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Motives for Adopting Bio-based Plastic Packaging Materials in the Dutch Food Industry

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Abstract

The purpose of this study is to provide insight into the factors that determine the willingness of brand owners in the Dutch food industry to adopt bio-based plastic packaging. In order to obtain an answer first a conceptual model is developed based on the Five Forces model by Porter, and Roger's adoption theory. To better determine the appropriate indicators for the measurement of the concepts a pilot consisting of expert interviews is performed. The data for this study is collected by means of an online survey sent to all brand owners in the Dutch food industry.

Descriptive statistics of the survey data show that there are only two groups of bio-based plastic adopters among Dutch brand owners: those that are currently considering bio-based plastic packaging, and those that have not considered it yet. Due to the low number of completed questionnaires advanced multivariate statistical methods cannot be used for data analysis. Instead the data analysis is performed using independent T-tests of means for both brand owner groups.

These tests identify incentives from the food service industry, expected opportunities for CO2 reduction on both the short-term and long-term, and the importance of the brand name in decision-making as factors that determine the willingness of brand owners to adopt bio-based plastic packaging. The tests also shows that in particular large brand owners, both in terms of employees and packaging volume, are considering the use of bio-based plastic packaging.

That brand owners are at best just considering bio-based plastic, and that there are only a few doing even that, indicates that while bio-based plastic packaging remains a substitute product within an already existing industry, it appears to be distinctive enough from petroleum-based packaging to initiate a new product life cycle. Another indication is that the food service industry currently has a more prominent role than retailers due to their stronger customer relationship and higher margins, which make it easier for them to cover the investment costs. There is no need for the government to interfere with regulations to stimulate the use of bio-based plastic packaging. Following the typical product life cycle, brand owners may be expected to gradually extend their activities to other markets, such as retail. One thing to keep in mind with using bio-based plastic is the effect of possible ethical discussions concerning competition with food and genetically modified biomass.

Foreword

At this point I'd like to first thank my parents, for supporting me during all my years of study. And I'd also like to thank both Jan Faber and Martin Patel for all the great help they've given me during this thesis project. Finally I'd like to thank all interviewees and respondents for their time, because without them this research would not have been possible.

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1 Introduction

The vast majority of plastics used in packaging today are petroleum based (PlasticsEurope, 2011a). This is undesirable because it contributes to environmental pollution, by producing CO_2 emissions (Oberstein *et al.*, 2001; van Aalst, 2006) and by causing waste issues (Stevens, 2001; Allwood *et al., 2010;* PlasticsEurope, 2011b; Alvarez-Chavez, *et al.,* 2012). Over the past decades bio-based plastics have been developed as a sustainable alternative (Stevens, 2001; Mohanty *et al.*, 2002). These plastics have developed considerably, but currently they are typically still not yet competitively priced and/or still offer a (slightly) lower performance (Shen, *et al.,* 2009; Hermann, *et al.*, 2010; Kuruppalil, 2011). Also, they can currently only be produced in very small volumes (Shen *et al.*, 2009), and there is still an ongoing debate about whether they meet their sustainability claims (Patel *et al.*, 2003; Guilbert *et al.,* 2011, Alvarez-Chavez *et al.,* 2012; Weiss *et al.*, 2012).

Regarding price and performance bio-based plastics could catch up with petroleum-based plastics within the next few years. This is possible due to the oil scarcity driving up the cost of petroleum-based plastics (Alekkett, 2007; de Almeida & Silva, 2009; Owen *et al.*, 2010; Tsoskounoglou *et al.*, 2008; Schippers *et al.*, 2009), and the ongoing price and performance improvements of bio-based plastics (Shen *et al.*, 2009; Hermann *et al*., 2010; Kuruppalil, 2011; Bohlmann, 2007). Production capacity on the other hand will need more time to catch up, but is rapidly growing despite the ongoing economic crisis (Shen *et al.*, 2009; ICIS, 2010, 2012).

However, there is also considerable uncertainty related to the price of bio-based plastics, which originates from the technological uncertainties involved in the relatively early stages of a new technological development (Tidd *et al.*, 2005), but also from the potential serious competition from bio-fuels for biomass (Gillespie *et al.,* 2011; Hermann *et al.,* 2011; Mathews, 2008; Bohlmann, 2007). Furthermore, even with the production capacity of bio-based plastic growing rapidly, there exists a realistic possibly that demand will exceed supply, particularly if bio-based plastic becomes popular.

Despite the current disadvantageous price, performance and production capacity, as well as the uncertainty regarding future improvements, several brand owners in the food industry have taken on a pro-active role in the development of bio-based plastics for their packaging solutions. For example, Coca-Cola and Heinz are seriously considering the adoption of bio-based plastics in extended pilot programs (Heinz, 2012; Coca-Cola, 2009, 2012) and are investing in the improvement of bio-based plastics (Coca-Cola, 2011; BPM, 2011; CPIS, 2012). The goal of this study is to gain more insight into what motives brand owners to consider using bio-based plastic for their packaging.

Prior studies suggest that this kind of pro-active behavior with regards to sustainability is typically driven by the influences of external stakeholders (González-Benito & González-Benito, 2006, 2010), such as suppliers, distributors, consumers and/or governments. While historically governmental influence tended to be a major driver (Bansal & Roth, 2000), other studies have revealed that there is still too little legislation

on bio-based plastics in order to be a significant driver in this case (Wydra, 2012; Hermann *et al.*, 2012; Gillespie *et al.*, 2011). In fact, current EU legislation favors bio-fuels, making it actually more difficult to adopt bio-based plastics (Hermann *et al.*, 2012). Furthermore, the previous paragraphs already indicated clear indications that brand owners could be experiencing a market pull from their distributors and/or end-consumers, in contrast to a technology push from their suppliers (Tidd *et al.*, 2005).

Over the past decades retailers in particular have obtained a strong position vis-a-vis their suppliers due to their massive size, with the USA based Wal-Mart taking the lead (Konefal *et al.*, 2007; Fuchs *et al.*, 2009; Warner, 2006). In recent years these retailers reached the limits of competition on price alone, and therefore started to differentiate also on quality (Konefal *et al.*, 2007). Because their public image has come to have a significant influence on their performance (Konefal *et al.*, 2005), public concern drove them to differentiate on food quality (Lowe, *et al.*, 2008), and more recently on sustainability (Jones *et al.*, 2005; Wal-Mart, 2007).

While this study focuses on the sustainability aspect, it is interesting to note that studies show that it were retailers, and not governmental organizations, which initially took the lead in setting (private) food quality standards, but also that their activity was primarily driven by business motives (Busch & Bain, 2004; Henson, 2008). Now the same appears to be happening with the sustainability trend, as Wal-Mart is very open about only being interested in any kind of sustainability improvements if they are profitable to them and do not raise prices for their customers (Wal-Mart, 2007).

With respect to packaging Wal-Mart has introduced a rating system awarding preferences to suppliers that use sustainable packaging (Wal-Mart, 2006). Because efficiency limits of plastic packaging have (nearly) been reached, brand owners need to consider alternative materials to improve the sustainability of their packaging. With bio-based plastics not yet being profitable alternatives, and Wal-Mart not accepting anything that is not profitable to them and not willing to raise prices, this implies that the upstream value chain has to take a hit to their margin. The pro-active behavior of brand owners suggests they are the ones taking, and trying to lower, this hit.

At the surface it might appear that brand owners, even major ones such as Coca-Cola, act simply because they have little choice due to Wal-Marts' purchasing power (Warner, 2006). On the other hand, gaining (or maintaining) a high preference in the supply lists of Wal-Mart could also generate benefits in terms of sales volume. Furthermore, just like their distributors, brand owners could also be considering the impact of the public concern about the environment on their image, and/or use it as a means of differentiating their products. After all, ultimately both distributors and brand owners are dependent on the preference of consumers. Finally, brand owners could be planning ahead, in anticipation of rising oil prices or legislation. From these perspectives they might be aiming to secure and/or improve their own supply chain or perhaps spread the cost of meeting the demands of future legislation. Essentially, brand owners could be acting on demands made by their distributors,

and/or they could be self-motivated after recognizing opportunities to improve their own profits.

1.1 Research question

The previous paragraphs outlined several plausible motivations for brand owners in the food industry to consider the adoption of bio-based plastic packaging for their products. The purpose of this study is to find out which factors do have a significant influence. This leads to the following research question:

> *Which factors determine the willingness of brand owners in the Dutch food industry to adopt bio-based plastic packaging?*

In order to answer this question the influences outlined earlier, including the role of various stakeholders, need to be further examined. The second chapter of this proposal describes the theoretical framework with all potentially influential stakeholders and factors. Next the research methods are described, followed by a timeline and working plan.

However, first it is worth bringing to the attention that this study focuses specifically on bio-based plastics, not biodegradable plastics. While both are bio-plastics, there is a considerable difference between the two (Shen *et al.*, 2009; Guilbert *et al.*, 2011; Alvarez *et al.*, 2012). Bio-based plastics are all plastics produced from a renewable source, but not always biodegradable. Biodegradable plastics on the other hand are not always produced from a renewable source. The focus of this study is on bio-based plastics for two reasons. Firstly, if a bio-plastic is not produced from a renewable source it does not actually address the main issues with petroleum-based plastics. Secondly, biodegradable plastics are often far less suitable for durable applications, which limits their potential as substitute for petroleum-based plastics considerably (Shen *et al.*, 2009).

Furthermore, there are various kinds of bio-based plastics (Shen *et al.*, 2009; Guilbert *et al.*, 2011). What most brand owners are considering now is blending bio-based plastics with petroleum-based plastic in a way that 20 – 30% of the packaging is made up of bio-based plastics. Depending on specific packaging requirements different bio-based plastics and compositions may be used. Some are aiming to use 100% bio-based plastic, which creates additional technological challenges. Aside from this there is no distinction made between specific kinds of bio-based plastics and/or compositions in this study. The first argument is that the use of bio-based plastic is currently not widespread enough to distinguish specific factors that determine the willingness to adopt specific kinds of bio-based plastic and/or compositions. Furthermore, given that bio-based plastics are an emergent technology it is quite uncertain whether enough knowledge about bio-based plastics exists among potential adopters for them to form an opinion about specific bio-based plastic technologies.

2 Theoretical Framework

The main purpose of this study is to gain more insight into what motives brand owners to consider using bio-based plastic for their packaging. Because this concerns an innovation adoption process, adoption theory (Rogers, 1995, 2003) provides a suitable basis for the analytical framework of this study. Adoption theory provides a framework in which an innovation, in this case bio-based plastics used for packaging, is evaluated from the perspective of a person or social entity, in this case the brand owner.

The introduction described the potential influence of distributors and consumers on the willingness of brand owners to adopt bio-based plastic for their packaging, and the possibility that brand owners act of their own accord based on perceived opportunities to improve their position. Both possibilities illustrate how the business environment is relevant to the decision making process of firms (Porter, 1996, 2008). Furthermore, prior studies have shown that stakeholders have a significant influence on the decision-making process regarding sustainability related matters (e.g. Bansal & Roth, 2000; González-Benito & González-Benito, 2006, 2010).

Consequently, the first sub-section of this chapter builds on the Five Forces model of Porter (2008), in order to provide an overview of all stakeholders in the business environment of brand owners for which it can be plausibly argued that they play a role in the decision making process of the brand owners. The second sub-section then elaborates on the earlier mentioned adoption theory. The adoption dimension in adoption theory factors will be linked to the stakeholders. The third sub-section describes four control variables included in this study. Finally, the fourth sub-section provides a graphical presentation of the complete conceptual model.

2.1 Stakeholders

Commercial organizations obviously do not function in isolation. At the least they need to interact with their customers. How a firm chooses to interact with its environment usually is of considerable importance to its performance (Porter, 1996). When there already is a well-established environment, such as in this case, the Five Forces model developed by Porter (Porter, 2008) makes a suitable starting point for providing an overview of relevant stakeholder groups. Porter's model, presented in figure 2.1, highlights five key forces that make up the competitive environment of an existing industry. These forces represent five stakeholder groups that a firm has to take into account when making decisions. To be clear, in this model the brand owners are positioned within the group of competitors.

Figure 2.1 - Five Forces that shape industry competition (Porter, 2008).

As already mentioned, the five forces model is a starting point. In the context of this study two of these five forces can be discarded as irrelevant. These are the "*Threat of New Entrants*" and the "*Threat of Substitute Products or Services*". It is unlikely that the type of plastic used for packaging a product has a significant impact on the opportunities for industry outsiders to enter the market and capture a significant market share from the brand owner, or on the opportunities for entirely new kind of products (Christensen & Raynor, 2003; van Orden *et al*., 2011). Other factors, such as the actual product contained within the packaging, are much more important to obtaining a position from which a firm can generate a profit within this industry (Teece, 1986).

The *"Bargaining Power of Suppliers"* relates in this case specifically to the suppliers involved in the supply chain of the plastic bottle. While earlier it was told that suppliers are unlikely to be a driving force behind the decision making process of brand owners, this is not certain without doubt. Furthermore, brand owners could be aiming to decrease the bargaining power of their suppliers. This would mean suppliers are not active stakeholders, but do comprise a relevant actor group. The potential related drivers are discussed in the section § 2.2.

Also, this case calls for "*Bargaining Power of Buyers*" to be sub-divided into two stakeholder groups, which are the *distributors* and *end-consumers*. There are two reasons for making this distinction. Firstly, these are clearly distinctive groups with different stakes and views. Secondly, brand owners have a direct connection to both groups. Distributors are the direct customers of brand owners, while the direct interaction with end-consumers is apparent by brand marketing and brand preferences of consumers. Naturally, distributors also have a direct relation with the end-consumers, and influence on the relationship of brand owners and end-consumers.

There are also two relevant stakeholders that are not represented by competitive forces, which are governments and non-governmental organizations (NGOs). Porter (2008) argues specifically that governments should not be considered as sixth force in his model because "[…] *government involvement is neither inherently good nor bad for industry profitability.*", whereas increased power coming from the five forces

always negatively impacts the position of a firm. Instead he argues that each policy should be considered as an independent factor that has an influence on one or more of the five forces. Regardless of how their influence is incorporated by Porter, governments (taken to including all governmental agencies) clearly represent a stakeholder group that can have a significant and direct impact on the decision making of a firm (Clarkson, 1995). Furthermore, prior studies show that legislation can have a significant role as driver of sustainable activities of commercial organizations (Zadek, 2004; Bansal & Roth, 2000; Clemens & Douglas, 2006).

Prior studies also reveal NGOs to have the potential of being an influential stakeholder group in the context of this study (e.g. Plambeck & Denend, 2008). At a first glance this stakeholder group appears to simply be disregarded by Porter. Closer inspection reveals how Porter considers union groups as representatives for the 'suppliers' of labor (Porter, 2008). Following this line of thought, environmental pressure groups could possibly be considered representatives of buyers in his five forces model. There is however a key difference, which is that such pressure groups lack the mandate of union groups. That is to say, environmental pressure groups have no direct control of the actual purchasing behavior of these buyers. Considering the purchasing behavior is a relevant aspect to this case, NGOs and buyers should be considered as separate stakeholders.

Clarkson (1995) categorizes NGOs as secondary stakeholders, because they have no direct influence on the performance of a firm. Even if their influence can be considerable, it is always indirect through their influence on consumer perception and policies developed by governments. Direct interaction between brand owners and NGOs does not change this fact. Brand owners may respond to direct demands from NGOs, but only because these NGOs could significantly affect the purchasing behavior of consumers and/or the development of legislation.

The model depicted in figure 2.2 provides an overview of all relevant stakeholders in this case. Again for clarification, brand owners themselves are positioned within the competitors stakeholder group.

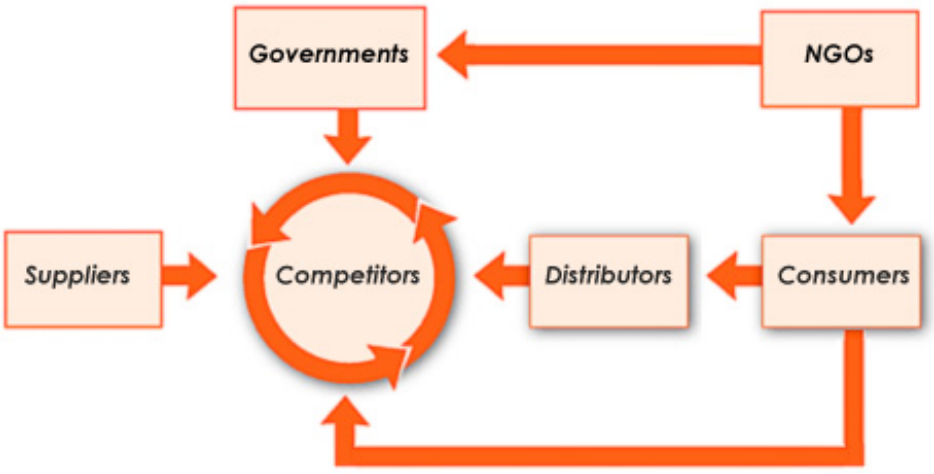

Figure 2.2 – Overview of the relevant stakeholders to the decision making process of brand owners.

2.2 Adoption factors

Inventions clearly do not instantaneously spread throughout a population; rather they gradually diffuse over time, if at all. According to diffusion theory (Rogers, 1995, 2003), individuals or social entities faced with an opportunity to innovate go through an innovation-decision process in which they decide whether or not to adopt the particular innovation. Rogers defined adoption as "*a decision to make full use of an innovation as the best course of action available*" (Rogers, 1995). In this particular case brand owners are the social entities faced with this decision.
During the evaluation process five key innovation characteristics, better known as '*adoption factors'*, play a central role (Rogers, 2003): (1) *relative advantage*; (2) *compatibility*; (3) *complexity*; (4) *trialability*; and (5) *observability*. Because this study concerns the willingness of brand owners to adopt, rather than actual adoption behavior, these factors need to be adapted accordingly. This means all factors are to be framed as expectations, rather than the experiences. The following sub-sections each discus one of the factors in the context of this case. The first of the adoption factors, *relative advantage* (1), is broken down further into three dimensions.

2.2.1 Relative Advantage

The adoption factor *relative advantage* is defined as *"the degree to which an innovation is perceived as being better than its precursor"* (Moore & Benbasat, 1991). Or put in different terms, the factor relative advantage represents the perceived added value compared to the current solution. In this case of course it is about the expected added value. This added value can be measured in terms of *financial risks*, *non-financial benefits* and *image*. This distinction is made partially because they are distinctive categories that provide structure to the considerable number of aspects related to the factor relative advantage, but also because they are expected to possibly have a different effect on the willingness of brand owners to adopt bio-based plastic packaging. Each of the dimensions is discussed in a sub-section, starting with the financial risks.

2.2.1.1 Financial risks

There are two basic ways for an innovation to create a financial advantage over an existing solution. It can reduce the cost of producing a product and/or it can create a higher added value for the customer. There is no indication that bio-based plastic packaging currently offers either of these benefits. As told before, bio-based plastics have developed considerably, but are typically still not yet competitively priced compared to petroleum-based plastics (Shen *et al.,* 2009; Hermann *et al.*, 2010; Kuruppalil, 2011).
While the current day pricing situation of bio-based plastics looks grim for brand owners, the pricing prospects for the next few years are arguably more positive. For one, there is considerable potential for significant production cost reductions, particularly compared to the relatively little remaining potential for improvement in petroleum-based plastics (Shen *et al.,* 2009; Hermann *et al.*, 2010; Kuruppalil, 2011). Furthermore, as the price for oil will certainly rise in the future (Alekkett, 2007; de Almeida & Silva, 2009; Owen *et al.*, 2010; Tsoskounoglou *et al.*, 2008; Schippers *et*

al., 2009), the pricing of bio-based plastics will become relatively more attractive. This may not directly influence margins as the production cost reductions do, but it would mean that lower margins (by sticking to petroleum-based plastics) become impossible.

On the other hand there is still a considerable degree of uncertainty regarding the price development of bio-based plastics. This uncertainty originates in part from the typical (technological) uncertainties involved with the relatively early stages of technological development (Tidd *et al.*, 2005). More specific to this case is the uncertainty that arises from the potential serious competition of bio-fuels for biomass, which is the basic resource for both bio-based plastics and bio-fuels (Gillespie *et al.,* 2011; Hermann *et al.,* 2011; Mathews, 2008; Bohlmann, 2007). Furthermore there are of course also the uncertainties in the supply and demand dynamics of bio-based plastics themselves, and the chain effect that the expected increase in production of bio-based plastics (e.g. Shen *et al.*, 2009) will have on the supply and demand dynamics of biomass – and thus by extension the price of bio-based plastic. Such uncertainties are generally considered to be a financial risk.

The second way to create a direct financial advantage depends on whether consumers are willing to pay extra for a packaging if it is made from bio-based plastics. If consumers do not consider it to add value to the product, and are consequently unwilling to pay a premium, then distributors are typically left with little choice but to keep the price unchanged or take a hit to their sales volume. After decades of studies there is still an ongoing debate as to whether or not consumers are willing to pay a premium for environmental friendly products (Autio *et al.*, 2009; Abdul-Muhmin, 2007; Diamantopoulos *et al*., 2003; Laroche *et al.*, 2001). What is clear at least is that there is no simple single answer (Diamantopoulos *et al.*, 2003).

An insightful remark made in one literature review is that many studies have no regard for the reality that the first barrier any novel (food) product in a store faces is that it needs to disrupt the subconscious purchasing pattern of a consumer (Abdul-Muhmin, 2007). Consumers may simply stick to the products they purchase out of habit without even considering to switch to the more environmental friendly packaged products. Another insightful aspect is the discrepancy between actual behavior and stated attitudes, indicating respondents are prone to provide social desirable answers (Diamantopoulos *et al.*, 2003). All things considered it is likely that there are still some consumers who will be willing to pay extra, but also that the mainstream consumers will not yet.

On the positive side, there is an ongoing trend that consumers are becoming more environmentally conscious. Even without a clear willingness to pay a premium on current prices, environmental performance could gradually become a criterion that consumers use in their purchasing decisions, similar to the way minimum food quality and safety criteria have become more important over the past years (Rhör *et al.*, 2005; Grunert, 2005). So while current day margins may be lower, there are some indications that in the future margins of bio-based plastic packaging could come to exceed those of petroleum-based packaging.

However, Wal-Mart, as major distributor for brand owners, is very clear about not paying more for bio-based plastic packaging than for the

current petroleum-based plastic packaging (Wal-Mart, 2007). They can take this stance because of their massive bargaining power (Porter, 2008) over their suppliers (Konefal *et al.,* 2007; Fuchs *et al.*, 2009; NY Times, 2006). If costs go up and the selling price remains the same then the margins go down. The question then becomes who in the downstream value chain is/are going to take a hit to their margins. While it could be that other distributors, such as food service chains, are more willing to share in the hit to the margins, any international brand owner will have to work with Wal-Marts like positions due to their dependency on the sales volume generated through such major retailers (Pfeffer & Salancik, 2003; NY Times, 2006).
Effectively Wal-Mart is forcing its suppliers to pay for their sustainability programs. Unless brand owners can exert similar pressure on their suppliers they will have to accept lower margins, at least for a large part of their sales volume. The pro-active behavior of brand owners to invest in the development of bio-based plastics (e.g. Coca-Cola, 2011) suggests they do not have this kind of bargaining power over the suppliers of bio-based plastics. This is in line with Porter's (2008) argument that suppliers gain bargaining power over their customers when their product is specialized and demand exceeds supply, which reportedly is the case for bio-based plastics (Shen *et al.*, 2009). On the other hand, the major size difference between well established brand owners and the young suppliers is also something to consider. But what is perhaps the overriding factor is that because bio-based plastic suppliers simply lack the benefits of large-scale production facilities, the production of bio-based plastics at a truly competitive price is currently still unfeasible, if not impossible (Shen *et al.,* 2009; Hermann *et al.*, 2010; Kuruppalil, 2011).
In the early stages of an innovation trajectory the benefits tend to be overstated, while the risks are often played down, given little thought or simply unknown (Alkemade & Suurs, 2012). Also, because this is an innovation in packaging that does not threaten core business model(s), brand owners are much less likely to be adverse to innovation (Gilbert, 2005). However, while the rising oil prices may provide some leniency, the two key elements to this dimension, being the lack of an opportunity to reduce costs and the lack of an opportunity to ask a premium for bio-based plastic packaging, represent definite financial barriers, or risks, that lead to the first hypothesis that is to be tested in this study:

> *H1: The expected financial risks have a negative influence on the willingness of brand owners to adopt bio-based plastics for their packaging.*

2.2.1.2 Non-financial benefits

Non-financial benefits generally concern business factors and legislative benefits. In this case the legislative benefits can be discarded as irrelevant. There is only a limited amount of legislation that affects bio-based plastics, which led recent studies to indicate that thus far legislation has not had any significant impact (Wydra, 2012; Hermann *et al.*, 2011; Gillespie *et al.,* 2011). This also means that although governments are categorized as primary stakeholders that have a direct relation with brand

owners (Clarkson, 1995), they are actually of little importance in this case.

Business factors comprise the other part of the non-financial benefits. One such a business factor starts with the realization that choosing to be a leading innovator in bio-based plastics, and making investments in the development of the technology, may result in unique knowledge that can be patented. Speed and unique knowledge are fundamental elements that help in establishing a strong appropriability regime (Teece, 1986), which means to say that they help a firm to obtain a large share of the (future) profits in the industry when bio-based plastics become more important.

It is no secret that firms with consumer relations, which in this case includes distributors and brand owners, are trying to leverage the societal concern about the environment as an opportunity to differentiate themselves from competitors (e.g. Konefal *et al.,* 2007; Konefal *et al.,* 2005; Jones *et al.*, 2005; Wal-Mart, 2007). Even though the added value perceived by customers may (still) be low, distributors differentiating on sustainability create additional support for brand owners also to differentiate on sustainability. Having unique knowledge allows a brand owner to do just that. And with a unique premium product they could increase their bargaining power towards the distributors that ask for sustainable products (Porter, 2008). While Wal-Mart may be refusing to pay more for bio-based plastic packaging, they may compensate their sustainable suppliers by awarding them a better exposure as preferred suppliers (Wal-Mart, 2006). Such a position can be expected to result in higher and more reliable sales volumes. Furthermore, the leading brand owners could license their proprietary knowledge to non-competitive brand owners.

Another business factor that could be of influence concerns the downstream relation with suppliers. As said before, there is still a considerable amount of uncertainty about the supply of biomass (Gillespie *et al.,* 2011; Hermann *et al.,* 2011; Mathews, 2008; Bohlmann, 2007). Furthermore, the production capacity of bio-based plastics is very low in comparison to that of petroleum-based plastics, even with taking into account its expected large growth (Shen *et al*, 2009; ICIS, 2010). This suggests that currently suppliers have a bargaining advantage (Porter, 2008). However, while on the one hand suppliers appear to be in a strong position, to grow they need significant up front investments. By taking the lead brand owners could provide support, as investors and/or as reliable launching customers through purchasing contracts. In either case it creates a dependency of these suppliers on the leading brand owners (Pfeffer & Salancik, 2003), which means that the relation between brand owners and suppliers is somewhat more complex than outlined before (in § 2.2.1.1).

In principle, the bargaining advantage brand owners have over suppliers could be used to achieve lower prices in the short term, but this would be in conflict with the current pricing disadvantage due to the low production capacity and the need of suppliers to get funds for scaling up this capacity. It would be much more likely that brand owners use their advantage as leverage to gain priority or even exclusivity rights as customer, and/or bargain for lower prices when production cost decrease.

The latter is already addressed as one of the financial benefits, but the former could be an expected non-financial benefit.
In sum, the following non-financial benefits of adoption of bio-based plastic for packaging by brand owners have been discerned; the competitive advantage (of unique knowledge), preferred supplier positions and a reliable supply chain. Accordingly, the following hypothesis is formulated:

> *H2: The expected non-financial benefits have a positive influence on the willingness of brand owners to adopt bio-based plastic for their packaging.*

2.2.1.3 Image

It used to be that consumers were highly loyal to brands. Today this is much less so, as more choice and information to evaluate products has become available (Smith, 2003; Hagel *et al.*, 2012). However, this does not mean brand names have become irrelevant. Branding is still a very useful marketing tool that companies use to communicate with their consumers (Christensen *et al*., 2005). With the decreased loyalty of consumers its role has actually changed to become more important for brand owners.
Traditionally the purpose of a brand was to communicate the qualities of the product(s) the brand owner offers, but citizens have become increasingly concerned with how brand owners run their business (Smith, 2003; Zadek, 2004; Hagel *et al.*, 2012). This is commonly referred to as Corporate Social Responsibility (CSR), which includes how their activities impact the social and natural environment. CSR is far from being something new, but has never been considered more important than in the past decade (Smith, 2003). Smith (2003) notes that because of its current perceived importance strong business cases can be made for CSR related activities.
Prior studies reveal how retailers have become more dependent on maintaining a positive public image (Konefal *et al.*, 2005), and have started addressing the societal concern for the environment as an opportunity to differentiate themselves from their competitors (Jones *et al.*, 2005; Wal-Mart, 2007). Other studies have shown in more generic terms that being in close contact with consumers, as is the case with distributors and brand owners, increases the chances that a firm becomes involved in environmental activities (Haddock-Fraser & Fraser, 2008; Haddock-Fraser & Tourelle, 2010). Considering all of the above it is rather likely that brand owners are very concerned about their image.
The name 'bio-based plastic packaging' obviously suggests the packaging is environmental friendly. However, there is actually still some debate as to whether bio-based plastics are better for the environment than petroleum-based plastics (Patel *et al.*, 2003; NatureWorks, 2009; Guilbert *et al.,* 2011, Alvarez-Chavez *et al.*, 2012; Weiss *et al.,* 2012). To be more precise, bio-based materials generally offer better performance when it comes to greenhouse gas (GHG) emissions, but in turn create their own issues. These are in particular higher eutrophication and stratospheric ozone depletion, and the increased land use (Weiss *et al.*, 2012).

All three issues are a result of the way biomass, the base resource for any bio-based material, is produced today. By improving existing production methods and by switching to more sustainable alternative sources for biomass these issues can be addressed (Weiss *et al.*, 2012). Another option for improving the environmental performance is to integrate the production of bio-based plastics in a chain of other processes, to minimize waste. Furthermore, the considerable potential for production process improvements and up scaling of the production plants are also two factors that are likely to lead to a better environmental performance (Shen *et al.*, 2009; Natureworks, 2009; Weiss *et al.*, 2012). All in all it can be concluded that on the long term – a horizon often associated with the concern for the environment – bio-based plastics are likely to outperform petroleum-based plastics.

Of course, reality is that while the average citizen is growing more concerned about the environment, they are likely not even aware of the complex scientific debates on Life Cycle Assessment (LCA) results and measurement methods related to the various plastics available to be used for packaging. Contrary to what might be expected that does not make LCAs useless in the context of a brand owners' concern for their brand image. For one, competitors would probably respond with legal action if (advertising) claims were unfounded. This means that particularly in a business-to-business (B2B) context LCAs are critical. But more to the point here is that NGOs tend to do pay attention to these matters. Based on such studies NGOs can decide whether or not to endorse the bio-based plastic packaging, benefitting the brand owner's sales and image. Currently, two NGOs support bio-based plastics over petroleum-based plastics, namely Greenpeace and WWF (CPIS, 2012).

As a closing note on the subject, brand owners do need to be very careful about where their biomass is produced. The industry supporting bio-fuels took a considerable, perhaps irreparable, hit to their image when it was discovered that the biomass they used was produced on land that from an ethical point of view should have been used for food production (Gomiero *et al.*, 2010; Boyx & Tait, 2011; Delshad *et al.*, 2010). However, the production methods of biofuel have since seen considerable improvements. That is to say, non-food sources of biomass are technological possibilities and are becoming economically viable alternatives (Delshad *et al.*, 2010; Havlik *et al.*, 2011). The same direction could be taken with producing bio-based materials (Weiss *et al*., 2012*).* Also, the required production capacity of biomass for use in bio-based plastics is very low (Natureworks, 2009). Avoiding the use of land that is suitable for food production, particularly in areas that do not have an abundance of food, is an important element for maintaining a positive image, but not an insurmountable task considering the technological improvements and relatively low production requirements of biomass for the production of bio-based plastic.

As such a benefit to the brand image can still be expected, allowing the following hypothesis can be formulated:

> *H3: The expected benefit to brand image has a positive effect on the willingness of brand owners to adopt bio-based plastics.*

2.2.2 Compatibility

Compatibility, the second adoption factor, is defined as "*the degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters*" (Moore & Benbasat, 1991). The most significant changes in switching from petroleum-based plastic to bio-based plastic occur in the production process of the plastic by the suppliers. This means that brand owners have little to worry about the majority of the compatibility issues of switching to bio-based plastics for packaging.
Some brand owners are either considering or already using packages with 20-30% bio-based plastic (e.g. Coca-Cola, Heinz). In this case the packaging that brand owners get to work with is effectively identical to the packaging made from petroleum-based plastic. To these brand owners the factor compatibility is of no consequence. However, when using 100% bio-based plastics, such as PLA, the physical properties of the packaging are slightly different. This is inherent to the material and/or necessary to meet performance requirements (Shen *et al.*, 2009). The brand owners aiming for 100% bio-based plastic in their packaging may therefore have to worry about the compatibility of their own installations and recycling streams. In finely attuned machinery small changes can be enough to create compatibility issues. So by aiming for 100% bio-based plastic packaging brand owners can expect compatibility issues. This results in the following hypothesis:

> *H4: The expected compatibility issues have a negative effect on the willingness of brand owners to adopt bio-based plastic for their packaging.*

2.2.3 Complexity

The third adoption factor, complexity, is defined as "*the degree to which an innovation is perceived as being difficult to use*" (Moore & Benbasat, 1991). The main way by which adoption of bio-based plastic for packaging can be expected to cause complexity concerns the establishment and management of new supply chains.
The supply chains have already been brought up before various times. It has been argued that the competition for bio-mass might be a cause of concern (§ 2.2.1.1), but also that adopting bio-based plastics could in fact benefit the reliability of supply lines (§ 2.2.1.2), and that this benefit does not come at the price of compatibility issues (§ 2.2.2). The benefit of having a reliable supply of bio-based plastic packaging could however come at the cost of added organizational complexity. The production capacity of bio-based plastics still needs to grow a lot (Shen *et al.*, 2009; ICIS, 2010). It can be expected that a supply chain that is new and growing rapidly will require brand owners to be more involved, leading to a higher organizational complexity, compared to simply putting in an order for more packaging, as could be done in a mature supply chain such as that of petroleum-based plastic packaging.
Finally, there is also the necessity of continuously ensuring that the resourced biomass is produced without having a detrimental impact on the local food production. As told earlier, failing in this respect could bring considerable damage to the brand image, as it did in the industry for bio-

fuels (Delshad, 2010). Over time this aspect can be expected to become less relevant as alternative ways of producing biomass become more viable (Havlik *et al.*, 2011; Weiss *et al.*, 2012). For the time being it remains important enough to keep an eye on.
As a result of the need for getting more involved in managing the supply chain, the following hypothesis can be formulated:

> *H5: The expected complexity has a negative effect on the willingness of brand owners to adopt bio-based plastics for their packaging.*

2.2.4 Trialability

Trialability is defined as "*the degree to which an innovation may be experimented with before adoption"* (Moore & Benbasat, 1991). In this case there are two ways of looking at this factor. The first way is to consider how difficult it is for brand owners to experiment with the innovation from a technological point of view. The second way is to consider how difficult it is to experiment in the market place.
From a technological point of view brand owners can easily experiment with the new bio-based plastic packaging on a relatively small scale, which also means the cost to brand owners is relatively low. To some degree brand owners are even forced to start small due to the limited production capacity (Shen *et al.*, 2009). So there is no reason to suspect that brand owners would expect this to be a barrier.
When it comes to trials in the marketplace there have been some surprising results in the past, such as the lack of enthusiasm for biological produce. Consumers were suspicious of the validity of labels and standards, were uncertain about what these labels and standards represented, and/or did not accept the premium price (Yiridoe *et al.*, 2005). As told earlier, 20-30% bio-based plastic packaging is effectively identical to 100% petroleum-based plastic packaging. The main difference is in how, and from what base materials, the packaging is produced. Furthermore, distributors are keen on avoiding premium prices due to bio-based plastic packaging (Wal-Mart, 2007). The one thing that is lacking is a clear and reliable label, which is a space that may yet be taken up by the standards set by brand owners that took the lead in adopting bio-based plastic for their packaging. Because two of the three main issues from prior experiences are dealt with the consumer acceptance of bio-based plastic packaging can be expected to be much better, compared to that of biological produce.
Overall the trialability factor from both a technological and market perspective can be expected to be positive, which leads to the following hypothesis:

> *H6: The expected trialability increases the willingness of brand owners to adopt bio-based plastic for their packaging.*

2.2.5 Observability

The fifth and final adoption factor, *observability,* is defined as *"the degree to which the results of an innovation are observable to others"* (Moore & Benbasat, 1991). According to Rogers (1995) higher observability leads to

a higher adoption rate, or in this case, a higher willingness to adopt. Essentially this factor describes the potential of a cascading effect. There are two aspects to the factor observability, the first being whether brand owners can see other brand owners adopting bio-based plastic packaging, and the second being whether the results of this adoption decision are seen to be positive.

Just looking at a packaging it is very difficult, if not impossible, to determine what kind of plastic was used to produce it. However, because image benefits (§ 2.2.1.3) depend on being visible, brand owners can be assumed to be well aware of what kind of plastic their competitors are using in the products they are putting on the market, and to some extent even what kind of research they are doing. The actual benefits (as in § 2.2.1) reaped by competitors may be less publicly visible, particularly when these benefits are (partially) still uncertain to the leading innovators themselves. However, a brand owner that decides to adopt (and continue with) bio-based plastics does signal that its expectations (and experiences) regarding the benefits are positive.

Observability therefore can be considered to be high in this case, or at least positive. However, it is valid to question also whether in this case this high observability really does lead to a higher willingness to adopt. Technological innovation in plastics does not have a very turbulent history, at least not in the past few decades. This makes the recent developments in bio-based plastics, or bio-plastics in general, stand out already. Anyone paying attention would have been aware of these developments and could have recognized the opportunities before the leading brand owners (e.g. Coca-Cola, Heinz) took serious action. From this perspective the high observability could be said to be inconsequential to the willingness of brand owners to adopt bio-based plastic for their packaging.

On the other hand, the awareness that a product exists is not the same as the awareness that your peers and/or competitors have adopted that product, and certainly not that these firms are benefiting from their decision. Every firm has to make decisions based on limited information (Simon, 1979), which in particular affects the smaller firms with more limited resources. Seeing large corporations such as Coca-Cola and Heinz considering adopting bio-based plastics would likely influence their decision making process.

Companies could also be influenced for additional reasons. Earlier sections told that switching to bio-based plastic offers brand owners opportunities to differentiate themselves and that there is also a link to long-term operational efficiency. Both provide a threat to competing brand owners, and thus a strong motivation for these brand owners to respond (Porter, 1996; Gilbert, 2005). Considering the early stage of the innovation trajectory, those that react now are likely to be the fast-followers, whose aim it is to establish a stronger appropriability regime than the leading innovators, allowing them to obtain a larger profit from the innovation (Teece, 1986). A practical example can already be provided here, because PepsiCo, the main competitor of Coca-Cola, has started using bio-based plastic packaging in answer to the activities of Coca-Cola (PlasticsNews, 2011).

It can therefore be said that the observability in this case is high, and indeed does have a positive effect on the willingness to adopt, leading to the following hypothesis:

H7: Observing other brand owners adopting bio-based plastic for packaging increases the willingness of brand owners to adopt bio-based plastic for packaging.

2.3 Control variables

The hypothesized effects specified in the conceptual model are controlled for the effects of four context variables. The first three being the number of employees, the year the firm was established, and the amount of packaging material used per year. The fourth control variable concerns how well the respondent is informed about bio-based plastic. Given that there was no control over who filled in the survey, this variable is included as an indicator of the reliability of the answers being provided by the respondent.

2.4 Conceptual model

Figure 2.4 shows a graphical representation of all previously described relevant factors in relation to the willingness of brand owners to adopt bio-based plastic for their packaging. The left side column provides a list of stakeholders (other than the brand owners themselves) relevant to the adoption factors listed in the middle column. The + / - signs indicate per factor whether it is expected to have a positive or negative influence on the willingness to adopt.

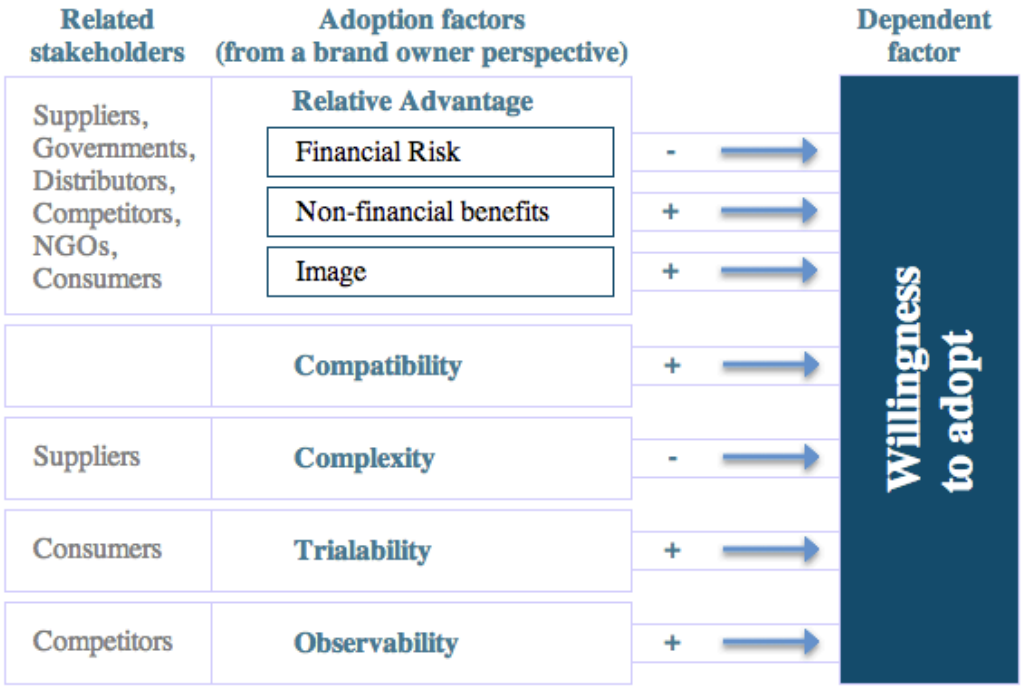

Figure 2.4 – Graphical presentation of the conceptual model.

3 Methodology

This study is explanatory in nature, because it focuses on testing hypotheses specified in the conceptual model. The data necessary for testing the hypotheses is collected by means of an online survey among Dutch brand owners in the food production industry. This demarcation to only Dutch brand owners rules out nation specific effects. Before the invitation to the online survey was send out to these firms, the conceptual model and survey questions were tested and improved in a pilot consisting of four interviews with industry experts.

The three main parts of this chapter describe the steps taken in performing this research. The first part describes the online survey, including the design, sample selection and response. The second part provides the operationalization of the concepts in the conceptual model, which includes a description of how the interviews for the pilot are performed. The third and final part concerns the methods used to test the hypotheses based on the collected data.

3.1 Data collection

The data required for this study is collected by means of an online survey. The following paragraphs discuss the survey design, the sample selection and the response.

Survey Design

The online survey consisted of three parts. In the first part respondents were asked general background questions that served to answer the control variables. In the second part respondents were first asked whether their firm has already started using bio-based plastic. If so, they were asked about the progress made thus far, and if not they were asked whether the firm had any plans to start using bio-based plastic.

The third part of the survey predominantly consisted of closed questions about their progress and the factors influencing their decision-making as discussed in the theoretical framework. For the vast majority of the closed questions respondents were asked to give a score on a five point Likert scale for both their short and long term expectations.

Sample selection

The main criteria for sample selection are that a firm manufactures food (including beverages) and uses, or can use, plastic in its product packaging. The first criterion stems from the focus of this study on brand owners in the food industry. The second criterion was formulated to select those firms for whom (partial) bio-based plastic packaging would be a relatively straightforward substitute for (part of) their current product packaging. In order to rule out nation specific influences this study was limited to Dutch firms only.

These criteria were used to select relevant industry categories from the trade register of the Dutch Chamber of Commerce. The selected categories can be found in table 3.1, which also lists the number of firms in each category. These numbers are the result after filtering out doubles

and invalid data entries. Due to the limited number of firms, 545 in total, every firm was contacted to participate in the study.

Table 3.1: Active firms per selected SBI category as registered at the Dutch Chamber of Commerce on 29-08-2012 (after applying filters for doubles and invalid data).

SBI-code	SBI category	No of firms
1032	Manufacture of fruit and vegetable juices	12
1041	Manufacture of plant and animal oils and fats	15
1042	Manufacture of margarine and similar edible fats	4
1051	Manufacture of diary products (no ice cream)	133
1052	Manufacture of ice-cream	57
1072	Manufacture of rusks and biscuits and of other preserved pastry	98
108401	Manufacture of condiments and seasonings	33
1085	Manufacture of prepared meals and snacks	111
1101	Manufacture of strong alcoholic beverages	21
1102	Manufacture of wine from grape	10
1103	Manufacture of cider and other fruit wines	7
1105	Manufacture of beer	30
1106	Manufacture of malt	2
1107	Manufacture of soft drinks and bottled waters	12
	Total	545

Response

Several actions were taken to increase the response rate. Respondents were offered a report detailing their position within the food industry with respect to bio-based plastic packaging. The respondents were first addressed by regular mail, and then two weeks later send a reminder by e-mail. Finally, the survey was made available in both Dutch and English. Despite these measures the response rate has remained low. Just 25 of the 545 respondents participated in the survey, of which 20 completed the survey. This gives a response rate of only 3,67%.

Something that immediately stands out from the response data is that none of the responding firms has already fully committed it self to implementing bio-based plastic. Of the 7 options available to respondents for the dependent variable, measuring the willingness to adopt bio-based plastic, only 2 were used, being *'We have not yet thought about implementing bio-based plastic.'* and *'We are currently considering bio-based plastic.'*. Also, looking at one of the control variables, firm size, it appears that predominantly smaller firms participated in the survey, but that especially larger firms are considering the use of bio-based plastic packaging materials. These descriptive results are shown in table 3.2.

That none of the respondents has yet made a decision regarding implementing bio-based plastic leads to two possible explanations for the low response rate. Firstly, the decision to implement bio-based plastic packaging materials could still be beyond the horizon of most firms invited to participate in the survey. The second possible explanation is that firms want to keep their insights to themselves during the time they are still making a decision about whether or not they will implement bio-based plastic packaging materials.

Table 3.2: The number of responding firms per firm size considering (not) implementing bio-based plastic packaging materials.

Number of employees (fte)	Considering bio-based plastic		
	No	Yes	
0 – 20	12	1	**13**
21 – 200	2	1	**3**
201 – 500	0	2	**2**
500+	0	2	**2**
	14	**6**	**20**

3.2 Measurement of variables

The operationalization of the conceptual model, as presented in figure 2.4, in part follows from what is already described in the theoretical framework. In order to better determine appropriate indicators to measure the variables from the model a pilot test of the conceptual model was performed, consisting of four expert interviews.

The four interviewees comprise three senior employees from brand owners of varying sizes and one interviewee from a major supplier of bio-based plastic. The interviews were conducted with some time in between, which allowed for iteration between interviews and deskwork so the input could be cross-validated and improved upon. Each interview was performed using a semi-structured set of questions. One interview could be recorded, which helped to increase the accuracy of the analysis, and one interview was performed by telephone. Once the data from the interviews had been transcoded and analyzed the interviewees were contacted again to confirm that the results reflected their views. In addition to these interviews informal discussions at a conference about bio-based plastics, mostly with suppliers, and two meetings regarding another bio-based plastics project also provided several valuable insights that aided in establishing appropriate indicators for the conceptual model.

Before these indicators are presented there are some remarks to be made about decisions that have been made. Relative advantage is a concept in the conceptual model that is already distinguished into three dimensions in the theoretical framework. These three dimensions, which are financial risks, non-financial benefits and image, are individually operationalized. Unless specified differently all indicators are measured on a 5-point Likert scale. Some of the independent concepts/dimensions are measured on the short-term and/or long-term. The timing of these two timeframes has by intention not been defined explicitly, because that would force

respondents to use timeframes that would likely be at odds with their own short and long-term horizons.

The operationalization of the concepts and dimensions specified in the conceptual model are presented below in table 3.3. In table 3.3 the available response categories are sometimes preceded with an S and/or an L. This indicates the indicator is measured in a short-term and/or long-term context. The 3x that is used once refers to the three distinctive stakeholders represented by a separate indicator.

Table 3.3: Operationalization of concepts (1/2)

Concept	Dimensions	Indicators	Available response categories
Willingness to adopt (Dependent variable)		Implementation level	1 = No, we have not yet thought about implementing bio-based plastic 2 = No, we are currently considering bio-based plastic 3 = Yes, we have already decided to implement bio-based plastic 4 = We have made initial preparations 5 = We have a pilot project 6 = We have extended our pilot project 7 = We use bio-based plastic on a large scale
Financial risks			
		Expected effect that adopting bio-based plastic will have on the revenues (S)	S | 1 = Large decrease, 2 = Small decrease, 3 = No effect, 4 = Small increase, 5 = Large increase
		Expected willingness of consumers to pay a premium price for bio-based plastic	S | 1 = No-one, 2 = A niche market, 3 = Several types of customers, 4 = The majority, 5 = Almost everyone
		Expected effect of petroleum pricing on price of regular plastic (L)	L | 1 = Indifferent, 2 = Small problem, 3 = Moderate problem, 4 = Big problem, 5 = Very big problem
Non-financial benefits			
	Reliability of supply	Importance of reliability of supply	1 = Very negative, 2 = Negative, 3 = No role at all, 4 = Positive, 5 = Very Positive
		Importance of involvement in and control of supply chain	1 = Very negative, 2 = Negative, 3 = No role at all, 4 = Positive, 5 = Very Positive
	Competitive advantage	Expected opportunity for competitive advantage	S & L | 1 = Indifferent, 2 = Small opportunity, 3 = Moderate opportunity, 4 = Big opportunity, 5 = Very big opportunity
	Stakeholder influence	Received incentives from food service industry, retailers and Gov agencies	3x | 1 = No incentive, 2 = Small incentive, 3 = Moderate incentive, 4 = Strong incentive, 5 = Very strong incentive
		Influence of incentives from distributors	1 = Very negative, 2 = Negative, 3 = No role at all, 4 = Positive, 5 = Very Positive
		Influence of legislation	1 = Very negative, 2 = Negative, 3 = No role at all, 4 = Positive, 5 = Very Positive
Image			
	Consumer reception (L)	Expected long-term consumer response to bio-based plastic packaging	L | 1 = Strongly negative, 2 = Negative, 3 = Indifferent, 4 = Positive, 5 = Strongly positive
	CO2 footprint	The extend to which bio-based plastic packaging helps reduce the company CO2 footprint	S & L | 1 = No reduction, 2 = Small reduction, 3 = Moderate reduction, 4 = Strong reduction, 5 = Very strong reduction

Table 3.3: Operationalization of concepts (2/2)

Concept	Dimensions	Indicators	Available response categories
	Influence of NGO opinion	Expected reaction from NGOs	1 = Strongly negative, 2 = Negative, 3 = Indifferent, 4 = Positive, 5 = Strongly positive
		Influence of NGO opinion	1 = Very negative, 2 = Negative, 3 = No role at all, 4 = Positive, 5 = Very Positive
		Received incentives from NGOs	1 = No incentive, 2 = Small incentive, 3 = Moderate incentive, 4 = Strong incentive, 5 = Very strong incentive
	Brand risks	Influence of brand image in decision	1 = Very negative, 2 = Negative, 3 = No role at all, 4 = Positive, 5 = Very Positive
		Competition with food production	1 = Very negative, 2 = Negative, 3 = No role at all, 4 = Positive, 5 = Very Positive
		Crop modification	1 = Very negative, 2 = Negative, 3 = No role at all, 4 = Positive, 5 = Very Positive
Compatibility			
		Are technical material characteristics expected to create an advantage or problem	S & L | 1 = Big problem, 2 = Small problem, 3 = Indifferent, 4 = Small advantage, 5 = Big advantage
		Influence of switches in production and operation	1 = Very negative, 2 = Negative, 3 = No role at all, 4 = Positive, 5 = Very Positive
Complexity			
		Expected complexity of supply chain management in comparison with current situation	S & L | 1 = Much more difficult, 2 = More difficult, 3 = No difference, 4 = Easier, 5 = Much easier
Trialability			
		Expected short-term consumer response to bio-based plastic packaging	S | 1 = Strongly negative, 2 = Negative, 3 = Indifferent, 4 = Positive, 5 = Strongly positive
		Influence of customer preferences	1 = Very negative, 2 = Negative, 3 = No role at all, 4 = Positive, 5 = Very Positive
Observability			
	Competitor activity	Number of immediate competitors working on the implementation of bio-based plastic	1 = None of our competitors, 2 = One competitor, 3 = Some competitors, 4 = Most competitors, 5 = All competitors
		Influence from behavior of competitors	1 = Very negative, 2 = Negative, 3 = No role at all, 4 = Positive, 5 = Very Positive
	Interaction between firms	Influence from behavior of bio-based plastic pioneers	1 = Very negative, 2 = Negative, 3 = No role at all, 4 = Positive, 5 = Very Positive
		Number of times that contact has been sought regarding bio-based plastic activities	1 = Never, 2 = Once, 3 = Occasionally, 4 = Regularly, 5 = Often
Control variables			
	Size	Number of employees in fte	1 = 0 - 20 fte, 2 = 21 - 200 fte, 3 - 201 - 500 fte, 4 = 500+ fte
	Age	Year of establishment	Year
	Volume	Amount of packaging material used on a yearly basis	1 = Less than a hundred tons 2 = Hundreds of tons 3 = Thousands of tons 4 = Tens of thousands of tons 5 = Hundreds of thousands of tons 6 = Millions of tons
	Respondent knowlegde	Expertise of respondent	1 = Uninformed, 2 = Hardly informed, 3 = Reasonably informed, 4 = Highly informed, 5 = Fully informed

3.3 Data Analysis

Due to the low number of completed responses advanced multivariate statistical methods cannot be used for data analysis. It should be noted that because only two of the seven answer options were used for the dependent variable, this variable is actually a binary variable determining whether or not a firm is considering the implementation of bio-based plastic packaging materials – as seen in table 3.2. So, there are two clearly distinctive groups at different levels of implementing bio-based plastic packaging materials. Accordingly, independent T-test of means (Wonnacot & Wonnacot, 1990) are applied in order to test if firms either considering or not considering the implementation of bio-based plastic packaging materials differ from each other regarding their mean values of the various independent and control variables. If so then the dependent variable and the independent or control variables covariate with each other and a positive or negative relation may be presumed. The results of these tests are presented in the next chapter.

4 Results

As explained earlier, independent T-Tests of the means of the independent and control variables have been carried out, with the dependent variable 'willingness to adopt' as the grouping variable. The results of these tests are presented in table 4.1. Subsequently the results are described in more detail. Finally the results are summarized.

Table 4.1 presents the results per concept, and then distinguishes between indicators that show a significant difference in mean values, and indicators that show an insignificant difference. The only two indicators that are significant at $p < 0.05$ are for control variables. The remaining significant results are significant at $p < 0.10$.

Financial Benefits

None of the three indicators that make up the concept 'financial benefits' show a significant result in the independent T-test. The hypothesis related to this concept (H1) is therefore not accepted.

Non-Financial Benefits

One out of the nine indicators that make up the concept 'non-financial benefits' shows a significant difference in the independent T-test, being 'Incentives from the food service industry'. Taking a closer look at the data for this indicator it shows that only a few brand owners received small or moderate incentives from the food service industry, and that these brand owners are all among those considering the implementation of bio-based plastic. The other brand owners received no incentives from the food service industry at all.

Because of the significant indicator found for this concept, the hypothesis related to this concept (H2) can be accepted. However, it should be kept in mind that this positive influence is limited to brand owners supplying food service firms, such as Burger King.

Image

The results in table 4.1 show that three out of the nine indicators for this concept show a significant difference between the two groups of brand owners. Two of then relate to the opportunity presented by bio-based plastic to reduce CO_2 emissions. Brand owners who are considering bio-based plastic expect slightly better opportunities for CO_2 reduction, both on the short-term and long-term. Comparing the short and long-term

Table 4.1: Results of Independent T-Test of Means

Independent Samples Test					Considering bio-based plastic			
Concepts	Indicators	t	df	Sig,	No		Yes	
	Not significant				Mean	SD	Mean	SD
Financial Benefits	Short term revenues	0,86	18	0,40	3,07	0,48	2,83	0,75
	Long term oil prices	0,31	18	0,76	3,14	1,03	3,00	0,63
	Short term price premium	-1,07	18	0,30	3,86	1,03	4,33	0,52
Non Financial Benefits	Significant				Mean	SD	Mean	SD
	Incentives from the food service industry**	-2,08	5	0,09	1,00	0,00	1,83	0,98
	Not significant							
	Incentives from retail	-1,58	5	0,18	1,00	0,00	1,83	0,52
	Short term competitive advantage	0,95	18	0,36	2,86	1,23	2,33	0,82
	Long term competitive advantage	0,63	18	0,54	3,00	1,24	2,67	0,52
	Incentives from government	-1,19	5,2	0,29	1,07	0,27	1,67	1,21
	Role of distributor incentives in decision making	0,38	18	0,71	3,43	0,51	3,33	0,52
	Role of supply line influence in decision making	-1,16	18	0,26	3,14	0,66	3,50	0,55
	Role of legislation in decision making	-0,17	18	0,87	3,29	0,61	3,33	0,52
	Role of supply reliability in decision making	-0,36	18	0,72	3,14	0,95	3,33	1,37
Image	Significant				Mean	SD	Mean	SD
	Short term opportunity for CO2 reduction**	-1,86	15,7	0,08	2,29	1,07	3,00	0,63
	Long term opportunity for CO2 reduction**	-1,92	18	0,07	2,43	1,02	3,33	0,82
	Role of brand name in decision making**	-2,07	18	0,05	3,57	0,51	4,17	0,75
	Not significant							
	Response from NGOs	0,06	18	0,95	3,86	0,86	3,83	0,75
	Incentive from NGOs	-1,23	5,4	0,27	1,07	0,27	1,50	0,84
	Long term citizen response	0,30	18	0,77	3,93	0,62	3,83	0,75
	Role of NGO opinion in decision making	-0,20	18	0,84	3,29	0,47	3,33	0,52
	Role of food competition in decision making	0,10	18	0,92	3,21	0,80	3,17	1,33
	Role of crop modification in decision making	-0,30	18	0,77	2,71	0,73	2,83	0,98
Compatibility	Significant				Mean	SD	Mean	SD
	Short term technological characteristics**	1,80	18	0,09	3,21	0,80	2,50	0,84
	Not significant							
	Long term technological characteristics	1,57	18	0,13	3,36	0,93	2,67	0,82
	Role of switching cost in decision making	-0,51	18	0,62	2,57	0,94	2,83	1,33
Complexity	Not significant				Mean	SD	Mean	SD
	Short term supply management complexity	1,83	6	0,12	2,93	0,27	2,50	0,55
	Long term supply management complexity	0,00	18	1,00	3,00	0,39	3,00	0,63
Trialability	Not significant				Mean	SD	Mean	SD
	Short term citizen response	-0,49	18	0,63	3,50	0,65	3,67	0,82
	Role of consumer preferences in decision making	-1,42	18	0,17	3,71	0,61	4,17	0,75
Observability	Significant				Mean	SD	Mean	SD
	Frequency of being contacted about BBP**	-2,21	6,5	0,07	1,21	0,58	2,17	0,98
	Not significant							
	Number of competitors implementing BBP	-0,93	18	0,37	1,64	1,08	2,17	1,33
	Role of competitor behavior in decision making	0,57	18	0,57	3,64	0,50	3,50	0,55
	Role of pioneer behavior in decision making	-1,54	12	0,15	3,50	0,52	3,83	0,41
Control Variables	Significant				Mean	SD	Mean	SD
	Size in number of employees*	-3,47	5,4	0,02	1,14	0,36	2,83	1,17
	Volume in tons per year**	-2,20	5,6	0,07	1,29	0,73	3,17	2,04
	Knowledge level*	-2,82	18	0,01	1,93	0,83	3,00	0,63
	Not significant							
	Age in number of years	-0,92	18	0,37	30,50	38,64	49,17	48,08

* = significant at p <0.05, ** = significant at p <0.10

expectations it shows that while the expectations of brand owners who are not considering implementing bio-based plastic remain the same, the expectations for brand owners that do consider implementing bio-based plastic improve further on the long-term. The third significantly different indicator is the role of the brand name in decision making. While there is not one brand owner that expects bio-based plastic to have a negative impact on the brand name, those that are considering bio-based plastic award more importance to their brand name than those who are not, and expect a higher positive effect from implementing bio-based plastic.

While not all indicators of this concept are significant, the three that are significant make it clear that the benefits to brand image indeed have a positive effect on the willingness of brand owners to adopt bio-based plastics. In other words, H3 can be accepted.

Compatibility

One of the three indicators of this concept shows a significant difference between the group of brand owners who are considering bio-based plastic packaging, and the group of those who are not. This indicator is the expected short-term advantage or disadvantage that flows from the technological characteristics of bio-based plastic. The results show that those who are considering bio-based plastic are less positive about the technical characteristics. It should be noted that while the largest brand owner in terms of volume considers the technical characteristics as an opportunity, all other brand owners that are considering implementing bio-based plastic consider the technical characteristics as a disadvantage.

Even though one indicator was found to be significant, hypothesis 4 is not accepted. The reason for this is that the results for this indicator actually suggest a relation that is the reverse of what was expected. The expectation was that expected compatibility disadvantages of bio-based plastic have a negative effect on the willingness to adopt bio-based plastic.

Complexity

None of the two indicators for the concept 'complexity' is significant. The hypothesis related to this concept (H5) is therefore not accepted.

Trialability

None of the two indicators for the concept 'trialability' is significant. The hypothesis related to this concept (H6) is therefore not accepted.

Observability

One of the four indicators for the concept observability is significant, being the frequency at which brand owners are being contacted. Brand owners who are considering bio-based plastic are contacted slightly more often, but none of them is contacted more than occasionally. Hypothesis 7 could be accepted on the basis of the single indicator that is significant. On the other hand, the indicator only shows a small difference between both groups. Also, the indicators that are more important to the concept of

observability, those that concern the behavior of competitors and pioneers, are found to be not significant. Therefore, H7 is not accepted.

Control variables

Three of the four control variables are significantly different between both groups of brand owners. For instance, nearly all companies that are considering bio-based plastic have more than 50 fte (and nearly all companies with more than 50 fte). The indicator for the volume of plastic used in tons per year closely resembles the indicator for the size of companies, with as notable exception that one of the largest brand owners uses only very little plastic. Furthermore, almost all who are considering bio-based plastic find themselves at least reasonably knowledgeable on the subject of bio-based plastic. It is important to note that although there is a significant difference between the groups, even among those who are not considering bio-based plastic only a few consider themselves uninformed.

Summary of results

In sum, the indicators that are of importance concern the incentives from the food service industry, the opportunity presented by bio-based plastic to reduce CO_2 emissions on both short and long term, and the importance of the brand name during the decision making process. The significance of indicators means that H2 (non-financial benefits) and H3 (image) are accepted. Furthermore, the results for the control variables show that bio-based plastic packaging material is predominantly considered by big brand owners, with more than 50 fte, that use a high volume of plastic packaging material per year, and have considerable knowledge of bio-based plastic.

5 Discussion and conclusion

This research set out to find an answer to the following question:

> *Which factors determine the willingness of brand owners in the Dutch food industry to adopt bio-based plastic packaging?*

This chapter aims to provide the answer to this question by using the results described in the previous chapter and to derive theoretical implications, as well as managerial and policy implications. The final part of this chapter describes four limitations of this research.

5.1 Theoretical implications

Based on the results of prior studies it was expected in the theoretical framework that both internal and external factors would play a role in determining the willingness of brand owners in the food industry to adopt bio-based plastic packaging. In a very general sense this expectation has been met by the results. However, a considerable number of the factors, which are described in the theoretical framework, did not turn out to have significant effects.

In terms of external factors the results confirm that the government has no significant influence on the willingness of brand owners to adopt bio-based plastic packaging material. However, the results also show that retailers have no significant role in driving the adoption of bio-based plastic. This goes against what is described in the theoretical framework. Instead the results indicate that incentives from the food service industry are a significant positive factor. While this was not unexpected, the food service industry plays a secondary role in the theoretical framework.

In terms of internal factors the results show that the only significant factors are related to the brand image. First there are the short and long term expectations regarding the opportunity to reduce CO_2 emissions by adopting bio-based plastic packaging materials, and then there is also the importance of the brand name in decision-making. Interestingly enough de results also show that NGOs, the external factor related to the brand image, are not considered to have a significant influence.

Looking at the results of this study it may at first make no sense to say that brand owners have recognized bio-based plastic as an opportunity to make profit, because none of the internal factors relating to financial benefits are significant. This also applies to the factors concerning competitive advantages towards suppliers, distributors and competitors. It becomes more sensible to reconsider the decision to use the Five Forces model of Porter as part of the basis for the theoretical framework. The Five Forces model was chosen because the study is concerned with an established industry with stakeholders that already had ongoing (competitive) relations. A change in packaging material is very unlikely going to massively upset an industry where the actual product is food, not packaging. Therefore, bio-based plastic packaging material was considered to be a substitute for petroleum-based plastic packaging material.

However, the results show that the adoption of bio-based plastic is currently in such an early stage of the product life cycle (Utterback, 1994) that it makes the five competitive forces described by Porter not relevant yet. That the adoption of bio-based plastic is in the early stage of adoption by the Dutch food industry is particularly apparent from the dependent variable – the willingness to adopt bio-based plastic. Brand owners are at best considering the use of bio-based plastic, and those few who are doing so are to be conceived as early adopters or even innovators (Rogers, 1995, 2003). It is also apparent from the low response rate of this study, which indicates the decision to implement bio-based plastic is very likely still beyond the horizon of most brand owners.

Another typical indication of a new product life cycle is the focus on quality rather than high quantity and low cost. The focus on quality is shown in the results by the adoption of bio-based plastic packaging being partially driven by the food service industry, and not by retailers. In the food service industry the relation with a customer is more direct, stronger and generally more important than in retail, leading to an increased

importance of product quality. Retail on the other hand is generally more focused on high quantity and low cost.

So, while bio-based plastic packaging remains a substitute product within an already existing industry, it appears to be distinctive enough from petroleum-based packaging to initiate a new product life cycle (Utterback, 1994). And in this new product life cycle the environmental characteristics of bio-based plastic are treated as a unique asset and the basis for competition. Considering this setting, it would have been more appropriate to use the Resource-based View (Conner & Prahalad, 1996), which focuses on internal forces driving decision-making, in the theoretical framework to complement Roger's Adoption theory.

5.2 Managerial and policy implications

As told in the theoretical implications, the adoption of bio-based plastic packaging is driven by the demand of the food service industry rather than the demand of retail, as well as the expected opportunity to reduce CO_2 emissions. On the other hand, the government does not have a significant role.

These observations are in line with the results of an earlier study, which showed that firms are increasingly taking voluntary environmental related initiatives based on business motives, leading to a decreasing role of governments when it comes to stimulating these firms (Clemens & Douglas, 2006). That study also remarks that there is still a major role for governmental coercion when it comes to laggards. This means that governmental action could eventually be necessary for stimulating the laggards in adopting bio-based plastic packaging material, but so far there is no reason to interfere because the product life cycle is driving itself for now.

There are two explanations of why the food service industry is partially driving the adoption of bio-based plastic by brand owners. The first explanation is based on the simple reasoning that bio-based plastic packaging is a premium feature, and that the relatively high margins of the food service industry allow more room for applying such features. The second is that in the food service industry a positive brand image is of very high importance, and that firms in the food service industry are more stringent than retailers in meeting societal expectations regarding environmental behavior. Once the processes have been improved and production capacity has been increased brand owners will without a doubt follow the familiar product life cycle path and expand their use of bio-based plastic packaging into other markets than the food service industry, for example, for their products supplied to the retail industry.

As such there is a good chance the government does not need to take any action to stimulate adoption. The two issues both governments and brand owners need to be alert on are the possible negative effects of ethical discussions concerning the competition between biomass production and food production and the societal concerns regarding genetically modified crops.

5.3 Limitations

There are four limitations to this study. The first three limitations concern the three demarcations of this study, which are the demarcation to Dutch brand owners, the demarcation to brand owners in the food industry, and the demarcation to bio-based plastics, excluding biodegradable plastics. Because of these demarcations it is uncertain how the results of this study apply beyond the context of these demarcations. Future research may provide more insight.

The final limitation of this study is that the decision about whether or not to adopt bio-based plastic is very likely beyond the horizon of most respondents, who have not yet informed themselves about bio-based plastic. Accordingly, they showed no interest in this research project resulting in a very low response rate to the survey. So, in this study the population for which bio-based plastic is currently relevant seems to have been largely overestimated.

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