An investigation into environmentally responsible beverage packaging

Katrin Herdering

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Attestation of authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person, nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

K. Herdering

Katrin Herdering

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Abbreviations

DfE	design for the environment
FMCG	fast moving consumer goods
Frucor	Frucor Beverages
HDPE	high-density polyethylene
LCA	life cycle assessment
MRF	Material Recovery Facility
NPD	new product development
NGOs	non-governmental organisations
p. a.	per annum
PET	polyethylene terephthalate
PHA	polyhydroxyalkanoates
PLA	polylactic acid
PP	polypropylene
WasteMINZ	Waste Management Institute of NZ

Abstract

In this dissertation I construct and evaluate the business case for environmentally responsible beverage packaging as part of a sponsored project with both a theoretical and applied orientation. Theory on corporate sustainability and the win-win paradigm is investigated in the context of building a business case for environmental sustainability. My overall research question examines the likelihood that a win-win situation could be achieved in the most plausible business case for the introduction of an environmentally responsible beverage pack.

Information for this project was derived through discussions with employees from six different departments at the sponsoring company and with 12 external current and potential value chain partners who may or may not be involved in any future introduction of a bioplastic beverage pack. Considerable background information was also researched as a basis for understanding the complexities of bioplastic beverage packaging and the assessment of a corporate environmental initiative.

Regarding data analysis I took a reflective and pragmatic approach by assessing the above information against the background of my theoretical knowledge gained from relevant academic literature. I then decided on useful information to answer the research questions. I constructed the most plausible business case and assessed this case from an environmental and a financial perspective for further discussion with key stakeholders.

Major findings include the multifaceted barriers opposing the introduction of an environmentally responsible beverage pack. These barriers threatening the realisation of a financial win encompass the high initial investment, compromised material properties, and the complexity of engaging value chain partners. The realisation of an environmental win is particularly threatened by the lack of management commitment to sustainability. I find that these factors make the establishment of a win-win situation particularly hard and are likely to result in trade-offs at the expense of sustainability. However, the difficulty in defining the impact of such a sustainability initiative on both environmental and financial performance hinders a precise assessment of whether a win-win situation could be established from the business case at present.

I suggest that a major implication of my research for theory is the need for further development of metrics that support managers in holistically evaluating the financial impact of sustainability initiatives. Regarding recommendations to the sponsoring company, I acknowledge that at present, the business case for sustainability which I constructed in this project is unlikely to be strong enough to lead to the implementation of environmentally responsible beverage packaging. The practical value of my project is currently being assessed by the sponsoring company. At the very least, the research raised the sponsoring company´s executives' awareness for necessary future steps if the company wanted to contribute to sustainable development.

Chapter 1
Introduction

1.1. Background to the research

My research investigates an environmentally responsible beverage packaging option. It is undertaken on behalf of Frucor Beverages who I refer to as either Frucor, or the sponsoring company. Frucor is a leading Australasian manufacturer and distributor for non-alcoholic beverages headquartered in Auckland, New Zealand. It employs around 700 people in New Zealand and Australia and is owned by the Japanese brewing giant Suntory. Frucor´s major competitor, the Coca-Cola Company, has released a bioplastic pack overseas. If this competitor launches the more environmentally responsible beverage pack in New Zealand, the competitive context in the local beverage industry will significantly change. If a company like Frucor fails to react to competitive new product launches with sufficient pace, it can suffer through delayed market entry, ongoing loss of market share, and wasted profits (Kotler, 2003). However, initial or early market entry of innovative products can make possible the development of new markets, enduring market leadership, and foreclosure of reactions from rivals (Crawford, 1988). Therefore, Frucor needs to prepare itself to respond in a way that resonates with consumers to protect and enhance its position in the market.

1.2. Research aim and research questions

My research aim, congruent with the sponsoring company´s aim, is to collect, analyse and evaluate sufficient information to inform a company decision on the potential introduction of a new bioplastic beverage pack. For the sponsoring company, I construct and evaluate the most plausible business case with regards to the estimated financial and non-financial impact of the potential introduction of the pack. I look at aspects such as costs and benefits, as well as risks and opportunities occurring in the event of the bioplastic pack introduction. Two different perspectives are considered: environmental responsibility and financial performance. According to Porter and van der Linde (1995), investing in environmentally responsible strategies can create a win-win situation in which both profitable corporate opportunities and ecological enhancement are realised. The overall research question underpinning my research is:

What is the likelihood that a win-win situation could be achieved in the most plausible business case for the introduction of an environmentally responsible beverage pack?

Subordinate research issues are summarised in the following four questions:

1. *What are the environmental and financial requirements for a win-win situation?*
2. *What is the most plausible business case for the introduction of an environmentally responsible beverage pack at Frucor?*
3. *What are Frucor´s challenges in achieving a win-win situation in the most plausible business case?*
4. *How useful is academic theory in helping inform the establishment of a win-win situation?*

This study is conducive to theory refinement as it delivers thick and in-depth descriptive research on environmental strategy extending beyond entity/firm level concerns. Theoretical concepts are applied to practice and reflected upon regarding their potential and actual usefulness for business. Recommendations for amendments to these frameworks are given and gaps identified. The dissertation also offers insight into the application of an “interventionist research” approach.

1.3. Justification for the research

The project centres on the development of a business case for the introduction of environmentally responsible beverage packaging made from a cutting-edge emerging biobased and biodegradable plastic. Frucor´s Executive Board will use the business case to decide if the company should initiate a comprehensive new product development project in 2011 for a new bottle, which would entail substantial corporate commitment regarding time, expertise and financial resources. Implementing the innovative bioplastic poses a variety of challenges. It requires the sponsoring company to explore numerous areas, for example, the required investment, the properties and adequate application possibilities of the bioplastic material, the target market and different end-of-life-options for the beverage pack, the pack´s environmental impacts, as well as potential risks and opportunities to its introduction.

A key challenge is to ensure a responsible end-of-life for the bioplastic bottle. The introduction of the new bioplastic material to the New Zealand market requires collaboration along the value chain and the engagement of partners across the product´s life cycle for the collection and separation of post-consumer waste. At present the volume of bioplastics in New Zealand is well below the required threshold for recycling to be economically viable. If a company the size of the sponsoring company introduced bioplastic beverage packaging, the percentage of bioplastics in the mainstream recycling plastic waste stream would presumably cross that threshold. Recyclers are concerned that the conventional oil based plastic stream could be contaminated, if the bioplastic introduction is not done properly.

This investigation offers a theoretically informed response to the above-mentioned real world business problem. It attempts to move beyond an entity/firm level consideration of what makes environmental and business sense to a systems level consideration through engaging partners for the betterment of the environment. It is important to note that the consumption of water from single-serve bottles causes a significant amount of waste. The market for “drinks on the move” is unlikely to disappear, however. Thus, consideration of environmentally more responsible packaging is very much in order.

The introduction of an environmentally responsible beverage pack signifies a corporate environmental initiative, which can contribute to ecologically sustainable development. As noted earlier, environmental investment can also bring financial benefits, which would lead to a win-win situation for the company and the environment (Porter & van der Linde, 1995). However, managers adhering to the win-win paradigm tend to view business with a focus on the financial domain potentially leading to trade-offs in the environmental domain (Hahn, Figge, Pinkse, & Preuss, 2010). Therefore, it is worth seeing whether a true win-win situation can be created in this bioplastics business case.

1.4. Method and positionality

In terms of the research design, the project has features of a case study as I comprehensively investigate a current business situation within its real-life setting. Also characteristics of interventionist research can be found in the dissertation. I try to fuse theory and practice together, aiming at a mutual gain in terms of knowledge enhancement for me, as the researcher, and the sponsoring company.

I signed a confidentiality agreement with Frucor, and I was introduced to and included in a normal business process. Throughout the project I was in regular contact with the sponsoring company´s Environmental Manager to ensure that my theoretical considerations were still in tune with the real world business case.

At the beginning of the project, I accumulated theoretical background knowledge by reading academic literature and industry literature on bioplastics. In terms of data gathering, I simultaneously accompanied the Environmental Manager on a round of discussions where I could pose questions based on my background research. I had meetings with employees from six cross-functional departments at the sponsoring company. I also had meetings with 12 external current and potential value chain partners and was able to conduct site visits at some of them. To capture what was said I took detailed notes during the conversations with both internal and external informants.

To answer my research questions, I first developed a theoretical framework to assess an environmental initiative based on the reviewed literature. The framework includes general requirements and performance indicators for both an environmental and a financial win. It assists in the evaluation of the business case later in the dissertation. Next, I developed potential material flows along the product´s value chain, which were then refined to rough drafts of potentially viable business cases for the implementation of an environmentally responsible beverage pack. The cases differed in elements like the target market and the end-of-life of the pack. After challenging the different options by consulting both company employees and value chain partners, I could exclude some of the unfeasible alternatives and one business case remained. For this most plausible business case I gathered more detailed information such as financial data, and I identified opportunities as well as barriers and risks. I next evaluated the business case with the help of the previously developed framework for the appraisal of a win-win situation. I then identified Frucor´s challenges in achieving an environmental and a financial win. Next, I evaluated the usefulness of the academic concepts from the reviewed literature for the project. Finally I assessed the likelihood of achieving a win-win situation in the business case to answer my overall research question.

This sponsored study has both a theoretical and an applied orientation and is being written up in two forms. One outcome is this dissertation, which, for academic purposes, integrates literature and reflection on the process of the research and its results. The other outcome is a report for Frucor´s Executive Board. The company´s Environmental Manager is to indicate which parts of the dissertation are useful for the company. In addition to the information from the dissertation, the report should include commercially sensitive and relevant financial data for the company.

I take a reflexive approach regarding my positionality, describing who I am and where I stand with respect to the research field and the researched subjects (Takacs, 2002). I am a Master of Business student with a major interest in business and sustainability. My theoretical knowledge relevant to the dissertation is mainly based on business and sustainability literature. I reflect on the company project through an environmentally conscious lens, and I am biased towards a genuinely environmentally responsible business case for the introduction of a bioplastic pack. Therefore, I take a critical view of the sponsoring company´s general attitude towards environmental initiatives and its probable decision on the potential introduction of a bioplastic pack. However, I acknowledge that, in contrast, the sponsoring company takes a mostly financially oriented perspective, and is likely to only approve a business case with a strong financial return. Consequently, in order to respond to the task posed by Frucor, I also take a practical view. I combine both a theoretical stance with a broad systems based ideal of sustainability and a practical stance based on a business orientation. In order to achieve a balance between these two partly opposing standpoints, I strive for a pragmatic win-win reconciliation (Porter & van der Linde, 1995; Prasad & Elmes, 2005). I am aware that this approach might result in trade-offs (Byggeth & Hochschorner, 2006).

Here I note that as I went through the research and writing process described above, the dissertation developed in ways I did not originally anticipate. There was a tension between responding to the sponsoring company´s task and answering the broader questions that emerge for someone like me interested in a systems approach to sustainability. The original company task to construct a business case expanded to the subsequent evaluation of this business case. Consequently, there was a significantly larger amount of work in this project then is normally the case for a 60 point dissertation at my university.

1.5. Outline of the dissertation

The dissertation comprises six further chapters. In Chapter 2 I review academic literature, covering sustainability in the business context, management approaches for environmental product stewardship, financial metrics for the evaluation of environmental initiatives, and the new product development process. Based on the reviewed literature I establish a theoretical framework to assess an environmental initiative.

In Chapter 3 I describe more fully the research method including the research design as well as the methods and framework to gather information. I also explain my positionality in the analysis of information and my role in the project, as well as the method to answer my research questions and to complete the company project.

Chapter 4 offers my more general findings about bioplastics and the function of the environmentally responsible materials for beverage packaging. In particular, I provide information on the bioplastic polylactic acid (PLA) regarding its source and production, its properties in the bottle application, its potential end-of-life options, and suitable labels and closures (caps) for PLA bottles. Furthermore, I offer a simplified life cycle analysis of PLA.

In Chapter 5 I focus on the business case construction for the implementation of a PLA beverage pack at the sponsoring company. I look at the New Zealand and company context, the elements of the most plausible business case for the PLA bottle introduction, and the excluded elements of less plausible business cases. I identify opportunities as well as barriers and risks related to the most plausible business case. Potential options and future developments impacting on this business case are also explained.

In Chapter 6 I discuss the feasibility of a win-win situation based on the most plausible business case and the business context. I revisit the general requirements for both an environmental and a financial win. And I investigate the impact of the environmental initiative on environmental and financial performance in the business case. I also scrutinise the usefulness of the academic concepts used for the theoretical framework.

In the final chapter, Chapter 7, I provide answers to the research questions. I allude to the requirements for a win-win situation in environmental and financial terms, the most plausible business case for a PLA bottle introduction, and the challenges in achieving a win-win situation in this business case. Furthermore, I comment on the extent to which theory helps to inform the establishment of a win-win situation and identify implications for theory. I address the overall research question by discussing the likelihood that a win-win situation could be achieved in the most plausible business case. I also offer recommendations to Frucor and suggest implications for management in general.

1.6. Delimitations of scope and limitations of the research

The focus in this dissertation is on environmental and financial sustainability. The third pillar of sustainability, the social dimension, while not entirely ignored, is outside the scope of the study.

Furthermore, the project focuses on the investigation of a bioderived and biodegradable bioplastic material, called PLA, for a beverage pack, since this option is currently considered by the company to be the most environmentally responsible one. Bio-PET is another ecologically responsible beverage pack option. In this dissertation this material option is just touched on lightly, as, from an environmental perspective it is not considered to allow for an ultimately sustainable material flow. It has a lower environmental impact compared to PET and signifies a more tactical low risk response to Coca-Cola´s launch of the PlantBottle™. Other beverage pack options which are not taken into account are, for example, glass (comparably heavy and breakable), and tetra pak (not a package alternative for the hydration segment selling water in clear plastic bottles). For these reasons, the research focuses on the development of a business case on the beverage pack material PLA.

In the dissertation I refer to the new product development process even when the product being considered is essentially the packaging. Nevertheless, for beverages like water, the packaging is a substantive product consideration.

For this project, in line with company expectations, I did not talk to people from non-governmental organisations, media, competitors or local authorities. Excluding members from the wider society could be regarded as a limitation to this dissertation because it signifies that I did not take a comprehensive systemic perspective.

Due to the broad theoretical background needed and the consideration of a great variety of environmental management approaches, I made compromises in the theoretical underpinning resulting in a wide, rather than deep, coverage of the literature. In some cases, the reviewed literature is not high-end scientific, e.g. with regard to LCA, which could be considered as a limitation.

As noted above, the dissertation developed in ways I did not originally anticipate. The focus of this dissertation shifted from building a business case for an environmental initiative to the assessment of such an initiative. For the establishment of the theoretical framework I reviewed literature from the more general environmental management field. I chose those indicators that seemed to be useful for the evaluation of the business case. I assumed that when informing myself about the environmental impact of bioplastics and beverage packaging I would come across relevant supplementary performance indicators. I did not review specific academic literature on requirements for an environmental win and environmental performance indicators. To do so would have gone beyond the scope of the company project, because Frucor did not require an extensive environmental assessment. Please note that in a well advanced stage of the dissertation I realised that, potentially, the review of academic literature with a stronger focus on requirements for an environmental win and environmental impact indicators would have made the evaluation of a potential win-win situation easier. Also the interaction between theory and practice would have had a stronger academic foundation and I could have identified more gaps in the academic concepts. Nevertheless, I assert, that the more general appraisal of the environmental impact of the bioplastic pack introduction is sufficient for answering my research questions.

1.7. Summary

In this chapter, I laid the foundations for the research. I introduced the company project, the research aim and the research questions. Then I justified the research, illustrated the method and my positionality, outlined the structure of the report, and specified its scope and limitations. I next turn to a detailed presentation of relevant literature.

Chapter 2

Literature review and theoretical framework

2.1. Introduction

Over the last thirty years, the pressure on companies to address environmental problems and resource constraints has risen significantly. At the same time, managers are increasingly expected to improve shareholder return, corporate financial performance or competitiveness (Weybrecht, 2010).

In this chapter I review relevant academic literature to develop a sound academic base that helps answer my research questions, and in particular underpins the establishment of a business case with an environmental focus. First, I look at sustainability as a theoretical ideal and as a practical orientation for business. Since the dissertation is based on a project at a sponsoring company, I take a practical perspective highlighting the win-win concept and I touch on upon environmental and social performance indicators. Next, I elaborate on management tools that promote environmental product stewardship. I look at life cycle assessment/costing, the cradle-to-grave and the cradle-to-cradle approaches, development of environmentally responsible products, and value chain collaboration. I then shift from an environmental focus to a more economic focus and consider financial metrics that may be useful for evaluating the business case of an environmental initiative. Further, I offer insights on the new product development process as identified within the marketing literature, taking into account a more environmentally aware perspective. Based on the reviewed literature, I finally develop a theoretical framework for the assessment of a corporate environmental initiative in ecological and financial terms.

2.2. Sustainability in the business context

2.2.1. Sustainability as a theoretical ideal

The so called 'Brundtland Report' by the World Commission on Environment and Development offers the most widely-cited definition of sustainable development characterising it as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World-Commission-on-Environment-and-Development, 1987, p. 43). It thus describes a change process towards sustainability, which can be defined as an ideal future state that can endure indefinitely (Connor & Dovers, 2004).

Stead and Stead (1994) describe ecological sustainability as a comprehensive and dynamic concept based on interconnected systems and processes ensuring the “carrying capacity” of the planet. Companies embracing ecological sustainability need to “view themselves as part of a larger, interconnected, social and ecological network governed by biological and physical processes” (p. 15). According to Stead and Stead, firms need to address the central views and values which inform their relationships with the wider ecosystem. Bradbury (2003) also considers businesses as woven into biophysical and socially interdependent systems. Starik and Rands (1995) take a similar view attempting to refocus management literature on the notion of multi-level and multi-system approaches to comprehend ecologically sustainable organisations. Sustainability can also be characterised as “a broad systems level concept that transcends entity and national boundaries […], not limited to economic, social and environmental conditions which support life for all” (Collins & Kearins, 2010, p. 502). The “systems perspective” seems to be a unifying and repeated requirement in academic considerations of sustainability issues.

Since businesses are part of interconnected, social and ecological systems, the impacts they and their products cause are not constrained within the boundaries of a single firm. Businesses´ strategic decisions affect the earth as a living system with human interaction and resource constraints. In order to operate within the natural and social boundaries of the earth, businesses need to take responsibility for their actions beyond company boundaries within their “subsystem” – the wider business environment – and align their decisions to the limits of the ecosystem (Hart, 1995; Stead & Stead, 1996). This can play out, for example, by taking strategic decisions on product options based on a product price that internalises external costs for waste disposal, instead of leaving these expenditures to the general public (Epstein, 1996).

Starik and Rands (1995) suggest that an organisation striving to be environmentally sustainable firstly should implement a closed-loop value chain. Then it should partner with environmentally complementary businesses to introduce industrial ecosystem partnerships. Such a “network of inter-organizational arrangements” aims at reducing waste and protecting resources by redesigning “material and energy flows into essentially closed-loop systems that mimic natural ecosystems” (Starik & Rands, 1995,

p. 917). Furthermore, such an organisation should collaborate with ecological associations, authorities, and other industry partners to advance public policy and industry standards linked to enhanced ecological performance. At last, an ecologically sustainable organisation should work together with the media or educational institutions in order to bring about the social and cultural shift crucial for a sustainable development. These authors´ call is taken into consideration in this dissertation, while acknowledging, however, that the sponsoring company´s current strategy does not include becoming a sustainable organisation in these terms.

The academic literature proposes that what companies need to become sustainable differs substantially from the current situation (Crane, Matten, & Moon, 2008). This assertion indicates a discrepancy between sustainability as a theoretical ideal and as a practical orientation for business.

2.2.2. Sustainability as a practical orientation for business

Shifting the definition of the World Commission on Environment and Development to the firm level, corporate sustainability can be described as "meeting the needs of a firm's direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, communities etc.), without compromising its ability to meet the needs of future stakeholders as well" (Dyllick & Hockerts, 2002, p. 131). Since the dissertation has a strong practical relevance for business, it embraces this more pragmatic definition of corporate sustainability entailing the ultimate aim of sustaining business and the endurance of the organisation. Due to the focus on an environmentally conscious beverage pack, the dissertation puts more emphasis on ecological rather than social strategies to achieve corporate sustainability.

In this context, Elkington´s (1997) concept of the triple bottom line might be perceived to offer a useful approach for practitioners. It suggests that the realisation of sustainability should be based on three pillars encompassing economy, society and environment, which should be granted equal status. With regard to integrating sustainability issues into corporate responsibility, McDonough and Braungart (2002a) state that the three pillar model has had a significant beneficial impact. However, in practice the desired goal of balancing economic growth, environmental integrity and social equity frequently seems to privilege economic concerns, with social or ecological advantages regarded as an addition rather than given equivalent priority at the outset.

A major reason for the divide between the theoretical ideal of sustainability and sustainability as a practical orientation for business is the fact that implementing the sustainability concept at firm level is particularly hard. Few empirical studies have been carried out with regard to formulating the business case for sustainability, for example how it can be integrated and applied in businesses (Salzmann, Ionescu-Somers, & Steger, 2005). Due to insufficient praxis-oriented and descriptive studies in this field, there apparently is a lack of understanding of organisations´ rationale for implementing corporate environmental and social policies. There also seems to be a deficiency of useful management tools to evaluate the sustainability concept and to implement it into the organisation (Salzmann et al., 2005). Therefore, Salzmann et al. (2005) argue that praxis-oriented and descriptive research would help. Peloza (2009) comes to a similar conclusion in finding a lack of financial metrics that aim at supporting practitioners to evaluate the impact of corporate sustainability initiatives on corporate financial performance. He calls for a closer collaboration between practitioners and academics to develop sustainability assessment instruments at business level. However, it remains to be seen if academic studies can actually offer a strong degree of support for practitioners.

Salzmann et al. (2005) find there are two main obstacles to research in corporate sustainability. Firstly, complexity impedes analysis because diverse factors between industries, operations, and national economies exist, and thus make the various business cases difficult to compare. A second obstacle is a lack of materiality as it is hard to quantify a financial value that becomes apparent only in the long run and that often is based on “intangible assets (e.g. brand value)” (Salzmann et al., 2005, p. 33). This obstacle will be addressed in more detail in the next section with regard to a lack of metrics that evaluate sustainability initiatives. These two obstacles result in a lack of understanding surrounding the design of business cases, their effectiveness, and the complications encountered. Since there is need for the development of a sound business case for sustainability at firm level (Salzmann et al., 2005), little guidance is given to analyse the introduction of an environmentally responsible pack at the sponsoring company. Nevertheless, referring again to sustainability as a theoretical ideal, even if and hopefully when the mentioned obstacles can be overcome, setting up a business case for sustainability at business level still is unlikely to take into account sustainability from a systems perspective.

2.2.3. Win-win paradigm in relation to sustainability

As to the arguments for ecological and social guiding principles, the notion of win-win outcomes regularly is cited. According to Porter and van der Linde (1995) both "economic and competitive opportunity" (e.g. cost cut, product quality improvement and competitiveness enhancement) and "environmental improvement" (e.g. pollution minimisation) can be achieved by investing in environmentally responsible procedures (p. 130). Similarly, Day and Arnold (1998) as well as Margolis, Elfenbein and Walsh (2007) hold that the business case for sustainable development is based on the generation of business value, in terms of the protection of the right to operate (legitimacy), cost/liability reduction, reputational reasons, increasing customer loyalty/market share, and the development of new markets. Dyllick and Hockerts (2002) maintain that sustainability at business level frequently is reduced to eco-efficiency. In short, the underlying notion of the win-win concept suggests that ecological, social and economic sustainability can be established at the same time (Porter & van der Linde, 1995; Salzmann et al., 2005).

Prasad and Elmes (2005) take a critical perspective on environmental management approaches characterising them as mostly embracing only what is "practical" (p. 863). For them, being practical means businesses frequently enhance their individual economic prosperity, but fail in preserving natural resources or abating industrial pollution. Similarly, Aragón-Correa and Rubio-López (2007) state that most academic literature on corporate sustainability centres around the identification of opportunities in which ecologically responsible and socially favourable programmes pay off in economic terms. They maintain, consistent with the win-win paradigm, ecological and societal concerns are considered only to the extent to which they improve corporate financial performance. As a result, from the perspective of this paradigm the significance of ecological and social issues for corporate sustainability is based on a merely financial focus (Hahn et al., 2010). In the end, corporate sustainability comes down to "a business approach that creates long-term shareholder value by embracing opportunities and managing risk from three dimensions: economic, environmental and social dimensions" (Lo & Sheu, 2007, p. 346). Decision-makers adhering to the win-win paradigm consequently assess sustainability concerns "through the lens of profit maximization" rather than considering sustainable development as an end in itself (Hahn et al., 2010, p. 219). This results in trade-off situations, which can be described as "compromise situations when a sacrifice is made in one area to obtain benefits in another" (Byggeth & Hochschorner, 2006, p. 1420). In conclusion, researchers doubt the win-win paradigm helps in the achievement of strong sustainability.

Although these approaches promise financial benefits for the adoption of an environmental strategy, there are numerous studies that inquire about the general relationship between corporate social performance (encompassing social and environmental issues management) and corporate financial performance (J.D. Margolis et al., 2007; Peloza, 2009). According to the meta-analysis of 167 studies by Margolis et al. (2007, p. 80) there was a “small, positive, and significant” impact of ecological and social responsibility activities on the financial performance of businesses (p. 27). This result is supported by Peloza´s (2009) meta-analysis findings. Due to this modest support, again, the majority of business cases for environmental/social initiatives may be hard to make. An exception might be straightforward and cheap sustainability programmes that simply reduce risks and sustain a company´s reputation or legitimacy.

2.2.4. Corporate environmental and social performance indicators

According to Peloza (2009), there is a vast variety of metrics that can be used to frame corporate social performance. His research, which focuses on the financial evaluation of sustainability initiatives and which will be explained in more detail in Section 2.4, briefly touches sustainability initiative metrics. He finds metrics quantifying companies´ ecological or social impacts, such as “pollution control or output”, “environmental, health, and safety investments”, or “third party audits or awards” (p. 1522).

Delmas and Doctori Blass (2010, p. 246 f.) cite studies by Ilinitch, Soderstrom, and Thomas (1998), Lober (1996), and Wood (1991). Delmas and Doctori Blass summarise that metrics for businesses´ environmental performance are typically separated into three primary classes: “(1) environmental impact (toxicity, emissions, energy use etc.); (2) regulatory compliance (non-compliance status, violation fees, number of audits etc.) and (3) organizational processes (environmental accounting, audits, reporting, environmental management system etc.)”.

It remains to be seen how useful these top level indicators are for the evaluation of the particular initiative in this project in environmental terms.

2.3. Management approaches for environmental product stewardship

Product stewardship is a wide-ranging pro-active strategy for ecological sustainability that encompasses various broad management frameworks and more specific tools

(Hart, 1995). In this section I elaborate potential ways to implement the concept of product stewardship into business practice to ultimately enable companies to contribute to sustainability. Since the investigation of an environmentally responsible beverage pack looks at creating a business case for environmental sustainability, I limit the discussion of potential management frameworks and tools to those that relate to environmental issues. After elaborating on product stewardship, I discuss the following six approaches to implement this pro-active strategy: (1) life cycle assessment, (2) life cycle costing, (3) the cradle-to-grave model including eco-efficiency, (4) the cradle-to-cradle model including eco-effectiveness, (5) approaches for the development of environmentally responsible products, and (6) value chain collaboration.

2.3.1. Product stewardship

Taking a pro-active strategy and adopting the concept of product stewardship signifies that a manufacturer voluntarily takes responsibility for all phases of the product life cycle beyond organisational boundaries (R. Roy & Whelan, 1992). It thus requires the integration of the environmental impacts of products and processes along the whole value chain (Hart, 1995). Stead and Stead (1996) caution about voluntary market-driven sustainability policies as they can be detrimental if they are not actually achieving effective ecological enhancements. These policies may be regarded “as little more than inflated marketing claims” (pp. 217 f.). Therefore, market-driven sustainability should account for real product stewardship (Epstein, 1996).

Embracing the concept of product stewardship of a company’s own accord often takes place in a regulatory environment where authorities put into practice a variety of compulsory environmental policies to manage ecological impacts of businesses. Concepts such as product “take-back” – urging producers to take ultimate responsibility for post-consumer waste – are increasingly an issue on corporate agendas (Weybrecht, 2010, p. 241). In the European Union schemes of extended producer responsibility, such as for electronic goods and automobiles, impose the “physical and financial responsibility on producers to recover and then dispose, recycle or reuse their products” (Weybrecht, 2010, p. 241). In general, the concept of extended producer responsibility offers an incentive to minimise ecological impacts all over a product’s life cycle, beginning at a very early phase, such as the design. Furthermore, these schemes relocate the costs for waste collection from local authorities to manufacturers. This shift in turn encourages manufacturers to internalise the total expenses of waste (Weybrecht, 2010). In addition, the institution of market-based policy instruments, such as emissions trading aiming at the reduction of greenhouse gases, puts pressure on producers to embrace environmental strategies (Subramanian, Talbot, & Gupta, 2010). These environmental regulations suggest the need for businesses to use tools that help them assess and minimise the ecological costs of products throughout all phases of the life cycle for the firm itself and its stakeholders along the value chain (Epstein, 1996).

According to Braglia and Petroni (2000) top management engagement in the decision-making practices is a vital requirement for the effective implementation of the product stewardship concept. Furthermore, the successful adoption of the concept across the whole product´s life cycle significantly depends on a corporate environmental strategy and a general commitment by top management (Braglia & Petroni, 2000). In the course of the dissertation I reflect on the decision-making process and the extent of the support of top management for product stewardship at the sponsoring company.

2.3.2. Life cycle assessment

I am aware that in the following I am not referring to the latest high end scientific literature on life cycle assessment (LCA). I stress the general principles of LCA rather than catering to the specific application and implementation of the assessment tool. I maintain that the basic principles of LCA are sufficient for the practical orientation of the dissertation to inform the construction and evaluation of the business case.

Applying the life cycle concept to an ecological assessment of products and processes is “the most far-reaching implication of integrating environmental concerns in the economic decisions of companies” (Richards, Allenby, & Frosch, 1994, p. 13). LCA takes into account the ecological impact of business actions, both upstream and downstream in the value chain, including “raw material procurement, manufacturing process design, product and package design, and environmental impact of transporting, consuming, and disposing of the product“ (Banerjee, 2007, p. 78). Hart (1995) states that LCA is a minimum prerequisite for integrating product stewardship into an organisation since it assesses environmental impacts beyond an organisation´s boundaries.

Referring to Dillon (1994) and Sullivan and Ehrenfeld (1994), Stead and Stead (1996, p. 205) produce a list of six stages of the assessment of the complete life cycle:

- In the first stage of the evaluation an investigation of the environmental impacts of purchasing the input factors for the business' products (both goods and services) and processes, which is "raw materials and energy", is carried out.
- Second, the firm's environmental impact occurring during the production process, encompassing both the production of components and finished goods has to be measured.
- The third stage is to assess the ecological burden of the "transportation and distribution systems" to convey the goods to the market with regard to "distribution modes, distances, fuel consumption, and so forth".
- In the fourth stage the ecological impacts of the product usage are evaluated, encompassing the measuring of "product durability, energy requirements, polluting potential, and the like".
- The fifth stage is to examine the "product's potential for reuse and/or recyclability".
- The final stage is to analyse the product´s end-of-life options, as to "its toxicity, volume, biodegradability, and so on".

Epstein (1996) states that LCA is one of the most remarkable advancements in the management decision analysis process. Banerjee (2007) recognises that the assessment tool has the potential to identify rewarding approaches that significantly reduce the environmental impact of a firm's product or process. He stresses that the tool strives to measure as many factors of ecological consequences as feasible (see also Stead & Stead, 1996; Veroutis, Ullmann, Fava, Steinmetz, & Kerfoot, 1996).

However, early on, LCA was regarded as extremely multifaceted, comprehensive, and far from being perfected (Richards et al., 1994). Furthermore, its methodologies were characterised as not particularly straightforward (Sekutowski, 1994). Results of LCA were seen as being strongly subject to analyst bias. And the findings were often regarded as featuring ambiguity concerning the environmental responsibility of analysed products and processes (Richards et al., 1994). A lack of agreement on the relative importance of diverse life cycle consequences may have caused contradictory results (Veroutis et al., 1996).

More than a decade later, LCA is still not considered to be a precise science (Banerjee, 2007). Luo, van der Voet, and Huppes (2009), who conducted an LCA of Brazilian bioethanol, indicate that the tool has its restrictions when it comes to "data acquisition and validation" (p. 1614). For all these reasons, I assess LCA to remain difficult to implement in practice with a view to obtaining exact answers from the methodology, unless considerable scientific expertise is brought to bear, and even then it is still open to questions. Thus, drawing on LCA results, when taking a decision, might be challenging. Despite the methodological restrictions of the tool, which imply that it is unready at present to deliver all the insights in the relationship between organisations and nature, it is based on an appropriate academic ideology (Ayres, 1994). Therefore, I consider LCA as a worthwhile approach. However, due to the significant complexity of the tool I do not conduct a complete LCA. I still estimate taking a life cycle perspective, which extends beyond firm boundaries, is necessary since in this dissertation I seek to assess the environmental impact of the bioplastic pack in particular with regard to the different end-of-life options.

2.3.3. Life cycle costing

Epstein (1996) takes LCA a step further towards life cycle costing adding monetary measures to each environmental impact of a product or an activity and forecasts likely expenditures and benefits in the future. He suggests applying "discounted cash flow analyses" from the capital investment or financial analysis arena (p. 55). According to Rebitzer and Hunkeler (2003), allocating all costs that occur during a product's life cycle might influence product profitability and pricing decisions. They maintain life cycle costing includes both internal and external environmental costs for the firm. The internal costs represent the expenses that someone (e.g. a manufacturer, distributor or consumer) pays for during production, consumption, or at the end of a useful life. Beyond these costs that are integrated into the economic system, life cycle costing internalises all the expenses that are external to the firm and borne by the general public (Rebitzer & Hunkeler, 2003). This approach signifies that no one has been made responsible for paying those external costs (Epstein, 1996), merely because "neither the marketplace nor regulations" has allocated them to a firm (Shapiro, 2001, p. 122).

These to date mostly neglected costs may shed light on other potential options for feasible action to reduce current and future ecological consequences. Thus, the forecasted environmental expenditures and benefits are integrated into costing as well as into capital investment decisions and might offer guidance in the business case for financial option assessment. Nevertheless, companies may become frustrated in their efforts to improve their evaluation and management of ecological effects. These firms are typically worried about the feasibility of forecasting trends regarding regulatory changes and technological developments and the related effects and costs for the business. They are concerned about “the long time horizon attached to much of the projected environmental costs and benefits” (Epstein, 1996, p. 57).

2.3.4. Cradle-to-grave model and eco-efficiency

There are two concepts that build on the notion of a product’s life cycle both seeking to implement product stewardship into strategic decision making. There is the cradle-to-grave model (e.g. Elkington, 1997) and the further reaching cradle-to-cradle model (McDonough & Braungart, 2002a). They generally differ in terms of the ultimate end-of-life solution, resulting in either linear or cyclical material flows. Both concepts are explained in more detail below.

The cradle-to-grave approach is based on the product life cycle concept. It suggests that a company’s accountability for a product should go beyond the company´s boundaries. Businesses should literally take “cradle-to-grave responsibility” for their products (Elkington, 1997, p. 189), (see also Banerjee, 2007; Keoleian & Menerey cited in Hart, 1995). This approach signifies companies should measure the ecological implications of their activity starting from raw material procurement, through to manufacturing processes, usage and finally end-of-life treatment, the product disposal (Elkington, 1997). The cradle-to-grave approach can be used to include the perspective of the environment into product analysis, design, and development.

Braungart, McDonough, and Bollinger (2007) claim that the underlying supposition for the cradle-to-grave approach is a “one way, linear flow of materials through industrial systems: raw materials are extracted from the environment, transformed into products and eventually disposed of” (p. 1337). The tool is intended to provide support for business to comprehend the complete extent of impacts caused by their products and processes and to minimise these identified environmental impacts (Elkington, 1997). However, due to the linearity of such a cradle-to-grave approach, the life cycle comes to a point where valuable materials are discarded. One might even say that valuable material is wasted and “new raw materials must continually be extracted” (McDonough & Braungart, 2002a, p. 113). In today´s cradle-to-grave systems, around 90 percent of the resources devoted to produce products end up in landfill, and a large amount of it is toxic (McDonough & Braungart, 2002b).

Eco-efficiency is a common strategy within the cradle-to-grave concept. The World Business Council for Sustainable Development characterises eco-efficiency as concentrating on "maintaining or increasing the value of economic output while simultaneously decreasing the impact of economic activity upon ecological systems" (as cited in Braungart et al., 2007, p. 1337). Welford (1997) explains that eco-efficiency may be an important principle by which to conduct and appraise a firm's effort towards an ecologically less unsustainable development. However, he maintains the concept has limitations due to the underlying linearity of material flows which therefore will not be able to contribute to the achievement of strong sustainability.

The approach is similarly criticised by McDonough and Braungart (2002a) stating that eco-efficiency merely aims to decrease the quantity and speed of the ecological depletion and the toxicity of the industrial system. Eco-efficiency might lead, for example, to reduction in material use; however, it does not stop the destructive exploitation of the planet, it only slows it down. Recycling, another exemplary element of the concept, is disapproved of as well since it often actually should be described as "downcycling". Downcycling can be defined as impairment in material quality rather than genuine recycling that maintains material value and properties. For example, recycled plastic bottles frequently get blended with different plastics. The generation of a lower quality hybrid decreases the value and alters the properties of the material eventually. McDonough and Braungart (2002a) hold that the crucial flaws are poorly designed materials and systems that are inappropriate for recycling. They conclude that in the long run the well-established idea of eco-efficiency only seeks to incrementally minimise negative environmental impacts of products and manufacturing processes. As eco-efficiency maintains the traditional linear systems (see Figure 1) that provoked the issues in the first place, it causes decrease and dematerialisation and thus, is not a sustainable strategy.

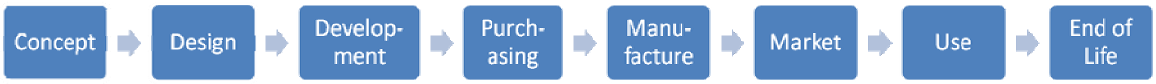

Figure 1: Cradle-to-grave model with linear material flow during product life cycle (Own illustration)

2.3.5. Cradle-to-cradle model and eco-effectiveness

A further-reaching, more positive approach to achieve product stewardship is the cradle-to-cradle model. In their seminal book "Cradle to cradle: Remaking the way we make things”, McDonough and Braungart (2002a) propose to substitute the current ordinary cradle-to-grave concept by a truly cyclical approach, converting industrial capitalism´s linear model to a closed loop system. This idea is in tune with the earlier theory of natural capitalism (Lovins, Lovins, & Hawken, 1999). According to McDonough and Braungart (2002a) the cradle-to-cradle concept aims at creating products and services that operate within a cyclical material flow. This means that biodegradable material should stay in “biological cycles” and technical material should run through “technical cycles” (p. 104).

McDonough and Braungart (2002a) suggest that this closed-loop concept could be achieved by the implementation of eco-effectiveness, an approach that preserves or upgrades the material quality and productivity (termed “upcycling”, in contrast to “downcycling”). By taking the stance that “waste equals food” eco-effectiveness seeks to eliminate the concept of waste. Products, packaging, and systems should be designed right from the start according to the notion that waste does not exist (McDonough & Braungart, 2002a) and that every product becomes “food for either biological or technical metabolisms” (McDonough & Braungart, 2002b, p. 177). For example, the majority of packaging can be constructed “as biological nutrients [...] to safely biodegrade after use” (McDonough & Braungart, 2002a, p. 105). However, achieving this state requires that the post-consumer waste is entirely non-toxic and biodegradable, otherwise “air, water, and soil do not safely absorb our wastes” (McDonough & Braungart, 2002a, p. 55). Ultimately, eco-effectiveness strives to sustain or even improve the resource status of materials over consecutive life cycles, and aims for the design and manufacturing of products and services that feature social, economic, and ecological benefit. Below I give a simplified example of a closed loop product life cycle (see Figure 2).

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Figure 2: Cradle-to-cradle model with closed loop material flow
(Own illustration, partly derived from Plastics-New-Zealand, 2006, p. 6)

McDonough and Braungart (2002a) suggest that in order to realise eco-effectiveness companies need to do three things: reorganise material flows, approve financial benefits that become apparent in the long-term, and solve toxicity problems of the material, as explained below:

- Restructuring material flows means removing the conventional linear cradle-to-grave industry systems and closing the loop by setting up novel cyclical material flow systems.
- Approval of long-term financial benefits signifies that companies should extend their financial planning horizon to include returns on investment that play out only in the long run (Peloza, 2009).
- Solving of toxicity problems relates to the very design of the products and seeks the development of goods that exclude toxic substances during their production, which are toxic-free during their use, and that do not set free toxic matter at the end-of-life during their period of recycling or decomposition (Epstein, 1996; McDonough & Braungart, 2002a; Rebitzer & Hunkeler, 2003). An appropriate tool could be design for environment (DfE), which is discussed in the next section.

Young and Tilley (2006) evaluate eco-effectiveness as calling on businesses to reinvent themselves. They state that eco-effectiveness requires the replacement of the old linear eco-efficiency concept by a truly cyclical concept, “one that mimics systems which are to be found in nature” (p. 404). As the concept of eco-effectiveness is based on “a vision of industry that is 100% good, that supports and regenerates ecological systems and enables long-term economic prosperity” (Braungart et al., 2007, p. 1342), I consider this approach to be extremely pro-active and therefore, it remains to be seen to what extent it is applicable to this research project

2.3.6. Development of environmentally responsible products

Design for the environment (DfE) is another management tool that promotes product stewardship (Banerjee, 2007). There is a general agreement that the design process, due to its early stage in the product development process, has a major impact on the ultimate ecological effects of a product throughout its life cycle (Santos-Reyes & Lawlor-Wright, 2001; Veroutis & Fava, 1997). The thinking behind DfE is to integrate all ecological considerations and limitations into the product design process (Allenby, 1994, p. 139; Banerjee, 2007). The aim of DfE is to set up ecologically responsible manufacturing processes and to create ecologically responsible products at the same time as ensuring to keep up with competitors regarding product performance and price (Allenby, 1994; Santos-Reyes & Lawlor-Wright, 2001). DfE is considered by businesses to be a significant method for integrating process-driven sustainability strategies into their products as it facilitates the link between environmental issues, market trends, technology trends, and legal conditions (according to Lent & Wells, 1994 as cited in Stead & Stead, 1996, p. 215). A company embracing a product stewardship strategy is required to reshape the entire industrial process from “research to design, process engineering, large-scale manufacturing, marketing, and, lastly recycling procedures” (Braglia & Petroni, 2000, p. 77). Thus, DfE needs not only to be applied to products but also to business processes.

Veroutis and Fava (1997, p. 65) argue that design groups simultaneously integrate advanced “functionality, performance, cost, quality, manufacturability, and other issues important to the product´s success in the marketplace” (see Figure 3). The authors take a conventional approach focusing on economic sustainability and ensuring the survival of the company in the long run, as they suggest not letting the introduction of the environmental dimension water down these classic product development dimensions.

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Figure 3: The components of product design
(Veroutis & Fava, 1997, p. 65)

Aspects of DfE cover the capability for dismantling, refurbishment, recyclability of component parts, as well as materials recyclability (Gladwin, Levin & Ehrenfeld, 1994 cited in Stead & Stead, 1996, p. 216); and “material substitution, source reduction and waste reduction of energy and toxic substances, product life extension, remanufacturing, and energy and materials recovery” (King, 1994 cited in Stead & Stead, 1996, p. 216).

Putting DfE into practice demands that businesses conduct a comprehensive and cross-functional analysis of the product or the process to discover what environmental impacts are caused and what the customer wants (Santos-Reyes & Lawlor-Wright, 2001). Furthermore, according to Allenby (1994), implementing DfE requires the company to examine the particular design alternatives, products, processes, or input factors and to come up with strategies to minimise the environmental impact.

Nowadays, many firms from different industries use the DfE concept when designing new products and altering present ones. However, it is apparent that often both practitioners and scholars centre on particular concerns of the product´s environmental responsibility (Santos-Reyes & Lawlor-Wright, 2001), such as dismantling or recycling (Banerjee, 2007; Elkington, 1997). Therefore, companies wanting to systematically consider all ecological issues caused by a product throughout its life cycle need to ensure that they take a structured cross-functional approach to DfE and include industry partners along the value chain.

DfE and LCA come together in business policies of environmentally responsible product development (Banerjee, 2007; Elkington, 1997). Since both approaches are relatively complex, they involve a considerable investment of time and money. In consequence it might be difficult to convince managers that the effort of applying these approaches will be compensated by means of boosted product sales (Banerjee, 2007).

Thurston (1999, p. 50) maintains that ecologically responsible design and production poses one of the hardest challenges engineers have ever faced. It demands them to take into account concerns “outside their area of expertise, far beyond the boundaries of the individual firm and over time periods much, much longer than the typical product planning horizon” (Baumann, Boons, & Bragd, 2002, p. 410). This situation indicates that a close collaboration between different functions with different expertise would be highly beneficial.

However, regarding the development of environmentally responsible products, little research has been done that supports corporate managers in understanding the function and execution of tools in this area, according to results from a wide literature review by Baumann et al. (2002). The authors state most studies do not provide a business focus and they ignore financial, managerial and competitive implications. Only a small number of articles discuss the integration of management tasks, environmental tasks and the process of product development. Furthermore, Baumann et al. find that research addresses environmental product development as a new topic and is not based on existing approaches. The majority of articles deal only with sections of the value chain. However, to significantly improve a product´s environmental performance businesses need to manage ecological tasks not only at the company level but also beyond the organisation´s boundaries (Baumann et al., 2002). These authors suggest that to overcome the gaps researchers should take a systemic approach that links the internal development of products to other processes within the organisation. Environmental product development should also take into consideration processes of rivalry and collaboration with economic players in the value chain (Baumann et al., 2002). This insight is particularly relevant in the current research where I attempt to embrace such a systemic approach by considering both competition and cooperation.

2.3.7. Value chain collaboration

A product´s value chain can be regarded as “the ‘social’ dimension of a product´s life cycle” (Baumann et al., 2002, p. 419). It is formed by the different private and public organisations that are involved during a product´s life cycle, from the suppliers of raw materials or intermediate parts, to manufacturers, distributors, consumers, and recyclers, and end-of-life waste treatment facilitators (Baumann et al., 2002). This value chain concept extends Porter´s (1985) original value chain at company level which looks at the generation of value during primary and support activities within a single firm. From the perspective of a particular company, these relationships across an industry constitute inter-organisational linkages that go beyond the company boundaries (Baumann et al., 2002), which again connects to product stewardship.

Even though process systems at business level within a particular organisation could be advanced in environmental terms, significant potential lies in enhancements among organisations. “An industrial regional synergistic effort on material and energy use efficiency and waste reduction is more critical for sustainable development” (Cristina, Yinlun, & Helen, 2008, p. 1956). Due to major interdependence between industry partners, the endeavours of one partner to promote sustainability significantly relies on the endeavours of the other partners (Singh & Lou, 2006). And reciprocally, when making decisions, businesses should take into account their impact on the industrial network (Cristina et al., 2008).

Roy and Whelan (1992) present a successful project outlining cooperation between the various economic and administrative actors along a value chain in the electronic equipment sector. It constitutes a practical example that collaboration can facilitate, for example, products´ end-of-life recycling and disposal. The undertaking builds on the notion that producers need to embrace the earlier-mentioned product stewardship approach and adopt responsibility for all phases of the product life cycle beyond the manufacturing site. The authors state that due to the multi-sector nature of environmental problems, producers need to cooperate with economic actors up and down the value chain to solve particular problems. In terms of benefits found in this case, collaboration would enhance the information exchange with value chain partners across a product´s life cycle. A collaborative business environment also promotes innovation by “the cross-fertilization of skills and complementary knowledge of technology and markets” (p. 63). Other gains from value chain collaboration are sharing expenses and risks, and the establishment of compulsory industry-standards which put pressure on other industry partners to develop environmentally responsible practices.

Several cross-sectoral partners were engaged in the project to ensure a successful recycling concept of electronic equipment. These encompass - among others – “polymer suppliers, equipment manufacturers and designers, equipment distributors and retailers”, logistics companies for equipment collection, “equipment dismantlers and material re-processors, local and municipal authorities”, specialists with technological expertise, and Government (R. Roy & Whelan, 1992, p. 65).

One major difficulty encountered concerned the nature of a regional recovery system for the end-of-life equipment, because of the comparably high expenses for the reclamation (e.g. transport) proportionate to scrap value. Another obstacle was an insufficient market for recycled material (R. Roy & Whelan, 1992). I see this example as helpful because it provides practical hints as to the reasons why a cross-sectoral network should be established and which partners need to be included in such a network to be successful. It also shows potential difficulties in establishing an economically viable recycling system (lack of market demand for recyclables). Nevertheless, the implications of this study for the development of the business case in this dissertation are limited as only the electronic equipment sector is analysed. Moreover, the initiative of installing a multi-sector network emanated from an intermediate body which might have more influence on the individual actors than a single company in the value chain.

Baumann et al. (2007) find that current studies, whether conceptual or descriptive, “almost exclusively deal with existent product chains and changes in these rather than with the product chain in developing a new product” (p. 419). There was little academic support for the project to assist theorising the set up of a complete new value chain for a product, or pack material respectively.

Overall, putting the earlier-mentioned cradle-to-cradle concept into practice requires a company to take a systemic approach that goes beyond the organisation´s boundaries. This means a company should engage in value chain collaboration to close the loop to achieve cyclical material flows (Braungart et al., 2007). I hold that collaboration within the extended value chain, e.g. with raw material suppliers, distribution channels, recycling companies and composters, is a requirement for gathering information for my research, and to identify necessary new partners across the industry, which would be supportive during the bioplastic pack introduction.

2.3.8. Summary

Overall, for a company to contribute to environmental sustainability it needs to embrace environmental product stewardship, and the related management approaches, such as LCA, life cycle costing, cradle-to-grave, respectively cradle-to-cradle, environmental responsible product development, and value chain collaboration. Thus, I suggest having these environmental approaches in place is a requirement for establishing an environmental win from an ecological initiative. I take up this argumentation in Section 2.6 when I develop a theoretical framework to assess an environmental initiative.

Having reviewed literature on the environmental side of a business case for sustainability, in the next section I now illuminate the financial side.

2.4. Financial metrics for evaluating environmental initiatives

2.4.1. Significance of financial metrics

In this section I look at metrics that evaluate the impact of corporate sustainability initiatives on financial performance. I rely on one key source, Peloza (2009), because his recent account constitutes a systematic meta analysis of both research reports and practitioner literature that comprehensively investigate the business case for corporate social performance. Peloza (2009) reviews a wide array of key papers including two academic seminal meta analyses (J. D. Margolis & Walsh, 2003; Orlitzky, Schmidt, & Rynes, 2003).

According to Peloza (2009), managers have an intangible and abstract notion that corporate sustainability initiatives can positively affect the financial bottom line. However, those who aim to implement ecologically and socially conscious actions have difficulties in evaluating their economic consequences. When building the business case for sustainability, financial metrics are essential for a number of reasons. First, companies debating an investment in social and environmental initiatives have several alternatives between which they can pick. To take a decision, these abstract options need to be made comparable by a standard, such as economic value. Second, sustainability investments – like any other business expenses – “come under intense scrutiny and the managers responsible for them are expected to clearly quantify the effects of their programs on the bottom line” (Peloza, 2009, p. 1520). Roy and Epstein (2001) hold that initiatives which cannot be expressed in financial measures will be subjected to the mood of the public opinion, shifts in leadership, and the ups and downs of economic cycles. Third, financial executives and analysts are frequently averse to finance sustainability initiatives since there is not enough hard data to justify the investment, although they generally agree to the programmes´ value for business (Steger, 2006). Overall, managers wanting to successfully get their sustainability investments approved through mainstream budgeting are required to provide economic metrics of the returns from these expenditures (Peloza, 2009).

Peloza (2009) identifies four distinctive measures that describe the link between businesses´ sustainability programmes and financial performance. They encompass sustainability initiative metrics and three further metric systems (mediating metrics, intermediate outcome metrics, and end state outcome metrics) which evaluate the total value proposition of corporate sustainability investment in financial terms. The latter metric systems move “from [corporate social performance] to financial valuation in three distinct stages” (p.1523) (see Figure 4).

As mentioned earlier in Section 2.2.4, Peloza´s research did not focus on the first metric system, sustainability initiative metrics. He just briefly touches metrics that quantify companies´ ecological or social impacts. Therefore, in the following, I elucidate only the three financial metric systems, starting with the most commonly applied end state outcome metrics, moving to the least used mediating metrics.

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Figure 4: Stages of financial impact from sustainability initiatives
(Derived from Peloza, 2009, p. 1524)

2.4.2. End state outcome metrics

End state outcome metrics are represented in the vast majority of papers examined by Peloza (2009). The metrics are used to evaluate firm performance, such as external market measures (e.g. share price), or internal accounting measures (e.g. return on equity, return on sales). These purely financial metrics are essential since they facilitate cross-firm benchmarks and reveal how the programmes have enhanced shareholder returns. Nevertheless, they are restricted with regard to providing support in identifying when sustainability-related actions have achieved their target. Similarly, when limited to short term considerations, these measures can fail in capturing the value proposition of sustainability initiatives, as they do not represent well such long term impacts, as for example customer loyalty, improved relationships with authorities, and employee satisfaction. Beyond, end state measures are influenced by a multitude of other business factors, for instance “competitive pressures, economic cycles, or regulatory changes. The positive or negative impacts [of the activities] can simply be drowned out by this other noise” (Peloza, 2009, p. 1527). Therefore, applied as a single measure, end state outcome metrics offer limited assistance for managers seeking to evaluate the outcome of sustainability initiatives (Peloza, 2009).

2.4.3. Intermediate outcome metrics

Intermediate outcome metrics, which are used far less often then end state outcome metrics, appraise particular sustainability initiatives and their immediate bottom-line effect by either cost-based, revenue-based or integrative approaches (Peloza, 2009, p. 1526). Cost savings owing to energy and waste conservation would be a cost-based metric. These operational impacts need to be quantified by a company and then employed for the evaluation of a business case. This quantification can be comparably easy as the metrics often have a readily available market price. Furthermore, environmental and social activities can generate business value by three means “(a) garnering loyalty among current customers, (b) generating new market opportunities, and (c) trading carbon emissions” (Peloza, 2009, p. 1526). Intermediate financial metrics entail two valuable advantages for managers seeking to construct a business case for sustainability. Firstly, they allow for the quantification of impacts that would not play out in end state metrics because of other noise. Secondly, these measures take into account the company´s performance in the past. Beyond, they also allow for a greater insight regarding the internal processes that create business value from sustainability activities (Peloza, 2009).

2.4.4. Mediating metrics

Mediating metrics are used scarcely. They reveal the impacts of sustainability initiatives on a company’s strategic position to generate value and control risk. They also enable managers to detect the causal effects between the environmental/social programmes and the rise in economic performance. These measures are, at times, challenging to frame, discover, and calculate (Peloza, 2009). Different types of mediating metrics can be categorised into the following fields: the use of input/output factors (e.g. energy conservation, waste reduction); cultural shifts (e.g. innovation, improved interdepartmental processes); and reputation (e.g. customer loyalty, purchase intentions, price sensitivity, relationships with authorities) (Peloza, 2009).

Peloza's (2009) research identifies that the mediating processes are vital for evaluating the business case for sustainability initiatives because they ultimately create the financial value. They are a requirement for revealing causality and detecting less obvious benefits beyond evident financial value. In addition, comprehending the causal relationship between economic performance and environmental/social initiatives allows managers to pro-actively handle the mediation process. They can appraise how causality functions for their industry, company, or initiative. However, mediating metrics are only vaguely understood and need more examination. The Research Network for Business Sustainability (2008, p. 5) holds that "most of the business value from sustainability is in these strategic impacts. Unfortunately, the metrics required to verify this claim are complex or unavailable".

2.4.5. Requirements for financial evaluation

Overall, to wholly appreciate how sustainability strategies generate value, managers need to adopt a comprehensive approach that quantifies strategic mediating processes, operational intermediate outcomes, and purely financial end state measures. Such a holistic approach can grasp "the full costs and benefits of each initiative" (Peloza, 2009, p. 1532). However, Peloza (2009) finds that current academic research remains at a macro level, providing practitioners with general arguments to justify investments in sustainability initiatives. It thus lacks appropriate metrics for tracking the impacts of sustainability by a particular company. To overcome the lack of guidance for managers willing to implement sustainability initiatives, Peloza (2009) calls for a closer collaboration between practitioners and academics to develop sustainability assessment instruments at business level.

It is important to note that another major requirement for financial management striving to promote sustainable development is the orientation towards longer term financial strategies and appraisal periods. Strategic environmental investments usually show effect in the long run (Marsh, 2010; McDonough & Braungart, 2002a).

In the next section, the new product development process is examined, bearing in mind as noted earlier, its relevance to the new packaging development process at the centre of this investigation.

2.5. The new product development process

2.5.1. The conventional new product development process and its stages

The activities and required information for the sponsored project on the potential development of a bioplastic beverage pack feature certain similarities to the development process of any ordinary new product. Therefore, in this dissertation, the introduction of new packaging is equated with the introduction of an entire new product. In order to understand the general activities and needed data in the different steps in a new product development process I first review two academic sources that adopt a marketing perspective. I reference Bingham and Quigley (1990) who describe the traditional NPD process and the work of Tzokas, Hultink, and Hart (2004) which supplements this insight with different evaluation criteria for the various process stages.

The NPD process encompasses seven sequential stages: (1) idea generation; (2) idea screening; (3) conceptual development and testing; (4) business analysis; (5) product development; (6) test market; and (7) product introduction (Bingham & Quigley, 1990). According to circumstances, particular stages can be skipped partially or completely; however, the process remains innately complex and arduous, commonly engaging various departments and functional units executing a considerable range of tasks. Depending on the stage, the activities focus on different functions. It is also noteworthy that stages can overlap and that information gathering within the stages is iterative (Bingham & Quigley, 1990). The project in this dissertation covers - on a superficial level - stages two to four: idea screening, conceptual development and testing, and business analysis. Therefore, these phases are elaborated in more detail.

1. Stage one, **idea generation**, encompasses the quest for new, practical, valuable and competitive product ideas (Tzokas et al., 2004). Market data is analysed and evaluated by marketing; and engineering provides information on new technology and materials. Using this data, research and development carries out an appraisal of the generated ideas with regard to their general technical feasibility (Bingham & Quigley, 1990).

2. Closely connected to this stage is the second stage, **idea screening**, which emphasises containing the variety of ideas while taking into account their chances for success and the time line for introduction. Required information is delivered by engineering (e.g. technical feasibility, manufacturing resources), marketing

research (e.g. likely response of consumer groups, sensible pricing options), and marketing (e.g. distribution and channel alternatives, probable expense consequences, match with strategic plans). Decisive factors during screening are products, markets and finances (Bingham & Quigley, 1990). In this stage, product desirability and feasibility with regard to markets and technology need to be balanced. In some cases, product ideas are “kept aside waiting technical and market conditions to mature for future development” (Cooper, 1986 cited in Tzokas et al., 2004, p. 623).

3. **Concept development and testing** encompasses a verbal or pictorial sketch of the product idea (Tzokas et al., 2004). The refinement of the product idea regarding product attributes requires that (1) product designs are on hand to production and the market testing team; (2) market acceptance research on the product ideas is completed; (3) “consumer segments must be identified and target markets selected”; and (4) manufacturing studies need to be kicked off (Bingham & Quigley, 1990, p. 53). Market research assesses the match of the concepts to present and potential markets. Engineering gauges the technical compatibility between consumer needs and production capabilities. Using this data, marketing creates a depiction of potential target markets for each idea (Bingham & Quigley, 1990). Subsequent to an interpretation of potential consumers´ feedback to initial product designs, a decision is taken on the product concept´s market potential (Tzokas et al., 2004).

4. The **business case** is built based on a “thorough market, technical and financial analysis” (Tzokas et al., 2004, p. 620) and forms a dividing line between primary examination and real commitment. The research and development team converts the product concept into an actual tangible figure, including for instance computer-based designs or physical archetypes (Bingham & Quigley, 1990). At the end of this step, the product development team decides if “the product is technically feasible, has market potential, and will make a sound financial contribution to the firm” (Tzokas et al., 2004, p. 620). Supplementary and more detailed data is required such as internal expenses, market and sales forecasts. From this data the finance department calculates the profitability of the residual product options. The results of the business examination are of crucial importance because the development constitutes a great part of the new product´s expenses. The approval of a particular product entails significant commitment of capital and firm resources

(e.g. new manufacturing tooling, materials, and staff) and thus, implies the engagement of higher level executives (Bingham & Quigley, 1990).

5. The **product development** deals with the design and generation of various prototypes and the functional testing of the product including a check against the internal technical and production prerequisites (Tzokas et al., 2004). Technical and design issues are tackled, and the consumer response is assessed to formulate a market entry strategy (Bingham & Quigley, 1990).

6. Prototypes that succeed in the previous step, but are not yet considered to progress to commercialisation undergo the **test market** stage, because more data is needed regarding likely buyer behaviour of potential consumers (Bingham & Quigley, 1990). Finally, the test market outcome reveals the market potential of the prototype (Tzokas et al., 2004) which results in a management decision to either carry on with the product launch or to put it on hold (Bingham & Quigley, 1990).

7. The **product launch** follows the decision of actual commercialisation and encompasses the start of manufacturing, continuous quality control, extensive "advertising and promotional campaigns to stimulate future sales", and financial controlling (Bingham & Quigley, 1990, p. 56). A short term and a long term post-launch assessment should be carried out (Tzokas et al., 2004).

Overall, in order to gather all the required data, there has to be an ongoing communication in particular between the following corporate functions: marketing, marketing research, research and development, engineering, manufacturing, finance, purchasing, and quality assurance. Thus, a cross-functional team is required for a successful product development (Bingham & Quigley, 1990).

2.5.2. Evaluative criteria in the conventional NPD process

To facilitate the strategic decision-making process of a company, managers often employ particular "evaluation gates" with certain "evaluative criteria" at various steps during the NPD process (Tzokas et al., 2004, p. 219). These gates (see

Figure 5) indicate whether it would be rewarding to proceed in the development of an initial product idea, or later in the process a more detailed product concept and boost the chance for a favourable product launch (Tzokas et al., 2004).

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Figure 5: Dimensions and evaluation criteria in the NPD process
(Tzokas et al., 2004, p. 621)

Tzokas et al. (2004) find that the characteristics of each phase demand specific criteria with a focus on diverse dimensions such as the market, finance, product, process, or intuition. For example in the fourth stage, analysis of the business case, there is a focus on market-based (e.g. sales objectives, sales in units, market potential) and financial-based (break-even time, profit objectives, return on investment, margin) criteria set by management (Tzokas et al., 2004, p. 623).

2.5.3. Product development from an environmental angle

From an environmental perspective, with regard to the introduction of a new bioplastic product, the importance of the establishment of an ongoing cross-functional team is supported by European Bioplastics (2008), a branch association, and Loughborough University (2010).

However, in contrast to the marketing perspective, the development of environmentally responsible products requires a view from a wider angle. Baumann et al. (2002) use a model which sees the NPD process in a wider business context (see Figure 6). This framework is grounded on the notion that the development of an environmentally responsible product needs to be contemplated in context. Businesses need to acknowledge that the in-house procedures are implanted in a value chain (e.g. supply, consuming, recycling and disposing of the product), as well as in society (e.g. legislation, competitors, media) beyond the company´s boundaries. This systems perspective is helpful to ensure that information from all involved functions, business partners and other stakeholders is taken into account when building the business case.

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Figure 6: Product development in context
(Baumann et al., 2002, p. 410)

2.6. Theoretical framework to assess an environmental initiative

In this section I develop a theoretical framework based on existing theory synthesised in the foregoing literature review to assess a corporate environmental initiative as to whether it helps establishing a win-win situation in environmental and financial terms. The framework addresses my first research question, *"What are the environmental and financial requirements for a win-win situation?"* First, I define what an environmental win comprises, and secondly I look at the financial factors for a win-win situation.

2.6.1. Factors for an environmental win

A **general requirement** for the realisation of an environmental win from an ecological initiative is genuine product stewardship as well as true commitment, in particular from top management, to a corporate ecological strategy and values which warrant the benefits for environmental improvements (e.g. Braglia & Petroni, 2000). Furthermore, the literature (see Section 2.3) suggests that a company needs to evaluate its products´ environmental impacts and related costs for an entire product life cycle (e.g. LCA and life cycle costing). Moreover, the adoption of a cradle-to-grave or a cradle-to-cradle approach lays the foundation for eco-efficiency, or eco-effectiveness, respectively. In addition, a company necessitates product design that considers these impacts from the beginning of the product development (e.g. by design for the environment) and a collaboration of the company with its industry partners beyond the company boundaries. These general requirements are listed below in Table 1 in the top left hand quadrant.

For the evaluation of the environmental initiative in the business case from an ecological perspective, I need to employ **environmental performance indicators**. As mentioned earlier, Delmas and Doctori Blass (2010) find three primary categories of corporate environmental performance indicators: (1) environmental impact, (2) regulatory compliance, and (3) organisational processes. These indicator categories, supplemented with actual indicators noted in Section 2.2.4, are listed in Table 1 in the lower left hand quadrant. I also added those of Peloza´s (2009) sustainability initiative metrics (mentioned earlier in Section 2.2.4) that apply to an environmental initiative.

Since in this dissertation I investigate the establishment of an environmental win from an environmental initiative, I need to capture particularly the environmental impacts of the initiative. Therefore, in the following, I identify further metrics for the environmental impacts, the first category of indicators.

I suggest that generally, the environmental impacts of a corporate environmental initiative significantly depend on the degree of environmental pro-activity taken by the company. The firm can either strive for eco-efficiency or for eco-effectiveness. The eco-efficiency concept, using the cradle-to-grave approach, strives for an increase in the productivity or the conservation of natural resources, e.g. by using renewable resources (Lovins et al., 1999). The reduction of waste that goes to landfill and a diminished use of energy or toxic substances in the production processes are other examples (Elkington, 1997; Stead & Stead, 1996). The environmentally superior cradle-to-cradle approach based on the notion of eco-effectiveness is more ambitious. Its underlying notion “waste equals food” eliminates the concept of waste and leads to products that have the capability to stay in biological or technical cycles (=recycling systems). In these infinitive material flows, the material is not diminished or downcycled, and the material quality is retained over consecutive life cycles. Furthermore, in a biological cycle the product must be non-toxic at the end of its useful life because it is supposed to be composted (McDonough & Braungart, 2002a). Other environmental benefits that apply to both concepts are, for example, the reduction of greenhouse gas emissions, and a decrease in use of energy (Fernyhough, Markotsis, Newman, & Smith, 2010). The above mentioned performance indicators or benefits resulting from an environmentally responsible corporate programme contribute to an environmental win and are listed below in Table 1 in the lower left hand quadrant.

I am aware that there are further environmental impact indicators which might be relevant for this research. In the course of the project I identify additional indicators, when addressing the more specific literature on PLA and packaging. These supplementary environmental indicators are taken into account in my later assessment of the bioplastic beverage pack introduction.

2.6.2. Factors for a financial win

Since making a profit is the ultimate aim of almost all business, I assume that generally companies have the essential conditions in place to achieve a financial win from their corporate endeavours. Therefore, I do not mention these conditions explicitly. As regards the establishment of a financial win from an environmental initiative, one of the **major requirements** is to capture the total costs and benefits of such a measure. This can be done by applying a holistic evaluation approach that includes different metric systems (Peloza, 2009). Another important condition to seize all related costs and benefits is the orientation along longer term financial strategies (Marsh, 2010; McDonough & Braungart, 2002a).

Concerning the **performance indicators** for a financial win, I mainly rely on the financial metrics which Peloza (2009) suggests in his earlier reviewed meta-analysis (see Figure 4 in Section 2.4). I complement these with for the business case relevant financial- and market-based criteria, which Tzokas et al. (2004) propose for evaluation during the different phases in the conventional NPD process (see

Figure 5 in Section 2.5.2). The general requirements and the performance indicators for a financial win resulting from a corporate ecological initiative are compiled in the two right hand quadrants of Table 1, which completes my theoretical framework for the assessment of an environmental initiative.

Environmental Win	Financial Win
General requirements: – Product stewardship – Corporate environmental strategy – Life cycle assessment – Life cycle costing – Development of environmentally responsible products – Cradle-to-grave concept, eco-efficiency – Cradle-to-cradle concept, eco-effectiveness – Value chain collaboration	**General requirements:** Capture total costs and benefits by – Holistic evaluation approach – Long term planning horizon
Performance indicators: **Environmental impact** – Conservation of non-renewable fossil resources – Decrease in use of energy – Reduction or elimination of waste – Recycling system and maintenance of material quality – Reduction of greenhouse gas emissions, e.g. carbon dioxide – No or less toxicity **Regulatory compliance** – Non-compliance status – Violation fees – Number of audits **Organisational processes** – Environmental accounting – Audits – Reporting – Environmental management system – Environmental investment	**Performance indicators:** **Mediating metrics** – Input/output metrics: o Energy conservation o Waste reduction – Employee satisfaction – Cultural shifts o Quality of cross-functional processes o Progress of innovation – Reputation and brand o Customer loyalty/acceptance o Relationships with authorities etc. **Intermediate outcome metrics** – Cost-based metrics: o Energy expenses o Operational efficiencies o Changes in risk profile – Revenue-based metrics: o Customer satisfaction o Market share o Sales in units/volume – Integrative metrics: o Profitability o Break-even time **End state outcome metrics** – Accounting: o Return on sales o Return on investment

Table 1: Theoretical framework for the assessment of an environmental initiative

The framework offers guidance for business to holistically assess an environmental initiative. It combines environmental and financial performance indicators derived from different studies from the environmental management literature (in particular Delmas & Doctori Blass, 2010; Peloza, 2009) complemented with indicators from marketing literature on NPD (Tzokas et al., 2004). The framework seeks to help examine whether a win-win situation can be established from an ecological initiative. It puts emphasis on a balanced investigation and genuinely assesses whether an environmental win can be achieved by checking if the general requirements are in place. That means, managers using the framework can reveal if a corporate initiative truly contributes to an environmentally sustainable development, or if it leads only to a financial win resulting in trade-offs at the expense of the environment.

2.7. Summary

The literature reviewed in this chapter led to the development of a theoretical framework for the assessment of an environmental initiative. The framework integrates both an environmental and a financial perspective to evaluate the establishment of a potential win-win situation from the initiative. It encompasses general requirements and performance indicators for the two wins.

I next detail the research method employed in this study.

Chapter 3

Research method

3.1. Introduction

In this chapter I describe the research design of the dissertation as a case study that shows features of the new approach “interventionist research”. Then, I explain the methods and the framework for gathering internal and external information. I also go into my positionality in the analysis of information and into my role in the project. Lastly, I elucidate my method to answer each of the four research questions and the overall research question, as well as how I complete the company project.

3.2. Research design

The overall research design is a case study, centred on a single beverage manufacturer situated in an interdependent value chain with diverse business partners. Yin (2009) defines a case study as an empirical investigation that examines contemporary “organizational and managerial processes” (p. 11) “in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (p. 18). The case study method is useful as I comprehensively study a current business situation within its real-life setting, where the boundaries between the organisation and its business partners in the potential “closed loop system” are blurred.

Usually, a case study examines phenomena where “the relevant behaviours cannot be manipulated” by the researcher (Baard, 2010). This is not quite the case for my examination. It is correct that I have little influence on the behaviours of the company members and business partners during the period of the research. However, my results do seek to inform the decision to be made by the company´s Executive Board and might lead to action eventually.

For this reason I consider the study to feature characteristics of interventionist research. The approach, which can also be conducted as a case study, originates from action research (Baard, 2010) and strives for the solution of real problems within a company (Argyris, Putnam, & Smith, 1985). Westin and Roberts (2010, p. 6) state that “the aim of intervention research is to meld theory and practice together” and “to investigate and solve practical problems” by means of a close collaboration between “the researcher and the practitioner” (Jönsson, cited in Westin & Roberts, 2010, p. 6). Baard (2010, p. 16) recapitulates that the approach has two merits: “a knowledge product for both researcher and practitioner and a practice product or intervention developed for problem solution”. This approach supports the argumentation in my case study that both members of the sponsoring company and I could learn and gain from the cooperation. The integration of theory and practice allowed for a contribution to theory and for company members to gain new insights to inform the decision concerning a potential introduction of a bioplastic pack. However, I did not actually witness the intervention and its results, as the study was limited in time. My research concluded before the decision on the bioplastic pack is implemented. So the contribution to theory is restricted to the discussion around the practicability of academic concepts and does not include the actual environmental and economic outcomes of the decision made.

3.3. Methods and framework for information gathering

Yin (2009) states that a case study “relies on multiple sources of evidence, with data needing to converge in a triangulating fashion” (p.18). Therefore, I gathered information from many different internal and external perspectives. I analysed corporate non-public information, including detailed financial information such as Frucor´s profit and loss calculation. I also examined public company documents and industry publications related to the bioplastics and recycling industry, e.g. websites, journal articles, and position statements. A particularly valuable source is the commissioned scientific report for Frucor by Fernyhough, Markotsis, Newman, and Smith (2010). The variety of data sources is to back up the information given by the informants. Furthermore, the establishment of a theoretical framework for the assessment of an environmental initiative, as in Chapter 2, guided the gathering and analysis of information.

As to the selection of the informants for the case study, the company´s Environmental Manager supported me in the identification of the most important informants. The choice was based on: (1) the informants´ current and potential involvement in the value chain and processing of a bioplastic pack; and (2) their knowledge in this field. The Environmental Manager also provided initial contacts. The informants for this project can be divided into two groups; they are either internal company members or external current or potential value chain partners for the sponsoring company.

For the internal information collection I took a cross-functional approach. I had discussions with employees in the following six departments: purchasing, marketing, finance, technical research and development, sales and consumer insight, and manufacturing. In addition I spoke to the technical director. Taking into account expertise from these different fields to accumulate comprehensive and complementary knowledge was in tune with the literature on the NPD process reviewed in Chapter 2. Furthermore, I received significant direction from the company´s Environmental Manager who, therefore, played a central role in the project. His view was that I should include environmental concerns in the development of an ecologically responsible beverage pack, while the wider company view privileged an economic perspective. Figure 7 shows the sources of information for this research and the development of a bioplastic beverage pack, assuming my key contact was via the Environmental Manager.

In order to garner comprehensive information from sources external to Frucor I included various members along the product´s potential value chain. From an environmental perspective, I did so in line with various calls from the literature to assume a systemic view (e.g. Baumann et al., 2002), as well as to promote product stewardship (Hart, 1995) and a closed loop value chain (Baumann et al., 2002). From an economic stance, integrating value chain partners was to reap the expertise from organisations and individuals beyond company walls who were pioneers in the bioplastics field (R. Roy & Whelan, 1992).

Baumann et al. (2002) suggest that examining the development of environmentally responsible products goes beyond the in-house processes of a firm and includes a wider business context, e.g. a product´s value chain, and society (see Figure 6 above) (compare also R. Roy & Whelan, 1992). This systems perspective is helpful to ensure that information from all involved internal business functions, external business partners and other stakeholders is taken into account when building the business case. Therefore, I shaped my own picture of the company´s context for the product development process. Figure 7 shows the different parties along the potential value chain involved in the bioplastics project.

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Figure 7: Systemic perspective on the product development of a bioplastic pack (Derived from Baumann et al., 2002, p. 410)

I had meetings and discussions with the following current and potential business partners either at the sponsoring company´s premises, during site visits, via telephone conference or via email contact:

- a potential raw material supplier of PLA resin situated in the USA (NatureWorks),
- a local producer of PET plastic bottles that could be a potential supplier for PLA bottles (Visy PET)*,
- a local facility for mechanical plastic recycling (Astron Plastics)*,
- a local supplier for conventional bottle labels (Adhesives)*,
- a potential local supplier for bottle labels made from PLA (Jenkins Labels),
- Auckland´s municipal Material Recovery Facility (Visy MRF)*,
- a potential local business partner for industrial composting (Envirofert)*,
- a potential buyer for post-consumer and post-industrial PLA situated in the USA (BioCor),
- a Belgium-based chemical PLA reprocessor with a subsidiary reprocessing plant in the USA (Galactic), and
- suppliers for alternative beverage packaging, such as Tetra Pak, glass bottles (O-I Recycle Glass), and cans (Amcor).

I was able to conduct site visits at those value chain members marked with an asterisk (*). Furthermore, I had a discussion with a New Zealand research institute (Scion). In accordance with company expectations, for this project I did not talk to representatives from non-governmental organisations (NGOs), media, competitors or local authorities.

3.4. Positionality in analysis of information and role in project

To capture what was said I took detailed notes during the conversations with both internal and external informants. With regard to the analysis of information I pursued a reflective approach, assessing the statements from Frucor´s employees or value chain partners against the background of my theoretical knowledge. In a pragmatic manner I went through my notes and sought information that could answer my research questions. After that I created a logical chain of evidence to ensure reliability.

As already mentioned in the introduction (Section 1.4) I consider myself to be a positioned researcher. I admit that I favoured a genuinely environmentally responsible business case for the introduction of a bioplastic beverage pack. Nevertheless, I also took a practical view when evaluating the financial viability of the most plausible business case to ensure I meet Frucor´s requirements striving for a business case with a strong economic return.

Departing from the role of a conventional student/academic researcher, in this project I adopted more the role of a consultant. To clarify I note that the dissertation work did not involve the usual interviewing of research participants. My research did not include asking a range of pre-formulated questions; but rather - as invited by the Frucor´s Environmental Manager – I asked any question that seemed to clarify or add insight into the sponsoring company's product development process. Consequently, I did not include any quotes from meetings in the dissertation or in the company report. I did not audio-record the discussions or transcribe any data. As previously noted I took notes in the meetings and wrote up my own thoughts afterwards.

It is noteworthy that although I was remunerated by the sponsoring company, I had no financial interest in the outcome of the research. The research seeks to inform Frucor´s strategic decision on whether or not to proceed with the establishment of a comprehensive NPD project that requires further commitment and investment.

Next, I outline the process of how I answered the five research questions and solved the business case for the sponsoring company.

3.5. Method to answer research questions and to complete company project

3.5.1. General method for overall research question

In this dissertation I answer the overall research question

> *What is the likelihood that a win-win situation could be achieved in the most plausible business case for the introduction of an environmentally responsible beverage pack?*

and subordinate questions outlined in Chapter 1 by combining academic concepts with insights from the practice at the sponsoring company. During the six months of my dissertation, I simultaneously conducted a project at Frucor, the sponsoring company, on the potential development of a new environmentally responsible beverage pack. I spent one to two days per week at Frucor´s premises. Hence, I had two tasks to solve at the same time: First, I had to write my dissertation and answer my research questions with a strong academic focus. Secondly, I was to solve a real business problem by taking a practical and pragmatic approach and ultimately writing a report for Frucor.

I signed a confidentiality agreement with Frucor, and thus, was introduced to and included in a normal business process. Throughout the project I was in regular contact with the company's Environmental Manager and could ensure that my theoretical considerations were still in tune with the real business case. In the first weeks at Frucor I accompanied the Environmental Manager on a round of discussions to become familiar with the project, the contributing employees and business partners, as well as the company´s processes relating to a product development proposal.

3.5.2. Development of theoretical framework

While I became familiar with the business environment, I started rereading academic literature on sustainability and environmental management, as well as for the first time publications related to bioplastics and the beverage industry in New Zealand. This background knowledge helped me to put my dissertation and the company project into context and to structure the analysis of the two tasks. In order to answer my first research question,

> *What are the environmental and financial requirements for a win-win situation?*

I developed a theoretical framework to assess an environmental initiative, which was presented at the end of Chapter 2. This framework is based on existing theory synthesised in my literature review, encompassing concepts such as environmental product stewardship and related management approaches, as well as environmental and financial indicators for the evaluation of a sustainability business case. I formulated general requirements and performance indicators for both an environmental, and a financial win. The framework assists in the evaluation of the business case later in the dissertation.

3.5.3. Business case construction

Regarding my second research question,

> *What is the most plausible business case for the introduction of an environmentally responsible beverage pack at Frucor?*

I needed to understand the peculiarities of the business case, the internal business activities, and the new product´s life cycle. First, in order to get a rough idea about the company project, I had two meetings with Frucor´s Environmental Manager. Next, the Environmental Manager set up introduction meetings, internally with other Frucor employees from different departments, and externally with current and potential members of the value chain. During the discussions with the Environmental Manager and the informants I took notes and posed questions based on my previous background research with a view to incrementally developing the most plausible business case. By using the information gathered I started drafting potential value chains in form of ideal cyclical material flows for the bioplastic beverage pack made from PLA (see Appendix I for an early example).

These drafts helped me to identify gaps in information. Once I had gained an overview of the project, I was free to set up meetings to fill the gaps. During further iterative discussions with both internal and external informants, I questioned whether the material flows I had drafted were viable with regard to the company and wider industry context. Incrementally, the newly acquired data allowed me to refine the PLA beverage pack´s potential material flows, which differed in elements such as the target markets for the PLA bottle and the end of its useful life. For the plausible scenarios I acquired some financial data to build rough business cases. The Environmental Manager gave regular feedback on my proposed material flow scenarios which then became potentially viable business cases. He provided valuable insight into the organisation to help exclude less plausible elements of the business cases. Finally, I identified the most plausible business case for the introduction of an environmentally responsible beverage pack. For this case I gathered thorough data to construct a complete business case including detailed financial information (e.g. a profit and loss calculation). I also identified opportunities as well as barriers and risks of the pack introduction.

Once a business case element was considered unlikely to be feasible in the foreseeable future – at least at this point of time – it was not investigated in further detail. However, I still outline these elements in brief to inform the reader about other options and to give reasons why they were excluded. This information might be useful for Frucor with respect to the fast changing business context, as some of the excluded end-of-life options might become feasible unexpectedly, if and when suddenly a major change occurs.

3.5.4. Identification of challenges to and likelihood of a win-win situation

In order to approach my third research question,

> *What are Frucor´s challenges in achieving a win-win situation in the most plausible business case?*

I assessed the proposed most plausible business case in environmental and financial terms. I used the previously developed theoretical framework, which I supplemented with further environmental impact indicators derived from the more specific literature on bioplastics and packaging. First, I checked which of the proposed general requirements and performance indicators for a win-win situation would be applicable. Then, I identified which of the requirements would be in place at the sponsoring company and how the environmental and financial indicators would be impacted by the business case for the beverage pack introduction. Finally, I could determine Frucor´s challenges in achieving an environmental win and a financial win in the business case.

To address the aforementioned overall research question, I considered the challenges identified in the third research question. Reflecting on these challenges while taking into account the current business context and probable future developments enabled me to evaluate the likelihood that a win-win situation could be achieved in the business case for the introduction of an environmentally responsible beverage pack.

3.5.5. Reflection on usefulness of literature

I examined the fourth research question

> *How useful is academic theory in helping inform the establishment of a win-win situation?*

by reflecting on the reviewed literature for the assessment framework and other relevant theoretical concepts. I appraised their applicability to the situation examined and their utility in solving this real world business task.

3.5.6. Completion of the company project

Beyond the dissertation, in this project I also need to produce a short report for Frucor´s Environmental Manager and its Executive Board. The Environmental Manager is to indicate which parts of the dissertation are useful for Frucor. In addition to the information from the dissertation, the report should include commercially sensitive and relevant financial data for the sponsoring company, e.g. the profit and loss calculation. Finally, I am to present the report to the Executive Board and seek to inform the decision on a potential extensive NPD project for the introduction of a PLA beverage pack.

3.6. Summary

In this chapter I described the research design, the methods of information gathering and analysing as well as my positionality and role in the project. I explained my approach to answering the research questions and to complete the company project. The chapter underlines the interweaving of the theoretical and applied orientation of the dissertation. It builds the foundation for the following two findings chapters.

Chapter 4

Findings I - Bioplastics for beverage bottles

4.1. Introduction

This chapter complements the academic literature review with information on the bioplastics and recycling industry. Data is derived from a variety of sources, including a commissioned scientific report for Frucor (Fernyhough et al., 2010) and sources related to the bioplastics and recycling industry, e.g. websites, journal articles, and position statements. I also rely on relevant data and technical information gained in discussions with people that have technical expertise and insight in the bioplastics, recycling and beverage industry. This chapter takes a technological and scientific perspective and is more generally focused than the one that follows considering New Zealand and company context for these issues.

4.2. Bioplastics in general

In general, the term bioplastics encompasses plastics derived from renewable biobased materials, and plastics which can be categorised as biodegradable. The term "biodegradable" signifies that the bioplastic can be digested by aerobic and anaerobic micro-organisms (Plastics-New-Zealand, 2009). The two classifications "renewable" and "biodegradable" are not necessarily overlapping. Bioplastics can be renewable without being biodegradable, or the other way round, biodegradable but not renewable, or both biobased and biodegradable. However, the renewable resource definition tends to predominate. Therefore, in this dissertation the term bioplastics signifies "made from renewables".

In a confidential report for Frucor, Fernyhough et al. (2010) find that there is obvious evidence of a growing importance placed on decreasing the environmental impacts of packaging. At present, bioplastics represent a marginal market with less than one million tonne per annum (p.a.) within the global plastics market exceeding 200 million tonnes p.a. However, this market is rapidly increasing with predicted growth rates of more than 10% p.a. The finite nature and instability of fossil fuel supply, taken up in discussions around peak oil (Höök, Hirsch, & Aleklett, 2009) are underlying causes for the worldwide trend towards renewable resources (Fernyhough et al., 2010). A recent report by the New Zealand Parliament (2010) supports this view. It maintains that “another supply crunch [in oil] is likely to occur soon after 2012” with oil prices spiking “to high levels” (p. 1). Other main reasons impacting growth of bioplastics are the global ecological movements towards “reduced emissions and carbon footprints, the potential for less price volatility compared to petroleum based plastics”, the recent fall in bioplastics prices, growing volumes or availabilities, and enhanced performance levels of the material (Fernyhough et al., 2010, p. ii). Genuine end-of-life utilisation alternatives, such as composting or feedstock recycling, are also supporting factors in favour of bioplastics (Fernyhough et al., 2010).

4.3. Bioplastics in beverage bottle packaging

In beverage bottle packaging, presently polyethylene terephthalate (PET) is the primary plastic employed with a global production of annually 30 million tonnes. It is produced from non-renewable oil resources and features an outstanding combination of “gas and moisture barriers, heat and water resistance and good mechanical properties – all at a very cost competitive price” (Fernyhough et al., 2010, p. ii).

The two leading sorts of bio-polyesters available today are PLA and polyhydroxyalkanoates (PHA). PLA, the bioplastic on which this dissertation focuses, is the prevalent bio-polyester by volume (Fernyhough et al., 2010) with a US plant producing 160,000 tonnes per year run by NatureWorks and further suppliers coming on board. This material fits into both categories of bioplastics; it is 100% made from annually renewable sources and it is also biodegradable. As regards costs, PLA is approximately 25-50% more expensive to produce than PET. Compared to PLA, PHA´s commercial availability is limited due to low production volumes and a price at least three times higher than PLA. Concerning future price development, PLA and PHA are expected to come within 25% or less of PET prices during the next five years, or a little longer for PHA. “The economic competitiveness of bioplastics is currently restricted by generally very high development costs and lack of the economies of scale which come with mass production” (Fernyhough et al., 2010, p. 34). However, predictions about rising and instable crude oil prices indicate that the use of biobased plastics will likely become more economical. Volatile pricing in oil and increasing alarm regarding long-term energy security have raised the appeal of alternatives such as bioplastics. Rising prices in crude oil triggered by “strong demand and political conflict” significantly impact on conventional plastic prices which makes bioplastics more attractive (Fernyhough et al., 2010, p. 34).

Another bioplastics development is the emergence of so called “bio-PET”. At present, bio-PET is made from up to 30% plant-based materials resulting in 20% renewable and biobased carbon content in the polymer (note: the terms plant-based and biobased are not the same) (Schnarr, 2010). The renewable part is currently restricted to the polyethylene (PE) component of PET which is made from bioethanol. A completely biobased PET is not likely within the next five years (Fernyhough et al., 2010). It is noteworthy that this bioplastic is indeed partly bioderived, but it is not biodegradable. However, it has the same properties as conventional PET and therefore can be recycled in the present PET recycling stream (Fernyhough et al., 2010). An example for a bio-PET bottle presents the PlantBottle™ recently launched in the USA and Denmark by Coca-Cola (The-Coca-Cola-Company, 2009).

4.4. Source and production of polylactic acid (PLA)

Currently, PLA is usually generated from fermented corn and related crops, which results in lactic acid and is then turned into a polymer, polylactic acid. This corn-related source is forecast to shift to lignocellulosic (woody biomass) matters and agricultural waste streams in the next five years (Fernyhough et al., 2010). This situation would involve introducing a new-generation PLA production method and would not only lead to a reduction in PLA production costs but also enhance PLA´s ecological benefits (Leaversuch, 2004).

As to the supply of PLA resin, the US-company NatureWorks manufacturing at one plant in Nebraska is the only producer of a PLA brand (Ingeo™) that has food contact approval, according to a NatureWorks´ agent I consulted. In the future, an Australian co-operative in the Queensland sugar cane industry may purchase a license for NatureWorks’ Ingeo™ technology, which would move the production of PLA closer to New Zealand.

4.5. PLA properties regarding bottle application

In comparison to PET, which is currently used for Frucor´s beverage bottles, the properties of PLA are similar in some regards and inferior or superior in others, according to an expert in the bioplastics industry I consulted, and Fernyhough et al. (2010).

The optical properties of PLA (e.g. gloss and transparency) and mechanical properties (e.g. hardness) are very similar to those of PET. The density of PLA is around 10% lower than PET, resulting in a better yield of the plastic resin. The bioplastic also has a good odour/flavour barrier and a high purity as it is made from a single monomer (lactide) and thus, has nil potential for migratory extractables that could result in taint or potential health issues. Furthermore, top load strength of PLA is superior to PET, which plays a role in enabling the packing and transportation of the bottles.

The gas and moisture barrier of PLA is, however 7-10 times lower compared to PET (e.g. transmission rates for oxygen and carbon dioxide), according to the NatureWorks agent. This situation results in a reduction of product shelf life and limits the application in particular for carbonated and perishable drinks (e.g. carbonated water or fruit juice). Therefore, Frucor looks to the use of PLA bottles only for pure and still water. Several solutions dealing with PLA´s barrier issues that are to lengthen product shelf-life in the future do already exist, e.g. plasma coating technology, or are currently being developed, e.g. additional layers. These options are very expensive. Furthermore, PLA´s susceptibility to heat (resistant to up to 50°C) leads to the limitation to cold fill only. However, a more expensive PLA resin is being developed that features improved heat resistance and would allow for hot fill. Different shrink/stretch ratios and poor melt stability of PLA require new pre-form and blow mould tooling during the manufacturing process of PLA bottles. Also PLA´s susceptibility to deformation requires an appropriate PLA bottle design, again leading to amendments in the pre-form and the blow mould tooling.

4.6. Potential end-of-life options for PLA

PLA has various end-of-life options, according a bioplastics expert I consulted, research by Fernyhough et al. (2010), NatureWorks (2010d), and European Bioplastics (2010b). These options are (1) organic recycling/composting, (2) chemical or feedstock recycling, (3) thermal recovery/incineration (based on the “waste to energy” concept), (4) mechanical recycling (melting, shredding or granulation), and (5) landfilling.

4.6.1. Composting

The term “compostable” is a specification of the earlier-mentioned term “biodegradable”. A compostable bioplastic can be digested by micro-organisms in specific end environments under particular conditions (e.g. level of heat, moisture, bacteria occurrence) that comply with recognised composting standards (see Figure 8). PLA can be categorised as industrially compostable (Plastics-New-Zealand, 2009).

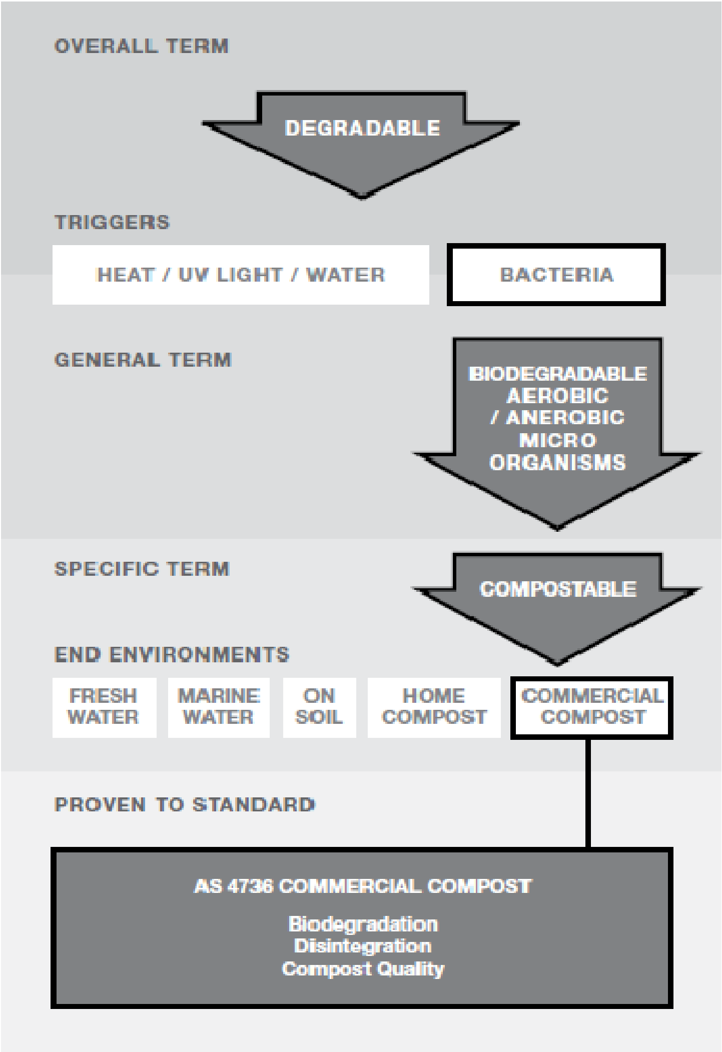

Figure 8: Australian system for classification of degradable plastics by meeting specific standards relating to specific end environments

(Plastics-New-Zealand, 2009, p. 7)

Composting PLA involves a two stage degradation sequence. First, under the influence of moisture, heat and UV-light, PLA is hydrolysed to shorter polymer fragments, and finally, lactic acid. Subsequently, this matter is organically decomposed by aerobic microorganisms, resulting in water, carbon dioxide and humus (biological nutrients) (NatureWorks, 2010e). In adequate industrial composting facilities this process takes somewhere between 42 and 90 days. The composting progression is temperature and humidity dependent and requires particular micro-organisms (Fernyhough et al., 2010). The PLA resin Ingeo™ is certified to compost "in municipal/industrial facilities according to compostability regulations of international standardisation organisations such as ISO, ASTM, and EN" (NatureWorks, 2010e). Since the material is derived from agricultural resources, PLA´s compostability allows for a closed loop system (Fernyhough et al., 2010) (see Figure 9).

This image has been removed by the author of this dissertation for copyright reasons.

Figure 9: Closed loop concept for compostable bioplastics (European-Bioplastics, 2010a)

Essentially, the bioplastic, which is generated from plants using photosynthesis and sunlight, can be turned back into the basic elements of carbon dioxide, water, and soil. The requirement for such organic recycling is the availability of a mainstream industrial/municipal composting option.

4.6.2. Chemical recycling

According to statements from experts in the chemical recycling industry and NatureWorks (2010f), chemical or feedstock recycling of PLA is the chemical hydrolysis (depolymerisation) of PLA back to lactic acid (monomer). The lactic acid can then be used as raw material for manufacturing virgin PLA. This recycling option offers superior flexibility over the constitution of the bottle (e.g. regarding closure and label), because it tolerates more contamination compared to mechanical recycling. From an environmental perspective, feedstock recycling is favourable because it signifies a closed loop with PLA remaining in a cyclical material flow that maintains the material value indefinitely. However, it requires large capital investment and an enormous mass of used bioplastic for the procedure to be cost-effective.

4.6.3. Incineration

Incineration or thermal recovery forms another end-of-life option. The high calorimetric value of PLA could be employed to produce heat and electricity (European-Bioplastics, 2010b). Importantly, no toxic gases (such as dioxins, hydrogen chloride, nitrogen oxide, or sulphur oxide gases) are emitted during incineration. The amount of carbon dioxide emission in combustion from PLA is lower than that of PET (PLA = 1.83 g/g-resin vs. PET =2.29 g/g-resin), but the heat level equates only half or one-third of the level of petroleum-based plastics (Unitika, 2010). According to a bioplastics expert consulted, PLA could be combusted together with other mixed plastics to generate energy. It is seen as a simple one step solution that prevents PLA and other currently not recycled plastics from going to landfill. Incineration may constitute a good “catch all” option with a low environmental impact until other better value alternatives become available. Nevertheless, it has to be taken into account that “mixed waste incinerators are inefficient energy producers, capturing only about 20% of energy generated by the waste”. Furthermore, combusting waste destroys resources that could be recycled or reduced, and therefore can act as a perverse incentive to better alternatives (Zero-Waste-New-Zealand-Trust, n.d.).

4.6.4. Mechanical recycling

According to a bioplastics expert, mechanical recycling includes melting, shredding or granulation of PLA and subsequent reprocessing as a slightly downcycled bioplastic. Strict New Zealand laws for food packaging prevent recycled PLA from being used for beverage bottles. Compared to chemical recycling, mechanical recycling has less tolerance for contaminants in the recyclate (waste materials recovered from recycling), e.g. with regard to labels and adhesives or closures, and thus requires diligent sorting and cleaning of the post-consumer PLA.

4.6.5. Landfilling

Disposing PLA in landfill is the least preferred disposal option by Fernyhough et al. (2010) and Khoo and Tan (2010). There is concern in the LCA literature that bioplastics, in particular PHA, will decompose in landfill under anaerobic conditions and therefore create methane, adding significantly to greenhouse gas emissions (Khoo & Tan, 2010). However, according to research initiated by NatureWorks (2010g) PLA "does not biodegrade in a conventional landfill" and therefore, "is a poor generator of methane". This is because of the low levels of oxygen and temperature which impede PLA from hydrolysing and becoming biodegradable for anaerobic microorganisms (NatureWorks, 2010b). This view is supported by Fernyhough et al. (2010) who state that the conditions in modern managed landfills are insufficient for PLA to biodegrade.

4.7. Suitable labels and closures for PLA bottles

Regarding labels for PLA bottles that would be compatible with the environmentally responsible end-of-life options composting and mechanical recycling, there are two different types, both available in New Zealand: (1) more common paper labels and (2) newly developed PLA labels. Paper labels have a price premium of around 15% compared to conventional PET labels. They do not work during direct mechanical recycling, as this end-of-life option is less tolerant to contaminants in the recyclate. Therefore, paper labels require the bottles to be washed prior to mechanical reprocessing. Surprisingly, PLA labels are, depending on the specification, between 50% less and 40% more expensive. Overall, for Frucor using PLA labels would be roughly 17% less expensive than PET labels. Consequently, from both a recycling and a financial perspective, PLA labels are the preferred option.

An expert in the bioplastics field maintained that PLA closures exist, but are currently not commercially available. It is estimated that PLA closures will take around two to three years to become economically viable, mainly depending on sufficient production volumes. A PLA-based closure will be made from a combination of PLA (a stiff substance) and biodegradable fruit pulp to soften the material. Due to its mechanical properties the cap will need to be flat rather than the more advanced zipper-cap. Until these closures become available, conventional polypropylene (PP) or high-density polyethylene (HDPE) closures can be used.

4.8. Simplified life cycle analysis of PLA

This section offers a simplified and incomplete LCA for PLA with some thought provoking impulses for an environmental evaluation of this bioplastic material. Due to the lack of a comprehensive and sound LCA I rely on information from external business partners. As mentioned earlier in the literature review on LCA, there are very many influence factors impacting on the results of an LCA and it is impossible to complete a fully objective LCA. Since Frucor´s business partners are likely to pursue their vested interest in the outcome of the PLA assessment, the results might be biased, potentially minimising downsides of the bioplastic material.

PLA is 100% made from annually renewable resources, which is considered a significant environmental benefit, as it contributes to the conservation of non-renewable oil deposits. However, the bioplastic is based on corn crops, and therefore is competing with food production for resources such as soil and water. An LCA for PLA (cradle to factory gate), which was commissioned by the PLA resin supplier, found that PLA is still doing better than PET with regard to total water usage. The comparison maintains that owing to a sophisticated manufacturing process, although growing corn for PLA consumes water, the overall process of producing PLA resin in the US uses 55% less total water compared to PET resin produced in Europe. This includes water for processing, cooling, and irrigation, according to an expert in the bioplastics field (NatureWorks, 2010a). Therefore, I am inclined to think that water usage for the production of PLA resin is not an issue (note: this impact assessment does not include the production and end-of-life of PLA bottles).

In addition, the commissioned cradle to factory LCA maintains, that the highly sophisticated production of the PLA resin in the US creates 60% less greenhouse gases than traditional polymers like PET produced in Europe (NatureWorks, 2010c).

According to European Bioplastics (2008), a branch association incorporating industrial producers, processors and users of bioplastics, PLA features an inherently decreased carbon footprint due to the renewable carbon in the material. This is because bioplastic is made from bioderived feedstock based on “biogenic carbon” which is captured from the atmosphere by plants during the growth process and converted into the required raw materials” (p. 6). When PLA releases the carbon dioxide at the end of its useful life, e.g. during composting, the biogenic carbon is released to the atmosphere. This means the carbon dioxide flows in a cyclical closed biogenic loop. Therefore, without taking the amount of carbon dioxide into account, which is released during the processing and transportation of the PLA, the material can be regarded as carbon-neutral.

Beyond the front-end of the bioplastic´s life cycle, the actual end-of-life options of the material have to be considered as well, since they will make up a considerable amount of the environmental impact. PET has the infrastructure in place to be correctly sorted and to be recycled, which is currently not the case for PLA. However, PET is usually downcycled (McDonough & Braungart, 2002a). Due to the lack of a PET recycling plant in New Zealand, currently post-consumer PET bottles are shipped to China. There they are processed to synthetic fabrics or carpets, which results in a diminished material status, according to members of the recycling industry spoken to.

Overall, in a comparison of LCAs for PLA and PET it was found for New Zealand that PLA has a lower environmental impact with regard to, for example, global warming (greenhouse gas emissions), total energy, and fossil resources, while PET has lesser impacts e.g. in the acidification and eutrophication (over-fertilisation with nutrients) of soil and water (Fernyhough et al., 2010, p. 46). Nevertheless, all the statements above should be treated cautiously and not be adopted untested. I will further discuss parts of the LCA in the Discussion in Chapter 2.

4.9. Summary

This chapter presented technical information about the current state of affairs regarding bioplastics in general and for beverage bottle packaging. It gave detail regarding PLA´s source and production, its properties for bottle application, potential end-of-life options, and suitable label and closure alternatives. The chapter also offered a simplified LCA of PLA. It laid the foundation for considering the potential introduction of a PLA beverage pack at the sponsoring company as examined in the next chapter.

Chapter 5

Findings II – Business case construction

5.1. Introduction

In this chapter I construct a business case for the implementation of a PLA beverage pack. I first describe the New Zealand and the more specific sponsoring company context for the potential introduction of a PLA beverage bottle at Frucor. Then, I elaborate the most plausible business case for the introduction of a bioplastic beverage pack which I have constructed for Frucor. I also outline elements of potential business cases which were initially taken into consideration but were excluded during the project. Furthermore, I identify particular opportunities, barriers and risks, as well as potential options and future developments which affect the feasibility and profitability of the proposed most plausible business case.

5.2. New Zealand and sponsoring company context

5.2.1. Pure water market and competitive environment

Information in this part is mainly derived from discussions with Frucor´s marketing department, in particular the Hydration Manager.

Currently, New Zealand´s pure water market has a net sales value of NZ$ 55 million. There are only two major and a few other minor players in this market. Frucor is one of the two major beverage manufacturers with an estimated market share of 20% which amounts to a net sales value of NZ$ 11 million. Frucor´s two key distribution channels addressing a mainstream market are grocery stores and service stations/convenience stores. According to marketing department staff, in the last 12 months the company´s pure water sales value has declined by 0.6% in the grocery channel and by 5.1% in the service stations channel.

There are two main reasons seen as causing many consumers to cut down on the consumption of bottled water: the low price for tap water and the rising public awareness of ecological objections towards water in plastic bottles. Safe, good quality tap water is obtainable in most parts of New Zealand. Tap water is inexpensive and in many places it is free. Water filters are also on the market and this option is regarded as ecologically more responsible and less expensive. Consumers´ key critique of bottled water relates to the plastic package of the water. Not only is the commonly used PET bottle made from non-renewable fossil-fuels, but it is also mostly discarded after a single use. Only around 30% of plastics end up in the recycling stream, so the vast majority is dumped in landfill. Plastics in landfill are regarded as environmental undesirable since they “take a long time to break down”, and require space in landfills possibly for “up to hundreds of years” (WasteOnline, 2006).

There have been two minor players in the New Zealand pure water market offering water in bioderived and biodegradable PLA bottles. Just recently, one of the two has ceased the manufacturing of water and has turned into a packaging consultancy (design, development and delivery of packaging). This company now collaborates with the one remaining bottled water manufacturer selling water in bioplastic bottles (Good-Packaging-Company, 2010). At present, the only remaining beverage company using bioplastic water bottles in New Zealand has a minor share of the total pure water market of only 0.5% in grocery and 0.1% in service stations, according to Frucor´s marketing department.

Frucor´s key threat in the water market comes from its major competitor Coca-Cola, who in 2010 launched PlantBottle™ for its water brand Dasani overseas. The bio-PET bottle is partly bioderived and can be disposed of in the mainstream recycling waste. According to findings of a study commissioned by Coca-Cola, the production of its bio-PET bottle creates a 12%-to-19% smaller carbon footprint than the production of a conventional PET bottle (Herring, 2010). For now, the competitor has not launched the package in New Zealand. However, as a multinational company it is in the position to do so in a small market like New Zealand. Once Coca-Cola launches PlantBottle™, the environmentally more responsible bottle could significantly change market conditions in Coca-Cola´s favour, because the initiative is expected to resonate with New Zealand consumers.

Coca-Cola´s current attitude is that it doesn’t see PLA as the best option now, probably meaning “not yet” for strategic reasons. The company states that this biodegradable plastic “makes sense for some applications, but not for [Coca-Cola´s] packaging needs” (Esposito, 2010).

According to a commissioned study on buyer behaviour for Frucor, a rise in demand for environmentally responsible products is forecasted (Colmar-Brunton, 2009). Consumers are geared to “easy ‘sign posts’ to do the right thing” (Colmar-Brunton, 2009, p. 6). Regardless of economic anxieties, consumers plan to spend as much or more on environmentally responsible products and services in the next year, given the received benefit is equal. Eighty-five percent of the consumers are “happy to play their part and do the right thing - as long as it’s easy and doesn’t cost any more. But only 7% are willing to pay a premium for sustainable and ethically produced products and services” (Colmar-Brunton, 2009, p. 9). “Sustainability pays” and is a strong driver in consumers´ choice particular with regard to food and beverages, energy, appliances and cars (Colmar-Brunton, 2009, p. 11). However, Frucor´s marketing personnel have doubts how relevant these general consumer statements are for actual buyer behaviour in their segment. They take a rather conservative stance towards the forecast of consumer acceptance of environmentally more responsible products, if the products are more expensive.

On an even more environmentally pro-active note, there are practitioners and academics holding the radical view that sustainability is an emerging megatrend, comparable to the IT and quality megatrends, which will result in a fundamental shift in the competitive arena. This drastic development is expected to generate inevitable “threats and game-changing opportunities” and to strongly impact on “companies’ competitiveness and even their survival” (Lubin & Esty, 2010, p. 45).

As a response to the competitive challenge and possible shifts in market demands, Frucor is set to deliberate the introduction of an environmentally responsible beverage pack which is bioderived and biodegradable.

5.2.2. Frucor´s environmental strategy

The above environmental considerations seem to be difficult to align with the general nature of the water industry. Since water (or soft drinks in general) is a product which sells rapidly at comparatively low price and is fully consumed over a short time period, it belongs to the category of fast moving consumer goods (FMCG). The industry is highly competitive and focuses on high product volume. Due to strong market pressure, a company needs to be able to quickly respond to competitor initiatives and to excel in fast product development. Frucor, for example, is capable of developing a new product, and producing it in large volumes, if necessary, within three months. This tactical approach allows for little environmental concern, e.g. about waste or efficiency in production processes, in the initial stage of the NPD process. Therefore, compared to other industries, FMCG can at times involve strong usage of resources and neglect of environmental considerations.

This highly competitive environment might explain the impression I received during my discussions with Frucor employees. I assess that the sponsoring company pursues a tactical approach towards ecological concerns rather than having a fully developed environmental strategy. In 2007 Frucor established the position of an Environmental Manager who first introduced and now runs an environmental management system certified to ISO 14001. This system offers guidance in addressing the company´s ecological impacts. On its website, Frucor states that it strives to reduce its ecological 'footprint' as far as possible, and to improve water and energy efficiency as well as recycling volumes (Frucor, 2010). The company also supports the New Zealand Glass Packaging Forum to introduce a product stewardship scheme for glass packaging. Furthermore, Frucor signed industry commitments regarding the conduct towards, for example, degradable plastics in New Zealand (Plastics-New-Zealand, 2009) or the "Code of practice for packaging design, education and procurement" (Packaging-Council-of-New-Zealand, 2010).

Unlike many other bigger companies, Frucor does not provide a voluntary sustainability report to inform its stakeholders in more detail about the objectives and achievements of its social and environmental programmes. The sponsoring company maintains that as soon as the manufacturers, consumers and recycling operators are prepared to adopt innovative and ecologically more responsible packaging, it will be part of the movement (Frucor, 2010). In relation to the introduction of a new bioplastics pack, this statement suggests that the sponsoring company takes a reactive and tactical approach waiting for the external conditions to develop, rather than one of proactive influence. Currently, the sponsoring company is, for example, not willing to invest in the comprehensive assessment of PLA´s life cycle, which would be costly if done properly.

From my observations and conversations there are a number of other managers and employees apart from the Environmental Manager who strongly support ecologically responsible approaches. Nevertheless, an all-embracing corporate environmental strategy that is central to this business decision-making process is missing. Therefore, environmental endeavours are more bottom-up than top-down and investment in environmental initiatives is rather modest. Frucor follows a business-as-usual model, with a short-term planning or payback horizon of around three years and a focus on economic concerns. Long-term environmental risks are regarded as less important.

Frucor's reactive and short-term perspective appears to be in contrast to its parent company´s attitude and corporate values. Suntory, the parent company, strives to contribute to the development of a "sustainable society 'resonating with people and nature'". Since 1997 the corporation has an environmental policy building the basis for all corporate programmes associated with the environment. This strategy leads to a corporate philosophy and forms the foundation for integrated group-wide ecological actions (Suntory, 2010). The general interpretation of Suntory´s influence on Frucor among staff spoken to is that the former adopts a laissez-faire governance style in relation to the latter. Therefore, it remains to be seen whether Suntory´s corporate environmental values will find stronger consideration in Frucor´s environmental strategy in the future.

5.2.3. Environmental legislation

In general, New Zealand has supported industry to take a voluntary approach to implementing extended producer responsibility, for example through the 2004 New Zealand Packaging Accord. At present, Government challenges "business leaders, community groups and local government [...] to develop a new packaging product stewardship scheme for New Zealand" (Product-Stewardship-Foundation, 2010). According to the Chair of the Packaging Accord's Governing Board, New Zealand businesses have two options: "one is legislation; the other is a voluntary agreement" (as cited by the Product-Stewardship-Foundation, 2010). In response to this challenge, in June 2010, the Packaging Council of New Zealand released an updated code of practice for packaging design, education and procurement. This code of practice holds that adequate packaging design avoids more waste than it generates. It offers specific performance indicators to assess environmental impacts of packaging. Following these guidelines is voluntary for business. I include a sample of useful environmental indicators from this code of practice later in my assessment of the PLA beverage pack introduction.

In accordance with New Zealand´s Waste Minimisation Act 2008, the Ministry for the Environment (2009b) assesses different industries for mandatory and voluntary product stewardship schemes. So far, no national mandatory product stewardship programmes have been established. Government has identified priority waste streams, e.g. agricultural chemicals, used oil, and refrigerant gases (Ministry-for-the-Environment, 2009a). Within the packaging industry, only the glass industry has established an accredited voluntary product stewardship scheme so far (Ministry-for-the-Environment, 2009a).

Overall, New Zealand relies on voluntary industry approaches rather than strict environmental legislation that forces manufacturers to make their businesses less environmentally unsustainable.

5.2.4. Bioplastics and its sorting from the recycling stream

In 2009, Plastics New Zealand published a guide and industry commitment regarding degradable plastics in the country which was signed among other industry members by Frucor. The trade organisation for manufacturers and suppliers in the country´s plastics industry has agreed on four commitments:

1. Use of clear and accurate information and labelling to indicate plastic type;
2. No use of false claims, but consistent interpretation of rules to not confuse the consumer;
3. Establishment of reference group to coordinate policy and standards development;
4. Education of consumers to inform about impact of purchase decisions (Plastics-New-Zealand, 2009, p. 8).

Plastics New Zealand states that “in New Zealand bioplastic packaging is currently not accepted in recycling and commercial composting systems” (2009, p. 15). According to a plastic recycler, currently there is no recovery infrastructure in place that can collect and sort bioplastics. PLA and other bioplastics do not have a unique code in the international resin identification coding system, but are categorised with the recycle identifier number 7 which stands for "other" plastics. A likely future development is however that the Society for the Plastics Industry will extend the material type code series and give PLA a unique code number, according to an expert in the bioplastics industry.

Due to the absence of a strong sorting infrastructure, PLA cannot be separated from co-mingled recycling waste. There are concerns in the recycling industry that PLA and other bioplastics signify a contaminant if “present in the conventional recyclate collection and separation processes” (Gledhill, 2006). Concern is particularly related to the devaluation of the recycling PET stream due to its optical similarity to PLA. The present plastic bottle reclaiming industry has effective technology, “satisfied customers, raw material, and investors”, focusing on HDPE and PET (Cornell, 2007, p. 295). Already low volumes of PLA, with a threshold of PLA occurrence in the PET stream of around 1%, are sufficient to compromise PET performance, according to an expert in the bioplastics industry.

Looking back, in 2006, the Recycling Operators of New Zealand (RONZ) (an organisation that recently dissolved) stated a highly critical position on PLA as a reaction to the then coming introduction of Good Water´s PLA bottle (Gledhill, 2006). As I learned from members of the New Zealand recycling industry (mainly recovery and sorting companies) during my project, the concerns about PLA ending up in the recycling stream still have currency. A lack in proper labelling and differentiating the PLA bottles lead to a lack of consumer awareness which in turn results in the material being discarded in the mainstream recycling system. Consequently, the New Zealand recovery and recycling industry is concerned about and resistant to an introduction of PLA in large volumes contaminating the conventional plastics stream. Nevertheless, RONZ acknowledged PLA´s environmental benefits and supported the intent of the suppliers of PLA and the brand owners that switched from oil based plastics to biobased plastics (Recycling-Operators-of-New-Zealand, n. d.).

To introduce adequate sorting infrastructure for PLA at operators in New Zealand, two different types of sorting have to be considered: (1) optical sorting and (2) manual sorting. For the sophisticated recovery facilities using optical sorting machines to process large volumes of waste, generally, technology exists that could effectively separate PLA from PET and HDPE, e.g. by means of near-infrared sorting systems (Fernyhough et al., 2010). However, for smaller manual sorting operators this technology is not applicable. Therefore, the PLA bottles need to be easily distinguishable from PET bottles, e.g. by shape, colour and/or brand. Most important, PLA has not yet achieved sufficient quantity in the marketplace to reach the “critical mass necessary for independent reclamation” (Cornell, 2007, p. 295). Plastics New Zealand states that currently, less than 200 tonnes of PLA have been worked into products in the country. The industry guide does not mention the required threshold for the situation to change (Plastics-New-Zealand, 2009).

I now move to the elements of the most plausible business case I constructed.

5.3. Elements of the most plausible business case

5.3.1. Mainstream target market

Frucor considers taking a mainstream approach for the potential implementation of a PLA bottle in the New Zealand market. The sponsoring company would introduce the new beverage pack for both of its water brands and use the two major distribution channels, groceries and service stations, aiming at reaching as many consumers as possible. To maximise consumer resonance, Frucor would not increase the retail price, although costs per bottle are forecasted to rise.

The PLA properties result in shorter shelf life of the products, unsuitability for carbonated drinks, and a restriction to a cold-fill bottling process. Therefore, Frucor currently looks at excluding sparkling and carbonated water and applying the package only to pure and still water beverages. If the sponsoring company replaced all PET bottles for pure and still water for both of its brands with PLA bottles, post-consumer PLA would account for roughly 2% in the bottle PET recycling stream (I calculated this rough number based on figures from the sales and consumer insight department. I compared the weight of total New Zealand beverage PET bottles with the weight of PLA bottles, which Frucor might introduce to the market). As mentioned before, the contamination threshold for PLA in the recycling stream is around 1%. Therefore, Frucor needs to ensure that the bioplastic could be separated from the conventional plastics stream.

5.3.2. Consumption and disposal of bottles

The consumption of the water in the PLA bottles would happen at consumers´ homes as well as out and about. The empty bottles would be disposed of in consumers´ co-mingled recycling kerbside bins in regular household and business waste, and in public places, parks and on streets. In New Zealand, currently the collection of waste outside of households is mainly in bins that go to landfill. However, from 2011, on the occasion of the Rugby World Cup, there are plans to have established co-mingled recycling bins for the collection of plastics and other recyclates. Optional, in public places such as supermarkets, extra collection bins or reverse vending machines for PLA bottles could be set up. With the present system, assuming the same ratios for PLA as for PET, roughly 70% of the sold PLA bottles would end up in landfill and 30% in the recycling stream.

5.3.3. Sorting of co-mingled recycling waste and required investment

For post-consumer PLA to be diverted from the recycling stream, in particular from the PET stream, both automated optical and manual sorting operators need to establish adequate sorting infrastructure. As mentioned earlier, larger facilities with optical sorters (e.g. Visy MRF) would need to set up an extra diverting machine, e.g. a near-infrared sorter. Such a machine requires an investment of around NZ$250,000. According to a representative of Good Packaging, the sorting operator Visy MRF would receive NZ$1,000 per tonne of sorted PLA. In comparison, the sorting facility receives around NZ$600 per tonne for sorted PET by recyclers. The relatively high price for post-consumer PLA might act as an incentive to invest in the sorting infrastructure.

Enabling manual, non-electronic sorting operators to distinguish PLA from PET bottles necessitates a significant change of the outward appearance of the bottle. A PLA package could be made discernible by shape, brand and colour of the bottle. One method effectively applied in the US is to add an UV-ink in the PLA, or gloss a UV-ink over the label which is visible only in UV light. The manual sorting facilities could then set up UV-lighting over their sorting tables and thus cause visible fluorescence of the UV-ink in the PLA bottle or on the label. Engaging with local authorities and the Waste Management Institute of NZ (WasteMINZ) is a requirement for the establishment of adequate sorting infrastructure. Sorting operations need to be advised prior to the PLA bottle launch about the coming new plastic package, details of the bioplastic´s bottle appearance, and viable options for PLA sorting infrastructure.

To introduce this option of visual sorting, considerable investment is necessary. First, Frucor´s research and development department needs time and money to design such an easily distinguishable PLA bottle. Then, a change in pre-form and blow mould tooling for the production of PLA bottles at Frucor´s bottle supplier Visy PET requires investment. And lastly, costs for sorting equipment, such as UV-lighting and near-infrared sorters accrue at manual and automated optical sorting facilities.

The desired result of the collection and sorting of PLA is that the vast bulk of PLA is correctly sorted and only a minor part of the bioplastic ends up in mixed plastics bales or in the PET stream. Based on the experience with PET recycling, it is estimated that between 25% and 30% of the used PLA bottles can be recovered.

5.3.4. Mechanical recycling into seedling pots

The correctly sorted post-consumer PLA bottles would be transported from the sorting operators to the mechanical recyclers. As mentioned before, for a straightforward mechanical recycling process, PLA labels would be required. As to closures, PP/HDPE would be compatible due to a so called "water bath, float sink separation" which is a common procedure to separate out different plastics. This method is already applied at the recycling plant which is likely to process the used PLA bottles. The pure bioplastic would then be mechanically treated by means of shredding, melting, and granulation to generate recycled PLA pellets.

In a second step the PLA pellets would be moulded into new biodegradable products. In New Zealand, the recently formed packaging consultancy Good Packaging has plans to establish a market for used PLA. Its product idea is a seedling pot for plantation forestry compounded with an organic fertiliser. Biodegradable seedling pots would be useful as they do not have to be removed from the seedling roots, but would be planted together with the seedling into the soil. Models project that due to the fertilising function and eliminating the trauma to the seedling roots from pulling off the pot, a pine plantation is likely to mature up to three years earlier than otherwise. The plantation matures more than 20% earlier which is economically very significant. Ultimately, PLA pots would biologically decompose in the soil and be organically recycled to carbon dioxide, water and biomass and thus serve as nutrients for the trees. The timing for this project to be initiated depends on the availability of sufficient volume of post-consumer PLA for sorting operations to start separating out a discrete stream of used PLA bottles.

In the described most plausible business case a PLA beverage pack would run through an incomplete "closed-loop" material flow (see Figure 10), which I revisit in Section 6.2.

5.3.5. Selling proposition and costs for marketing campaign

The unique selling proposition for Frucor would be to advertise pure and still water in bioplastic bottles made from 100% annually renewable resources, which are 100% recyclable in New Zealand. Frucor could also capitalise on the LCA for the PLA resin (cradle to factory gate) compared to the LCA of traditional PET, and state that manufacturing the PLA resin Ingeo™ produces 60% less greenhouse gases, and uses 55% less total water (including water for processing, cooling, and irrigation). The proposed life cycle of a PLA bottle with an end-of-life as a locally used biodegradable seedling pot follows a biological closed loop concept.

In comparison, PET is made from non-renewable oil resources, the LCA for the production process of PET resin is overall less environmentally responsible, and post-consumer PET is shipped over to China where it is usually downcycled. Therefore, an environmentally preferable PLA bottle is assessed to have great potential for a marketing proposition that is likely to resonate with consumers. Frucor considers making a very public move to PLA and telling the improved sustainability story in an effective and compelling way.

The cost for a marketing campaign to advertise the environmentally responsible beverage pack and to educate consumers is estimated to amount to NZ$250,000.

5.3.6. Probable reaction from the food and beverage industry

The general level of interest in PLA from manufacturers and brand owners has increased. Numerous large organisations are keeping a close watching brief on PLA. A well communicated shift by the sponsoring company towards a bioplastic bottle is likely to have a snowball effect on members in the food and beverage industry. One reason for this assessment is that a visible initiative by Frucor is likely to be seen by other smaller brands as the signal to move to PLA as well. Such an initiative is believed to catalyse further initiatives towards bioplastics. It is appraised that most of these companies would be in product areas not directly competing with Frucor (e.g. Fonterra, a New Zealand based multinational dairy co-operative, and Goodman Fielder, Australasia's leading food manufacturer). In the beverage market, numerous small and medium sized brands are expected to join the snowball. Such a positive reaction would contribute to a faster achievement of required volumes of post-consumer PLA in the recycling stream warranting the sorting of bioplastics.

5.3.7. Technical requirements, consequences and resultant costs

The introduction of a PLA bottle has different technical requirements and consequences. One requirement is the higher specification in the design of a PLA bottle, e.g. with regard to shape and gauge of the plastic, because of the lower barrier qualities of PLA compared to PET, its different stretch/shrink ratio, and its susceptibility to heat and deformation. This elevated specification of the beverage container might lead to a change in the bottle design. Apart from an optimal bottle design in terms of the bottle´s physical material properties, a new bottle shape might also become necessary to make the beverage pack visually distinguishable from PET packs when it comes to manual sorting. As earlier-mentioned, this new bottle design is likely to require new pre-form and blow mould tooling at the bottle producer. A shift from PET to PLA also entails tighter specifications during the production process. In addition, a change in bottle design demands new production tooling for Frucor´s filling process.

Overall, these technical requirements are likely to demand upfront costs with regard to the research and development of a new bottle design, new pre-form and blow mould tooling at the bottle producer, and new tooling for Frucor´s filling machinery. The investment is forecasted to amount to NZ$1.3 million.

Ongoing elevated costs of around 5% might arise during the bottle manufacture due to process inefficiencies. Beyond, adequate ambient conditions for the storage and transportation of PLA bottles (hot and dry is worst, cool and humid is best) have to be ensured to help maintaining a sufficiently long shelf life, minimising a potential moisture loss, and avoiding deformation of the beverage containers. Consequently, the distribution process might become more expensive due to more specific conditions (e.g. refrigerated container).

5.3.8. Costing of a PLA bottle

The introduction of a PLA bottle results in higher ongoing costs for the PLA resin (18% to 28% per bottle) and the production process of the beverage container (around 5% per bottle). Consequently, the cost for the PLA container will probably increase by at least 22% to 31% per bottle.

The reduced costs for PLA labels (roughly 17% less) would not outbalance the increased cost for a PLA container. Regarding the closures it is assumed that for a start, the conventional PP/HDPE closures would be used which would not add extra cost. Nevertheless, desirable PLA closures, which will be commercially available in the future, are forecasted to come at a price premium also. Overall, Frucor would face a cost increase for PLA bottles of around 8%. On top of that comes the amortisation of the investment in pre-form and blow mould tooling (the bottle manufacturer is expected to amortise its investment cost within three years), and the manufacturing set up for the filling process at Frucor. In addition, upfront costs like advertising and research and development need to be factored into the cost calculation. These elevated costs would not be forwarded to consumers, since it is widely assumed that consumers are not prepared to pay a premium for an environmentally more responsible beverage pack.

In the process of constructing the most plausible business case I excluded the following less plausible business case elements.

5.4. Excluded less plausible business cases elements

5.4.1. End-of life option: Chemical recycling

Chemical recycling, due to its closed loop approach, is generally the most favourable end-of-life option for PLA in environmental terms. However, it is not viable in the current case. This end of life option was excluded from the business case since there is currently no chemical recycling in New Zealand or Australia. The closest chemical recycling facility for PLA is a plant in the USA recently established by Plarco (Verespej, 2010). For chemical recycling to become cost-effective, post-consumer volumes of PLA have to reach a threshold of at least 5,000 tonnes p.a., according to an operator of a chemical recycling plant in Belgium. Frucor would contribute roughly 1% of the required post-consumer PLA volume from introducing the bioplastic to both of its water brands for pure and still water.

5.4.2. End-of life option: Incineration with waste to energy

According to Frucor´s Environmental Manager, under current conditions the incineration of PLA would constitute the disposal option with the smallest environmental impact. His assumption runs counter to the earlier-mentioned research on chemical recycling impact. Incineration was not included in the business case, because municipal solid waste incineration is not available in New Zealand at present.

In the future, however, the concept “waste to energy” seems probable to be adopted in the country. Plastics New Zealand have been working on the establishment of waste to energy, for example. Although this alternative captures some end-of-life value of the material, it still offers only low remuneration for post-consumer PLA.

5.4.3. End-of life option: Landfilling

Landfilling constitutes the less favourable default option for PLA´s disposal, since it does not capture any value of the material at its end-of-life, but imposes landfill disposal fees on recovery operations (roughly NZ$120 per tonne). Landfilling could still be taken into consideration, since it offers a straightforward way of introducing PLA to the New Zealand beverage market in large volumes. This option would not require any investment in the recycling infrastructure and would still circumvent a contamination of the recycling PET stream, assumed that the PLA bottles are labelled genuinely and explicitly. In general, PLA in managed landfills does not contribute to the emission of greenhouse gases. Although landfilling would frustrate any attempts to recycle PLA, this unsustainable end-of-life option would at least enable the taking effect of the environmentally responsible front-end of PLA, its production from renewables. Landfilling could be adopted as an intermediate solution until sufficient volumes are achieved that warrant the introduction of adequate recovery and recycling infrastructure.

Nevertheless, this option is assessed as environmentally unsustainable which led to the exclusion from the business case for the PLA introduction at Frucor. The sponsoring company is unlikely to want to risk reputational issues of this nature. Furthermore, marketing department personnel assume that the environmentally little responsible end-of-life of the material would significantly reduce the marketing value of the positive front-end of PLA. Therefore, they assess that the overall marketing story would not resonate with consumers.

5.4.4. End-of life option: Industrial composting

Composting is an environmentally responsible end-of-life option as it signifies a closed biological loop in which the bioplastic is turned back into carbon dioxide, water and hummus. PLA could be composted in existing industrial composting facilities (Fernyhough et al., 2010). However, the requirement for such organic recycling is the availability of a mainstream industrial/municipal composting option. This is currently not the case, due to a lack of collection infrastructure for food waste in most parts of New Zealand, according to an expert in the composting industry. In addition, composting still demands a fee for the disposal as food waste (between NZ$55 and NZ$80 per tonne at a composting facility certified for the composting of PLA, which I consulted). Beyond, the processing of food waste is only allowed in approved facilities, and currently, most New Zealand composting facilities only handle green waste. For these reasons industrial composting was not further considered as a viable end-of-life alternative at this time.

Nevertheless, there might be some developments in the future that could change the situation. The waste levy for organics disposed of in landfill is forecasted to increase in the foreseeable future. It is also possible that the disposal of organic waste to landfill might be banned. These developments would make composting more cost effective than landfilling, provided adequate infrastructure was in place. Beyond, the value for compost and top soil due to an emphasis on organic fertiliser and avoidance of chemical herbicides is likely to rise as well, which might lower the disposal fee for organic waste.

5.4.5. Niche target market

Furthermore, the niche target market was a less viable business case element. Originally, there was the proposition to introduce the bioplastic pack to one niche water brand and to launch the product on a niche market. The underlying idea was to start the product launch with a small pilot project that enabled the sponsoring company to responsibly control the post-consumer PLA flow. The aim was to ensure that the PLA would neither end up in the PET stream nor in landfill. This approach sought a way to circumvent the mainstream collection of waste. Thus, it avoided Frucor´s nationwide engagement in the recycling industry and a related investment in the sorting infrastructure for recyclates.

In a confined consumer market, e.g. a festival or a university campus, product consumption as well as the post-consumer PLA bottle collection would be restricted to a certain area. Thus, the used PLA bottles could easily be disposed of in food waste bins. These food waste bins are already established for the collection of other food waste from places such as festivals or universities. The proposed end-of-life option was to compost the biodegradable PLA bottles together with the food waste at industrial composting facilities.

This concept signified an environmentally responsible closed loop material flow and was likely to resonate with consumers. However, there were some barriers to make the idea of a niche market approach viable:

- Firstly, in New Zealand, most composting facilities are not certified for the processing of PLA at present.
- Furthermore, referring to a previous PLA bottle introduction of a smaller competitor, it was estimated that the sales volumes in a small and confined market would be comparably low. The sales volumes of the bioplastic product were finally considered to be too low to generate sufficient traction for the post-consumer PLA volumes to reach a certain threshold that warrants an investment in the sorting infrastructure. The achieving of a critical mass, however, was necessary to expand the niche concept to a mainstream concept for a nationwide introduction of PLA bottles.
- Finally, engaging with festival organisers or sales outlets at universities was seen to involve a significant effort and complexity not remunerated by low sales volumes.

Having discussed the excluded elements of the business case, I now focus on opportunities generated by the introduction of an environmentally responsible beverage pack.

5.5. Opportunities in the most plausible business case

5.5.1. Improvements of market share and sales performance

The implementation of a PLA beverage pack by Frucor as the first company in the New Zealand market could significantly raise the customer acceptance of bottled water. Such a positive effect could increase Frucor´s share in the pure and still water market (total net sales value: NZ$55 million) by 2% to 22%, resulting in a net sales value gain of NZ$1.1 million. It would signify an increase of 10% for the sales and production volumes for both of Frucor´s water brands in the pure and still water segment. Being the first beverage manufacturer implementing the bioplastics bottle in the New Zealand market is likely to enhance customer loyalty. This effect would be beneficial in case other competitors followed Frucor´s shift to a bioplastic beverage pack.

5.5.2. Improvements in reputation and avoidance of compulsory legislation

Frucor could improve its reputation and avoid compulsory legislation. By designing a single use disposable bottle from a renewable resource and responsibly introducing it, Frucor would take a proactive environmental product stewardship approach. The proposed business case takes into account the demands of the impacted stakeholders:

- Consumers feel they have actively contributed to conserving non-renewable resources and have acted environmentally responsible by disposing of the used PLA bottles in the present recycling bins. This environmentally conscious behaviour is easy for the consumers and does not cause any inconvenience. The introduction of a PLA bottle in the manner proposed is likely to resonate with consumers.
- The recycling industry, in particular the recovery and sorting operators, are not faced with a contamination of the PET recycling stream and also have a buyer for the sorted PLA that remunerates them for the investment.
- Due to a useful application of the post-consumer PLA as a seedling pot, local authorities and their subcontractors do not have to defray for waste to landfill or industrial composting sites.
- The responsible introduction of an environmentally responsible beverage pack might improve the reputation with NGOs and lay the foundation for a potential collaboration, e.g. to communicate the environmental benefits of a PLA bottle.

This prudent behaviour is assessed to enhance Frucor´s reputation with consumers, NGOs, and the recycling industry. Acting responsibly with regard to the environment and the wider value chain is likely to satisfy local authorities and the national government. Consequently, Frucor could be perceived as a responsible leader in the beverage industry. In contrast, a negligent introduction of the bioplastic material could bear the risk of prompting environmental legislation (e.g. a compulsory Packaging Product Stewardship Scheme).

5.5.3. Independence from volatile and increasing oil-prices

The introduction of PLA beverage packaging would make Frucor more independent from volatile and increasing oil-prices, since the packaging is biobased and made from renewable resources, not from crude oil.

Next, I explain the various barriers and risks in the most plausible business case.

5.6. Barriers and risks in relation to the most plausible business case

5.6.1. Technical hurdles

The successful development and introduction of a PLA bottle requires Frucor to master a variety of technical hurdles in advance. The sponsoring company has to ensure, for example, that the bottle has satisfactory barrier properties, and resistance to panelling and moisture loss. Similarly, the company faces the challenge to guarantee suitably cool and humid storage and transportation conditions for PLA bottles.

5.6.2. High initial investment and elevated ongoing costs

In addition, as identified earlier, introducing a PLA beverage pack entails the risk of high initial investment most likely to be borne by Frucor. Beyond, the predicted ongoing costs for PLA bottles would be higher compared to PET bottles due to more expensive resin and conversion.

5.6.3. Complexity of selling proposition and impact across product range

Telling the improved sustainability story of a PLA bottle in a compelling way is estimated to require complex consumer education. Frucor would for example need to explain why it only uses the bottle for pure and still water, but not for carbonated or flavoured water of the same brand. Beyond, education might prompt consumers to be more critical of other beverage containers offered by Frucor, such as PET, cans, glass and tetra pak. The increased environmental expectations could raise the bar for Frucor itself and for others in the beverage and food industry beyond where the company might be prepared to go. It could even result in a loss in value of Frucor´s other brands if alternative packaging was discredited too much and the consumers were put off the consumption of Frucor´s other more traditionally packaged beverages. Therefore, the sponsoring company faces the challenge of promoting a PLA bottle and convincing consumers of the environmental benefits without impacting on the sales of its other products coming in less ecologically responsible packages.

5.6.4. Achieving sufficient post-consumer PLA volumes

Realising the proposed end-of-life of the bioplastic pack is also difficult. The establishment of adequate sorting infrastructure is a prerequisite for the feasibility of the desired end-of-life option. It includes collection via kerbside recycling bins for businesses as well as for households, diversion from the PET stream to recover pure PLA, and its subsequent mechanical recycling. Currently, the most significant challenge for Frucor is to achieve the critical mass of post-consumer PLA that warrants the introduction of sorting infrastructure for independent reclamation of the bioplastic.

The recovery of a discrete stream of used PLA bottles, then, is a precondition to create a market for post-consumer PLA. Without sufficient volumes of recovered PLA for mechanical recycling the reprocessing of the bioplastic into seedling pots will not take off. The seedling pots are seen to be a product made from recycled PLA that could realise an adequate price when sold to forestry industry, a supposedly valuable market. This market is deemed to be able to remunerate the mechanical recycling facilities, as well as the sorting operators providing the diverted post-consumer PLA bottles further upstream of the recycling chain. Thus, it is essential to reach the required threshold to make the sorting of post-consumer PLA economically viable in the first place.

5.6.5. Engaging the recycling industry

It is important that local authorities, the WasteMINZ, as well as the sorting operators work together in relation to the introduction of PLA in large volumes and the development of sorting infrastructure for the recyclate. The collaborative engagement is needed to ensure that the required sorting infrastructure is established. To get these organisations engaged well-timed, communication prior to the PLA bottle launch is required. The active communication should ensure provision of sufficient information about the new plastic package, including details about the new PLA bottle appearance.

However, getting the recycling industry on board might pose a hurdle to Frucor´s initiative. Appeasing the recovery and sorting facilities regarding their concerns about a contamination of the PET recycling stream might still be necessary given the strongly entrenched reservations. In addition, recovery and sorting facilities will likely be resistant to investing in sorting infrastructure until they have an economic incentive to do so. As explained above, sorting PLA will pay off as soon as sufficient PLA volumes in the waste stream allow for a valuable post-consumer PLA market. This market for post-consumer PLA would then compensate sorting operators with a profitable price for sorted PLA. Frucor might need to go for an active engagement with members in the recycling industry and the announcement of an extra resource value that will emerge for sorting operations once volumes of post-consumer PLA reach the threshold level.

In addition, engaging the different parties in the recycling industry down the value chain goes well beyond Frucor´s core business. Getting all New Zealand recovery and sorting facilities on board requires considerable effort and is a relatively complex undertaking.

5.6.6. Uncertain availability of a market for post-consumer PLA

A further risk in the implementation of a bioplastics bottle is the fact that, although likely to happen in the future, mechanical recycling and the market for seedling pots from recycled PLA still have to become available in New Zealand. The time horizon for this market for post-consumer PLA to take effect is still difficult to predict. The uncertain conditions make it difficult to forecast whether the required market for post-consumer PLA can actually be established soon and on a steady basis. Although other applications, e.g. clips for use on grape vines, are evolving, this end-of-life option would then possibly be the only economic one for post-consumer PLA.

5.6.7. Dependence on a single supplier for PLA resin

Another risk poses the dependence on a single supplier for PLA resin, since there is currently only one provider for PLA resin with certification for food contact (monopoly). However, other food certified PLA providers are emerging.

5.6.8. Retaliation by major competitor

Furthermore, Frucor faces the risk that its major competitor could follow quicker than expected or even pre-empt its introduction of PLA packaging. This would minimise the first mover advantage that might be perceived as a reward for the costly move.

Another risk might be that competitors receive commercially sensitive information about the PLA bottle before its actual launch which could impair Frucor´s competitive advantage. Therefore, Frucor faces the challenge to fulfil the requirement to advise sorting operations in advance of a forthcoming PLA package but to still keep the launch of the PLA bottle confidential.

There are some potential options and future developments that might positively influence the advancement of the proposed business case, discussed next.

5.7. Potential supporting future developments and options

5.7.1. Support from beverage industry to increase PLA volume

The probable reaction from the beverage industry to a PLA introduction is forecasted to show a snowball effect resulting in rising PLA volumes in the recycling stream. This would help increase the post-consumer PLA volumes a lot quicker than if Frucor relied simply on its own efforts. Indeed, it might be difficult to actively engage companies and to convince them to introduce PLA as well. Such a direct engagement requires considerable effort beyond Frucor´s company boundaries outside its core business. Nevertheless, the two major dairy companies, Fonterra and Goodman Fielder, are considering the introduction of a PLA milk bottle. If these large companies came on board, they could significantly contribute to attaining the required volume to warrant the sorting of PLA. This would accelerate the development of and give stability to the proposed mechanical recycling into PLA seedling pots and other evolving PLA products as an end-of-life option.

Beyond, chemical recycling in New Zealand or in Australia could become a viable end-of-life option. In case other members in the beverage industry introduced PLA bottles, the threshold for post-consumer PLA volume of 5,000 tonnes p.a. might be reached in the foreseeable future. The attainment of this level would then warrant a chemical recycling plant to be established in Australasia.

5.7.2. Funding for environmental product development and recycling industry

The required investment to develop and introduce an environmentally responsible PLA bottle for Frucor is high. However, there is potential for Frucor to tap into funding from the Zero Waste initiative or the Waste Minimisation Fund which would financially support Frucor´s effort. In addition, there might be funding available to help the recycling industry in establishing sorting infrastructure for PLA in New Zealand.

5.7.3. Extension of the material type code series

Frucor´s endeavour to make PLA separable from the PET recycling stream might also be assisted by the likely future development that the Society for the Plastics Industry extends the material type code series and gives PLA a unique code. This step would make it easier to identify PLA in the recycling stream.

5.7.4. Improvement options for PLA properties

Since PLA is a relatively new polymer, its characteristics are expected to continue to evolve and improve by way of chemistry and design properties. If hot fill was possible and the barrier properties of PLA would allow for an extension of shelf life for carbonated and perishable drinks, the bioplastic bottle could be extended to a wider product range. This would enlarge volumes of post-consumer PLA.

At present, barrier properties could be improved by 90 times by means of plasma coating (layer of silicon dioxide = natural glass) on the inside of a PLA bottle. However, the set up of the underlying technology is particularly expensive. Therefore, it is unlikely to be applied in the short term. Heat resistance could be raised to 80°C by using an advanced PLA resin (crystallisable Ingeo™) while retaining optical clarity. Nevertheless, the resin price is 5% more expensive than common PLA, and the commercial availability still needs to develop. Consequently, the applicability of PLA bottles to other beverages apart from pure and still water will likely still take a while.

5.8. Summary

In this chapter I presented the findings from my discussions with Frucor employees and experts in the wider industry about the potential introduction of a bioplastic beverage pack by the sponsoring company in the New Zealand market. I offered context, presented the elements of the proposed most plausible business case for the implementation of a PLA bottle, and outlined the excluded less plausible business case elements. I also covered the opportunities, barriers and risks, as well as potential future developments impacting on the launch of a PLA bottle. Despite the benefits, there are multifaceted barriers opposing the introduction of an environmentally responsible beverage pack. I laid the foundation for the ensuing discussion about the extent to which a win-win situation can be established in this business case.

Chapter 6

Discussion – Win-win situation

6.1. Introduction

I now move to consider whether a win-win situation can be found in this business case. In order to evaluate the potential introduction of a PLA beverage pack at Frucor, I use the theoretical framework for the assessment of an environmental initiative (see Table 1 in Section 2.6.2), which I developed based on my literature review.

In the first two sections of this chapter, I look at the potential creation of an environmental win. In these sections I identify which of the general requirements and environmental performance indicators proposed in the literature review are applicable. In the following two sections of the chapter, the same procedure is carried out for the potential creation of a financial win. At the end of each of the four sections I summarise the factors in a table. In the final section, I comment on the usefulness of the academic concepts earlier reviewed.

6.2. General requirements for an environmental win

6.2.1. Product stewardship and corporate environmental strategy

According to Epstein (1996), Hart (1995), and Roy and Whelan (1992), the implementation of ecological sustainability requires the embrace of environmental product stewardship. Clearly a successful implementation of PLA bottles from a sustainability perspective requires the adoption of environmental product stewardship and a company to take responsibility for the impacts of its product and actions on the environment and its business partners, e.g. the sorting operators.

For Frucor embracing product stewardship is not seen so much as about doing good to the ecosystem, but as a potential mechanism for industry leadership, reputation and legitimation. The sponsoring company´s Executive Board appreciates a beneficial environmental outcome only if it is associated with a beneficial financial outcome as well. Since voluntary purely market-driven initiatives which are perceived as an exaggerated marketing claim without any substance are detrimental (Stead & Stead, 1996), Frucor needs to ensure that it instead embraces real environmental product stewardship (Epstein, 1996).

As mentioned earlier, at present there is no corporate environmental strategy at Frucor, but a purely tactical stance to competitors´ environmental initiatives. Thus, there is little commitment to implementing a comprehensive set of ecologically responsible initiatives. Nevertheless, the successful adoption of product stewardship requires a corporate environmental strategy and a general commitment by top management (Braglia & Petroni, 2000).

A lack in top management engagement and a lack in an environmental strategy might diminish the effectiveness with which Frucor would implement the environmentally responsible PLA beverage pack. Given the earlier-mentioned highly competitive nature of the FMCG industry which focuses on high speed to market and high product volume for newly developed products, environmental concerns might be subordinated. A lack of environmental prioritisation could result in an inconsequent adoption of the approaches that manifest product stewardship, e.g. LCA, which is explained next.

Environmental product stewardship as a requirement for an environmental win is not fully attained, because Frucor is unlikely to entirely adopt a proactive stance, but, rather, takes a reactive approach. The requirement of an environmental strategy is not fulfilled since the sponsoring company has no strategy in place at present.

6.2.2. Life cycle assessment

To thoroughly consider the ecological impact of the bioplastic beverage pack along the whole value chain, the company needs to adopt the life cycle approach to the ecological assessment of the product (Banerjee, 2007; Richards et al., 1994). Frucor´s Environmental Manager and Packaging Manager strive to take into account all the environmental impacts of a PLA bottle throughout the different phases of its life. However, no formal and comprehensive LCA is undertaken. The company can only rely on life cycle information on the material offered by business partners. The business partners can be presumed to mostly pursue their own interests and are likely to be biased when evaluating the environmental impacts. Therefore, the provided information is often limited to parts of the life cycle, and sometimes looks like advertisements. Due to the complexity of an LCA and the required scientific expertise (Veroutis et al., 1996), I was not in the position to conduct such an environmental assessment myself.

Therefore, neither the company nor I had access to a comprehensive LCA for PLA encompassing the entire life cycle of the bioplastic beverage pack, as indicated as necessary by the literature (Stead & Stead, 1996). However, at the very least, the critical appraisal in the reviewed literature (Banerjee, 2007; Richards et al., 1994; Sekutowski, 1994; Veroutis et al., 1996) ensured I was discerning in buying into ecological claims made by business partners.

Since no comprehensive LCA is carried out by Frucor, the ecological evaluation of the bioplastic beverage pack across its life cycle is quite limited. Thus, LCA as a requirement for an environmental win is only partly achieved.

6.2.3. Life cycle costing

Life cycle costing, a process that generally follows an LCA, requires the internalisation of all the expenses that are external to the firm and borne by the general public (Rebitzer & Hunkeler, 2003). Thus, it offers guidance for financial option assessment when accounting for environmental concerns (Epstein, 1996, p. 57). In the context of this project, Frucor considers the expenses due to a responsible end-of-life disposal for the establishment of sorting infrastructure (e.g. near-infrared technology). These costs are external to the firm because they are likely to be borne by the municipal recovery and sorting facilities. Although Frucor is probably not internalising these expenses, which go beyond its own boundaries, it still takes them into account when deciding on a potential introduction of PLA bottles. This situation resembles the concept of life cycle costing.

Nevertheless, life cycle costing cannot be carried out in detail because the previous step, a comprehensive LCA, is missing. Furthermore, due to a limited commitment to ecological improvements, it appears that the company would not agree to absorb the environmental costs that occur during the PLA bottle´s life cycle. For example, LCA concerns regarding the sourcing of the raw material from a food crop might in fact be mentioned by company members, but these “costs” do not influence the calculated product profitability and pricing decision.

Due to the limited information about costs occurring during the bioplastic pack´s life cycle, life cycle costing is severely limited in its presence in the project. Since there is a lack of awareness of environmental costs, this requirement for an environmental win is only partly fulfilled. This threatens the establishment of an environmental win.

6.2.4. Cradle-to-cradle and cradle-to-grave concept

The environmentally highly favourable cradle-to-cradle model and the underlying concept of eco-effectiveness demand cyclical material flows in which waste equals food (McDonough & Braungart, 2002a). In the project the most plausible business case advocates PLA as a material which theoretically could flow through indefinite cyclical material flows since it is bioderived and biodegradable. The implementation of the bioplastic has the potential to eliminate the very concept of waste. Also the proposed end-of-life option might ultimately allow for a closed loop, since the mechanical recycling of the PLA bottles to seedling pots entails that the PLA degrades in the soil, where it originally was derived from. However, strictly speaking, the current system does not allow for a true cradle-to-cradle concept with underlying eco-effectiveness for several reasons (see Figure 10). These reasons are discussed next.

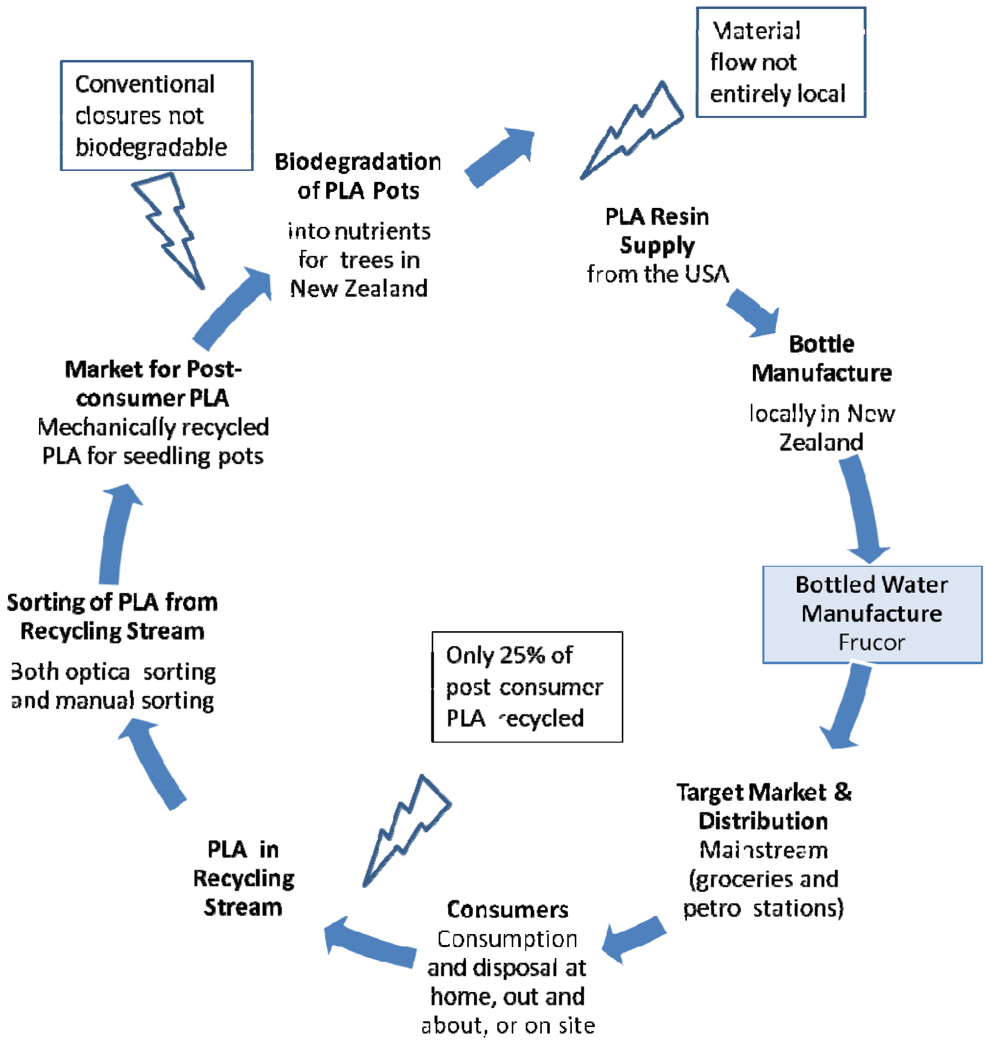

Figure 10: Incomplete “closed-loop” material flow of a PLA beverage pack for the most plausible business case

(Own illustration)

The nutrients do not remain in a local closed biological cycle, because the raw material for the PLA bottles comes from the US, and the seedling pots made from recycled PLA ultimately biodegrade in New Zealand soil. Beyond, it is noteworthy that even if the material flow was entirely local, there still is a major default in the system. Based on the forecast that 70% of the PLA are likely to end up in landfill, the material flow for most of the PLA would be linear and not cyclical at present. Furthermore, the closures for the PLA bottles would still be made from oil-based and non-biodegradable plastics in the next couple of years. Due to this incomplete “closed-loop” material flow, the cradle-to-cradle concept and the linked idea of eco-effectiveness as requirements for an environmental win is only partially present in the business case.

In contrast, the less environmentally advanced cradle-to-grave concept and the related notion of eco-efficiency are strongly applicable and present in the business case. The cradle-to-grave concept requires businesses to assume responsibility for the environmental impact of their products along the value chain (Banerjee, 2007; Elkington, 1997) in which the value chain follows a linear material flow (Braungart et al., 2007). Eco-efficiency aims at decreasing the quantity and speed of the ecological depletion and the toxicity of the industrial system (McDonough & Braungart, 2002a). As noted above, PLA is bioderived and contributes to the diminishing of natural non-renewable resources. Furthermore, I assess Frucor to extend its responsibility beyond its boundaries by taking the product´s environmental impact into account along the value chain. The cradle-to-grave concept as a requirement to establish an environmental win is fully present in the business case. It could be interpreted as a preliminary stage to the environmentally more favourable cradle-to-cradle concept.

6.2.5. Development of environmentally responsible products

The idea of DfE is to integrate all ecological considerations and limitations into the product design process (Allenby, 1994, p. 139; Banerjee, 2007) and still keep up with competitors with regard to product performance and price (Allenby, 1994; Santos-Reyes & Lawlor-Wright, 2001; Veroutis & Fava, 1997). From my discussions with Frucor´s research and development team I conclude that if the implementation of a PLA bottle is agreed upon, the company would act responsibly. It would ensure right from the development phase in the product´s life cycle that the PLA beverage pack is not only fulfilling its conventional functions, such as protecting the beverage, but that the bottle is also environmentally responsible. The design team in collaboration with other departments would create an environmentally responsible PLA bottle that is able to work within the proposed closed loop system when it becomes feasible with composting of recycled PLA pots at the end of life, and still satisfy consumer demands. The major components of the beverage pack (bottle and label) would be non-toxic and could be mechanically recycled as well as composted, in line with ideals noted in the literature (McDonough & Braungart, 2002a; Stead & Stead, 1996). However, due to the fact that Frucor would, at least in the interim, apply conventional oil-based and non-biodegradable closures compromises the environmental responsibility of the product design.

Since the recycling/composting of the PLA bottle necessitates the establishment of a closed loop material flow, Frucor would need to integrate environmental concerns into business processes - apart from products (Braglia & Petroni, 2000). Setting up a closed loop system also signifies cooperation, for example, with members in the recycling industry. The company has already signalled the willingness to do so in tune with the need to include industry partners along the value chain (Banerjee, 2007).

The cross-functional involvement of internal company members and the engagement with industry partners beyond company boundaries initiated during this project, appear as if Frucor would in fact make an effort to take an approach that resembles a systemic approach for the development of an environmentally responsible product (Baumann et al., 2002). Nevertheless, Frucor still would make compromises in the product design. Therefore, this requirement for an environmental win is present at Frucor with a slight reservation.

6.2.6. Value chain collaboration

Collaboration across a value chain requires the building of inter-organisational relationships across different industries that go beyond the company boundaries (Baumann et al., 2002). In the bioplastics project setting up an environmentally responsible business case entails the engagement of organisations beyond Frucor´s core business. Frucor depends, for example, on members in the recycling industry to create a closed loop material flow for PLA. The company´s Environmental Manager considers the company´s impact upstream and downstream in the value chain and is actively involved with concerned business partners in the wider industry, as suggested by the literature (Cristina et al., 2008).

However, Frucor´s executives do not strive for ecological benefits for the environment´s sake, but rather for realisation of financial benefits. Therefore, I maintain they could be reluctant to fully utilise synergistic efforts to contribute to sustainable development (Cristina et al., 2008). I assert that the executives may embrace value chain collaboration but might limit their effort towards actually realising it. They might compromise the extent to which the company exerts influence on the value chain members and ensures that the proposed end-of-life option works properly, for example that PLA is correctly sorted by the sorting operations.

Roy and Whelan´s (1992) finding that collaboration can facilitate, for example, products´ end-of-life recycling and disposal is confirmed in the business case. Their case study was helpful in identifying cross-sectoral partners that could contribute to a cyclical value chain (e.g. "polymer suppliers", manufacturers, retailers, companies for collection, material re-processors, and local authorities (p.65)). In the bioplastics project the company could benefit from collaboration by enhancing the information exchange (e.g. about material prerequisites for recycling). Nevertheless, Frucor is unlikely to capture further potential benefits indicated by the literature, such as the sharing of expenses and risks (R. Roy & Whelan, 1992), due to an arms-length level of value chain collaboration. Roy and Whelan´s (1992) report was also useful in detecting difficulties during the project since they found similar barriers to the realisation of their project compared to my project (the nature of a regional recovery and an insufficient market for recycled material).

Table 2 summarises the evaluation of the discussed general requirements with regard to their applicability and their evidence of presence in the business case.

Environmental Win		
General requirements	**Applicable**	**Present**
– Product stewardship	✓	(+)
– Corporate environmental strategy	✓	-
– Life cycle assessment	✓	+
– Life cycle costing	✓	(+)
– Cradle-to-cradle concept, eco-effectiveness	✓	+
– Cradle-to-grave concept, eco-efficiency	✓	++
– Development of environmentally responsible products	✓	+
– Value chain collaboration	✓	+

Table 2: Evaluation of the general requirements for an environmental win

Key			
✓	applicable	x	not applicable
-	not present	(+)	negligible evidence of presence
+	some evidence of presence	++	strong evidence of presence

The next section discusses whether Frucor´s environmental performance can be improved in the most plausible business case.

6.3. Impact on environmental performance

The reviewed general environmental management literature proposes a variety of environmental performance indicators that could be positively affected by the introduction of an ecologically responsible bioplastic pack. Additionally, in this assessment I have included indicators relevant in discussions and reviews about the environmental impact assessment of PLA and general packaging.

6.3.1. Conservation of non-renewable resources

One indicator for the improvement in the environmental performance of a sustainability initiative is the conservation of natural resources, e.g. by using renewable resources (Lovins et al., 1999). By replacing the oil-based PET bottles for both of Frucor´s water brands (pure and still water only) with PLA bottles made from annually renewable corn starch, the company would notably reduce its usage of fossil fuel resources and contribute to the conservation of non-renewable resources (Fernyhough et al., 2010).

6.3.2. Decrease in use of energy

The diminished use of energy, e.g. in the production process of the material, is another indicator for ecological improvement (Elkington, 1997; Stead & Stead, 1996). For the production of PLA bottles, compared to PET bottles, lower temperatures are sufficient to process the material, which reduces energy consumption. Nevertheless, after each production charge of PLA the machine needs to be cleaned, which adds to the usage of energy. Although LCAs for PLA and PET find that PLA has a lower environmental impact with regard to total use of energy (Fernyhough et al., 2010), it remains unclear if all life cycle stages were taken into account in the assessment.

6.3.3. Reduction or elimination of waste

A reduction in waste that would go to landfill or would be downcycled is an additional sign for the creation of environmental benefits, achieved via eco-efficiency (Elkington, 1997; Stead & Stead, 1996). Since the proposed end-of-life option for the PLA bottle in this business case allows for the ultimate composting of the bioplastic in New Zealand soil, Frucor would even strive to eliminate the concept of waste – at least in this special case. This ambitious approach follows eco-effectiveness as suggested by McDonough and Braungart (2002a). Nevertheless, only between 25% and 30% of the PLA bottles would actually be recovered; the rest would end up in landfill. In addition, there are no PLA closures commercially available at present. Thus, oil-based non-biodegradable closures from PP or HDPE would be used. As long as this is the case, conventional plastics would need to be separated from the PLA to ensure the seedling pots from recycled PLA were not contaminated. The separated plastics would probably go to landfill. Therefore, this environmental performance indicator would be significantly improved but further potential for improvement exists.

6.3.4. Recycling system and maintenance of material quality

According to McDonough and Braungart (2002a), a material maintains its quality if it stays in a biological or industrial/chemical cycle. The proposed end-of-life option envisages a temporary loss in material quality (downcycling) when the PLA bottle is mechanically recycled because the resulting PLA resin is not virgin, which would be possible only in chemical recycling. The pellets from recycled PLA could not be used, for example, for new bottles due to the lower material purity. However, since the recycled PLA is moulded into seedling pots and finally decomposes to its natural elements (carbon dioxide, water and hummus), the material stays in a biologically closed recycling system. Thus, following McDonough and Braungart´s (2002a) definition, the raw material is neither devalued nor extracted from the ecosystem. Theoretically, the process could continue indefinitely.

Nevertheless, the fact that the source of the raw material and the end-of-life location of the bottle differ, limits a totally positive outcome being achieved. This limitation could be mediated by the potential production of PLA in Australia. Since the Australian co-operative in the Queensland sugar cane industry aims at purchasing a license for the PLA resin supplier´s sophisticated manufacturing technology, the production of PLA could move closer to New Zealand in the future.

6.3.5. Reduction of greenhouse gas emissions

As mentioned earlier, the PLA resin supplier claims that the production of PLA in the US, considered from cradle to factory gate only, uses 60% less greenhouse gases owing to an environmentally sophisticated manufacturing process. This is in comparison to the production of traditional polymers like PET produced in Europe (NatureWorks, 2010c). On the one hand, I am inclined to assume this statement is correct. On the other hand, I cannot entirely support the supplier´s statements. Further concern was noted by Frucor´s Packaging Manager because the calculations are not easily comprehensible. Adding to this insecurity is the fact that I appraise a comparison of the two plastics as difficult, because the figures for PET are based on an LCA conducted in Europe and the LCA for PLA originates in the US. In particular it is unclear to me the extent to which the comparison remains valid for PLA and PET used in New Zealand. Questions arise such as: From where is the PET sourced? Does the shipping of the PLA/PET to New Zealand influence the percentages?

One could also argue that PLA itself is carbon neutral because of its bioderived feedstock based on “biogenic carbon”. During biodegradation, the proposed ultimate end-of-life option in this case, PLA releases only the carbon which previously during the photosynthesis had been used to build the corn starch (European-Bioplastics, 2008). If the PLA stayed in a chemical cycle, no carbon dioxide was released. In this circumstance PLA could even be regarded as a carbon sink, locking the carbon in the bioplastics. However, chemical recycling currently is not an option for Frucor.

An independent New Zealand research institute finds that in a comparison of LCAs for PLA and PET, PLA contributes less to global warming and greenhouse gas emissions (Fernyhough et al., 2010). Still, statements on a reduction in greenhouse gas emissions also depend on the compared plastics (e.g. PLA vs. bio-PET looks completely different) and the chosen/available end-of-life option of the compared materials (e.g. recycled or landfilled PET would keep the carbon, whereas composted PLA would release the carbon).

Since the above statements are ambiguous, they should be treated with cautiousness and not be adopted untested (e.g. in making marketing claims). I assume that if there actually is a positive balance in greenhouse gas emissions for PLA compared to PET, it might be small.

6.3.6. No or less toxicity

Another indicator for improved environmental performance is the diminished use of toxic substances in the production processes (Elkington, 1997; Stead & Stead, 1996), or, according to the ambitious concept of eco-effectiveness, the non-toxicity of a product at the end of its useful life and the product´s capability to stay in biological cycles (McDonough & Braungart, 2002a). Since the proposed end-of-life option in the business case is biodegradation, Frucor would need to develop a non-toxic beverage pack which is biodegradable. Since PLA would fulfil this requirement, the discussed environmental performance indicator could be significantly enhanced by a PLA bottle.

However, as long as oil-based non-biodegradable closures from PP or HDPE are used, conventional plastics would need to be separated from the PLA to ensure the seedling pots from recycled PLA are not contaminated with conventional plastics. The company would realise the full potential for recyclability, as soon as PLA closures become commercially available and allow for an entirely biodegradable bottle.

6.3.7. Supplementary indicators for the environmental impact of PLA

Apart from the performance indicators mentioned in the mainstream environmental sustainability literature, there are some other factors affecting the ecological assessment of the introduction of a PLA bottle, e.g. competition of corn for plastic with corn for food production, acidification, eutrophication, and total water usage.

Apart from the mainly positive environmental impacts, PLA has some downsides which should be considered for a balanced evaluation of the material. The bioplastics is based on corn crops, and therefore is competing with food production for resources such as soil (Fernyhough et al., 2010). In addition, compared to PET, PLA has larger impacts e.g. in the acidification and eutrophication (over-fertilisation with nutrients) of soil and water (Fernyhough et al., 2010). Nevertheless, I estimate that using the recycled PLA for seedling pots would not have a negative effect on over-fertilisation since the plants would assimilate the nutrients.

As mentioned in the brief LCA on PLA, total water usage during the production of the PLA resin in the US (cradle to factory gate) is considered to be less compared to PET resin produced in Europe. Yet, for the complete life cycle the result might shift if the production of the PLA bottle required a high level of water usage.

6.3.8. Supplementary indicators for the environmental impact of packaging

For completeness I also include a sample of specific indicators for the assessment of the environmental impact of packaging taken from the “Code of practice for packaging design, education and procurement” offered by the Packaging Council of New Zealand (2010), see Appendix II. My choice of indicators is based on their applicability to the project.

Total material use is a significant indicator for the packaging´s environmental impact that needs to be taken into account. Due to a lack of information I cannot comment on the actual performance of PLA in the business case. The impact of the use of PLA on the material waste is estimated to be negative. This is because PLA has tighter specification requirements during production compared to PET, which would lead to increased waste by way of defective bottles. Another negative factor is that the PLA used for beverage bottles would have to be virgin. Therefore, no post-consumer recycled material could be used. Nevertheless, this requirement also applies to PET bottles, so the impact of the packaging would stay the same in this respect. Since the barrier qualities of PLA bottles are inferior to those made of PET, the bioplastic beverage pack would not be suitable for re-use, which would constitute a negative impact of PLA. However, ordinary PET bottles are not supposed to be re-used either so the outcome of this evaluation is neutral. PLA resin would not be locally sourced in New Zealand, since it would be supplied from the USA. In this context, the efficiencies of the transportation along the supply chain would make a considerable difference. However, I do not have sufficient information to comment on that impact in detail.

Although the evaluation of these special packaging indicators seems to be negative, overall the environmental impact of PLA compared to PET is still estimated to be smaller. The main reasons are that the material is made from renewable resources and could be recycled within New Zealand, at least when, and if the scenario implied in this business case takes effect.

I added the discussed supplementary indicators to the theoretical framework presented in Chapter 2 for the sake of completeness. Table 3 summarises the impacts of the introduction of PLA beverage packaging on the performance indicators for an environmental win.

Environmental Win		
Performance indicators	**Applicable**	**Impact**
Environmental impact		
General indicators		
– Conservation of non-renewable resources	✓	++
– Decrease in use of energy	✓	-/+ ?
– Reduction or elimination of waste	✓	+
– Recycling system and maintenance of material quality	✓	+
– Reduction of greenhouse gas emissions	✓	+
– No or less toxicity	✓	+
Supplementary indicators for PLA		
– Competition with food production	✓	-
– Acidification	✓	-
– Eutrophication	✓	-
– Total water usage	✓	-/+ ?
Supplementary indicators for packaging*		
– Total material use	✓	?
– Material waste	✓	-
– Virgin material use	✓	-/+
– Post-consumer recycled material use	✓	-/+
– Re-use of packaging	✓	-/+
– Locally sourced materials	✓	-
– Transportation (supply chain) efficiencies	✓	?
Regulatory compliance		Companywide indicators
– Non-compliance status	X	
– Violation fees	X	
– Number of audits	X	
Organisational processes		
– Environmental accounting	X	
– Audits	X	
– Reporting	X	
– Environmental management system	X	
– Environmental investment	X	

Table 3: Evaluation of impact of PLA packaging introduction on environmental performance

* Indicators from the “Code of practice for packaging design, education and procurement” as suggest by the Packaging Council of New Zealand (2010, pp. 11-19), see Appendix II

Key			
✓	applicable	x	not applicable
?	no information available	-	negative impact
-/+ ?	impact uncertain	+	positive impact
++	very positive impact		

For the company project only the first category for corporate environmental performance indicators, the environmental impact, was relevant to the evaluation of the business case. I did not assess the other two categories in the framework, regulatory compliance and organisational processes, since the indicators in these categories are more useful to assess companywide environmental performance. They do not provide information as to whether a true environmental win can be established in this business case. For example, the investment level in an environmental initiative, the frequency of third party audits, or the presence of an environmental management system would not directly indicate the environmental impact of the PLA beverage pack.

6.4. General requirements for a financial win

In this section I examine the extent to which the requirements for the establishment of a financial win, identified in the literature, are present in the bioplastics business case.

6.4.1. Holistic evaluation approach

Wholly appreciating how sustainability strategies generate value at business level requires managers to embrace a comprehensive approach (Peloza, 2009). Only a holistic quantification of strategic mediating processes, operational intermediate outcomes, and a purely financial end state can grasp the entire costs and benefits of an environmental initiative (Peloza, 2009). In the project I found that Frucor calculates the measures for intermediate/operational outcome and end state/ financial outcome. However, Frucor does not evaluate the proposed mediating metrics, apart from reputation and brand (see Table 6). These findings are in tune with Peloza´s (2009) perception of the application of the three metric dimensions at business level.

According to the academic literature, mediating metrics are vital for detecting the causal effects between an environmental initiative and a company's strategic position to generate value and control risk, and thus for evaluating the initiative´s impact on corporate economic performance (Peloza, 2009). An association for business sustainability even maintains that the major business value from sustainability initiatives lies in these strategic impacts (Research-Network-for-Business-Sustainability, 2008). Regrettably, the sponsoring company does not have the measures in place to quantify strategic mediating processes. This finding supports the literature stating that these measures often are too complex or not obtainable at companies (Research-Network-for-Business-Sustainability, 2008). Therefore, important information is neglected when building the business case for sustainability without mediating metrics, and might lead to an incomplete result of the financial metrics. I estimate that this circumstance might contribute to the fact that the Executive Board considers the introduction of a PLA beverage pack as unfavourable, because not all elements of the value proposition of the environmental initiative are taken into account.

6.4.2. Long term planning horizon

Another key requirement for financial management to adequately assess environmental initiatives, is the orientation towards longer term financial strategies (Marsh, 2010; McDonough & Braungart, 2002a). The sponsoring company does not have an environmental strategy that supports planning and appraisal of long term investment in ecological initiatives and that allows for long term pay back. Instead, Frucor´s management is perceived to appraise the environmental investment within a business-as-usual horizon of three years (considered to be still relatively short term). This short term planning makes it very difficult for a longer term strategic environmental investment, as necessary in the bioplastics project, to be assessed as financially beneficial. Table 4 summarises the two general requirements.

Financial Win		
General requirements	**Applicable**	**Present**
Capture total costs and benefits by		
– Holistic evaluation approach	✓	**(+)**
– Long term planning horizon	✓	**-**

Table 4: Evaluation of the general requirements for a financial win

Key			
✓	applicable	x	not applicable
-	not present	(+)	negligible evidence of presence
+	some evidence of presence	++	strong evidence of presence

6.5. Impact on financial performance

This section discusses which of the financial performance indicators suggested in the literature are currently applied at Frucor and are likely to be taken into account by Frucor´s Executive Board when assessing the bioplastics business case. Furthermore, I examine the impact of the introduction of a PLA bottle on Frucor´s economic performance. At the end of this section I offer a summary of the various performance indicators which should be taken into account. Please note that this dissertation does not include the detailed financials I calculated for the sponsoring company. The financials are to be given to Frucor and included in the report for the Executive Board.

6.5.1. Mediating metrics

As mentioned before, the mediating metrics, which are supposed to indicate Frucor´s strategic position to generate value and control risk, are mainly neglected in constructing the business case (see Table 6). The only mediating metrics accounted for at the sponsoring company are customer acceptance and relationships with authorities. However, the improvement in the latter metric is more a tangential benefit which might be overlooked when taking the decision on environmentally responsible beverage packaging. The probable improvement in the relationship with local councils, the recycling industry, and NGOs is not valued in financial terms. Also disregarded are input/output metrics, employee satisfaction, and cultural shifts.

Although input/output metrics like “waste reduction” and “energy conservation” could probably be improved (as indicated in Section 6.3), their financial impact is unlikely to be taken into account in Frucor´s final investment decision. The reason is that the resulting cost reduction of the two improvements would be external to the business, and thus, would not take effect at the sponsoring company. In addition, the complexity and the ambiguity of LCA reports would make a precise calculation of the cost reduction difficult. Beyond, measures like employee satisfaction, quality of cross-functional processes and progress of innovation can be positively influenced, according to the literature (Peloza, 2009). Consistent with the Environmental Manager I estimate that to some extent this is likely to be the case at Frucor. Nevertheless, the potential impacts on the long term financial performance, which would be captured by these strategic indicators, are not calculated. Therefore, they are not incorporated in the investment decision.

6.5.2. Intermediate outcome metrics

In contrast to the mediating measures, most of the proposed operational metrics are used at Frucor to assess the potential introduction of a PLA beverage pack. Quantification of relevant cost- and revenue-based measures was comparatively easy, as most of them have a readily available market price, as also found by Peloza (2009). These measures could be compared to the budget for the two water brands packaged in conventional PET bottles. As regards the impact of the PLA bottle introduction on the cost-based metrics, if anything, there would be a change for the worse. No savings in energy expenses would be achieved at Frucor and operational efficiencies at the bottle producer would likely decline (rising costs due to inefficiencies would be passed on to Frucor). The changes in the risk profile are complex; some risks are likely to decrease, others are likely to increase, as summarised in Table 5.

Changes in risk profile	
Decreasing risks	**Increasing risks**
– Customer churn – Compulsory environmental legislation due to poor reputation with local authorities and the recycling industry – Price volatility and long run price increases for oil-based material	– Technical hurdles – High initial investment and elevated ongoing material cost – Negative advertising impact of PLA bottle across product range – Complexity of engaging the recycling industry – Uncertain availability of market for post-consumer PLA – Single end-of-life option for PLA – Dependence on a single supplier for PLA resin – Retaliation by major competitor

Table 5: Changes in risk profile

The outcome of the changes in the risk profile is hard to forecast. However, it appears that Frucor´s Executive Board is likely to focus on the increasing risks caused by the introduction of a PLA beverage pack. In contrast, the sponsoring company does not seem to attach much importance to the risk of price volatility and long run price increases for plastics made from crude oil, or the risk of environmental legislation.

The revenue-based measures are all likely to increase if a PLA bottle was introduced. Rising customer satisfaction is forecast to enhance both market share (+2%) and sales volume (+10%). The integrative metrics, such as profitability, combine the cost- and revenue based metrics and are, in contrast, predicted to be negatively impacted. Overall, the rise in costs is estimated to exceed the growth in market share and sales volume, which decreases profitability. The costs taken into account for profitability encompass, for example, the price premium for the PLA resin, the increased conversion price for PLA at the bottle manufacturer, and importantly the high amortisation rate for the investment. The level of the amortisation rate depends on the amount of the amortised investment and the amortisation period. The amortisation period (=break-even time) for the investment is fixed to three years by the financial department. This relatively short time frame for the break-even period significantly increases the annual costs. As mentioned earlier, the shortness of the generally allowed payback time does not coincide with more strategic and therefore long-term environmental investments.

It is important to note that generally, the introduction of PLA bottles is predicted to result in a profit for Frucor, but profitability when using PLA bottles would decline compared to profitability when using PET bottles.

6.5.3. End state outcome metrics

For this project Frucor uses only return on sales as a financial end state outcome metric to appraise the impact of a PLA beverage pack introduction. The return on investment is not calculated. Return on sales is forecast to be negatively affected by the environmental initiative and to decrease by around 10%, which is mostly due to the high amortisation rate for the investment. As noted earlier, financial end state outcome metrics can fail in capturing the complex value proposition of sustainability initiatives, when limited to short term considerations, because these measures do not represent well the strategic long term impacts. Long term impacts are captured by mediating metrics (Peloza, 2009).

The impact of a PLA bottle introduction on the discussed financial indicators is summarised in Table 6.

Financial Win		
Performance indicators	**In use**	**Impact**
Mediating metrics		
– Input/output metrics:		
o Energy conservation	x	(+)
o Waste reduction	x	(+)
– Employee satisfaction	x	(+)
– Cultural shifts		
o Quality of cross-functional processes	x	(+)
o Progress of innovation	x	(+)
– Reputation and brand		
o Customer loyalty/acceptance	✓	+
o Relationships with authorities	(✓)	(+)
Intermediate outcome metrics		
– Cost-based metrics:		
o Energy expenses	✓	-
o Operational efficiencies	✓	-
o Changes in risk profile	(✓)	-/+?
– Revenue-based metrics:		
o Customer satisfaction	✓	+
o Market share	✓	+
o Sales in units/volume	✓	+
– Integrative metrics:		
o Profitability	✓	-
o Break-even time	(✓)	-
End state outcome metrics		
– Accounting:		
o Return on sales	✓	-
o Return on investment	x	?

Table 6: Evaluation of impact of PLA packaging introduction on financial performance

Key			
✓	in use	x	not in use/not impacted
(✓)	limited use		
?	no information available	-	negative impact
-/+ ?	impact uncertain	+	positive impact
(+)	positive impact, but not taken into account		

6.6. Usefulness of academic concepts employed in framework

The discussion about the usefulness of academic concepts in this section is limited to those used in the win-win theoretical framework. I comment on the remaining theoretical concepts reviewed in the conclusion.

6.6.1. Environmental management approaches

As indicated in the discussion about the general requirements for an environmental win in Section 6.2, the various environmental management approaches proved useful in this project to different extents. I consider the following approaches to be most important underpinning this research and project: the product stewardship concept and the closely linked deliberations around a corporate environmental strategy, LCA, the cradle-to-grave and the cradle-to-cradle concept, as well as the idea of value chain collaboration.

Regarding the usefulness of the **product stewardship** concept (e. g. Epstein, 1996; Hart, 1995; R. Roy & Whelan, 1992) and deliberations around a **corporate environmental strategy** (Braglia & Petroni, 2000), I maintain that both academic notions were important for critically evaluating the business context for the introduction of a bioplastic beverage pack. It appears that the environmental win is threatened because these concepts are currently not (genuinely) embraced by the sponsoring company. I consider the two approaches to provide solid and necessary background theoretical knowledge.

In this project the **LCA** concept was particularly useful for the development of a potential PLA material flow during the construction of the environmental business case. It shifts the focus from a company restricted value chain to an entire product life cycle, and thus, increases awareness for environmental concerns beyond company boundaries (Hart, 1995). The LCA concept was also valuable for the evaluation of the PLA bottle’s impact on the environmental performance indicators, because it points to an objective disclosure of both the virtues and the downsides of the bioplastic. Knowing about the restrictions of LCA in general such as analyst bias was helpful to ensure that I treated the gathered LCA information with some scepticism. I assert that, overall, for the evaluation of an environmental win, LCA is indispensable. Nevertheless, I had only restricted reliable LCA information for PLA available. Due to the extensive information needed for an LCA and the significant complexity of the tool I did not conduct an LCA myself. Therefore, the concept was useful for the project only to a limited extent.

Major support was also provided by the **cradle-to-cradle** concept and the related idea of **eco-effectiveness** (McDonough & Braungart, 2002a). These approaches constituted the basic theoretical knowledge for the ideal idea of a closed cyclical value chain for the introduction of a PLA bottle. They were helpful to understand the general context and requirements of cyclical material flows (e.g. the reorganisation of material flows as a prerequisite to implement cyclical material flows (McDonough & Braungart, 2002a)). The concepts also emphasised the significant contribution of a closed loop value chain to ecological improvements and environmentally sustainable development. However, both approaches are very ambitious and were not entirely applicable to the business case.

The less environmentally ambitious **cradle-to-grave** concept, which seeks to play out **eco-efficiency**, proved to be more applicable to practice. In fact, the proposed value chain looks at the product´s life cycle “from the cradle to the grave” and strives to minimise the environmental impact (Banerjee, 2007; Elkington, 1997). The cradle-to-grave concept was of importance for the business case evaluation since it highlights the constraints of the proposed not perfectly cyclical value chain.

Also very valuable was the concept of **value chain collaboration** (Baumann et al., 2002; Cristina et al., 2008; R. Roy & Whelan, 1992). I regard the collaborative approach as very useful to assess to which extent the sponsoring company is likely to carry out future endeavours when actually putting the cyclical value chain into practice and getting business partners on board. However, Frucor might not be prepared to generate all the synergies proposed in the literature, since I appraise the required effort to be considerable for the sponsoring company. In this project, the suggested mutual benefits such as shared risk or costs do not seem to apply. This collaborative notion also encouraged me to not only gather information from a variety of external sources but to also mutually exchange information in some cases (e.g. with resin supplier, label supplier, bottle manufacturer, mechanical recycler). Therefore, I actually carried out Frucor´s first collaborative steps with members of the potential value chain for PLA. I received feedback for my ideas which ensured that the proposed scenario for the PLA bottle introduction would be generally feasible at some point in the future.

Of less importance were the management approaches life cycle costing and development of environmentally responsible products. In this project, only restricted data for **life cycle costing** (Epstein, 1996; Rebitzer & Hunkeler, 2003) was available, due to limited LCA information in the first place. More importantly, since the approach extends financial responsibility for environmental issues well beyond the company boundaries, it is questionable as to how far Frucor would take life cycle costing into account for its investment decision, if it was available. Therefore, I consider the tool to have a low value to the evaluation of this business case, while accepting that theoretical knowledge about the tool is useful background. It enabled me to detect a lack in the awareness of environmental cost at Frucor and to identify this lack as a potential challenge to the establishment of an environmental win.

The literature on the **development of environmentally responsible products** (Allenby, 1994; Banerjee, 2007; Santos-Reyes & Lawlor-Wright, 2001; Veroutis & Fava, 1997) contributed to my understanding that the ecological performance indicators of a new product can only be improved, if environmental responsibility is embedded in the development of the product right from the start. Furthermore, the approach highlighted, that I needed to gather data from a variety of cross-functional company members to be in the position to construct an environmentally and financially plausible business case. Nevertheless, apart from general background knowledge, concepts like DfE did not offer detailed help in how to go about the evaluation of this particular case, which made them less useful for this project.

Beyond the discussed academic approaches which helped me determine requirements for the establishment of an environmental win, I used the general environmental management literature to get a first overview of environmental **performance indicators.** This literature proved useful to build a sound base of ecological factors for the assessment of the business case. I also included supplementary indicators from discussions and reviews about LCA of PLA and packaging to make the assessment more thorough. I cannot comment on the usefulness of more specific literature on environmental performance indicators. I did not review such academic reports because of time and scope constraints. I maintain that due to the high complexity and variety of the different factors influencing a product´s LCA, additional indicators for a more balanced appraisal would be necessary. Therefore, I conclude that in a more detailed NPD project a comprehensive and product tailored assessment of the environmental impacts would be vital.

6.6.2. Theory on financial indicators

Peloza´s (2009) comprehensive framework proved very useful in this project. Complemented with operational outcome indicators useful in an NPD process proposed by Tzokas et al. (2004), the framework offered guidance to evaluate the financial impact of the environmental initiative. I based my assessment of the financial impact on forecasted figures. Since the introduction of a PLA bottle is under consideration, but has not been realised yet, there are no historical figures available at present. In particular, forecasts of the end state outcome metric return on sales was a rough estimate. However, originally the framework was created for the financial impact assessment of already implemented environmental initiatives. I still consider the tool to be very helpful, even in the early stages of planning an environmental initiative, because even the estimated figures helped in pointing out the probable rough impact of the PLA beverage pack introduction. In addition, the framework offered valuable support in detecting the gaps in Frucor´s approach in holistically evaluating the potential financial benefit generated by a bioplastic pack introduction.

Similar to Peloza (2009), the research for this project finds that Frucor´s managers lack the appropriate mediating metrics for tracking the impacts of an environmental initiative within the company or beyond and for linking these impacts with the financial end state outcome metrics. Therefore, I support Peloza´s (2009) call for a closer collaboration between practitioners and academics to further develop environmental sustainability assessment metrics and instruments at business level.

6.7. Summary

This chapter discussed the extent to which the requirements for the establishment of an environmental win and a financial win are present in the current business case. It also assesses the impact of the environmental initiative on environmental and financial performance indicators. The discussion suggests that the establishment of a win-win situation might be particularly hard to realise. It might not be possible to establish a financial win because of particularly high investment costs. Also the realisation of an environmental win might be difficult. This is because of the lack of Frucor´s management commitment to environmental sustainability, and, importantly the difficulty in defining the impact of the proposed sustainability initiative on both environmental and financial performance.

Chapter 7

Conclusion

7.1. Introduction

The conclusion first provides answers to each of the four research questions. It includes the requirements for a win-win situation, the most plausible business case for the introduction of PLA beverage packaging, the sponsoring company´s challenges in achieving a win-win situation in the business case, as well as an assessment of the usefulness of academic theory in this practical project and implications for theory. I answer the overall research question regarding the likelihood for a win-win situation in this business case, and I offer recommendations to Frucor. Finally I suggest implications of this research for management in general.

7.2. Requirements for a win-win situation

The first research question was:

What are the environmental and financial requirements for a win-win situation?

Based on the environmental management and sustainability literature reviewed in Chapter 2, I maintain that the establishment of a win-win situation from a corporate environmental initiative has various requirements.

From the **environmental perspective**, several general requirements need to be in place. A company needs to embrace genuine environmental product stewardship and act according to a corporate environmental strategy. Also the management needs to show real commitment to environmental initiatives. Furthermore, environmental management approaches such as LCA, life cycle costing, the cradle-to-grave/cradle-to-cradle concept, and the development of environmentally responsible products should be adopted to allow for the realisation of an environmental win. I assert that the possible extent to which environmental performance can be improved strongly depends on the presence of the aforementioned general requirements. In addition, the indicators for the environmental impact of the initiative need to be positively affected. General ecological impact indicators of an initiative are:

- conservation of non-renewable fossil resources,

- decrease in use of energy and water,
- reduction of waste,
- presence of a recycling system allowing for the maintenance of material quality,
- reduction of greenhouse gas emissions, and
- no or less toxicity.

To enable a **financial win**, the two general requirements of a holistic evaluation approach and a long term planning horizon need to be in place. These requirements influence the extent to which the financial indicators can be impacted positively. The economic indicators, which need to be affected positively for a financial win, can be categorised in three groups: (1) strategic mediating metrics (e.g. reputation and brand, employee satisfaction); (2) operational or intermediate outcome metrics (e.g. cost/revenue based metrics); and (3) financial end state outcome metrics (e.g. return on sales).

The above-mentioned factors of a win-win situation are summarised on a more general level in the theoretical framework in Chapter 2. In Chapter 6 this framework, refined with regard to the environmental indicators, is used to assess the introduction of a PLA beverage pack at Frucor. For the assessment of the bioplastic pack introduction I added supplementary performance indicators derived from literature on PLA (e.g. acidification and total water usage) and on packaging (e.g. use of virgin/post-consumer recycled material and transportation efficiencies).

7.3. Most plausible business case for introduction of PLA beverage packaging

The second research question was:

> *What is the most plausible business case for the introduction of an environmentally responsible beverage pack at Frucor?*

The most plausible business case for the introduction of an environmentally responsible beverage pack at Frucor, as described in Chapter 5, encompasses the following elements.

I propose the PLA bottle would be introduced to both of Frucor´s water brands, but, due to material properties, only to the still and pure water product range. The target market would be the two mainstream distribution channels, groceries and petrol stations. To resonate with as many consumers as possible and to achieve high volumes, Frucor would not increase the retail price compared to its current PET bottled water, although costs are likely to increase considerably. Frucor´s selling proposition for PLA bottled water would be that the bioplastic bottles are made from 100% annually renewable resources, which are 100% recyclable in New Zealand.

The consumption of the water and the disposal of the PLA bottles would happen at consumers´ homes as well as out and about. The empty bottles would be disposed of in consumers´ co-mingled recycling kerbside bins in regular household and business waste, and in public places, parks and on streets. Thus, the PLA would enter the established recycling stream.

For post-consumer PLA to be diverted from the recycling stream, both automated optical and manual sorting operators need to establish adequate sorting infrastructure. This infrastructure is particularly expensive for automated sorting facilities. To enable manual sorting operations to separate PLA bottles from the PET stream, Frucor has to significantly change of the outward appearance of the bottle, e.g. by shape and/or colour. Engaging and informing the recycling industry prior to the PLA bottle launch is an essential requirement for the establishment of adequate sorting infrastructure.

The proposed end-of-life option for post-consumer PLA is mechanical recycling into seedling pots. These PLA pots could be used by the forestry industry for the plantation of trees. Ultimately, PLA would biodegrade in the soil, which means the bioplastic material could be biologically recycled in New Zealand.

By introducing a PLA beverage pack, Frucor could benefit by pre-empting its major competitor in launching an environmentally responsible bottle, which would increase market share by a forecast 2%. The sponsoring company could also decrease the risk of volatile and long term rising prices for oil-based plastic. Furthermore, Frucor would improve its reputation with authorities and might reduce the risk of environmental legislation being enacted. However, implementing a PLA bottle entails considerable investment and elevated ongoing costs. These costs are predicted to lead to a 10% decrease in return on sales, although the market share is forecast to increase by 2%. Further barriers and risks opposing the business case are summarised in the next section.

7.4. Challenges in achieving a win-win situation

The third research question was:

> *What are Frucor´s challenges in achieving a win-win situation in the most plausible business case?*

7.4.1. Challenges for a financial win

There are two major requirements for an environmental initiative to be evaluated as financially beneficial. Both pose challenges in the business case. First of all, Frucor does not embrace a holistic evaluation approach as suggested by Peloza (2009). Since the sponsoring company lacks the measures to quantify the strategic mediating metrics, a vital part of the potential business value from the sustainability initiatives is neglected (Research-Network-for-Business-Sustainability, 2008). A number of impacts are not valued in financial terms. These include: possibly increased employee satisfaction; progress of innovation; improved relationships (e.g. with local councils); reduced risk of environmental legislation; and the potential for and impact of rising oil-prices. The company builds the business case on hard financial data, and thus does not capture the entire value proposition of the environmental initiative.

Secondly, Frucor does not evaluate the figures with a longer term financial strategy in mind, as proposed by Marsh (2010) and McDonough and Braungart (2002). Instead it retains its business-as-usual financial practice and appraises the environmental investment with a relatively short term horizon of three years. From an environmental perspective, Frucor´s financial metrics employed to properly assess the environmental initiative appear incomplete. In addition, the short term pay-back horizon for a strategic environmental investment, as necessary in the bioplastics project, seems unsuitable. These circumstances are considered to contribute to a less favourable financial assessment overall.

Further tangible challenges to a financial win as apparent in this assessment are listed below:

- high initial investment for production tooling and research and development;
- elevated ongoing material costs;
- technical hurdles of the PLA bottle due to inferior material properties;
- negative advertising impact of PLA bottle across product range;

- complexity of engaging the recycling industry;
- uncertain availability of market for post-consumer PLA;
- single end-of-life option for PLA;
- dependence on a single supplier for PLA resin; and
- potential retaliation by major competitor.

Most importantly, the rise in cost (amortisation of investment and elevated ongoing material costs) are predicted to exceed the rise in net sales value, which results in a negative impact on return on sales. Therefore, Frucor´s Executive Board is likely to appraise the introduction of a PLA beverage pack as financially unfavourable.

7.4.2. Challenges for an environmental win

There are several challenges in achieving an environmental win when implementing the proposed most plausible business case within the present business context. With regard to the environmental impact of the introduction of the PLA beverage pack I assert that the material would be, overall, environmentally responsible. The beverage pack is likely to have a positive ecological impact in terms of the conservation of non-renewable resources. GHG emissions can be reduced, and, due to a favourable end-of-life option for post-consumer PLA, the initiative is predicted to reduce waste. However, major ecological issues remain, such as the competition of corn for bioplastic with corn for food production, the sourcing of PLA resin from overseas, and importantly the fact that still 70% of PLA will likely still end up in landfill which excludes the vast majority of the material from being biologically recycled.

Beyond, the environmental win might be challenged by Frucor´s lack of an environmental strategy that would attach significant importance to the ecological dimensions of corporate decisions. This research on an environmentally responsible pack is not motivated by a concern for the natural environment. It appears more as a tactical response stimulated through the potential launch of a bio-PET beverage pack by a major competitor.

If Frucor´s Executive Board actually decides to implement the bioplastic beverage pack, and to embrace my proposed scenario for the pack introduction, I assume that the company might adopt environmental product stewardship to a feasible minimum extent. Getting engaged and taking responsibility across the product´s life cycle, however, would be a requirement to maximise the achievable environmental benefits. It remains to be seen the extent to which the company would actually show genuine effort to get engaged with value chain partners beyond its own boundaries, and if the lack in commitment would lead to a compromise in environmental advancements. The incomplete assessment of the environmental impacts throughout the bioplastic pack´s life cycle and the related sporadic information about environmental costs and benefits might pose another hurdle.

7.5. Usefulness of academic theory and implications for theory

The fourth research question was:

> *How useful is academic theory in helping inform the establishment of a win-win situation?*

In this research project I reviewed a wide range of environmental management literature in order to inform the potential establishment of a win-win situation from an environmental initiative. During my project the variety of academic concepts for general environmental management was necessary to gain a broad theoretical background. This knowledge was helpful to assess the business case with a good balance between financial and environmental concerns. It was useful to detect where challenges for the establishment of an environmental win could come from. However, there are no ready-made academic frameworks that can be easily applied.

The win-win concept was most useful to this research since its suggestion that ecological, social and economic sustainability can be established at the same time (Porter & van der Linde, 1995; Salzmann et al., 2005) substantiated the win-win assessment of this business case. For the development of the theoretical framework, I consider the following approaches to be most important for the evaluation of a win-win situation from an environmental perspective, as mentioned in Section 6.6. The product stewardship concept and the closely linked deliberations around a corporate environmental strategy gave a valuable contribution to the appraisal of the likelihood of an environmental win in the most plausible business case. LCA was useful to critically assess the environmental impacts of the corporate initiative. The life cycle perspective also helped creating the potential PLA material flow beyond Frucor´s boundaries. The cradle-to-grave and the cradle-to-cradle concept highlighted that the environmental impact of a product significantly depends on the general construction of the product´s material flow (eco-efficiency vs. eco-effectiveness). In particular the cradle-to-cradle concept inspired me how an ideal closed cyclical material flow system could be constructed. The idea of value chain collaboration was useful to assess to which extent the sponsoring company is likely to engage value chain partners and to make the proposed product value chain work. This idea also was useful since it encouraged me to take a systems perspective when collecting information. Overall, these concepts were useful in identifying the general requirements needed to establish an environmental win. In this context, also life cycle costing and concepts regarding the development of environmentally responsible products helped identify challenges to the establishment of an environmental win, but they were not easily applicable. The former concept was too ambitious because it requires the allocation of cost to Frucor that are well beyond its boundaries. The latter concepts did not offer detailed help in how to go about the evaluation of this particular business case.

Peloza´s (2009) framework to evaluate the financial impact of sustainability initiatives was particularly helpful in this project. It laid the foundation for the financial perspective of my theoretical framework to assess whether a win-win situation can be established. In particular, Peloza´s suggestion for companies to identify mediating metrics was valuable. These metrics largely are ignored by Frucor´s Executive Board, although they are required to capture the whole value proposition of an environmental initiative. However, Peloza´s research neglects some financial indicators required during an NPD process, and it does not focus on environmental impact indicators. In this context, Tzokas et al.´s (2004) dimensions and evaluation criteria in the NPD process were useful to complement the financial indicators for the assessment of the potential PLA packaging introduction.

The suggestion to adopt a systemic view of the business in its wider context (Baumann et al., 2002; Starik & Rands, 1995; Stead & Stead, 1996) was very helpful in gathering comprehensive information to build the business case for an environmental initiative. It ensured that the evaluation of the environmental win took into account concerns beyond company boundaries.

However, there are theoretical concepts that were less useful. The presented traditional NPD process (Bingham & Quigley, 1990) was useful for both the company project and the dissertation. It provided valuable background knowledge for the different process phases and the required information in the NPD process. Nevertheless, the applicability of this marketing framework to this project is limited as it does not consider specific features of NPD focussing on environmentally responsible products. Also, the metrics for corporate environmental performance encompassing three primary classes proposed by Delmas and Doctori Blass (2010) had limited applicability to this project. For the evaluation of the environmental initiative only the first category, environmental impact, was applicable of the three suggested categories.

A useful contribution of this research is the theoretical framework which I have developed for the company project (see Section 2.6). The framework seeks to assess the environmental and the financial perspective in a well-balanced way to identify whether a company makes trade-offs to the detriment of the environment. It does not only evaluate the actual environmental and financial performance indicators, but also takes into account the general requirements which have to be in place to allow for a win-win situation. If these requirements are missing, it is likely that compromises in terms of an ecological win are made. By taking into account environmental management concepts that help implement genuine environmental product stewardship, e.g. LCA, life cycle costing or value chain collaboration, the evaluation strives to take a systems perspective.

I suggest that future projects seeking to research whether a win-win situation can be established in a business case should use the proposed framework. As to future research, I endorse Peloza´s (2009) call that academia and practitioners need to collaborate to develop metrics that help evaluate the entire value proposition of environmentally responsible initiatives, in particular strategic mediating metrics. Those researchers and managers with a sustainability agenda could look at metrics that assess the initiatives´ long term impact on intangible assets, for example on progress of innovation capability, company reputation, brand value, improved relationships (e.g. with local councils), and reduced risk for environmental legislation. Since these metrics look at long term improvements, the period under consideration should be extended beyond the business-as-usual short term horizon.

This research also contributed through the research approach “interventionist research”. During the project, both Frucor members and I learned from the cooperation. By applying theory to practice, Frucor´s executives learned that in order to capture the whole value proposition of an environmental initiative the evaluation of mediating metrics is required. They also realised that the establishment of an environmental win from a corporate initiative necessitates more than the introduction of environmentally responsible beverage packaging. For an environmental win also certain circumstances have to be in place, such as an environmental strategy. I, as a researcher, gained from the collaboration, because I got insight into business processes and access to company data to understand the construction of a business case. Without being part of the company, gaining such an extensive knowledge about the practical implication of theoretical ideals about environmental business cases is hard. Since I did not witness the intervention and its results, the contribution to theory is restricted to the discussion around the practicability of academic concepts. The scope and timeframe of the dissertation did not extend to include the actual environmental and economic outcomes of the decision made.

7.6. Likelihood for a win-win situation

The overall research question was:

> *What is the likelihood that a win-win situation could be achieved in the most plausible business case for the introduction of an environmentally responsible beverage pack*?

At present, the high initial investment and the elevated ongoing costs result in a predicted negative financial impact of the PLA beverage pack introduction. In addition, the considerable technical hurdles, the potential adverse advertising impact across the product range and other risks make the business case less attractive. Therefore, I assess that a financial win could not be achieved right now. As regards the environmental perspective, I consider that it will likely be difficult to gain approval for an extensive NPD project to develop and implement a PLA bottle subsequent to this dissertation. This is due to Frucor´s lack of an environmental strategy and little management commitment to environmental concerns combined with the predicted negative financial impact and risks of the initiative. If the NPD project was not initiated at all, the opportunity to improve the ecological impact of the beverage pack and to realise an environmental win would be eliminated. I assert that if the PLA pack was still introduced and PET bottles were replaced today, overall an environmental win could be achieved. Although the material is made from renewable resources and recyclable in New Zealand, the win would be compromised by a linear material flow due to, for example, raw material sourcing from the USA and a major amount of PLA not being recycled. Consequently, I appraise that at present, the proposed business case would result in a situation with a small environmental win and no apparent or immediate financial win.

In the future, this situation could change. The material properties are likely to be improved which would reduce technical challenges and allow for the application of the packaging material to a wider product range. With more PLA resin suppliers evolving, the price for PLA might reduce, whereas the price for PET is predicted to rise. Consequently, other companies in the food and beverage industry in Australasia might introduce PLA packaging. Investment in tooling for PLA bottle production might be shared by other companies coming on board. PLA volume in the recycling stream would likely rise and make the sorting of PLA more financially viable. It would also allow for a stable post-consumer PLA market with new products from recycled PLA evolving. In addition, consumers might become more environmentally sensitive and be prepared to pay a premium for environmentally responsible packaging. As a result, the use of PLA packaging is likely to become financially more attractive, and might even have a positive financial impact.

Also the environmental impacts of PLA are forecast to improve. There are plans to set up PLA resin production in Australia, which would reduce emissions due to transportation. PLA generation related to corn is predicted to shift to lignocellulosic matters and would not compete with corn for food production any more. PLA closures are forecast to become commercially available which would facilitate mechanical recycling and ultimately biodegradation of the PLA seedling pots. Also ecologically more responsible consumers might improve their behaviour in recycling the bioplastic. These changes might lead to the fact that the former linear material flow is getting closer to a cyclical material flow allowing for eco-effectiveness. Overall, I suggest that in the future, Frucor could likely establish a financial and environmental win-win situation when implementing a PLA beverage pack.

In the final phase of this project, it came to my knowledge that Frucor executives are now considering introducing a bio-PET beverage pack. From the business perspective, this would signify an easy move to implement environmentally more responsible packaging. The plastic made partly from renewables has the same material properties as conventional PET. Therefore, it could easily replace PET bottles for the entire product range and it could enter the conventional PET recycling stream without causing any issues. Frucor would not have to change bottle shape or invest in production tooling. The sponsoring company would simply need to change its supplier for plastic resin. From the environmental perspective, the now likely introduction of bio-PET seems to be a trade-off. If the introduction of bio-PET frustrates further endeavours regarding a PLA introduction, environmental improvement is compromised in favour of financial benefit. I consider the introduction of bio-PET to be a small incremental step towards environmental sustainability, because still around 80% of the polymer is non-renewable carbon content derived from oil. Currently, also, post-consumer PET is shipped to China where it is downcycled, and there is no recycling of PET in New Zealand in the foreseeable future. Therefore, the implementation of bio-PET appears to be a more tactical appeasing manoeuvre that resonates with environmentally sensitive consumers. It reduces the incentive to work towards more sustainable material like PLA which could ultimately allow for cyclical material flow systems.

7.7. Recommendations to Frucor

By constructing a business case for the introduction of a PLA beverage pack and offering an assessment of the initiative in environmental and financial terms, I provide useful information to Frucor´s Executive Board. This information is to inform the executives decision on the potential introduction of the bioplastic beverage pack, which was my research aim. I assess that at present, the introduction of a PLA beverage pack does not constitute a strong enough business case to be assessed as financially beneficial, in particular under short term considerations. In addition, as mentioned earlier, there are many barriers to the realisation of this pro-active environmental initiative. However, as indicated above, the external circumstances are likely to change over time, e.g. by cost reduction or improvement in material properties. Also, Frucor´s major competitor is likely to introduce an environmentally responsible beverage pack, which would force the sponsoring company to react tactically. Therefore, even if Frucor does not implement the PLA beverage pack now, I recommend that Frucor keeps a watching brief for the appropriate circumstances to develop. The PLA product idea could be "kept aside waiting technical and market conditions to mature for future development" (Tzokas et al., 2004, p. 620). As soon as the time has come to implement PLA bottles, the sponsoring company could use the information about PLA beverage packaging gained in this project to quickly do so.

In general, if Frucor´s Executive Board wanted to adopt a more strategic stance to environmental concerns and take an environmental stewardship approach that genuinely contributes to environmental sustainability, the executives would probably need to shift their mindset. Realistically, at Frucor a shift of mindset would happen incrementally. It could be achieved by taking small steps, establishing an environmentally responsible overall direction, and achieving success. Frucor executives would need to gradually develop their decision-making capabilities to account for environmental concerns. For example a future evaluation of an environmental initiative, e.g. the introduction of bio-PET, could include a win-win assessment by applying the framework proposed in this dissertation. To improve the evaluation, I suggest two developments at Frucor: (1) the identification of mediating metrics between the environmental initiative and the financial end state outcome metrics (in addition to the conventional financial metrics calculated) to constitute a more holistic approach (Peloza, 2009); and (2) the execution of a sound and comprehensive LCA of the bioplastic. As to the mediating metrics, Frucor could for example take into account the progress in innovation processes. Since PLA requires more research and development effort, its introduction might offer more potential in progressing the company´s innovation capabilities than the straightforward introduction of bio-PET. I also consider completing a validated LCA for PLA and bio-PET (e.g. by taking the packaging impact indicators in Appendix II into account) as highly beneficial, since an LCA could inform the executives' decision and choice between the two bioplastic material options. However, the decision-making process based on LCA requires guidance by objectives for environmental endeavours. Since a comprehensive corporate environmental strategy is unlikely to be established because of Frucor´s current tactical environmental approach, the Executive Board could at least define the company´s overall environmental direction as regards tangible objectives and priorities.

Beyond mediating metrics and LCA, I assert that adopting the cradle-to-grave concept e.g. for a potential PLA bottle implementation might signify another step for Frucor in the direction of environmental responsibility beyond the company´s boundaries. The concept is assessed as an important preparatory step towards any possible later move to the environmentally more favourable cradle-to-cradle concept. Frucor could partner with suppliers, and members in the recycling industry and in the food and beverage industry (e.g. Fonterra or Goodman Fielder) to build up a strong and environmentally responsible value chain for PLA. This could also offer the possibility to share mutual gains such as sharing risk and costs in the implementation of environmentally responsible packaging (R. Roy & Whelan, 1992).

As to achieving success with ecological initiatives, I recommend that Frucor starts with implementing projects with moderate complexity. Maybe even the introduction of bio-PET, although less environmentally responsible compared to PLA, could help shifting the Executive Board´s mindset towards environmental sustainability by easily achieving a financial win from an environmental initiative.

When I present to Frucor´s Executive Board I intend to communicate two key ideas that will hopefully begin to inform their future decision making. I intend to suggest the implementation of strategic mediating metrics into the evaluation of environmental initiatives and the company´s engagement with industry partners across a product´s life cycle to improve its environmental impact.

7.8. Implications for management in general

This dissertation, based on a sponsored company project, seeks to offer the needed praxis-oriented and descriptive research in the development of a business case for corporate sustainability at firm level, the lack of which was identified in the literature (Salzmann et al., 2005). Managers also seem to lack useful management tools to evaluate environmental sustainability initiatives and to implement them into their businesses (Salzmann et al., 2005). This is particularly so with new product developments where a huge range of information needs to be brought to bear across not just a company value chain but a product life cycle. Although this project was not able to build a strong business case for environmental sustainability, it still offered insight as to how such a business case could be built. The project also demonstrates Frucor´s executives´ business logic for potentially implementing environmentally responsible beverage packaging. The proposed most plausible business case suggested how an environmental initiative could potentially be applied in business. It examines how effective the initiative would probably be and what risks and barriers it would likely involve.

I found that the literature provides little comprehensive guidance to analyse the introduction of environmentally responsible packaging, particularly from a systems perspective. This research project brings together a theoretical framework for managers who strive to assess an environmental initiative as to whether a win-win situation can be established from that initiative, as presented in Chapter 2. The framework seeks to assess the environmental and the financial perspective in a well-balanced way to identify whether a company makes trade-offs to the detriment of the environment. The framework can easily be amended by enriching the environmental and financial impact indicators with indicators which are useful to the particular business case. The thick and in depth description of the assessment of an environmental business case I give, can be used as an illustrative example.

By involving potential and current value chain partners in the research, I took a systemic approach in the development of the business case. The study offers an example for looking at the whole life cycle of environmentally responsible packaging and identifies environmental issues not only at company level but also beyond the company´s boundaries. Therefore, the research strives to close the gap concerning the integration of management tasks, environmental tasks and the process of product development from a system´s perspective (Baumann et al., 2002).

Companies that want to evaluate the entire value proposition of environmentally responsible initiatives need to develop strategic mediating metrics. Collaboration with academia might support managers in this task. However, even if the whole value proposition of an environmental initiative was captured by financial metrics, a business case might still not be convincing. Realistically, business is likely to take small steps towards sustainability in the future, which leads to incremental changes and small environmental wins. An external shift in the business environment, e.g. shifting consumer demand towards more environmentally responsible products, environmental legislation or increasing oil price is needed, to make environmentally responsible initiatives more financially beneficial. A clear financial win from those initiatives is likely to motivate companies with a more conservative and tactical attitude towards environmental sustainability to adopt an environmentally more proactive strategy.

Finally, the research suggests that, currently, often companies are not motivated to invest in environmental initiatives, since the business case for environmental sustainability is still hard to make and investment does not appear to pay immediately. Businesses are not willing to engage in sustainable development to the extent that is needed to actually achieve sustainability. Government relying on voluntary environmental product stewardship schemes might not bring about change very quickly. Therefore, from a systems level perspective it might make environmental and business sense to enact environmental legislation to create a business context in which environmental investment is financially rewarded. Encouraging partners along value chains across entire product life cycles, including consumers is essential for sustainability. It is also in everyone´s interest.

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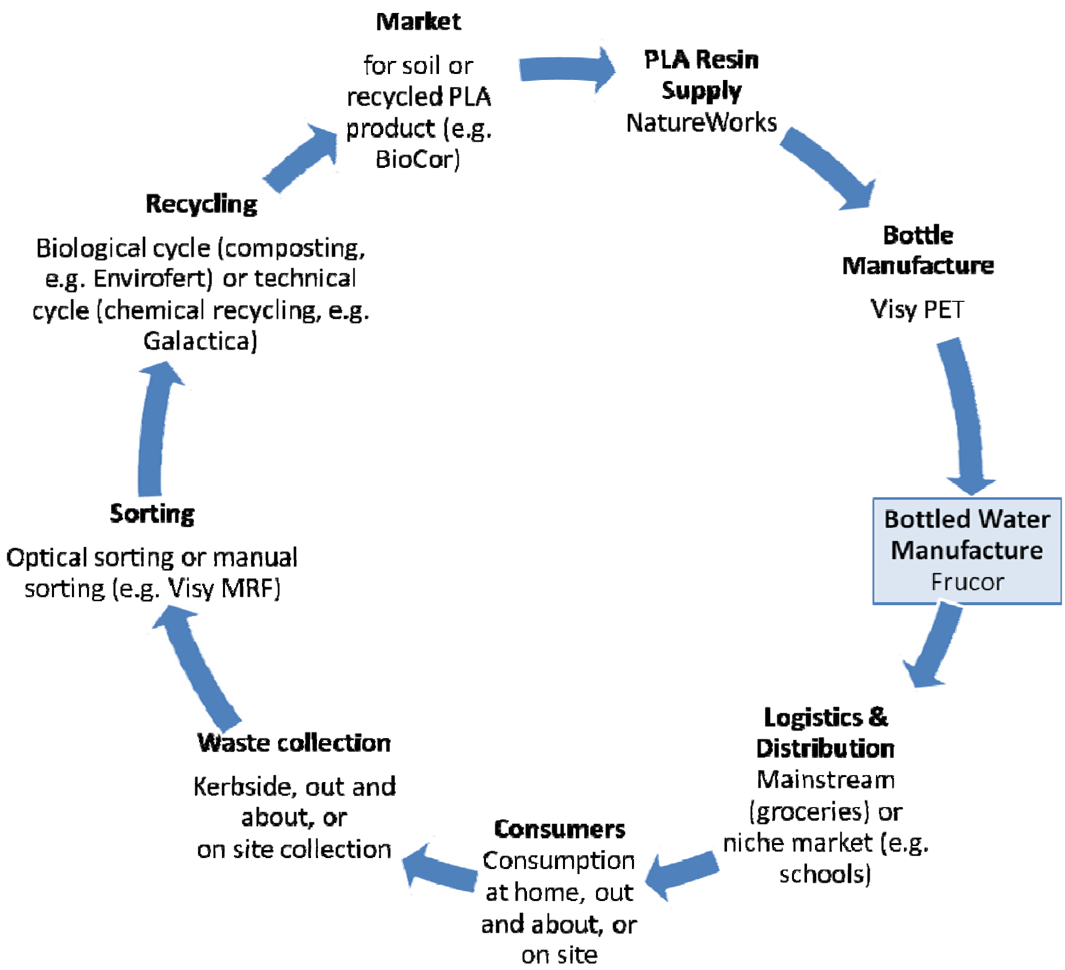
Appendix I

Example early draft for cyclical material flows for a PLA beverage pack

Below I offer an example early draft for a potentially cyclical material flow for PLA beverage packaging. This draft combines different options as to target market and end of life of the beverage pack. Please note, several such figures were prepared, and the final version appears in Figure 10 in Section 6.2.4 of this dissertation.



Appendix II

Indicators for the environmental impact of packaging

The following indicators are derived from the “Code of practice for packaging design, education and procurement”, suggested by the Packaging Council of New Zealand (2010, pp. 11-19).

* Indicators, which supplemented the theoretical framework for the assessment of the environmental initiative in this project.

Resource Efficiency

New product development (NPD) process

- Total material use*
- Material waste*
- Virgin material use*
- Post-consumer recycled material use*
- Post-industrial material use
- Material use reduction
- Re-use of packaging*

Existing packaging review

- Not applicable for this project

Minimise materials

- Total material use
- Virgin material use
- Renewable material use
- Post-consumer recycled material use
- Post-industrial recycled material use

Transportation (supply chain) efficiencies*

- Life-cycle energy intensity
- Life-cycle non-renewable energy intensity
- Life-cycle renewable energy intensity

Energy efficiencies

- Energy audits conducted
- Total lifecycle energy intensity
- Renewable energy proportion
- Lifecycle energy intensity (non transport)
- Lifecycle non-renewable energy intensity (non transport)
- Lifecycle renewable energy intensity (non transport)

Water efficiencies

- Lifecycle water consumption
- Lifecycle water used from stressed sources
- Water emissions
- Chemical oxygen demand (COD) emissions
- Suspended solids released

Low Impact Materials

General indicators

- Lifecycle green house gas (GHG) emissions
- Total lifecycle energy intensity
- Lifecycle non-renewable energy intensity
- Lifecycle water consumption
- Lifecycle water used from stressed sources

Re-usable packaging

- Re-use of packaging
- Total lifecycle energy intensity
- Renewable energy proportion
- Lifecycle energy intensity (non transport)
- Lifecycle non-renewable energy intensity (non transport)
- Lifecycle renewable energy intensity (non transport)
- Recovered latent energy
- Material use reduction
- Lifecycle water consumption
- Lifecycle water used from stressed sources
- Landfilling of packaging

Post consumer recycled materials

- Post-consumer recycled (PCR) material use
- Lifecycle GHG emissions
- Total lifecycle energy intensity
- Lifecycle non-renewable energy intensity
- Lifecycle water consumption
- Product safety

Recyclable materials

- Recycling of packaging

Materials from renewable sources

- Renewable material use
- Chain of custody

Degradable materials

- No indicators suggested

Risks associated with hazardous materials

- No indicator suggested

Locally sourced materials*

- Total lifecycle energy intensity (transport)
- Lifecycle non-renewable energy intensity (transport)

Materials from responsible suppliers

- Chain of custody

End-of-Life Options

Recovery for recycling purposes

- No indicator suggested

Recovery for composting purposes

- No indicator suggested

Energy recovery

- Packaging energy recovery rate

Landfilling

- Landfilling of packaging

Katrin Herdering MBus 2010