandCampina should look at the whole chain until end-of-life. Interviewee 4 states that this is already happening: it is called 'from grass to glass'. He adds that it is important to look at how much energy the consumer has to add to the product before it is consumable. If the product is simple in its composition, the consumer has to add more energy than when the product is complex in its composition. So, the complexity of a product can be influenced and as a result, the amount of energy a consumer has to use as well. Interviewee 8 underpins the importance of determining the amount of water and energy used in the production chain and what kind of waste does the company produce and how much?

Overall, it can be stated that the interviewees think that the production chain as a whole should be taken into account: from grass to glass. Interviewee 3 calls this the approach of circular economy while interviewee 1 underpins the benefits of circular economy in relation to biodiversity and not in relation to the supply chain as a whole per se. Another argument mentioned was that it is of great importance to look at how much energy the customer has to add to the product before consuming it.

4.2.11 CO_2 emissions & Waste

Interviewee 5 highlights the importance of reducing CO_2 emissions; he mentioned this in relation with climate change and pressure on world's population. Interviewee 3 also points out that the reduction of CO_2 emissions is an important subject with the integration of sustainability in NPD processes. He argues that the company is already looking at this but 'it is more an ad-hoc activity rather than a proactive activity'. According to interviewee 4, the

reduction of food waste is of great importance. The packaging team has defined this subject and is working on this project at the moment. Interviewee 2 also denotes consumer food waste and other residual streams as an important issue regarding the integration of sustainability in NPD. Interviewee 5 supports this by stating that residual streams are important to take into account; however, this is done insufficiently at the moment. Interviewee 3 states that the company should not be allowed to produce more waste than it is doing now, and the company should reuse this waste. Interviewee 8 puts this argument forward as well by stating that waste should be reused. Interviewee 3 points out that operations, with the help from outside the company, should figure out how to reduce waste production. Hence, this does not mean that the company should figure things out all by themselves.

The company should handle reduction of CO_2 emissions and waste production more proactively; moreover it should look at residual streams as well. Several interviewees argue that waste should be reused.

4.2.12 Packaging & Shelf-life

According to interviewee 4, the packaging team is working on food waste; how to alter packaging material and design in such a way that customers produce less food waste. Interviewee 2 denotes that packaging material should be sustainable and easy to recycle. Besides that, she argues that shelf life is another important topic to focus on in the NPD process. It is stated that a product with a longer shelf life is more sustainable since the time of exporting the product can be extended. Interviewee 4 goes further by saying that the part after product launch can be influenced as well. R&D can influence the amount of energy a customer has to add to the product; if the product is easy in its composition, the consumer has to add more energy. Interviewee 5 denotes the importance of product shelf life in the NPD process. According to interviewee 4, at the moment shelf life is not a sustainability parameter but a product quality parameter.

Several interviewees mention packaging as an important topic in NPD. It is stated that packaging material should be sustainable and easy to recycle, thereby; the design should ensure that consumers generate less food waste. Shelf life is important to sustainability as well since this influences the export time and transport costs, however, at the moment this is a product quality parameter.

4.2.13 Wrap-up

The purpose of the internal interviews was to investigate what subjects are important to employees of FrieslandCampina regarding the integration of sustainability in NPD and how they think this can be accomplished. All interviewees agreed that the first stages of the NPD process are important to create awareness; workshops and tools could help with creating awareness. Obligatory goals regarding CO_2 emissions, water and energy use have to be set, whereby the supply chain as a whole is taken into account: from grass to glass. This means that the organizational structure of FrieslandCampina has to be organized in such a way that there is one central management to structure small isolated sustainability projects. For

example, sustainability projects at the farm, at the R&D department, within the NPD process should be centrally organized to avoid overlap and regulate finance.

4.3 Workshop 1

Workshop 1 consisted of three parts (see Appendix C): First, the participants determined the maturity level of FC Domo by answering question from the IRI Sustainability Assessment Tool which was developed by the Industrial Research Institute. According to the PLC, the questions start with 'material selection', followed by supply chain, manufacture, use-phase, and end with 'end-of-life'. Customer insight and LCA are touched upon as well. The participants were asked to elaborate on their answers, which helped to get insight in topics that are still in their infancy and topics that are developing or well developed. The participants explained which topics were found to be important to FC Domo and which not; in this way it could be determined what topics should get special attention. Figure 10 derived from the answers in this workshop and shows the maturity level of FC Domo for these different topics. The LiDS Wheel formed the theoretical framework in the last part of the workshop. The participants picked three strategies from the LiDS Wheel that, in their opinion, could be applied best in project Wave3 and elaborated on how these strategies could be implemented in practice. The findings gave insight in which strategies and principles could be applied in the Wave3 project and which strategies are less easy to apply.

4.3.1 Customer insight

According to the participants of workshop 1, the company sees sustainable product development as additional costs that provide little or no value to the customer. The organization does not conduct market research to understand what sustainability characters are important to the customer. The company does not see sustainable NPD as a competitive advantage, and it does not require that all new products specifications include a sustainable element. There are no measurable sustainability criteria and customers are not engaged in the development process to produce more sustainable products. It is stated by the participants that the company is consciously incompetent.

4.3.2 LCA

From the results it can be stated that life cycle assessment is being developed. The company has gathered primary data for use in conducting LCA's and an appropriate functional unit has been defined. When an LCA is conducted by the company, the total life span is included; from raw material to end-of-life. Still, there is work to be done: product developers are not trained and educated on LCA concepts and results from LCA studies are not yet presented to design and development teams. LCA data do not play a role in decision-making about product lines and NPD processes yet. Often, the participants said: 'The company does not include these questions *yet*', which indicates that the above statements are changing or are about to change.

4.3.3 Material part selection

All materials and parts are assessed to ensure regulatory compliance. Also, materials with hazardous or toxic properties are identified. The company has begun to investigate sustainability of raw materials and there is a procedure implemented for raw material qualification that assesses sustainability and environmental impact of the material. On the other hand, the product design process does not include considerations for the environmental impact of materials and parts. Also the company has not started to design products to proactively reduce environmental impact of materials and parts. The company does not use sustainable materials wherever possible yet. Looking at the results, it can be concluded that the company does include some sustainability requirements for the simple reason that this is obligatory. Especially in the food industry safety and regulatory compliance are a main subject, which cannot be compromised. Additional questions regarding sustainable material part selection are not denounced since this is not obligatory yet and are seen by the company as extra and time-consuming activities. Participants of workshop 1, however, think that including these requirements is important.

4.3.4 Supply chain

According to the participants, the product design teams use the supply chain to achieve a sustainable design and not to only produce what is being specified. The company uses suppliers that are capable of supplying material meeting specific regulations and directives; however, this does not indicate that these regulations are subject to sustainability per se. Suppliers understand how they impact the company's products or services environmental impact; they also initiate improvements in their products or services that positively impact the company's product or service. However, the company's suppliers are not involved in the early stages of design activities related to sustainability and do not participate in DfE activities. The environmental impact of transportation is not used in the selection of suppliers, which indicates that there might be a supplier that has a lower environmental impact of transportation. Overall it can be stated that suppliers know their product very well and the company chooses suppliers on the basis of capabilities and regulations. However, suppliers are not included in the design stages of NPD process. According to the participants, this is relevant information and should be part of decision-making in the future.

4.3.5 Manufacture

The company has begun to assess environmental impact of the manufacturing processes; LCA specialists do this. The company has also begun to take steps to reduce waste and energy consumption. According to the participants, R&D does understand how product design affects the selection of manufacturing technologies and R&D considers the resulting environmental impacts. The environmental impact of the manufacturing process is a criterion for product designs as long as the cost price is not affected. According to the participants, the company has started to invest in less hazardous and more sustainable manufacturing processes, but this is still in its infancy. The environmental impacts of the manufacturing stage are communicated to the customer reactively, e.g. only if the customers ask for it information is supplied. Products are not designed to reduce the environmental impact, and reduced

environmental impact of the manufacturing phase is not a requirement in NPD processes. Accordingly, reduced environmental impacts of the manufacturing phase are not communicated to the customer. It is argued that reducing the environmental impact of the manufacturing phase is not a starting-point by itself.

4.3.6 Use-phase

The company has investigated and documented the environmental aspects and impacts of product use, which is consistent with actual customer use scenarios. The company has begun to identify and document design criteria that directly affect the environmental impacts during the use-phase, since the customer requests this. Since there are limited requests from customers (Only Unilever and Danone to a limited extent), the company does not engage with customers to better understand product-use scenarios. The company does not prioritize aspects with the highest environmental impact; moreover, products are not designed to minimize the user impact. The company does not use LCA results to reduce the environmental impact of the use-phase and products designs are not optimized according to this subject. When assessing the environmental impact of the use-phase, the location of the customers is not taken into account.

4.3.7 End-of-life

The company has assessed its products for recyclability, recoverability and/or reuse. A question that has not been asked yet, but is considered to be important is: Regarding packaging material, has the organization defined a metric and calculation method to measure recyclability of products? The participants state that recyclability is not a key criterion during the material selection process, but should be a criterion for packaging material. Thereby, packaging designs should ensure that materials intended to be recycled can easily be separated and are not compromised for material recycling.

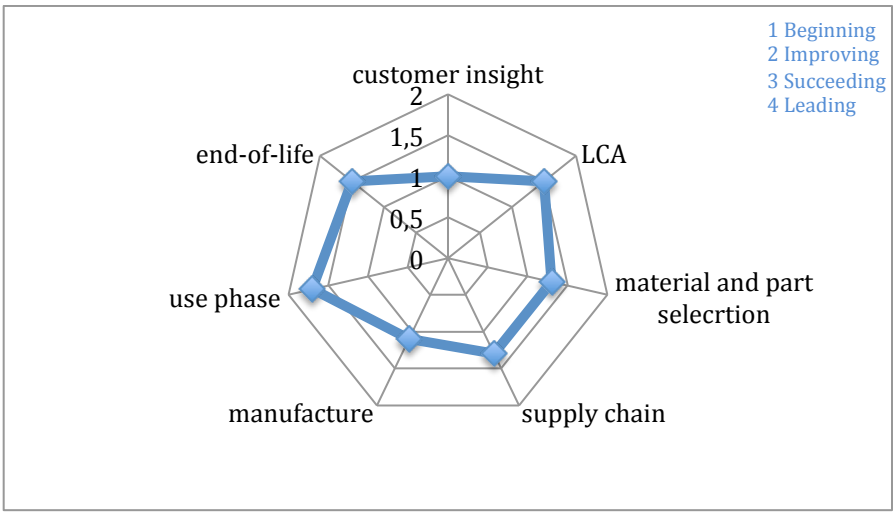

Figure 10. Maturity level of design strategies for FrieslandCampina Domo

4.3.9 LiDS wheel & project Wave3

People were asked to pick three strategies that could be applied to project Wave3 and elaborate on why they picked these strategies. The strategies and applied methods that were chosen for this project are outlined below:

1. Selection of low impact materials: Try to use every part of the milk and try to avoid chemicals or try to use as little as possible chemicals.
2. Reduction of material: By skipping drying step and transport liquid instead of dry material. Find the optimal source - production combination.
3. Optimization of production techniques. This is still in progress, however money remains a driving factor for this.
4. Optimizing the distribution system. Packaging material could be more efficient.
7. Optimizing end-of-life system. Valorisation of all milk fractions and take yield into account.

4.3.8 Wrap-up

The purpose of workshop 1 was to determine the maturity level of FrieslandCampina regarding the integration of sustainability in NPD. The aim was also to investigate which subjects of the online assessment tool were applicable to FC Domo and which were not, or could be improved. Since the government does not require it, FrieslandCampina does not include sustainable product development in their business practices because it could lead to more complicated processes and additional costs. The company has taken the first steps to conduct LCA's and hired specialists to carry out these assessments. Still, there is work to be done: product developers are not trained and educated on LCA concepts and results from LCA studies are not yet presented to design and development teams. Regarding the supply chain, the company uses suppliers that are capable of supplying material meeting specific regulations and directives; however, this does not indicate that these regulations are subject to sustainability per se. The environmental impact of the manufacturing process is a criterion for product designs as long as the cost price is not affected, which indicates that there is no real urgency to include environmental requirements. It can be stated that monitoring the environmental impact of the use-phase is still in its infancy since the company does not engage with customers to better understand product-use scenarios. It is argued that end of life is not an R&D activity since the product consists of food. Packaging material however, is something the company could take into account. From figure 10 it can be stated that FrieslandCampina has a maturity level between one and two: beginning and improving.

The aim of the last part of workshop 1 was to investigate which strategies of the LiDS wheel are, according to the participants, the easiest to apply to a project. This information can be used with the organization of future workshops to inform the employees on less useful strategies as well. Strategy 1, 2 and 3 were mentioned several times as the most logical and easy step towards sustainability. Strategy 4 and 7 were mentioned only two times, which indicates that researchers find it easier to think of the first stages of the product life cycle while developing a product. Taking the whole product life cycle into account can help thinking of the use-phase and end-of-life systems as well.

4.4 Workshop 2

The LiDS Wheel formed the theoretical basis of this workshop and was examined by the participants (see Appendix D and Appendix F). All seven strategies were examined and analysed. The strategies and principles were applied to project Phoenix to get a clearer insight in how to apply the DfE strategies in practice. Some strategies were adjusted, removed or information specific to FC Domo was added to make the model better fit for the dairy industry. The adjusted strategies are outlined below. Results are shown in appendix G.

4.4.1 Select low impact materials (Strategy 1)

The participants in the second workshop stressed that the use of materials that could be hazardous during production or disposal should be avoided. Some materials have a higher carbon footprint than others. Use of these materials is only justified if they lead to other positive environmental product features. For example milk from farms using green energy is preferred over the use of 'regular' milk. Choose a strategic production location to ensure the lowest carbon footprint possible. Reduce transportation costs and CO_2 footprint for raw materials incl. milk, whey and intermediate product streams. By choosing a production location close to the supplier and/or customer, transportation costs and CO_2 emissions will decrease.

4.4.2 Reduction of material usage (Strategy 2)

Using less material goes hand in hand with lowering the product's environmental impact. Here an inventory is needed by means of, for example, a brainstorm session. The inventory should include the following topics: water, chemicals and raw materials. A higher number of less bulky products (including the packaging) can be transported by a specific mode of transport.

4.4.3 Optimization of production techniques (Strategy 3)

When selecting a production technique, the company should focus on those alternative techniques, which have a low environmental impact, low losses of dairy, and techniques that generate the least amount of production waste. Also, there should be fewer production steps to ensure less use of energy. A company should not limit itself to its own production process but try to stimulate farmers, chemical suppliers, technology suppliers, and packaging material suppliers to improve their processes as well. The amount of operation materials and the amount of water used should be reduced as well.

4.4.4 Optimization of distribution system (Strategy 4)

The mode of transport, logistics and packaging were determined to be important, these components relate to the distribution system. Efficient transportation can be achieved by, for example, adjusting the route of the supplier or the milk collector in such a way that the distance is shortened. Packaging material of great importance according to the participants: it should be regarded as a product with its own lifecycle since both the product and the packaging material have their own product life cycle and are separated after the use phase of

the product. Packaging material could consist of little, clean, reusable packaging in order to have a positive environmental impact. It is stated that the mode of transport that is used, should be loaded efficiently. To achieve this, the main message is: work together with logistics to determine opportunities. Motivate sales department to work together with local suppliers and to introduce efficient distribution methods (e.g. distributing a large number of goods at the same time instead of making several smaller deliveries)

4.4.5 Reduction of user impact (Strategy 5)

Consumables such as energy and water and some applied products such as a knife to open the packaging material or a plastic spoon (inside the packaging material to measure out the product amount) are needed in the user stage for the product to fulfil its purpose. It is in favour of the environment to reduce these impacts of the user by ensuring that less consumables are needed to fulfil the product its purpose. Determine if the project contributes to lower energy consumption can do this, or determine if the product is complicated or simple in its composition. This can affect the amount of energy the consumer has to add to the product. To achieve this, evaluate how the customer applies the product and consider adjusted and optimized packaging volume and material. Work together with packaging specialists. It also has been advised to work together with procurement to choose the least harmful source of energy. Determine if packaging material can be reused and choose the right packaging unit and consider if it can be recycled. User behaviour can be influenced by the product design as well. There should be communication between the user and supplier to get information on the user behaviour, since product design can influence this behaviour, but vice versa, the behaviour could influence the product design as well.

4.4.6 Optimization of shelf life (Strategy 6)

According to the workshop participants, the objective of this strategy is to extend the shelf life of the product. They state that the product specification can be optimised so that it facilitates the intended use of the customer. ‘Try to understand customer needs and implement the needs in the product specification’ was another statement that was put forward by the participants. And when the product shelf life is optimized, this has a positive effect on transport costs and supplier-buyer time.

4.4.7 Optimization of end-of-life system (Strategy 7)

According to van Hemel (1998) ‘A product's end-of-life system refers to what happens to it after its initial life’. The participants agreed on this definition and stated: try to close material cycles to reduce the environmental impact of packaging material, this can be done by reusing the material or by recycling it. The latter can only be applied unless it has a lower environmental impact than producing new packaging material. According to the participants:
- All milk-fractions should be valorised
- Losses (yield) should be taken into account
- Alternative outlets for by-products should be identified
- Make a development plan and decide on it based on business case involved
- Usage of off spec product

It is of great importance that all disciplines, Operations, Marketing, Packaging, Technology, R&D, Sales PS and R&D work together here. Optimisation is very important for existing products. Can we improve performance of existing products by reducing costs, improving cost in use and reducing environmental impact? Identifying opportunities amongst disciplines is important here. Can we identify such opportunities for existing products in terms of energy and water usage, processing aids usage, packaging material usage, product yields and losses? Such sessions will deliver a list of opportunities. Prioritisation and decision making is then needed to decide on which steps to make.

4.4.8 Wrap-up

The aim of workshop 2 was to dive deeper into the theory of the LiDS wheel and investigate which exact parts are useful for FC Domo and how parts of the wheel can be altered to make them better fit for FC Domo. Every strategy and principle was analysed in workshop 2, consequently the outcome helped to refine the LiDS wheel according to Domo standards. Regarding strategy 1, it is not only important to select low impact materials; these materials should also be safe for humans and environment. The main focus point of strategy 2 is the reduction of water use and concentration of liquids before transport, which avoids drying steps. Reduction of water usage was mentioned to be very important with the optimisation of production techniques in strategy 3 as well. Overall it can be stated that optimisation of initial lifetime does only apply for packaging material and not for the product itself. Therefore, strategy 6 should be refined and renamed ‘optimisation of product shelf life’. The end-of-life is applicable to packaging materials as well; it is argued that it is of great importance that all disciplines, Operations, Marketing, Packaging, Technology, R&D, Sales and R&D work together here.

5. Conclusion

The objective of this thesis was to explore how a sustainable NPD process can be created in the dairy sector, more specifically at FC Domo. First, a synthesized NPD model was created combining literature on front-end innovation, NPD processes and DfE. The first part of the proposed model sketches activities occurring in the fuzzy front-end of the NPD process. In the creation phase, elements of the LiDS wheel were used as a framework to integrate sustainability in this part of the NPD process.

In order to understand current activities in NPD at FrieslandCampina Domo and to find out what is needed to integrate sustainability in NPD processes, literature and other documents were reviewed. Additionally, 11 interviews with both employees of FC and representatives of other companies were conducted and two workshops with representatives of FC Domo were organized.

Empirical data showed that the maturity level of FC Domo is currently between beginning and improving with regards to the integration of sustainability in NPD. This can be derived from the results of the first workshop where participants used the sustainability assessment tool to

determine the current maturity level of FC Domo. Especially customer insight and manufacture strategy are lagging behind (figure 10). In order to tackle the integration problem, it can be concluded that attention should be paid to sustainability in the first phase of the NPD process, for example through organizing workshops and other additional courses. It was stated that the integration should take place in the first stages of the NPD process since here the influence is greater than in later stages. This argument is in line with Herstatt & Verworn (2001) who claim that sustainability should be integrated in the FFE of the product development process, where the influence of designers on product design is high and costs from changes are relatively low (see figure 6).

According to the empirical data, several influencing factors and elements that match the NCD theory were determined. Other factors, such as awareness and obligatory goals, were found to be specifically important to FrieslandCampina and were added to the proposed synthesized NPD model. It can be concluded that leadership is one of the key driving factors for including sustainability in NPD, since a 'leader' can set targets and goals to achieve sustainability targets. From leadership follows a business strategy for the organization, where the social aspects, health and environment were determined to be very important. To make the translation from strategy to actions in R&D successful, money has to be available to finance research on this topic. Culture, or 'the way of thinking', or norms and values are a driving factor as well; if sustainability is embedded in someone's norms and values, there is a greater chance that these norms and values are integrated in an NPD process. Norms and values can be changed by creating awareness through, for example, workshops and other additional courses; a CSR tool is one example of a tool, which can help creating awareness.

The above stated elements influence the activities in the fuzzy front-end of the NPD process were opportunity identification or idea generation take place. From the data it can be concluded that strategies from the refined LiDS wheel have to be taken into account during opportunity identification or idea generation to tackle all the phases of the product life cycle. During idea and opportunity selection the refined LiDS wheel can help choosing one idea/opportunity over another. Concept and technology development is the last phase before entering the implementation phase were the strategies of the refined LiDS wheel are actually applied. The more strategies are applied, the more sustainable a final product will be.

Through analysing the LiDS wheel, it was found that the DfE strategies found in the workshops and interviews corresponded to six of the seven DfE strategies of the LiDS wheel. Some strategies needed to be adjusted since the situation in the dairy industry makes them difficult to use. Therefore, some principles were removed and others were added or altered to make them better fit for the industry. This thesis thus proposes a refinement of the LiDS wheel developed by van Hemel (1998). It is argued to focus on packaging materials in strategy 1 as well. Strategy 2 is relevant for the dairy industry; basic know-how on environmental figures and LCA is needed here. Strategy 3, the starting point of NPD and 'production waste' could be focussed more on 'residual streams'. Strategy 4 is relevant to the packaging specialists, thus it is of great importance that there is alignment between the R&D department and the packaging specialists. Regarding strategy 5, it is recommended to

communicate sustainability goals with procurement to increase the success rate of reaching these goals. The focus of strategy 6 should lay with the shelf life of the product, where customer needs should be taken into account. Strategy 7 should focus on 'valorising all milk-fractions'.

The different models, which were part of the proposed synthesized NPD model, were assessed to be very useful for the dairy industry. However, some refinements were applied to make the model fit better, specifically for FC Domo. To come to an answer on the research question, the refined concept model (figure 11) was developed. This model enables the dairy industry to integrate sustainability in their NPD process.

The answer to the research question "*how to incorporate sustainability in the new product development process in the dairy industry"* is that positive influencing factors and elements have to be introduced in the diary industry. Examples are: a sustainability culture, leadership and finance for sustainable product development and a sustainable business strategy. These elements will have a positive influence on idea genesis and opportunity identification in the first phase of the NPD process. Here, as well as in the opportunity and idea selection phase, the strategies of the refined LiDS wheel can help to make decisions. Concept and technology development is the last element of the fuzzy front-end before entering the creation phase were the refined LiDS wheel can actually be applied to the product.

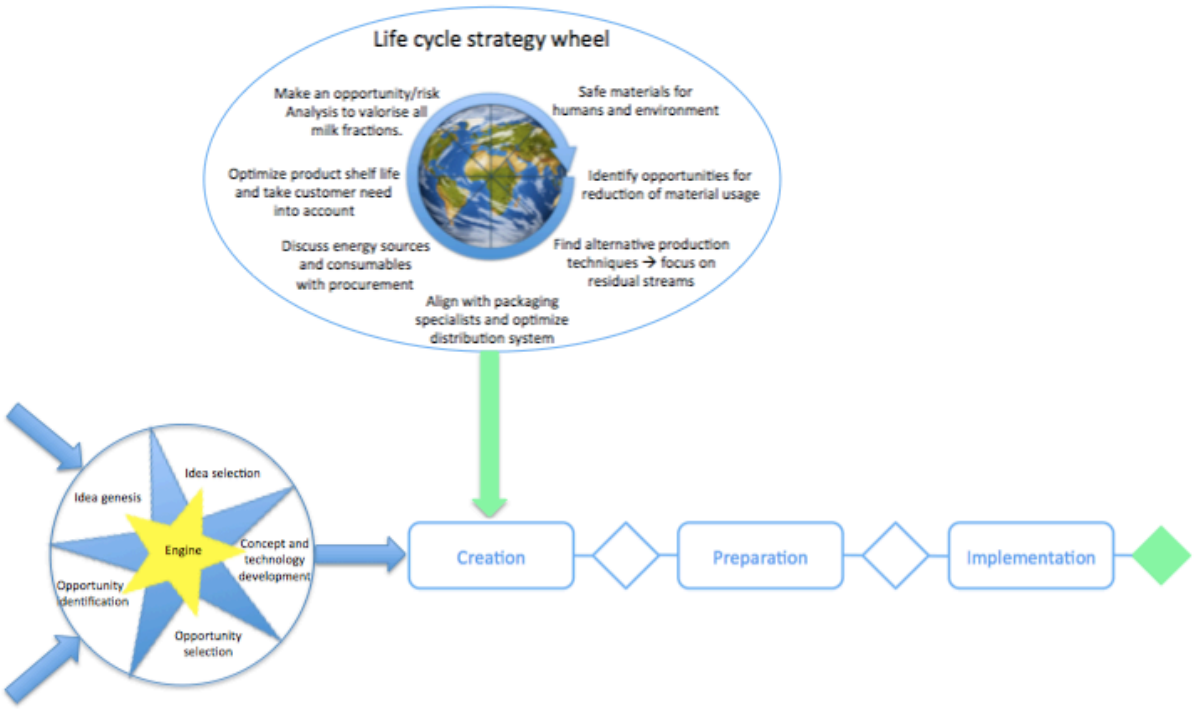

Figure 11. Proposed synthesized NPD model

6. Discussion

All interviewees and workshop participants were willing to make time available, were interested in the subject, and gave useful input. Researchers of FC Domo see the urgency of sustainability issues but are not able to handle these issues due to a lack of knowledge. Any help or suggestions regarding the integration of sustainability in NPD were warmly welcomed.

The LiDS wheel, which was used as a theoretical basis during the workshops, turned out to be very useful since it covered all aspects of the product life cycle (van Hemel et al., 1998). However, this tool has been developed within the school of industrial design, and was therefore sometimes not entirely applicable to the dairy industry. The purpose of workshop 2, however, was to refine the DfE strategies and principles of the LiDS wheel in such a way that the tool can be used in the dairy industry. It is stated that only one study on refining a model can give rise to validity issues, thereby it is difficult to generalize these findings.

External interviewees appropriate for this research were difficult to find since they should meet specific requirements. The external interviewees should work in companies that are preferably frontrunners in integrating sustainability into their business practices. Thereby, the interviewees should have specific knowledge of the NPD process and, more ideally, knowledge of integrating sustainability in NPD. Two interviewees were found to be researchers, working in fast moving consumer goods (FMCG) companies, while the other interviewee worked at the R&D department of a technology company that was not particularly a frontrunner at integrating sustainability into their business. Especially the latter seems questionable regarding the viability of the data obtained from this interview. It can be argued that the technical industry does not match the dairy industry, which makes this data less useable. However, the third interviewee could elaborate on efficiency and the optimization of production techniques, which is useful in technical innovation in the dairy industry.

Further research on the integration of sustainability in NPD is advised; it is recommended to start the research where this thesis has left of and test the proposed synthesized NPD model. The model should be used with the start of a new project until market launch, to test whether the final product is more sustainable than the initial one and to find what organizational issues may arise in using the proposed model. To ensure the data is valid and reliable, more than one project should be subjected to the synthesized NPD model. Also, refinement of the model is recommended after every project.

To generalize the NPD model and make it applicable to the dairy industry as a whole, additional studies could be performed in other companies in the dairy industry. This research was performed at FC Domo: a subsidairy of Royal FrieslandCampina N.V. Two projects were analysed by performing different workshops. The information obtained from the workshops is very specific to FC Domo, which makes the analysis per se not generally applicable to other dairy companies. An NPD model for the dairy industry as a whole requires generalization of

the model and it is recommended to work together with other companies, especially frontrunners, to accomplish this.

7. Advice to business

This research provides a synthesized NPD model to integrate sustainability in the process of developing new products. The research has been conducted for the dairy industry, specifically for FC Domo. To refine the model for FC Domo it should be tested in future projects and adjusted after every market launch.

It is recommended to work in partnerships with suppliers and customers to make positive changes toward sustainability happen. Working together with suppliers and customers can stimulate to reach goals and targets can be set collectively. It is advised to intensify communication with suppliers and customers to identify their needs and it is advised to collaborate on this to reach common goals. Working together internally is of great importance as well, for example R&D should cooperate with packaging specialists and procurement to find solutions for specific sustainability issues.

In order to tackle the integration problem, all levels of management are advised to set in their annual targets and goals to innovate: develop and produce products in a sustainable manner. Negative consequences should ensure that NPD professionals are forced to meet these targets. Consideration of sustainability standards and indexes should be taken into account to ensure the company also gets recognition for its efforts.

From the very beginning of the NPD process there should be attention for sustainability, this can be achieved by creating awareness. All R&D employees should receive regular updates on the progress that FrieslandCampina has made towards their sustainability goals of Route 2020. It is advised for each site to have an interactive event approximately every quarter to engage employees to not only look at sustainability in their daily work but also be active in their personal life. Personal attention is important, which means identifying employees that have made positive changes towards sustainability happen.

Next to creating awareness, there should be more room for inventory; different options toward sustainable actions should be outlined and determined, accordingly the most efficient and sustainable option is chosen. Consequently, financial support is essential here, since inventory is time consuming and thus expensive.

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9. Appendices

Appendix A List of interviewees

Interviewee	Organization/Function	Interviewee nr.	Date interview
Internal	Sustainability manager	1	13-01-2016
	Development manager	2	16-12-2015
	Business development manager	3	14-12-2015
	Senior scientist	4	08-02-2016
	Researcher	5	22-12-2015
	Researcher	6	27-12-2015
	Supply chain trainee	7	13-01-2016
	Sustainability intern	8	13-01-2016
External	FMCG – R&D	1	10-12-2015
	FMCG – R&D	2	05-01-2016
	Technical innovation R&D	3	07-01-2016

Appendix B Interview structure

Internal and external interview questions

1. What is, in your opinion, the definition of sustainability and what does this definition mean for your company?

- What does this definition mean to you in personal life?
- Are there practices you learned at work and practice at home as well?

2. Is this definition applicable to new product development process within R&D? In other words, on which above stated sustainability issues is R&D currently working?

- Are there other sustainability issues that R&D is working on at the moment?
- What sustainability issues are, in your opinion, important to work on in NPD processes?

3. How does your company create awareness among R&D employees regarding sustainability?

- Which of these methods are the most efficient in your opinion?
    - Why?
- Are there other ways to create awareness that would work (better)?
    - Can you give examples?

4. Looking at the new product development process of your company, at what point people start thinking of sustainability goals?

- Why at this point?
- What would happen if people start thinking of sustainability in an earlier or later stadium?
- Would the final product be different?
    - If yes, in what way

External interview question

5. How does your company integrate sustainability in the new product development process?

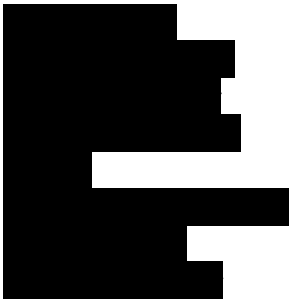
- At what point?
- Can you give examples of any sustainability topics that are touched upon in the NPD process?
- If you have to improve this integration, how would you do that?

Appendix C Structure workshop 1

Workshop Integrating Sustainability in NPD Processes

Zaal: B 0.60 (Lactose)
Datum: 19-01-2016
Tijd: 10.00-13.00

Deelnemers: 8



10.00-10.15 → Koffie – Introductie
In de inleiding duidelijk maken wat het doel is van de workshop en dat er meerde workshops zullen komen. Vertellen vanuit welke studie je onderzoek doet. Dat de er wordt geprobeerd een brug slaan tussen praktijk en theorie in deze master en dat deze workshop daar dan ook een goed voorbeeld van. De theorie linken met praktijk en specifieke inside information die niet in de literatuur te vinden is bij de mensen zelf 'halen'. Dus duidelijk maken dat jij de hulp van Domo mensen nodig hebt omdat het model een tailor made model wordt en dus speciaal voor Domo wordt ontwikkeld. Je hoopt na de workshops een idee te hebben van wat voor de product ontwikkelaar belangrijk is.

10.15-10.25 → Ruimtelijke opdracht
Vervolgens de ruimte gebruiken en iedereen op een lijn laten staan. Welk cijfer hang jij aan duurzaamheid bij het ontwikkelen van nieuwe producten? Waarom? Hoe komt het dat er soms nog weinig aandacht voor is en hoe zouden we dat kunnen veranderen?

10.25-10.40 → Presentatie Elsa
Doel: R&D helpen in het creëren van duurzame producten die zorgen voor groei. Duurzaamheid includes people, planet profit, maar we gaan het vandaag vooral hebben over de 'environmental aspect' van duurzaamheid. De tool die we vandaag gaan gebruiken helpt bij benchmarking de vooruitgang in de reis naar het integreren van duurzaamheid in NPD processen. Dit zorgt voor competative advantage.

- A recent MIT Sloan Management Report found that companies believe that sustainability will eventually become a core function that is central to a business's success. –

Duurzaamheid wordt pas echt bereikt als de tripple bottom line in alle aspecten van de business is geïntegreerd. Toch wordt meestal als eerste stap vaak environmental strategies opgesteld. Er is echter nog weinig onderzoek gedaan naar de relatie tussen environmental strategies en green product development. Tot op heden is er nog weinig informatie voor NPD professionals over duurzaamheid. De ROR groep heeft hieraan gewerkt en is met een model gekomen.
10.40-10.50 → Presentatie [redacted] – Wave3

10.50-10.55 → Uitleg werkwijze
Elk duo krijgt een vragenlijst uit de assessment tool. Deze vragen zijn met ja of nee te beantwooren. De duo's moeten de vragen beantwoorden en daarna aangeven of ze het antwoord (ja/nee) zo goed vinden of dat ze het graag anders zouden willen zien. Daarbij geven de deelnemers uitleg waarom deze vraag wel of niet relevant is, daarbij kan als voorbeeld het Wave3 project worden gebruikt.

1. Beantwoord vragen met ja/nee
2. Geef aan of je tevreden bent met het bovengenoemde antwoord, of dat je dit graag anders ziet.
3. Geef uitleg waarom deze vraag wel of niet relevant is, daarbij kan als voorbeeld het Wave3 project worden gebruikt.

- Schrijf de antwoorden van deze drie vragen op één flip per ronde.

1. Specification/Customer Insights

Does your organization only include sustainable elements in product specifications when cost analysis shows a positive ROI for business?
Does the organization view sustatinable product development as more then just as additional cost that provides little or no value to the customer?
Does the organization conduct market research to engage customers and understand what sustainability characteristics are important to them?
Does your organization utilize sustainability-related market research data to produce new product specifications?
Does your organization view developing sustainable products as a competitive advantage?
Does your organization require that all new product specifications have a sustainable element included?
Does your organization currently or plan to rewrite existing product specifiations to include sustainable elements?
Does your organization have a validation process to ensure product specifications meet the customer requirements?
Does your organization utilize Voice of the Customer (VOC) feedback when developing product specifications?
Do product specifications include specific and measurable sustainability criteria?
Does your organization engage customers in the design and development process to produce more sustainble products?

2. Life Cycle Assessment (LCA) Process

Has your s company's development organization been trained and educated on LCA concepts?
When products are being considered for LCA's, have the appropriate and relevant environmental indicators been identified?
Has your organization defined an appropriate functional unit for any LCA studies?
Have LCA's utilizing secondary data been conducted for any products?
Are the results from any LCA study been presented to design and development for consideration in NPD?
When conducting LCA studies, does your organization follow the Product Category Rules relevant to your product?
Has your organization gathered primary data for use in conducting LCA's?
When conducting LCA's, does your organization consider the total lifespan of a product, from raw material to end-of-life?
Does your organization utilized LCA data to make decisions about product lines?
Does your organization prioritize new projects based on LCA data?
Does your organization require LCA's as a part of the NPD processes?
Does your organiztation have their LCA's peer-review by a third party?
Does your company contribute to the product category rules for your industry?
Does your company contribute to the LCA inventory database for your industry?
Does your organization use LCA Data as a control variable to feedback & improve process/product for future offerings?

3. DfE-Material and Part Selection

Are all materials and parts assessed to ensure regulatory compliance?
Does your design process include consideration for the environmental impact of materials and parts?
Has your organization started to design products to proactively REDUCE the environmental impact of materials and parts?
Does your organization identify materials with hazardous or toxic properties (working in conjunction with supply chain)?
Do you perform an alternatives assessment on hazardous substances in materials and parts to identify if safer alternatives are available?
Have you begun to investigate the sustainability of materials?
Is a procedure implemented for raw material qualification that assesses sustainability and environmental impact of the material?
Does the engineering team proactively identify safer and more sustainable materials?
Do engineering and procurement specifications require use of materials with reduced environmental impact?
Is reduced environmental impact and sustainability of materials and parts a mandatory design criteria in NPD process?
Are life cycle assessment (LCA) results used to identify materials with overall reduced envirionmental impact?
Are materials and parts selected to reduce environmental impact of manufacturing and other downstream life cycle stages?
Does your organization work closely with supply chain to improve the sustainability of materials and parts and develop alternatives when needed?
Material and Part selection is based on Life Cycle Assessment results to minimize environmental impact and maximize sustainability?
The organization uses sustainable materials where ever possible?
The organization is an industry leader in proactive R&D efforts (directly or in conjunction with supply chain) to develop sustainable materials with minimum environmental impact?
The company is an industry leader in development of new sustainable materials and will collaborate with competitors to bring better material options to market?

4. DfE-Supply Chain

Do product design teams use the supply chain as a partner in sustainable design and not to only procure what is being specified?
Does the company use suppliers that are capable of supplying material meeting specific regulations and directives?
Are the company's suppliers involved in early stages of product design activities related to sustainability and environmental responsibility?
Are "Greener" materials and processes being used because of the involvement of suppliers in design activities?
Is the environmental impact of transportation used in the selection of suppliers?
Are the company's suppliers actively engaged in the Eco-design process?
Do the company's suppliers understand how they impact your products or services environmental impact?
Do your company's suppliers initiate improvements in their products or services that positively impact your product or service?

5. DfE-Manufacturing Impact

Has the company begun to assess the environmental impacts of the manufacturing processes and options?
Has the company begun to taking steps to reduce waste / energy consumption?
Does the design organization understand how product design affects the selection of manufacturing technologies and consider the resulting environmental impacts?
Is the environmental impact of the manufacturing process a criteria for product design?
Has the company begun to investigate and perhaps invest in less hazardous and more sustainable manufacturing processes?
Are products being designed to reduce/optimize the environmental impact of the manufacturing processes?
Is reduced environmental impact of the manufacturing phase a mandatory design criteria in NPD process?
Are LCA (cradle to grave) results used to assess overall envirionmental impact of manufacturing phase?
Is the transportation of material from suppliers and distribution of finished product to end customers included in the life cycle assessment?
Are the environmental impacts of the manufacturing phase communicated to your customers?
Does your company work with equipment manufacturers to reduce the environmental impacts of their equipment and/or to develop more sustatinable manufacturing process?
Has your oranization been recognized as an industry leader for innovation in design that reduces the environmental impact during the manufacturing of your products?

6. DfE-Use Phase Impact

Have you investigated and documented the environmental aspects and impacts of product use which is consistent with actual customer use scenarios? (includes resource usage and field service activities)
Have you begun to identify and document design criteria that directly affect the environmental impacts during the use phase?
Has your company identified the impact of design on field service activities?
Do you engage with your customeres to better understand product use scenarios?
Do you use analysis tools to assess environmental impact of use phase?
Have you prioritized the aspects with the highest environmental impact?
Do you design your products to minimize field service activities?
Is reducing the environmental impacts of the product use phase a mandatory design criteria in NPD process?
Are LCA (cradle to grave) results used to assess overall envirionmental impact of use phase?
Are product designs optimized to reduce the environmental impact of product use?
Is the location of customers considered in assessing the environmental impacts of use phase, with respect to the use of resources (e.g. energy, water, etc)?
Has your company been recognized for innovation of product offerings with best in class environmental performance during use phase?
Does your company benchmark the use phase impact of its product against competitive products with similar use?
Do your design teams work with suppliers to develop materials and products that reduce environmental impact of use phase?

7. DfE-End of Life Impact

Are products assessed for recyclability, recoverability and/or reuse?
Have products been designed to support refurbishment and/or reuse where applicable?
Has the organization defined a metric and calculation method to measure recyclability of products and materials?
Is recyclability a key criteria during the material selection process?
Designs ensure that materials intended to be recycled can be easily separated and are not compromised for material recycling (e.g. avoid use of coatings)?
Are products designed to simplify product refurbishment and reuse?
Overall, have products been designed to IMPROVE recyclability, recoverability AND reuse (as applicable)?
The organization has a recyclabiliity metric and calculation method to measure recyclability comparable to the industry?
Does the organization use Life Cycle Assessment (cradle to grave) results to select the best method for recycleability, recoverability or reuse trade-off decisions?
The company considers alternatitve methods for reuse/recycling including development of new techniques / processes to maximize EOL benefits and minimize negative impacts?
If uncommon recycling technology or EOL process is needed, does the organization implement business models (i.e. renting, buy back, etc.) to achieve the EOL goals?
Do parts that are not recyclable allow environmentally sound energy recovery or other beneficial results other than disposal?
Are your products optimized for recyclability, recoverability and reuse?
Does the organization optimize its designs for both reuse AND eventual recycling?
The recyclabiliity of the organization's products is at a worldclass performance level within its industry.
The company supports the design by implementing new techniques / processes or other business models to ensure reuse/recycling (i.e. renting, buy back, etc.) or works with partners to builds infrastructure ensuring reuse/recycling beyond standard reuse/recycling streams.
Overall, the organization designs its products to maximizes reuse, recyclability, recoverability and recyclability.

10.55-11.25 → Ronde 1
11.25-11.55 → Ronde 2

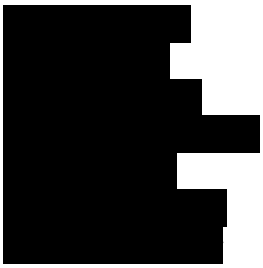
11.55-12.00 → Pauze

12.00-13.00 → Bespreking antwoorden
10 minuten per dimensie (er zijn 6 dimensies) = 60 minuten

Appendix D Structure workshop 2

Workshop Integrating Sustainability in NPD processes
Zaal: B 1.68 (Magnesium)

Deelnemers: 7



09.30-09.45 → Koffie - Introductie

In de inleiding duidelijk maken wat het doel is van de workshop en dat er meerde workshops zullen komen. Vertellen vanuit welke studie je onderzoek doet. Dat de er wordt geprobeerd een brug slaan tussen praktijk en theorie in deze master en dat deze workshop daar dan ook een goed voorbeeld van. De theorie linken met praktijk en specifieke inside information die niet in de literatuur te vinden is bij de mensen zelf 'halen'. Dus duidelijk maken dat jij de hulp van Domo mensen nodig hebt omdat het model een tailor made model wordt en dus speciaal voor Domo wordt ontwikkeld. Je hoopt na de workshops een idee te hebben van wat voor de productontwikkelaar belangrijk is.

09.45-09.50
Vervolgens de ruimte gebruiken en iedereen op een lijn laten staan. Welk cijfer hang jij aan duurzaamheid bij het ontwikkelen van nieuwe producten? Waarom? Hoe komt het dat er soms nog weinig aandacht voor is en hoe zouden we dat kunnen veranderen?

09.50-10.05 → Presentatie Elsa
Roelof Joosten in de groene trein naar Parijs. Van breed naar smal: Klimaattop Parijs, PvdA en GroenLinks voorstel, FrieslandCampina als bedrijf, Domo R&D. Heel duidelijk de scope aangeven: Wat er gebeurt op de boerderij daar kan R&D niks aan veranderen ook al zou dit wel de grootste impact hebben op duurzaamheid. Het gaat dus echt om het proces van ontwikkelen van nieuwe producten en wat we binnen Domo R&D kunnen doen met betrekking tot duurzaamheid.

Uitleg LiDS Wheel.

Per DFE principle moet duidelijk worden wat voor Domo de aandachtspunten zijn. Theorie wordt verder uitgewerkt. Alle hulpstoffen moeten in een overzicht komen. Vorm geven aan begrippen als clean, renewable low energy content.
Wat betekent dit voor een Domo NPD project. Wat moet je doen als je dit Phoenix project hebt gestart.

10.05-10.15 → Presentatie Jan, Phoenix

10.15-10.20 → Uitleg werkwijze
Elk duo krijgt een strategie met bijbehorende elementen. Per elementen moeten drie vragen worden uitgewerkt:

1. Is dit element relevant om duurzaamheid in het NPD project onder de aandacht te brengen. Ja/Nee, waarom?
2. Hoe zou je dit element verwoorden/omvormen zodat deze past binnen Domo-NPD gedachten? Eventueel met gebruik van R&D Wageningen jargon. Waar kan de vraag specifieker/scherper worden gesteld?
3. Wat is de actie voor het project Phoenix met betrekking tot dit element?

* Schrijf de antwoorden van deze drie vragen op één flip per ronde.

De antwoorden worden op een flipover geschreven; per vel papier één element met dus drie bijbehorende antwoorden. Na 20 minuten worden de strategieën ingeleverd en verruild voor een nieuwe strategie. Voor de nieuwe strategie wordt de werkwijze nogmaals herhaald. Let op: strategie 2 en 4 worden samengevoegd zodat uiteindelijk alle 7 strategieën aan bod komen.

10.20-10.50 → Ronde 1 (strategieën 1 t/m 4)

10.50-11.20 → Ronde 2 (strategieën 5 t/m 7)

11.20-11.30 → Pauze

11.30-12.30 → per duo 20 minuten presentatie: 10 minuten per strategie (3 duo's x 20 minuten)
Elk duo heeft twee strategieën behandeld. Per strategie is 10 minuten de tijd om deze te presenteren en feedback van anderen te krijgen. Alle extra input wordt op een flipover geschreven. Ook hier zijn strategie 2 en 4 samengevoegd.

Strategy 1: Select low impact materials

1.1: Choose clean materials
1.2: Choose renewable materials
1.3: Choose materials with low energy content
1.4: Choose recycled materials

Strategy 2: reduction of material usage

2.1: Reduction of weight
2.2: Reduction of (transport) volume

Strategy 3: Optimization of production techniques

3.1: Choose alternative production techniques
3.2: Fewer production steps
3.3 Low/clean energy consumption
3.4 Less production waste
3.5 Few/clean production consumables

Strategy 4: Optimising the distribution system

4.1 Little/clean/reusable packaging
4.2 Energy-efficient logistics

Strategy 5: reduction of the user impact

5.1: Ensure low energy consumption
5.2: Choose a clan energy source
5.3: Reduce the amount of consumables required
5.4: Choose clean consumables
5.5: No waste of energy or consumables

Strategy 6: Optimization of initial lifetime

6.1 Increase reliability and durability
6.2 Ensure easy maintenance and repairs
6.3 Ensure a modular, adaptable product structure
6.4 Aim to achieve a classis design
Ensure a strong product-user relation

Strategy 7: Optimization of the end-of-life system

7.1: Stimulate reuse of the entire product
7.2: Stimulate remanufacturing and refurbishing
7.3: Stimulate material recycling
7.4: Stimulate safe incineration with energy recovery
7.5: Ensure the safe disposal of product scrap

Idee voor vervolg workshop:

Hoe gaan we dit verwerken in NPD model van Cooper? Moeten alle vragen in een stage worden gesteld of verspreid over het proces? Iedereen mag een strategie of een principle op een post-it schrijven en die ergens in het NPD proces plakken. Daarna kunnen de post-it's worden geclusterd. Natuurlijk moet er worden uitgelegd waarom de post-it op de plek is geplakt en niet ergens anders.

Appendix E Presentation workshop 1

Duurzaamheid integreren in New Product Development

FrieslandCampina - Domo

19 januari 2016

Inleiding

"Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs"
(Brundtland Report - WCED, 1987)

Opdracht 1.

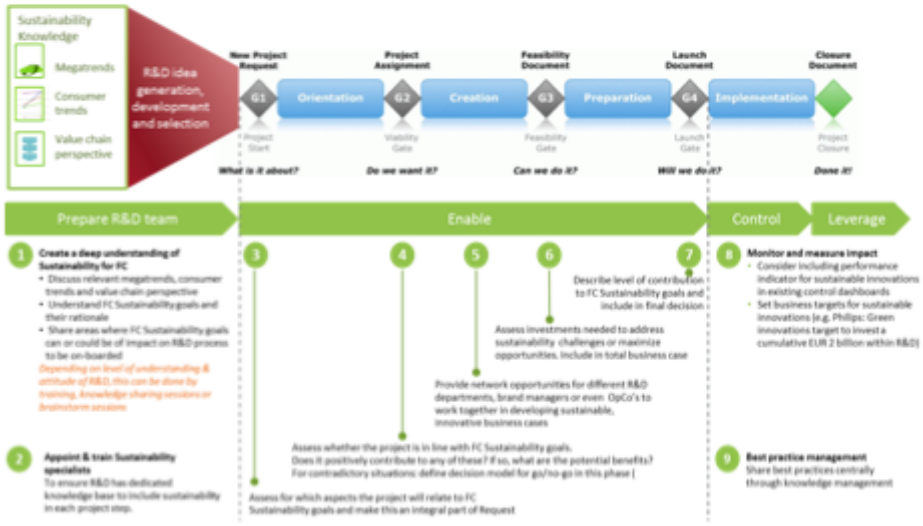
Schrijf 5 voorbeelden op van wat jij onder duurzame ontwikkeling verstaat m.b.t. Het NPD proces

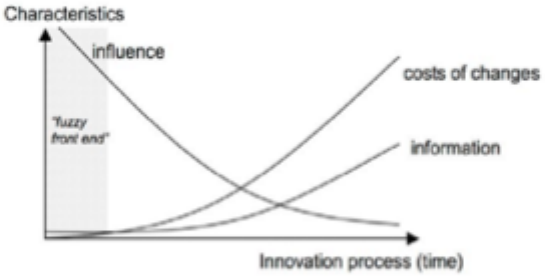
Wat betekent dit voor Nederlandse bedrijven en in het bijzonder voor FrieslandCampina?

- Er komen striktere regels: Bedrijven moeten aan bepaalde eisen gaan voldoen
- Boetes voor bedrijven die niet aan eisen voldoen
- Bedrijf wil deze consequenties voor zijn

Maar wat is de strategie en hoe wordt deze gerealiseerd?

way to embed sustainability in NPD processes





Design for environment (DfE) = The environment helps to define the direction of design decisions

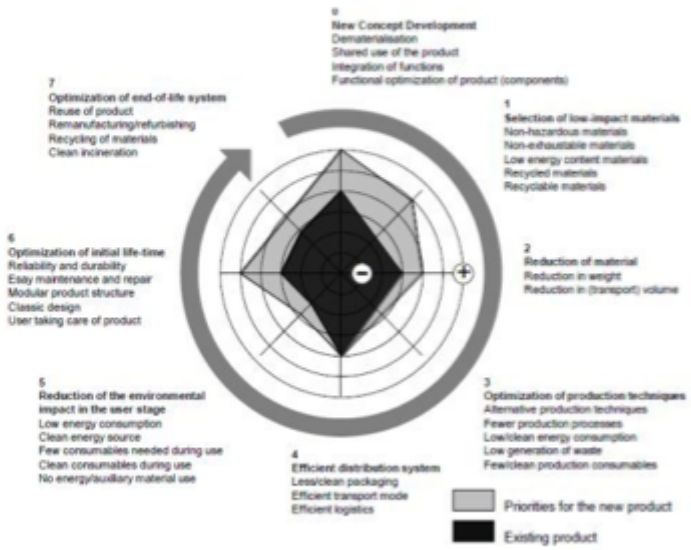
LiDS Wheel (Lifecycle Design Strategy Wheel)

DfE Principles: 'Potential means of operationalizing or realizing the DfE startegy

DfE Strategies: 'Potential routes a company can follow if it wishes to apply the principles of DfE to one or more of its products

*Elke strategie bestaat uit twee tot vijf principles

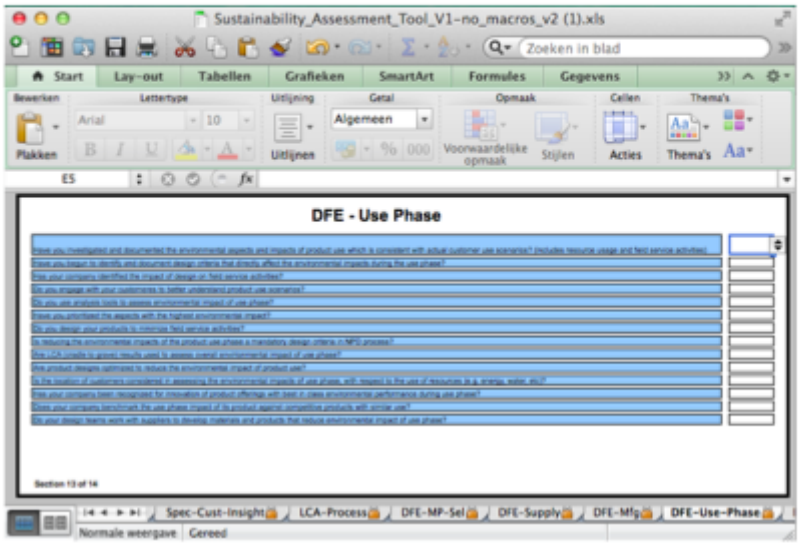
(van Hemel, 1998)



Brezet & van Hemel, 1998

LiDS Wheel niet direct implementeerbaar in Domo R&D

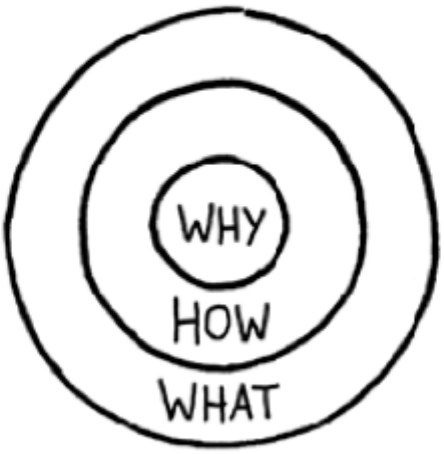
- Vragen niet specifiek op Domo aangepast
- Geen gebruik van vakjargon
- Men voelt zich niet aangesproken
- Gevolg – resultaten blijven te algemeen



Project Wave 3

A quick introduction to the why, what and how of this project

Project Wave 3



15

1. Beantwoord de vragen met ja/nee, of ?

2. Licht het bovengenoemde antwoord toe en geef aan of dit antwoord voor het NPD proces veranderd zou moeten worden in de toekomst

3. Kies drie strategieen uit het LiDS wheel en leg uit hoe deze binnen het project Wave3 zouden kunnen passen.

Appendix F Presentation workshop 2

Duurzaamheid integreren in New Product Development

FrieslandCampina - Domo

30 november 2015

Inleiding

"Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs"
(Brundtland Report - WCED, 1987)

Opdracht 1.

Welk cijfer geef jij duurzaamheid bij de ontwikkeling van nieuwe producten/processen? Ga op een denkbeeldige lijn in de ruimte staan

FrieslandCampina
Universiteit Utrecht

PARIS2015
LA RECHERCHE SE MOBILISE POUR LE CLIMAT

- 21ste jaarlijkse klimaatconferentie in Parijs
- Doel: nieuw klimaat akkoord bereiken wat in 2020 in zal gaan wanneer het Kyoto protocol ten einde is

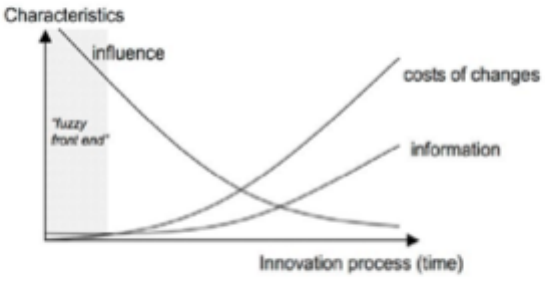
Wetsvoorstel PvdA & GroenLinks:

- Uitstoot CO_2 moet in 2050 met minstens 95% verminderd zijn ten opzichte van 1990
- De energie voorziening moet in 2050 volledig duurzaam zijn
- In 2030 moeten auto's grotendeels rijden op elektriciteit

Wat betekent dit voor Nederlandse bedrijven en in het bijzonder voor FrieslandCampina?

- Er komen striktere regels: Bedrijven moeten aan bepaalde eisen gaan voldoen
- Boetes voor bedrijven die niet aan eisen voldoen
- Bedrijf wil deze consequenties voor zijn

Maar wat is de strategie en hoe wordt deze gerealiseerd?



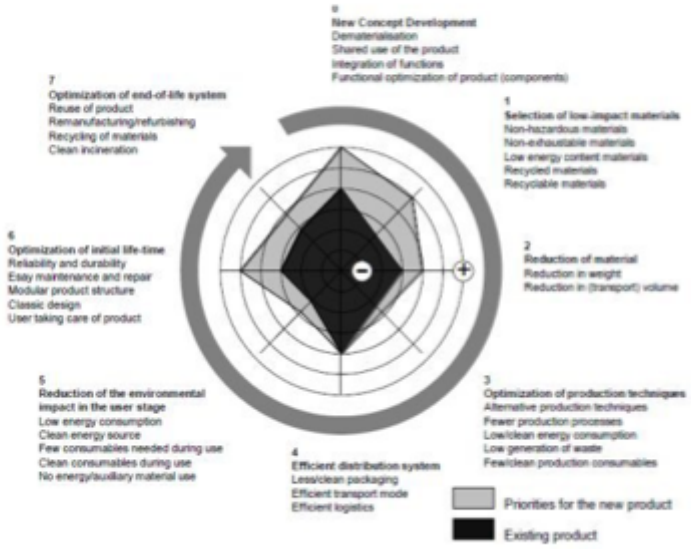
Design for environment (DfE) = The environment helps to define the direction of design decisions

DfE Principles: 'Potential means of operationalizing or realizing the DfE startegy

DfE Strategies: 'Potential routes a company can follow if it wishes to apply the principles of DfE to one or more of its products

*Elke strategie bestaat uit twee tot vijf principles

(van Hemel, 1998)



Brezet & van Hemel, 1998

LiDS Wheel niet direct implementeerbaar in Domo R&D

- Vragen niet specifiek op Domo aangepast
- Geen gebruik van vakjargon
- Men voelt zich niet aangesproken
- Gevolg – resultaten blijven te algemeen

Doel: Een “tailor made” model speciaal voor Domo ontwerpen

- Vragen en aandachtspunten die zorgen voor een trigger
- Aandachtspunten op zo’n manier naar voren brengen dat het interessant wordt ipv een checklist waar niemand iets van begrijpt.

FrieslandCampina

Project Phoenix

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Appendix G Results workshop 2, based on the LiDS wheel (van Hemel, 1998)

Strategy 1. Select low impact materials

Principle 1.1 Choose clean materials
Avoid the use of materials that could be hazardous during production or disposal.

- Choose safe materials for humans and environment: i.e. Food Grade, approved for use in the intended use/ country.
- Avoid cleaning techniques with chemicals during production process
- Avoid processing aids, additives where possible

Principle 1.2 Select materials with low carbon footprint and energy content
Some materials have a higher carbon footprint than others. Use of these materials is only justified if they lead to other positive environmental product features. For example milk from farms using green energy is preferred over the use of 'regular' milk.

- Choose materials with low carbon footprint - using milk from a fair source
- Choose recycled/renewable materials - such as recycled packaging material
- Choose suppliers with a clear CSR policy - a positive environmental impact of the supplier can be communicated to you customer as well!

Principle 1.3 Select strategic production location
Choose a strategic production location to ensure the lowest carbon footprint possible. Reduce transportation costs and CO_2 footprint for raw materials incl. milk, whey and intermediate product streams. By choosing a production location close to the supplier and/or customer, transportation costs and CO_2 emissions will decrease.

Strategy 2. Reduction of material usage

Principle 2.1 Reduction of material weight
'Using less material is in fact a direct attempt to lower the product's environmental impact.' Here an inventory is needed by means of, for example, a brainstorm session. The inventory should include the following topics:

- Amount of water used (a.o. avoid dilution steps)
- Amount of chemicals used (processing aids, additives)
- Amount of raw materials (dairy) used

Principle 2.2 Reduction of (transport) volume
A higher number of less bulky products (including the packaging) can be transported by a specific mode of transport.

- Concentration before transport
- Try to skip one or more drying steps, avoid dilution after concentration
- Deliver product in liquid form instead of dried for customers that will dissolve dried product again.

- Alter package design: optimize packaging size, re-usable packaging

Strategy 3. Optimization of production techniques

'When selecting a production technique, focus on those which have a low environmental impact, low losses of raw material (dairy) and which generate the least amount of waste. Particularly, when following this strategy, a company should not limit itself to its own production process but try to stimulate its suppliers (farmers, chemical suppliers, technology suppliers, and packaging material suppliers) to improve their processes as well.'

Principle 3.1 Choose alternative production techniques

- Evaluate all possible techniques and take an informed decision based on the options
- Make use of a table and choose a technique with the lowest possible environmental impact

Principle 3.2 Fewer production steps

- Describe the most efficient route to come the desired product
- Aim for the lowest possible number of production techniques

Principle 3.3 Low/clean energy consumption

- Evaluate all possible techniques to reduce energy consumption and to come to the desired product
- Try to compensate energy use so that the net result is positive

Principle 3.4 Less production waste

- Evaluate all possible techniques to come to the desired product and reducing waste at the same time
- Make use of a table which outline all the residual streams that are produced during the process, and choose a technique with the least residual streams

Principle 3.5 Few/clean production consumables

'This approach aims to reduce the amount of production consumables or operation materials required; these should also be composed of non-hazardous substances.'

- Processing aids / loog & zuur / resins
- Express the amount of consumables per standardized unit
- Balance all possible options and choose the most environmental friendly one

Principle 3.6 Reduce water usage

Try to reduce the amount of water used.

- Environmentally: reduce usage
- Costs
- Infrastructure of factory limits water use (incoming capacity, storage, waste capacity, re-use capacity)

Strategy 4. Optimizing the distribution system

'Ensure that the most efficient transport is used to move the product from the factory to the Customer and then to the user. This relates to the packaging, to the mode of transport and the logistics involved. The environmental impact of the distribution system used for delivery of components should also be taken into consideration. If the project also includes looking at the aspect of packaging in detail, then packaging should be regarded as a product in itself, i.e. a product with its own lifecycle.' The main message is: Align with packaging sc-packaging specialists to determine opportunities.

Principle 4.1 Little-clean-reusable packaging

- Scaling up, (big) bags, IBC; containers and tanks
- Take into account recycling of packaging materials and sustainable sourcing of packaging materials

Principle 4.2 Energy efficient means of transport

Think of the transport method: the environmental impact of transport by air is far greater than transport by sea.

Principle 4.3 Energy/efficient logistics

The environmental impact can also be reduced by making sure that whichever mode of transport is used it is loaded efficiently, and that the distribution logistics are efficient too. Action point:

- Work together with logistics to determine opportunities
- Motivate sales department to work together with local suppliers and to introduce efficient distribution methods (e.g. distributing a large number of goods at the same time instead of making several smaller deliveries)

Strategy 5. Reduction of user impact

'Consumables (energy, water) and products (filters) are needed in the user stage for the product to fulfil its purpose. This strategy aims at designating the product in such a way that the user is unlikely to spill or squander materials, and/or searching for more environmentally efficient consumables.'

Principle 5.1 Ensure low energy consumption

- Determine if the project contributes to lower energy consumption
- Determine if the product is complicated or simple in its composition and does this affect the amount of energy the consumer has to add to the product?

Principle 5.2 Choose a clean energy source

- Work together with procurement to choose the least harmful source of energy

Principle 5.3 Reduce the amount of packaging material

- Evaluate how Customer applies the product and consider adjusted and optimized packaging volume and material. Work together with packaging specialists

- Consider bulk and IBC's
- Determine if packaging material can be reused
- Choose the right packaging unit and consider if it can be recycled

Principle 5.4 No waste of energy or consumables
'The product can also be designed in such a way that it influences user behaviour. Users are encouraged to use products efficiently in order to achieve a lower consumption of addition materials and to reduce the amount of waste. Here the focus lies with packaging material, whereby portions are chosen in such a way that the packaging material is used in an optimal way. Communication with the buyer to discover the need is essential.'

Strategy 6. Optimization of shelf life
The objective of this strategy is to extend the shelf life of the product. A shorter shelf life is only preferred if new, less energy consuming alternatives are under development.
Principle 6.1 Product specification optimization
- Optimize the product specification to facilitate intended use
- Try to understand customer needs and implement the needs in the product specification
- Optimize product shelf life. This has a positive effect on transport costs and supplier-buyer time. Not always max. Extension but prevention of complaints/off spec due to long storage. Prevention of off spec (discarding) product is sustainable.

Strategy 7. Optimization of the end-of-life system
A product's end-of-life system refers to what happens to is after its initial life.

Principle 7.1 End-of-life of packaging material
- Try to close material cycles to reduce the environmental impact of packaging material
- This can be done by reusing the material or by recycling it
- The latter can only be applied unless it has a lower environmental impact than producing new packaging material

Principle 7.2 End-of-life of the product
- Valorise all milk-fractions
- Take losses (yield) into account
- Identify alternative outlets for by-products
- Make a development plan and decide on it based on business case involved
- Usage of off spec product

Principle 7.3 Join forces
It is of great importance that all disciplines, Operations, Marketing, Packaging, Technology, R&D, Sales PS and R&D work together here. Optimisation is very important for existing products. Can we improve performance of existing products by reducing costs, improving cost in use, reducing environmental impact? Identifying opportunities amongst disciplines is important here. Can we identify such opportunities for existing products in terms of energy

and water usage, processing aids usage, packaging material usage, product yields and losses? Such sessions will deliver a list of opportunities. Prioritisation and decision making is then needed to decide on steps to make.

Appendix H Proposed synthesized NPD model