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Business Modelling in the Fuzzy Front End

Case study of new business opportunities based on by-products at SCA

Master of Science Thesis
in the Management and Economics of Innovation Programme

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Abstract

Found in the thesis to follow is a case study of SCA and their early attempts on finding new markets. Their intent is to bring in new revenues from their forest industry. The forest industry has started suffering from declined sales of paper, with media increasingly being distributed digitally. This they aim at doing by utilising otherwise unused waste materials from their paper production.

The idea of this study is to take a stab at this from a business modelling approach. The purpose of the study is to investigate how suitable using business modelling is for exploring and evaluating new business opportunities based on by-products from the core business of an established firm. The case of SCA serves as the arena for this investigation. Identifying the waste materials and their potential uses, evaluating which usage and market would have best potential for success and how SCA should take this work forward are the goals that will help answer the purpose of this study.

Several potential uses were found and investigated. A business model was created for each of these alternatives. Hypotheses regarding these were constructed and then tested by contacting market representatives, which resulted in the pivoting and updating of the business models. By doing this, three out of the total eleven business models were identified as the most interesting ones.

Since much is unexplored regarding the use of the identified waste stream material, there is much technological uncertainty for SCA to cope with. Here it is recommended that SCA continue the tests of the proposed business models to straight out as many unknowns as possible before investing heavily. This includes much laboratory tests since the features of the substances are not yet fully explored.

The thesis concludes with evaluating the business model approach. It is found from the study that given a well-constructed model for testing and pivoting business models, it is a good approach to evaluate business opportunities. It helps with illustrating the important aspects of an opportunity and enables you to optimise your business model before investing heavily and risk large losses.

Acknowledgements

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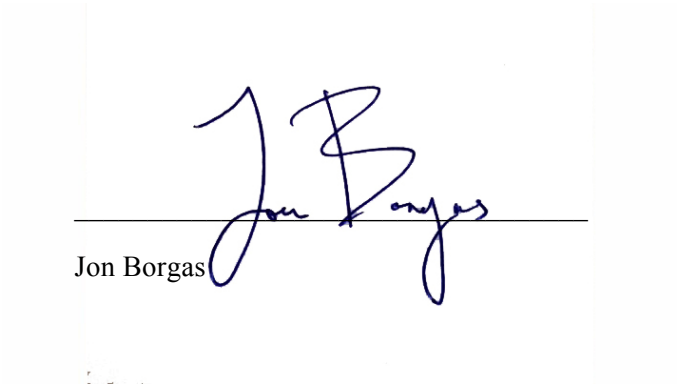
Gothenburg, January 2013



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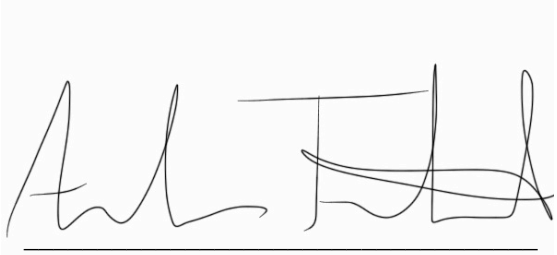

Andreas Törnkvist

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Abbreviations

GGM – GalactoGlucoMannan

PAA – PolyAcrylic Acid

3HPA – 3-HydroxyPropionic Acid

AA – Acrylic Acid

SAP – SuperAbsorbent Polymer

TMP – Thermo Mechanical Pulp

BMIT – Business Model Innovation Typology

CVP – Customer Value Proposition

FFE – Fuzzy Front End

NPD – New Product Development

CDIC – Customer Development Insight Cycle

CDP – Customer Development Process

1 Introduction

This study concerns finding usages and markets for unused waster streams identified at a paper pulp mill by using business modelling. This section will give an introduction to the study by presenting the study's background, the problem formulation, the purpose and goals of the study, and the general outline of the report.

1.1 Background

Forest industry constitutes a large part of Sweden's entire worth of exported products, and has always been one of great importance for the growth and prosperity of this country. Specifically of interest for this thesis, paper is a huge part of this industry's importance. But when print media is in decline; a new generation get their news through other channels, newspapers focus more on advertisement revenues through their websites, tablet applications et cetera, what then will the paper industry resort to in order to survive declining sales? The use of tablets for one thing is an area that has proven to significantly lessen the demand for paper (King, 2011). This affects as mentioned newspapers but also for books and magazines which people increasingly choose to read on electric devices instead. This is a trend that is only expected to continue, decreasing demand in North America for instance with up to 50% the coming 15 years according to an inquiry by Morgan Stanley in 2011 (King, 2011). And not to trivialise this challenge in any way, but not only is the decline in print media what is threatening the paper industry. These are uncertain times for the forest, paper and packaging market. Although the market is global, producers around the world are driven by different dynamics. The poor economic situation in the western world drives down demand and creates overcapacity for paper products, making actors in the market more and more compelled to focus on decreasing costs (Deloitte, 2012). Also, an increased focus of sustainability and recycling reduces packaging and increased substitution of virgin fibres with recycled fibres reduces the overall volumes (Food and Beverage Reporter, 2009).

SCA is the largest private owner of woodland in Europe with 2,6 million hectares, and a large producer of materials for magazines and newspapers (SCA, 2012). SCA are producers of personal care, tissue and forest products and have annual revenues of 106 billion SEK and 37 000 employees worldwide (SCA, 2012). As the decrease in demand for paper in recent years has become visible, and with it being predicted to drop even further in the future, SCA Forest Products are looking for new ways to utilize their materials and production facilities.

With SCA Hygiene Products being a producer of baby diapers and incontinence pads, the need for efficient super absorbents is crucial for the products. Today's Super Absorbent Polymers (SAP) are based on PolyAcrylic Acid (PAA) that is produced from mineral oil. With SCA engaging in finding environmentally friendly and sustainable solutions, the wish to find solutions not based on fossil fuel is of great interest. Russel Mills of Dow Chemical states that "95% of manufacturing is enabled by chemistry" (United Nations Framework Convention on Climate Change, 2011). From this it is not hard to see why striving to make this sustainable would be of great significance. A demand for eco-friendly products is also considered to be present on the market. Therefore SCA has begun work with finding such solutions, for example in cooperation with Södra and Chalmers. Their joint project named WooDi (Wood-based Diapers) aims at producing a working SAP from modified cellulose fibre, while a separate project with Chalmers alone strives to make PAA from lignocellulose material (woodi.se, 2013). Other companies are also pursuing emerging technologies to produce Acrylic Acid (used for SAP) in other ways.

This work therefore connects different parts of SCA and their needs and wants. SCA forest products need to find new markets as their biggest market is predicted to decline. SCA Hygiene products want to make their products better and more environmental friendly.

1.2 Problem Formulation

SCA is aware of the situation with a paper industry in decline, and they also know about possibilities of extracting previously unused materials from their waste streams. What is currently missing is the knowledge of how to best utilise this opportunity. Potential uses are novel and who might be interested in it and in what markets it could yield most profit must therefor be mapped out.

Depending on what the waste materials will be utilised as, it is much likely SCA needs to enter an entirely new segment. Such a venture naturally comes with much uncertainty. Being in the fuzzy front end, the stages prior to new product development (Koen, o.a., 2001) (Reid & de Brentani, 2004), adds additional uncertainties for SCA since they need to find market opportunities for a substance not currently used; they will not only embark on a venture new to them, but novel to the entire industry. Mapping out and evaluating the different alternatives as thorough as can be done in such an early stage is important and what SCA need to do before investing in any specific case. It not only includes investments material such as machinery, but the investment in setting up channels, customer relationships, partnerships etc. This is the problem this study is aimed to deal with.

Looking at this new venture within SCA, it will be important to not be afraid of changing ones business model (Dorf & Byers, 2008). Being open to change as a large corporation is essential to embrace new ventures such as this. With this thesis being written for SCA Hygiene Products, this poses some specific interest, while the waste materials comes from the department of SCA Forest Products.

1.3 Purpose & Goals

When finding out how to best utilize materials not earlier used, such as by-products from the core business, there might be a need of entering new markets and use new business ideas. To do this, an established firm must be willing to adopt a new business model to better suit the new opportunity. Having a structured business modelling approach can be one way of creating, testing, and evaluating different business models with the aim to find the most suitable business model for the new opportunity. This leads to the following purpose of this thesis:

To investigate how a business modelling approach can explore and evaluate new business opportunities based on by-products from the core business within an established firm.

The general purpose can be operationalized in three goals directly related to the case study at hand:

1. *Identifying which the waste streams are and how can they be used.*
2. *Assess which usages and markets show best potential for success.*
3. *State how SCA should continue with the work utilizing their waste streams.*

Achieving these goals will ultimately result in recommendations in form of one or several business models. The business model(s) deemed most suitable will be given extra attention to form a suggested plan for how SCA is to use the opportunity at hand.

1.4 Outline of the Report

The thesis at hand is made up of eight main chapters. Following this Introduction is the Theoretical Framework. Here theory relevant to the study is presented. The chapter is ended with an analytical framework synthesized from theory presented. This analytical framework tells how results of the study will be analysed in order to generate business models to recommend for SCA.

The third chapter is the Methodology. In the Methodology the work process for this research is ironed out. What type of study this is, how data is collected and analysed and finally a discussion regarding the quality of the study is presented.

After presenting how the study is conducted, chapter four present empirical findings. Here data used to analyse SCA's new business opportunities are presented. This consists of information gathered from

within the company, information found in external sources etc., and insights from conducted interviews.

The findings from chapter four are used to build business models for the potential usages in chapter five. Information from the company and external sources results in finding potential markets, while the interviews tests these hypotheses and pivots the business models to what is presented in this chapter. Eleven business models based on Osterwalder and Pigneur's (2010) business model canvas and their critical assumptions are presented.

In the sixth chapter the business models are discussed and evaluated. This with the help of criteria used to rate the models based on their suitability to pursue.

From what is found in the parts leading up to chapter seven, here some concrete recommendations are given to SCA. It is here stated what SCA should do when moving forward with the business models.

Lastly the final conclusions are presented in chapter eight. Here the purpose and goals of the thesis are answered.

2 Theoretical Framework

This chapter presents a theoretical framework that sets up a foundation of how empirical findings are to be processed, analysed and evaluated and how the results will be structured and presented. The theoretical framework is divided into four parts. The first part describes business model innovation and why this is important. The second part describes how business model frameworks, especially the business model canvas (Osterwalder & Pigneur, 2010), can be used to illustrate and develop business models. The third part covers the business model innovation process and the exploration process when testing business models. The fourth part is an analytical framework designed for stating, testing, and evaluating business models.

2.1 Business Model Innovation

"*A mediocre technology pursued within a great business model may be more valuable than a great technology exploited via a mediocre business model*" (Chesbrough, 2010)

Some of the most common types of innovations are product innovation and process innovation. A pure product innovation creates a new or improved product for sale without changing the production process, except that more inputs might be needed. A pure process innovation is simply changing the way in which a product is made, without changing the product itself. In practise a new product innovation affects innovations in the production process and vice versa. (Swann, 2009) Business model innovation is innovating with business models, and how resources such as products and processes are used (Chesbrough, 2010).

The interest for business models has in recent years been a focus of attention for both academics and practitioners, but despite this scholars do not agree on what a business model is or how it should be defined. There is a general lack of consensus as definitions are adopted to fit the purpose of specific studies and are difficult to reconcile with each other (Zott, Amit, & Massa, 2011). For instance the terms "business model", "business strategy", and even "economic model" are often used interchangeable (Trimi & Berbegal-Mirabent, 2012).

The definition for business model that is used in this report is that a business model "consists of four interlocking elements that, taken together, create and deliver value". These four elements are customer value proposition, profit formula, key resources, and key process (Johnson, Christensen, & Kagermann, 2008). This was picked as it illustrates in a practical way the most important parts of a business. Only saying that a business model describes how a business create and deliver value is a very broad definition, and the definition used in this report is more manageable as it is divides it in four parts that are easier to grasp.

The economic value of a technology remains latent until it is commercialized in some way via a business model, and depending on the commercialization the technology can yield different returns (Chesbrough, 2010). By the same arguments a mediocre technology pursued within a great business model may create more value than a great technology exploited via a mediocre business model (Chesbrough, 2010).

There can be a tension between the aspects of a business model that creates value and those that capture a portion of that value. E.g. a proprietary high-value technology easily earns a profit for the firm if alternatives offer less value. In many cases customer are unwilling to buy such products due to issues with price, limited availability, delivery or services, making the technology more open instead. Being open a technology is not locked to a supplier and their limited services, and the customers have more options to choose from. An open technology might be more appealing for customers, but also makes it harder to capture value from the offering. These factors have to be balanced to suit all actors (Chesbrough, 2007).

A good business model will provide considerable value to the customer and collect (for the developer or implementer of the business model) a viable portion of this in revenues. However no matter how novel a business model is, developing a business model is not enough in itself to assure competitive

advantage. Once implemented, most elements of the business model are often quite transparent and easy to imitate by competitors and end up being "shared" by multiple competitors. If not easily replicated by competitors, the business model can provide an opportunity to generate higher returns to the pioneer (Teece, 2010). Teece (2010) mentions three factors that are relevant to impede copycat behaviour. First, implementing business models require systems, processes and assets that often are hard to replicate. Second, the business model's level of opacity, how difficult it is for outsiders to understand in sufficient detail how the business model is implemented. Third and last, even if the business model is easy to imitate, incumbent actors might feel reluctant to adopt the model if it involves cannibalizing or upsetting current revenues, profits or business relationships. Developing a successful business model is in itself insufficient to assure competitive advantage, as imitation is often easy. Having a differentiated, efficient and hard to imitate business model is more likely to yield profits. In this way, business model innovation can in itself be a competitive advantage if the model is sufficient differentiated and hard to replicate for incumbents and new entrants (Teece, 2010).

Business model innovation is not to be taken lightly by established companies. These companies often create new products that disrupts competitors but without fundamentally changing their business model (Johnson, Christensen, & Kagermann, 2008). There is other times when venturing into unknown market territory and unknown business model territory is required to achieve growth. Johnson, Christensen and Kagermann (2008) identify five strategic circumstances for a business that often require business model change (see table 1 below). The business model change can be as a proactive act to seize an opportunity, but is can also be forced by competitors.

An opportunity to:	Example
1. Use disruptive innovation to reach the needs of large groups of potential customers that is shut out of the market due to limitations of the existing product	Tata's super cheap Nano-car, giving families in India the ability to afford a car.
2. Capitalize on a brand new technology by wrapping a new business model around it or leverage a tested technology to a new market	Apple's Ipod combined with software Itunes and online music store
3. When a job-to-be-done focus is required instead of a product-focus. This allows companies to redefine industry profitability	FedEx when competing in the package delivery market, they focused on speed and reliability instead of cost
A need to…	**Example**
4. Fend off low-end disruptors	Such as Tata's Nano-car for other automobile makers
5. To respond to a shifting basis of competition. This is common in industries where products become commodities and companies instead focus on solution	Hilti switching from selling to renting power tools

Table 1 Circumstances for business model change (Johnson, Christensen, & Kagermann, 2008)

Johnson, Christensen and Kagerman (2008) also say that companies should not pursue business model reinvention if they are not confident that the opportunity is large enough to warrant the risk and effort, otherwise it would be a waste of time and money.

Amit and Zott (2001) identify novelty, lock-in, complementarities and efficiency as key aspects of business model innovation. However, these may often conflict with the more traditional configurations of firm assets, whose managers are likely to resist experiments that threaten their on-going value to the company (Chesbrough, 2010).

Koen, Bertels & Elsum (2011) presents a model (figure 1) for illustrating the problem with handling disruptive innovations in the views of the established company. This model is called the business

model innovation typology (BMIT) and it classifies innovation along three dimensions: technology, value network, and financial hurdle rate. The BMIT further divides innovation in two parts: sustaining innovation, which established companies are usually good at, and business model innovation. Along the technology dimension the distinction between incremental, architectural, and radical technology is made. Incremental involves refinement, improvement or exploration of existing technology. Architectural technology means creating new ways to integrate components in a system based on current technology or incremental changes to current technology. Radical technology is entirely new core technology.

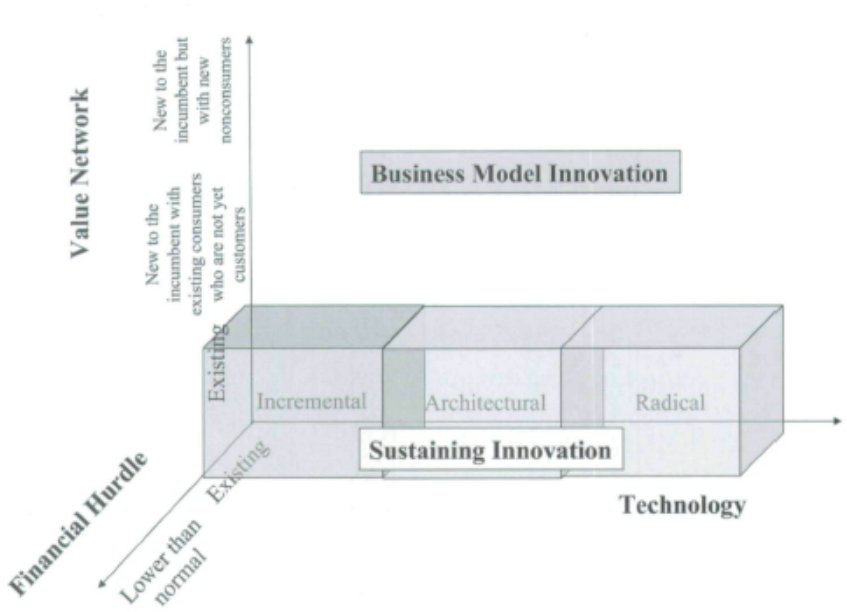

Figure 1 Business Model Innovation typology (BMIT) model (Koen, Bertels, & Elsum, 2011)

The value network dimension involves how the firm works with customers, suppliers and competitors. Business model innovation often requires the development of a new value network (Koen, Bertels, & Elsum, 2011). The value network is divided into two parts: innovations within the company's current value network and innovations requiring value networks with components that are new to the company. Companies with new value networks that pair new value networks with incremental innovation are more often successful than those that pair new value networks with architectural or radical innovations (Koen, Bertels, & Elsum, 2011).

The financial hurdle rate describes the relationship of a given project's financial projections to the minimal expected return. Traditional disruptive innovations that rely on a low-cost business model can, when seen from this dimension, be difficult to pursue because they do not meet the hurdle of the firm's cost structure and require rate of return (Koen, Bertels, & Elsum, 2011). Moving to low-cost business models is a challenge for established companies, as it requires maintaining two different business models (Christensen & Raynor, 2003).

2.2 Business Model Frameworks

Business models can be illustrated through different frameworks or representations of different kinds. Several authors have attempted to illustrate business models through a mixture of informal textual, verbal and ad hoc graphical representations (Zott, Amit, & Massa, 2011). These frameworks can be used for creation and support for business models of highly complex ventures that deal with fragile and volatile technologies and new procedures (Trimi & Berbegal-Mirabent, 2012).

According to Hulme (2011), illustrating the business model is useful for several reasons. First it helps communicating the business model as it forces the creator to articulate the business in detail. This makes it easier to references different parts, enabling creative discussions. Second, it forces the

entrepreneur to simultaneously consider each of the business model elements individually but also as a whole. Third, it helps entrepreneurs, customers, employees and others to understand what the business is made out of and creates a common language that everyone can relate to.

One way of illustrating a business models is using a causal loop diagram (Casadesus-Masanell & Ricart, 2010). In the causal loop diagram, choices and consequences are linked by arrows based on causality theory. All choices have consequences that affect other parts of the business model. A simple example could be the decision to raise price that should lead to the consequence of less sales, which in turn affects economies of scale and bargaining power of the firm. This type of diagram can be useful to show which parameters are rigid, e.g. regulations, and which are flexible, e.g. pricing, and what the possible effects of changing these are.

Chesbrough's (2007) Business Model Framework is in difference to other business model a framework for sequencing possible business models. This framework ranks business models after six types from basic business models to more advanced ones. Using this framework, companies can assess their current business model and plan appropriate steps for further business model development.

Maybe the most used framework for visualising a business model is the Business Model Canvas (Osterwalder & Pigneur, 2010). The content of the business model canvas, which will be presented further ahead, is similar to the content of the definition of business model that is used in this report. Customer value proposition, profit formula, key resources and key processes (Johnson, Christensen, & Kagermann, 2008) are all content that is covered by the business model canvas. Teece (2010) identifies some similar criteria for a well-designed business model that relates to similar content. These criteria are having value propositions that are compelling to customers, having advantageous cost and risk structures, and enabling significant value capture by the business that generates and delivers products and services.

As the business model canvas is also the preferred and recognised business model representation tool at SCA, it was chosen to illustrate and develop new business models related to this report. The business model canvas is a blueprint over how the company intend to make money and is built up by nine basic building blocks divided into four main areas of a business: Customers, offer, infrastructure and financial viability. The nine building blocks are as following:

The 9 Building Blocks of the business model canvas

The **Customer Segment** defines the different groups of people or organizations an enterprise aims to reach and serve. Some examples of different types of customer segments could be mass market, niche market or multi-sided markets.

The **Value Proposition** describes the bundle of products and services that create value for specific customer segments. The value proposition solves a customer problem or satisfies a customer need. Value propositions can be both very innovative as well as being similar to what exists on the market. Some examples of value proposition are performance, price or risk reduction.

The **Channels** describe how a company communicates with and reaches the customer segment to deliver their value proposition. These channels are made up of customer touch points including communication channels, distribution channels and sales channels. These channels not only deliver the value proposition to the customer, but also help raising awareness of products and services, helps customers evaluate the value proposition and provides customer support.

Customer Relationships defines the types of relationships a company establishes with specific Customer Segments. These relationships range from personal to automated and can be driven by motivations such as customer acquisition, customer retention and boosting sales.

Revenue Streams represents cash a company generates from each customer segment. Revenue streams can come both from one-time customer payment as well as recurring revenues from on-going payments (subscription revenues). Revenue streams are also affected on which pricing strategy is

used. The two main categories of pricing mechanisms are fixed pricing and dynamic pricing which affects the revenue streams. Examples of revenue streams include asset sale (selling), subscription fees, renting, advertising etc.

The **Key Resources** are the most important assets required to make a business model work. The key resources needed depend of the type of business model. Key resources can be physical, financial, intellectual or human and can be either owned or leased by the company or acquired from key partners.

Key Activities describe the most important things a company must do to make its business model work. As with key resources, the key activities vary from different business models.

Key Partnerships describes the network of suppliers and partners that make the business model work. Three motivations for creating partnerships are optimization and economies of scale, reduction of risk and uncertainty and acquisition of particular resources and activities.

The **Cost Structure** describes all costs incurred to operate the business model. After defining the other building blocks key resources, key activities and key partnerships some cost can be calculated relatively easy. Low cost structures are more important for certain business models than to others.

(Osterwalder & Pigneur, 2010)

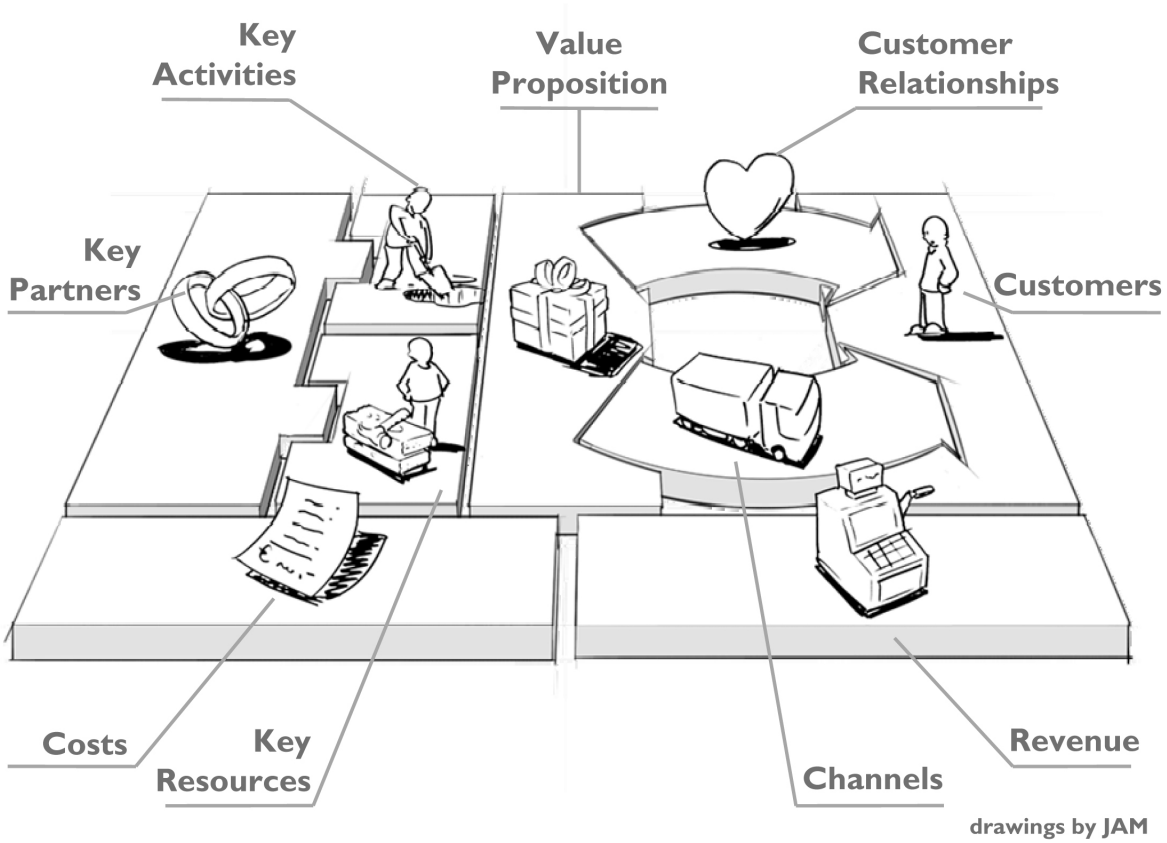

Figure 2 Osterwalder & Pigneur's (2010) Business Model Canvas

The building blocks make out four main areas: product (value proposition), customer (customer segment, channels and customer relationship), infrastructure (key resources, key activities and key partnerships) and finance (revenue streams and cost structure).

Ideas for business models can come from anywhere, and each of the nine building blocks can act as the starting point. Osterwalder & Pigneur (2010) distinguish between four main epicentres of business

model innovation: resource-driven, offer-driven, customer-driven and finance-driven. The resource-driven business models originate from the organisation's existing infrastructure or partnerships to expand or transform the business model. Osterwalder & Pigneur (2010) gives Amazon Web Services as an example of this, which was built on top of Amazon's online retail infrastructure. The offer-driven business model originates in creating new value propositions affects the other eight building blocks. The customer-driven business model answer customer needs, facilitated access, or increased convenience. The finance-driven business model is driven by new revenue streams, pricing mechanisms or reduced cost structures. There is also a chance for business model innovation to emerge from several epicentres, also called multiple-epicentre driven.

2.3 Business Model Innovation Process

This chapter is divided into two parts. In the first part challenges and opportunities related when working with business model innovation is introduced. The second part covers the process of working with business model innovation.

2.3.1 Challenges and Opportunities for New Ventures

Blank (2012) defines a start-up as a temporary organisation in search of a scalable, repeatable and profitable business model. Another definition of a start-up is Ries' (2011) "a human institution designed to create a new product or service under conditions of extreme uncertainty". When defining an "entrepreneur", Ries (2011) makes no difference between the traditional entrepreneur steering his/her own company and the "intrapreneurs", entrepreneurs operating within a large organisation. By these definitions a start-up could for example be an internal champion/team within an established company or organization with goals to create new products or services with new disruptive ideas. For this report and the potential new businesses as SCA, the definition of Ries (2011) is used when start-ups and entrepreneurs are mentioned.

The early days of a traditional stand-alone start-up are very similar to a new and radical idea in an established company facing the Fuzzy Front End (FFE). Roughly, the FFE denotes all activities, time and resources spent on an idea before the first official group meeting to discuss it (Reid & de Brentani, 2004). This can also be seen as the activities before the innovation process gets absorbed to organisational-level. The activities following the FFE are usually more formal, such as the New Product Development (NPD)-process or some kind of stage-gate process (Koen, o.a., 2001). As the activities and decisions comprising the FFE are the start of all new product development, they therefore determine the direction of any new product. A better understanding of these FFE-activities and decisions at this point could therefore lead to a competitive advantage over other firms (Reid & de Brentani, 2004). The uncertainty in the FFE is the greatest for novel and discontinuous innovations but also the greatest opportunity for improving the overall innovation process of the firm (Koen, o.a., Providing Clarity and a Common Lanuguage to the "Fuzzy Front End", 2001).

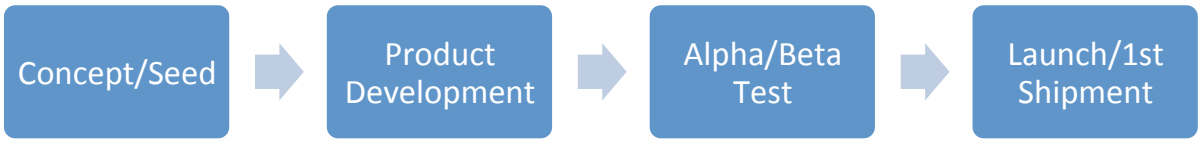

Figure 3. Basic New Product Development (NPD) process (Blank & Dorf, 2012)

In the same way as start-ups seeks customers and markets, a radical idea spawned in an incumbent player must also find a customer and market that usually is different from the company's current and

usually well-defined customer. The NPD process, figure 3, commonly used to describe how established companies do product development, is a good fit when customers are known and product details can be specified from the start. In this case the market should be well defined and the basis of competition understood (Blank & Dorf, 2012). The logic of the NPD process fits less well when introducing a product to a new market (Blank, 2005). First, the process does not guarantee customer acceptance as it focuses on execution instead of discovery and learning, which could be risky when entering a new market. Second, it does not integrate other factors such as marketing, production, sales, and business development, which could lead to unrealistic expectations by lack of seeing the big picture (Blank, 2005).

For start-ups or new ideas, Blank & Dorf (2012) makes the distinction of five different market types:

1. Start-ups that are entering an existing market
2. Start-ups that are creating an entirely new market
3. Start-ups that want to re-segment an existing market as a low cost entrant
4. Start-ups that want to re-segment an existing market as a niche player
5. Cloning a business model that is successful in another country

These market-types have very different sets of requirements to succeed and risks (Blank, 2005). Blank (2012) divides early-stage venture risk for start-ups in two parts, customer/market risk and invention risk. Furr & Ahlstrom (2011) mentions the same risks but call them technology risk and market risk. In markets with invention/technology risk there is question if the invention will ever work, but if it does, the customer will definitely want it. In markets with customer/market risk the question is whether or not the customer will adopt the product. When there are these risks, the NPD-process is not suitable as it assumes the customer and the customer's needs are known. Many entrepreneurs act as they face invention/technology risk but the truth is that 90 percent of companies fail because no customers want to buy their products, not because their products did not work (Furr & Ahlstrom, 2011). Market type changes how customer needs should be evaluated, customer adoption rate, how the customer understands his own needs and how the product should be positioned for the customer (Blank, 2005).

Sull (2004) writes that entrepreneurs and established companies alike pursue opportunities that promises outsized results, but also entails great uncertainties. Sull (2004) divides the lurking uncertainties into four groups: known unknowns (what you know you do not know), unknown unknowns (what you do not know you do not know), new information that is imperfect or incomplete, and conflicting signals. There are not only negative aspects of uncertainties, sometimes technologies work better than expected or solve an even bigger problem than the targeted, the market might be bigger or growing faster than expected, or rivals might have missed the technology (Sull, 2004).

How do companies cope with uncertainties, especially in the FFE or for start-ups? Some will just simple ignore uncertainties, others try to avoid all types of uncertainties and some try hard to eliminate uncertainties that will show up (Sull, 2004). Sull (2004) recommends a fourth more disciplined approach. This approach starts with the entrepreneur or manager formulating a hypothesis, which usually includes a definition of the opportunity, the resources required, the value created if successful and a plan to pursue the opportunity. This hypothesis can be in the entrepreneurs or manager's mind, in a business model, or why not stated in the business model canvas proposed by Osterwalder & Pigneur (2010). The hypothesis contains implicit and explicit assumptions about multiple variables, such as technology, customers, available resources and competitor response. As it is open for verification, modification or rejection when new information emerges, it is especially important to be flexible early in the process (Sull, 2004). A challenge is that many of the opportunities follow a bell curve; meaning that they create significant value if they succeed but is worth little is they fail. Sull (2004) mentions the importance of finding potential "deal-breakers", variables that are likely to prove fatal to the venture. These deal-breakers are often discernible early in the process, and managers should bring these critical uncertainties to the surface early on. It is also important to find out which variables affect possible payoffs, and which are the key drivers of success.

2.3.2 Working Process for Business Model Innovation

Business model innovation is the constant process in which when challenged by competition, market shifts and technological change, firms have to adjust their business models to remain viable (Bucherer, Eisert, & Gassmann, 2012). As business models are dynamic systems that constantly change (Morris, Schindehutte, & Allen, 2005) they also need to be constantly updated and tested. Chesbrough (2010) argues that companies must adopt an effectual attitude toward business model experimentation. Some of these experiments will fail, but as long as the failure informs new approaches and understandings within the constraints of affordable loss, this is to be expected and even encouraged.

In the entrepreneurial context, experiments are tests designed to reduce sources of uncertainty critical to the success of a new venture before deciding to commit more resources (Sull, 2004). These experiments could be such as doing customer research, building, launching regional services or working with beta customers. Depending on the results of the experiments, managers can decide whether to cut losses, revise the hypothesis, run another experiments or harvest the value. Sull (2004) divides these experiments into two main categories, partial and holistic experiments. Partial experiments reveal information about a single uncertainty while holistic experiments test multiple uncertainties and the interaction among them in a small scale. These differences of groups are similar to the distinction that Blank (2012) makes between iterations and pivots. Iteration is similar to doing partial experiments when changing one variable while pivoting is similar to doing holistic experiments when making substantive changes in one or more variables.

In the experiment process, Sull (2004) warns about experiment creep, experiments that drag to long, have to high costs or has no clear goal, which can hinder the progress. The experiments should therefore be designed carefully to avoid these mentioned problems, one way being inviting external parties to participate in the experiments. Focus should also be on market potential; projects should be selected on commercial potential instead of technological elegance. To do this the links between scientists/engineers and the business units need to be tight (Sull, 2004).

All new products and services introduced to customers are really experiments and the feedback from launch is both qualitative (do they like it?) and quantitative (how many like it?). The outcome from these experiments should be insights how to build a sustainable business (Ries, 2011). Ries (2011) illustrates the process of experimenting in his Build-Measure-Learn Feedback Loop (figure 4). Blank & Dorf (2012) presents a similar model as the Build-Measure-Learn Feedback Loop called the Customer Development Insight Cycle (CDIC) (figure 4). Both models are similar in the way that they formulate an idea that is tested, measured and evaluated. Focus should be on minimising the total time spent through the loop and reaching a sustainable business model as soon as possible. Measuring and learning from iterations are essential.

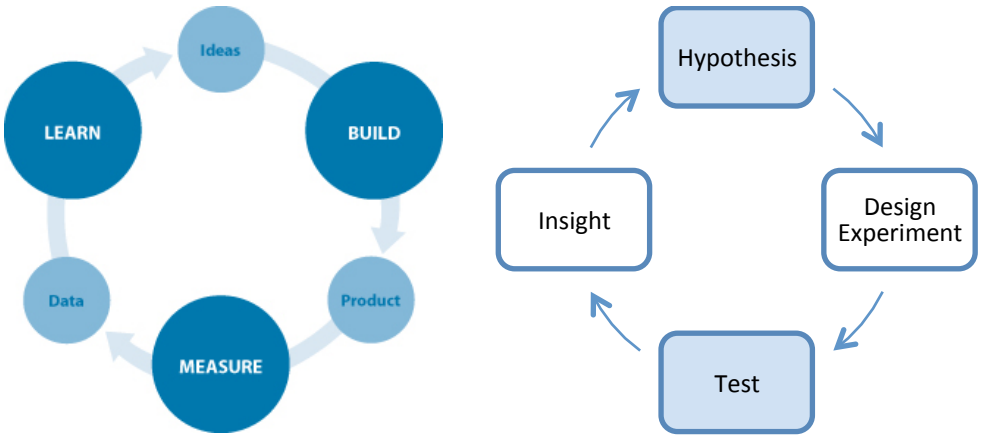

Figure 4. The Build-Measure-Learn Feedback Loop and the Customer Development Insight Cycle

To counter the flaws of the NPD-model presented earlier, Blank (2005, 2012) proposes another model for developing start-ups called the Customer Development Process (CDP) that overcomes the flaws of

the NPD-model when entering new markets. The CDP consists of four steps and focuses on investigational iteration instead of rigid development as in the NPD-model. The CDP is a four-step iterative process that is designed to simultaneously be able to explore market and product developments. The first step, *Customer Discovery*, captures the founder's vision and turns it into a series of business model hypotheses. This stage focuses on developing a plan to test customers' reaction to the business model hypotheses. The second stage, *Customer Validation*, tests if the business model hypotheses from the first stage are repeatable and scalable, if not, iterate back to the first stage. The third stage, *Customer Creation*, is the first execution stage. At this stage building a customer base from demand and driving them into sales channels to scale the business is essential. The fourth and final stage, *Company Building*, transitions the start-up to a company focused on executing a validated model. Each step is represented by a circular track with recursive arrows, stressing the iterative characteristic with the process. By iterating, the aim is to achieve enough success before carrying over to the next step. One of the main consequences with this is that the new venture keeps a low cash burn rate until the company has verified and approved the business model by finding a sufficient amount of customers (Blank & Dorf, 2012).

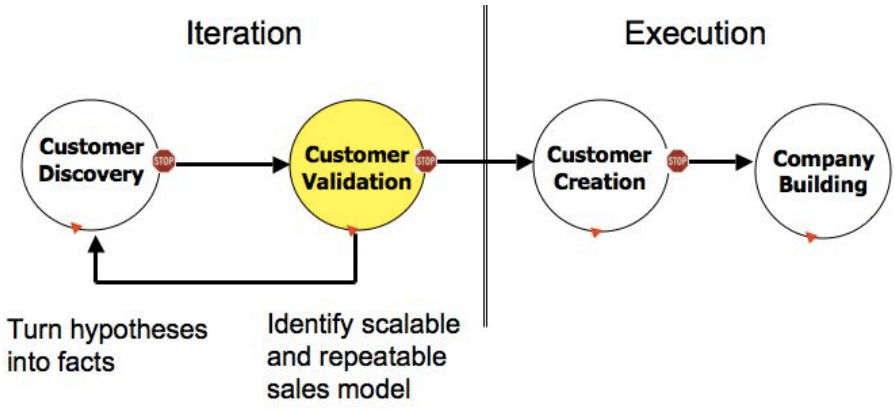

Figure 5 The Customer Development Process (Blank & Dorf, 2012)

There are other authors focusing on customer discovery and validation. Ries (2011) calls this progress from these steps validated learning. Validated learning is the progress of using data and facts to demonstrate that the start-up team has discovered valuable truths about current and future business prospects. Validated learning is meant to be more concrete, more accurate and faster than market forecasting or business planning. By achieving validated learning before starting executing reduces time and resources wasted on unwanted products and services. The main point of validated learning is avoiding costly execution of a plan that leads nowhere (Ries, 2011). Ries (2011) argues that doing experiment with customers could be one way of achieving validated learning, for example showing different versions of webpages and measure how potential customers react to the different versions and what results that led to. McGrath & MacMillan (2000) describes a similar process called discovery-driven planning. They argue that in difference from conventional planning where delivering number close to what you thought you would deliver measures success, success in value-driven planning means generating the maximum amount of useful learning for the minimum expenditure (McGrath R. , 2010). Many authors (Sull, 2004, Blank, 2012, Furr & Ahlstrom, 2011, McGrath & MacMillan, 2000, Ries, 2011) argue that minimising costs is important when a company or new venture is searching for the right business model. It is not until a sustainable business model is found that money should be spent in a non-parsimonious way. McGrath & MacMillan (1999) specifies five areas where discipline is especially important when using discovery-driven planning:

1. **Specification of frame**. This means specifying what any desirable business should look like at maturity and making this clear to everybody in unambiguous terms. This is a reality-check from the start to confirm the business is worth the effort.

2. **Competitive achievement and market reality**. This is to make sure not to fall in any traps such as giving the technology better performance than can be demonstrated, making the market appear larger

and more profitable than they really are or assuming that competition wont be an issue. Getting a grasp of what the benchmark parameters of a project to be competitively successful are is the aim of this area.

3. **Specification of organisational deliverables**. Translating the strategy into specific, implementable actions. Instead of as in conventional planning making assumptions about what you have today, with discovery driven planning you work backwards from what you have to deliver in order to get the results that will make it worthwhile.

4. **Document, test, and revisit assumptions.** The key is to converting the maximum number of assumptions to knowledge at minimum cost.

5. **Planning to learn key milestones.** Some early milestones can be for example business concept test, creation of prototype and first customer use.

In discover-driven planning, in difference to conventional planning, you put effort into looking or creating new patterns for business. The five discipline areas are a way to tackle the key problem of balancing the tension between creativity and the need for business like attention to costs, potential losses, and upside gains (McGrath & MacMillan, 1999).

Many authors stress the fact that almost no first business plan becomes an instant success, but instead often need adapting their business model to suit the market (Sull 2004, Furr & Ahlstrom, 2011, Mullins & Komisar 2009, Blank, 2012, Ries, 2011). Mullins & Komisar (2009) describes an iterative process for systematically test a business model to be able to adapt it to the market. This process consists of four building blocks; *Analogs*, *Antilogs*, *Leaps of faith* and *Dashboards*. Finding analogs means identifying other products or services that are similar to the products or services the start-up is planning to produce. The point is to learn from other people's successes and failures before trying something similar by yourself. Antilogs are predecessor companies compared with that you choose to do things differently from, perhaps because they were not successful. Looking at analogs and antilogs can be both easy and cheap to come by, as it can usually be found in marketing researchers secondary data which can be found on the Internet, at libraries or at other companies' performance reports. Leaps of faith in difference from analogs and antilogs cover what you do not know. Questions that cannot be answered through old data as analogs and antilogs leads to leaps of faith, believes despite having no real evidence that they are really true. The leaps of faith are handled through experimenting and seeing how customers respond. Identifying leaps of faith early and testing them will lead to learning whether or not your original plan works or not before wasting too much time and resources. A dashboard is used to structure a systematic way to guide the experiments and track the results that arise. This enables leaps of faith to be measured and evaluated as proven or refuted (Mullins & Komisar, 2009).

2.4 Analytical Framework for Business Modelling

As seen in sections 2.1, 2.2, and 2.3, business model innovation is a way to create value in an established firm. One way to business model innovate is using an illustrative business model framework and perform tests with the aim to validate, abandon or pivot the business model until finding a scalable and sustainable business model. Having a structured process for testing and experimenting with business models is also important to achieve validated learning and easy-to-follow work process.

To better evaluate business models an analytical framework has been created. This analytical framework aims at illustrating a process for stating, testing, and evaluating business ideas. The analytical framework is illustrated as follows with the various steps explained:

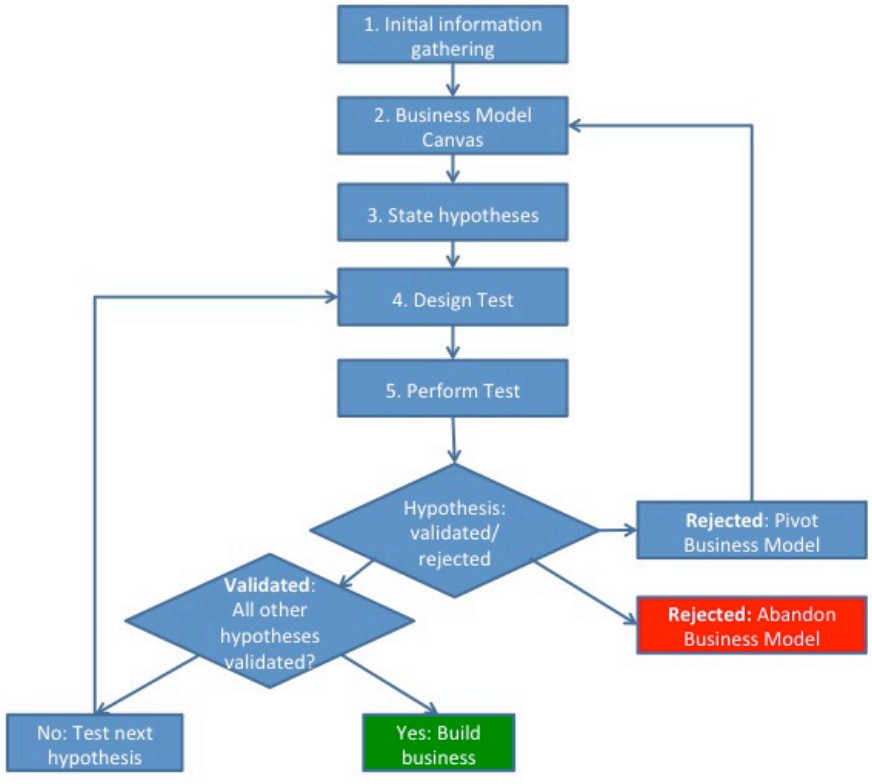

Figure 6 Analytical Framework for Business Modelling

1. **Initial information gathering**. This activity includes gathering information about the potential business area. Information can be finding external analogs, antilogs, technologies, and knowledge. This also concerns identifying internal technology, knowledge and other resources that can be used in the potential business area.
2. **Business Model Canvas**. At this stage the initial information gathered is used to fill out one or several business model canvases (Osterwalder & Pigneur, 2010).
3. **State hypotheses**. This activity states hypotheses or uncertain elements in the business model canvas. The different building blocks in the business model canvas are prioritized to identify which are most critical.
4. **Design Test**. At this activity test or experiments how to test earlier stated hypothesis are designed. Tests should focus on maximizing validated learning and minimizing costs.
5. **Perform Test**. Performing tests on hypotheses to confirm or discard critical assumption of the business model canvas.

After testing, the tester must evaluate the results and decide if the hypothesis is either validated or rejected. If rejected, either redo the business model canvas with the newfound learning, or abandon the business model. If the hypothesis was validated, depending on if there are other hypothesis and uncertainties, either test next hypothesis or start building the business.

3 Methodology

This chapter will go through the research methodology used in this thesis. First the method of how the study was conducted is presented. The work process of what was done and in which order follows this. This is in order to give an image of the path taken to reach the presented material and results. Then the methods of how information was gathered, summarised, validated and analysed will be gone through. The chapter ends with a section regarding the study's research quality, where the reports reliability and validity is discussed.

3.1 Choice of Method

According to theory and the constructed analytical framework presented in 2.4, working with business model innovation is an explorative and iterative process. Not much is known when the study began, and much was to be investigated. As the aim of the study is to examine whether or not a business modelling approach is useful in an established firm, an exploratory case study is therefore suitable for this kind of investigation.

This study has been practice-oriented in the definitions presented by Holmén (2012), as its objective has been to contribute to the knowledge of one practitioner. Holmén (2012) describes a case study as a study of one or several cases in their real life context and where the data is analysed in a qualitative manner. Since this study focuses specifically on SCA and the potentials of waste streams of theirs, it can be categorized as a case study. Only one case is studied, with help of existing theory. This also corresponds with case studies often favouring qualitative research designs.

This study was conducted in the fuzzy front end and much of the empirical material gathered came from the knowledge of individuals. The chemicals and other material to be extracted from the waste streams are by no means novel to the world; so data exists regarding it's worth et cetera. How much of it the waste streams actually contain and data regarding extraction processes however is something that has only recently been targeted for investigation at SCA's paper pulp plant. Neither are possible applications something that has been well investigated. Some research has been conducted for some areas, but not too much information exists on the subject. Much of the information is therefore gathered in interviews of qualitative nature and additionally through documents and earlier research.

3.2 Working Model

The goal of exploring options for the utilisation of SCA Forest's waste flows was predetermined for this thesis. In the early planning phases a rough plan on how to do this was conceptualised, giving a framework for some general steps to be taken throughout this process. It was early determined that an interesting way of evaluating various alternatives was through business modelling, used as a scenario planning tool.

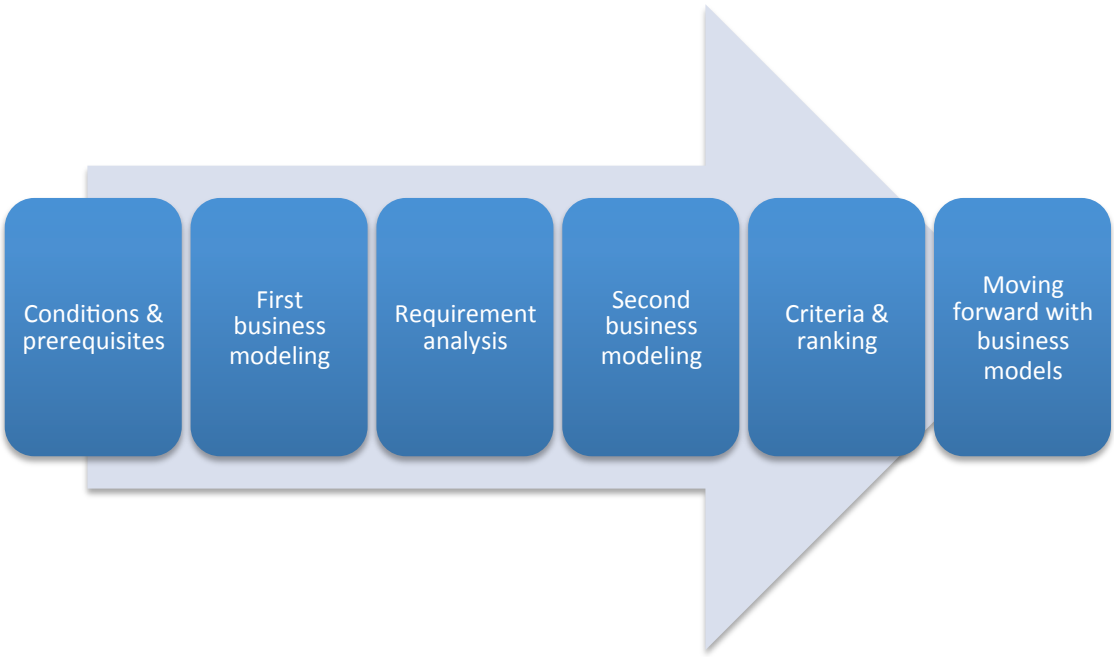

Figure 7 Work Process

The plan presented in Figure 6 is a general one. It is not aimed at giving the illusion of this being a linear process, but includes much iteration. It is however aimed at giving some insight into how the report reaches the conclusions made.

The initial phase was conducted with the thesis' examiner and SCA representative. Here the initial early aims of the report was set. It was decided that the report would investigate the potentials of using waste materials at the paper pulp plant and that business modelling would be the main tool for analysis. At a visit to the plant and interviews with on-site representatives, it was also decided that extractable materials from TMP-water would be especially interesting to look at. This phase also included a lot of data searching, looking for potential usages for waste streams in external documents and research.

The following phase took what was learned in the initial phase for an early stage of business modelling. Information gathered in the first phase was used to map out what could potentially be done with the waste streams available. This in order to better visualise the different paths that was going to be explored in the latter phases.

The third phase aimed at figuring out requirements from both SCA and the potential markets. This phase consist mainly of interviews. Open interviews with people working either for or with SCA helped with getting a better grip of what they consider interesting and possible. Semi-structured interviews with identified potential customers was conducted in order to get a glimpse of what the markets would consider important in a product to make it attractive to them.

In the fourth phase the additional information collected from contact with the markets is put to use in a second round of business modelling. The business models are here updated to better align the important activities etc. for SCA to fit what the markets desire. These are the final business models presented in this thesis.

In the phase following the second round of business modelling, the same models are evaluated. With set criteria's they are discussed to find the, or those, most suitable for SCA.

The final phase discusses the selected business models and how to continue the iterative process that has begun. The results from this stage are a plan for how to move on with the proposed business models.

3.3 Data Collection

The data collection consisted as mentioned of document searches and interviews, but also from observations at the paper pulp mill. The first interviews conducted were with experts at SCA and organisations associated with SCA. These interviews were done in order to gain information regarding the waste streams and their contents and to investigate regarding how these could be used. Little was known and much had to be ironed out. This stage of data collection was paired with a visit to the paper pulp plant, where technical data was given, and contact with knowledgeable on-site staff was made.

3.3.1 Observations

The processes of the paper pulp mill were observed in a tour of the paper pulp mill during a study trip to paper mill. The observation was of open and unstructured nature to get an initial understanding of the waste material streams and processes at the paper pulp mill. The observation was followed up by open questions to clarify what was seen and for better understanding of the processes. When questions could not be asked due to noise, jotted note were made for future questioning. Before observing the processes and material flows, the processes were reviewed by going through the process map of the paper mill and discussing the potential waste materials that was of interest for the study. After the observation the processes and waste materials seen were discussed and illustrated on a white board to give a better overall picture of the processes conducted at the paper pulp mill.

3.3.2 Open and Semi-structures Interviews

The first interviews conducted were with experts at SCA and organisations associated with SCA. In total, 13 open interviews were conducted. These interviews were conducted face-to-face in an open discussion manner. These can be seen summarised in Appendix 3. Organising these discussion face-to-face and in an open manner was due to this being an exploratory stage. Little was known and much had to be ironed out. Therefore posing direct questions would only limit the results of an interview to what little the interviewer already know. The open interview allows the interviewee to tell all he or she knows on the subject. Some disadvantages are that the discussions can easily drift from the subject, and that the results can be hard to compare to what other interviewees respond. (Bryman & Bell, 2011)

14 semi-structured interviews were conducted with potential customers. Also a meeting with BASF, a potential partner developing bio-SAP, were held to investigate their interest in the waste streams. The sample was chosen from the identified uses of GGM that were found and a list of companies to contact was created. With one of the main arguments of SCA's GGM being that it is produced locally from Swedish forest products, the sample was chosen entirely from the local Swedish market. Companies of interest were contacted and after briefly explaining what the interview was about, they suggested whom to best talk with. This resulted in interviews with product managers, R&D managers, owners/CEOs etc. The sample was of a convenience sample nature (Bryman & Bell, 2011). The criteria's were that they must be from Sweden and be actors in the industries of interest. From those filling these criteria's, interviewees were chosen and contacted based on availability. The questions posed, which can be seen in Appendix 1, were created by the authors and then tested and approved by the Master's Thesis company supervisor.

Semi-structured interviews have similar benefits to that of open interviews. It leaves room for the interviewee to answer somewhat freely, while it is guided by some more specific questions as well. Where open interviews are more guided around a topic, the semi-structured interviews results in more quantifiable data, making it possible to compare the various answers collected with each other (Bryman & Bell, 2011). Additionally, in order to have enough interviews to make any interesting conclusions from, the sole method of interviewing market representatives was over telephone. This so that there would be time to get in touch with enough interviewees.

3.3.3 Secondary Data

Secondary data in form of internal and external documents and other materials have been used in this study. Internal data were documents within SCA such as project plans, information about processes and waste streams, internal business intelligence etc. External data were in form of company web

pages, articles and press releases. Databases such as the Chalmers University of Technology's library search engine Summon, Google Scholar and SciFinder has helped find relevant data. The latter is a database specifically for chemistry and related science information. The secondary data was collected with main focus on finding usages and markets for waste materials, gather information of related external projects and find out more from companies and interviewees.

3.4 Analysis Method

Information gathered is used to form the business models presented and the hypotheses to be tested. Initial information gathered from scientists at SCA and through secondary data regarding potential uses of waste materials formed an initial set of business models. Their hypotheses were tested according to the model presented in 2.4. Phone interviews with market representatives were how this experiment was conducted. Assumptions regarding the markets were validated or rejected and resulted in revised business models with pivoted building blocks.

To make sense of the information collected, all interviews were transcribed. They followed a semi-structured questionnaire and what the respondents said was summarised in the order of this questionnaire. To help analyse the business models these answers were used in a rating system. For some important criteria's, the business models got scores from 1 to 3, denoting their suitability for SCA's proposal.

3.5 Research Quality

By looking on validity and reliability the quality of this study can be assessed. Reliability is concerned with the question if the results of a study are repeatable or not. Validity concerns whether or not the conclusions drawn can be said to be valid. (Bryman & Bell, 2011) (Golafshani, 2003)

3.5.1 Reliability

According to Bryman & Bell (2011) reliability can be divided in two parts, internal reliability and external reliability. External reliability is in which degree the study can be replicated. This is seen as very hard in qualitative research since "freezing" a social setting and the circumstances to make the study replicable. There are however, according to Bryman & Bell (2011), several strategies that can be used in order to approach the requirements of external reliability. A qualitative researcher can for example try to adopt a similar role as the original researcher; otherwise what the researcher conducting the replication sees and hears might not be comparable with the original research (Bryman & Bell, 2011). External reliability is relatively low for this study as interviews made were of semi-structured and open nature, making the study's reliability low. Internal reliability is by which the members of the research team agree about what they see and hear concerning the study (Bryman & Bell, 2011). As both authors were present at nearly all interviews and observations and the results where discussed directly afterwards, internal reliability should be relatively high.

3.5.2 Validity

Validity of a study can be estimated by looking at three different types of validity, construct validity, internal validity, and external validity (Bryman & Bell, 2011).

Construct Validity
Also referred to as measurement validity. Construct validity refers to that a measure devised for a concept really reflects the concept it is supposed to denote. Construct validity can be strengthened by the triangulation (e.g. by using multiple sources of evidence), chain of evidence (e.g. logical reasoning of research procedure), and having the respondents draft reports or notes (Holmén, 2012) (Golafshani, 2003). Estimating construct validity for this study is hard, but using multiple data sources and having continuous discussions with advisor at the host company construct validity have been improved.

Internal Validity
Internal validity is concerned with the issue of causality, that a conclusion that incorporates a causal relationship between two or more variables holds water (Bryman & Bell, 2011). An advantage of case

studies compared to other research designs is that it as a qualitative research method can have high internal validity (Holmén, 2012). The case study has been driven by findings from multiple sources containing thick descriptions, and internal validity is considered high.

External Validity

The issue is concerned with the question if the results from the study can be generalized beyond the specific research context (Bryman & Bell, 2011). Case studies like this generally have low external validity (Holmén, 2012). This is not to say case studies are not generalizable at all. Quite opposite, there are scholars who find this to be a misunderstanding and that case studies can be generalizable to a larger extent than given credit (Flyvbjerg, 2006). Looking at SCA Forest for example, they compete in an old and inert industry. To capitalise and make use of the forest and produce paper has been done for a long time. It is also something that is done in the same way around the world, with a few different pulping techniques. Any other actor that use the same pulping technique and spruce trees as their raw material could therefore learn from the case of SCA's efforts to enter new businesses. Making this a critical and specific case, but still generalizable for some.

4 Empirical Findings

In this chapter empirical findings from interviews, observations, meetings, and internal and external documents are presented. First, the empirical setting at the paper pulp mill and the waste flows are presented. Secondly, descriptions of the raw materials of interest are presented. This is followed by a description of galactoglucomannan (GGM), a material that can be found in some waste streams, and the chemicals that can be made out of this. Then a number of related external projects are presented. Finally the discovered potential usages for the identified waste materials are presented.

4.1 Empirical Settings

This part introduces the empirical setting and the investigated waste flows.

4.1.1 The Paper Mill

SCA is Europe's largest private owner of forest and one of the regions most profitable producers of forest-related products. SCA Forest Products are offering paper, pulp, sawn timber and renewable energy. This includes paper for magazines, newsprint, wood components for construction and furniture, and biofuels (SCA, 2012).

The paper-pulp mill is part of SCA Forest Products and is located close to Sundsvall in the northern part of Sweden. The paper mill produces coated printing paper, LWC (lightweight coated paper) and newsprint on four machines. The raw material used is spruce pulpwood, mostly from SCA's own forests in northern Sweden. The paper mill has a production of 880 000 tons of paper per year and relatively high efficiency of using incoming pulpwood (SCA, 2012). The process for creating paper from pulpwood has low margins and every enhancement of the process or extra income is highly appreciated. The paper mill uses several times more water than the paper it produces through the different steps in the process. The paper mill uses mechanical pulping which yield as high as 90-95 % (Pokhrel & Viraraghavan, 2004). The backside of the high yield as compared to for example chemical pulping is that the pulp is of lower grade and contains shorter fibres.

4.1.2 The Paper Production Process

OUT OF CONFIDENTIALITY REASONS THESE DATA WILL NOT BE INCLUDED IN THIS VERSION OF THE MASTERS THESIS

4.2 Waste Streams

There are several waste streams in the paper pulp mill, which are taken care of in different ways. The following are the main waste streams and what they currently are being used for. Possible usages for the waste streams are described in the following part. In the end there is a summary of the identified waste streams, their size, current usage and other possible usages.

4.2.1 Bark

Bark contains mainly of cellulose (11-23 %) and lignin (36 %) but also extractives and other substances. Every year the paper mill handles approximately 200 000 tons of bark. The barks origins from spruce trees and have a dryness of about 40 percent when being incinerated, which is the usage of bark at the paper pulp mill. The paper mill consumes very high amounts of energy, and the incineration of bark is a key part of satisfying the needs for heating and providing energy for the different activities in the pulping and paper processes. Bark has a relatively high energy-value, and is not as much a waste as other waste materials when incinerated. On the other hand, if there is a better use of bark than as energy, there are substitutes to be found on the market such as electricity or oil.

The heat value of bark chip with 45 percent dry weight is approximately 2.0 MWh per ton (Kastberg, 2012). The total energy output of 200 000 tons bark from the paper mill should therefore equal to roughly 400 GWh of energy each year. With an estimated average price of a year of 300 SEK per MWh, the total cost for substituting 400 GWh would be 120 million SEK.

An option could be to replace Bark with for example oil. 1 cubic meter of oil gives approximately 10 MWh (Kastberg, 2012). Each cubic meter of oil is equal to about 840 Kg of crude oil (Jernkontorets energihandbok, 2007). Each ton would therefore give 11.90 MWh. To cover the demand of 400 GWh there is a need for 33 613 tons of crude oil which is valued to about 29 million Euros or 253 million SEK (SCA, 2012).

These numbers and calculations are made with approximations and are not exact, but they give a good estimation of the value that bark provides for the paper pulp mill.

4.2.2 Fibre Sludge

Fibre sludge is a mix of waste from several processes on the way of creating paper from pulpwood. The fibre sludge does not have a single origin but from many different activities in the pulping process. The paper mill produces approximately 30 000 tons of dry fibre sludge each year. Today the fibre sludge is incinerated but not very efficiently. The fibre sludge contains a lot of water in the form in which it is incinerated, lowering the energy output in from the incineration. Lowering the amount of water for better incineration is not done as the drying process in itself is energy consuming and is not economically feasible.

The energy that is given by the fibre sludge by being incinerated is on even parts with the energy cost of the incineration with a smaller positive surplus. The costs are therefore covered, but no large gains are given from this waste flow. The average heat value created from incinerating the fibre sludge is almost the same as that from sludge.

4.2.3 TMP-Water

The TMP-water (thermo mechanical pulp-water) is used in many of the activities of the process of making paper. In the process TMP-water is flowing around through different activities and has no single exit, water is instead taken and added in several places to balance the flow of water needed for the process. Therefore there is not yet any exact number of how much of the TMP-water that can be removed from the cycle of activities without affecting the production negatively. DATA REMOVED

4.2.4 Bleacher-Pressing Water

This is the TMP-water output of the bleacher presses. Similar to the other TMP-water this waste stream contains GGM, but in a lower concentration. DATA REMOVED

4.2.5 Bleacher Flotate

Creating bleacher flotate is a rather new activity at the paper mill and the flotate contains materials such as pectin and extractives. Bleacher flotate is the solids taken from the water used in the bleaching pressing. Increasing pressure on the water allows the water to absorb more gas, and later lowering the pressure lets the water dispose gas. The disposed gas takes solids to the surface of the bleacher pressing-water, which later is pealed by a machine dividing the floating solids, the flotate, and the rest of the water. The water is later bound for the purifying stage and the flotate is burned together with the fibre sludge. The flotate has more potential value than the fibre sludge as it does not contain as much ashes and contains fines and ray cells. The content of the flotate is not good enough to create standard paper, but there could be ways to work around this., This has not been fully explored as extraction the flotate is as mentioned earlier, a relatively new activity. As mentioned, the current usage for the flotate is incineration produced heat. The raw flotate has a quite low energy value as it contains a lot of water, which needs to be minimized before incineration.

4.2.6 Summary of Waste Streams

Following is a summary of the identified main waste streams from the paper mill. The amount/weight of waste streams specified is if nothing else mentioned the waste materials in dry form, meaning not counting water that usually is bound to it. Note that 100 percent dry material normally is impossible to achieve and not cost effective. Current uses are specified as well as some alternative usages identified.

Waste streams	Amount (tons per year)	Current usage	Alternative usages
Bark	OUT OF CONFIDENTIALITY REASONS THESE DATA WILL NOT BE INCLUDED IN THIS VERSION OF THE MASTERS THESIS	Incineration	For creating fuels/chemicals
Fiber sludge		Incineration	For creating fuels/chemicals
TMP-water		No usage, clean-up and discarding	Extract and sell GGM or potentially further refinement of GGM to fuel/chemicals
Bleacher pressed-water		No usage, clean-up and discarding	Extract and sell GGM or potentially further refinement of GGM to fuel/chemicals
Bleacher flotate		Incineration (together with the fibre sludge)	Extract resources and develop further, or take use in paper production in non-standard methods

Table 2 Summary of waste streams

Of the different waste flows TMP-water is seen as the most interesting waste flow from the view of chemists working at SCA Forest Products. This is mainly because the TMP-water today does not provide any benefits in difference to the other waste flows that are incinerated and gives important energy to the mill that otherwise would have to be purchased. Bark, fibre sludge and bleacher flotate are quite valuable as energy sources. The bleacher pressed water contains less GGM than the TMP-water and requires more refinement. Thus it is off less interest. SCA Hygiene Products, the main driver of this thesis also specifically states that waste products from TMP-water are especially interesting. This is because it has potential when further refined to be used in a multitude of consumer products connected to SCA Hygiene Product's fields of interests. One of the potential usages is as bio-based super absorbent polymers (SAP) that SCA Hygiene Products is in high demand for as it is a key raw material in baby diapers and incontinence products. Today SAPs are petroleum-based, but there is research on bio-based SAP, and one potential way could be producing bio-based SAP from raw materials such as GGM. Most other potential usages for GGM is overall in an early research stage, of the potential usages identified not many have been commercialized earlier or been investigated by SCA. A side-focus to this study has been proposed by SCA, which is reaching the platform chemical 3-Hydroxypropionic acid (3HPA) that can with further refinement be used to produce SAP. The stages before TMP-water's waste materials can become 3HPA are numerous. In the case of this study the investigated production of 3HPA is through extracting GGM from TMP-water and using GGM's sugar components for creating 3HPA.

This study therefore focuses on extracting GGM from TMP-water, and what possibilities there are for GGM. To be able to produce SAP from GGM, two intermediate stages are glucose (sugar) and 3HPA. The following chapters with in more detail describe the different stages that are possible to develop with using GGM from TMP-water as raw material.

4.3 Introduction of Materials

This part goes through Galacoglucomannan (GGM), 3-Hydroxypropionic Acids (3HPA), Acrylic Acid (AA) and Superabsorbent Polymers (SAP) in more detail. Initial calculations of extraction costs for GGM and possible exchanges from GGM to 3HPA is then presented and compared with market prices of AA and SAP and alternative materials for GGM such as starches.

4.3.1 Galactoglucomannan

GGM is a water-soluble hemicellulose consisting of galactose, glucose and mannose. To reach reasonable concentrations of GGM the TMP-water needs go through filtration and perhaps also drying processes. Currently testing at SCA Forest Products in Sundsvall is conducted to investigate how high concentrations of GGM that it is possible to extract. Important aspects are costs of extraction but also investigating which concentrations and other attributes that is optimal for further processing or

suitable for external buyers. The main method for increasing GGM concentration is initially through ultrafiltration and later possibly some kind of drying.

As the GGM-substance still is new for SCA and not a commodity product on the market, mapping its properties and abilities are in no way exact. From information gathered from primary and secondary sources the following assumed attributes of GGM from wastewater has been identified:

Properties of GGM extracted from paper pulp mill	
Environmental impact	Low environmental impact
Production flow	Even flow entire year
Distribution flow	Even flow entire year
Price	Cheaper than substitutes such as starch (see 4.3.4 Extraction Costs of GGM and Price Comparisons)
Decomposing	Faster than food/oil-based products
Concentration	Low concentration (more water in product), higher concentration can be achieved for a higher cost
Effect	Low concentration effect (more weight of GGM for same effect as other products)
Purity	Low purity (more other materials in product), higher purity can be achieved for a higher cost
Laws & regulations	Same rules/regulations as food/oil-based products
Permeability	Good for oxygen and fat, worse for water
Quantity	DATA REMOVED

Table 3 Properties of GGM extracted from paper pulp mill

The environmental impact when using GGM is estimated to nothing or low in relation to substitutes. This is motivated by the fact that GGM today is not extracted, and that GGM is a waste material. Other than the minimal environmental impact of the raw material, transports can hopefully be minimized and also be more environmentally friendly than substitutes made of other materials. GGM have the advantage over food-based products when used in non-food products and applications since it cannot otherwise be eaten.

The production flow of GGM, or the potential extraction rate, is assumed to be even as TMP-water is flowing evenly through the process of making paper at the paper mill. The possibilities to distribute GGM to potential customers are in the same way assumed to be an even flow. Depending of specifications from potential customers, the concentration of GGM could vary.

As written many times before, GGM is taken from a waste flow and not currently used; there are no costs for the raw material other than the extraction cost. Costs for extraction are according to calculations in 4.3.4 lower than prices for substitute products such as starches. The price for GGM would therefore be able to compete on price with substitutes.

Potential attributes of GGM in different products, such as decomposing time, concentration, effect, and purity are not fully investigated, especially as it may differ depending on which field of usage GGM is used for. The decomposing time, important when used in for example in thickeners, are assumed to be lower that the decomposing time of competing thickeners. Concentration, effect and purity are initially expected to be lower than substitutes. Permeability when used as a barrier is potentially good for oxygen and fat, but less useful for water.

Laws and regulations depends on usage but are assumed to be the same as for substitutes. DATA REMOVED

4.3.2 3-Hydroxypropionic Acid

3HPA is one of the twelve platform chemicals identified by the United States' Department of Energy as most valuable that can be produced from sugars via biological or chemical conversions (Werpy &

Petersen, 2004). 3HPA can be converted to a number of different other chemicals. 3HPA can by dehydration be converted to acrylic acid, which makes 3HPA especially interesting for SCA Hygiene Products, but it can also be converted to other chemicals. As conventional industry is based on platform chemicals mainly derived from fossil resources, using 3HPA as a platform chemical has some clear advantages. Using fossil fuels is unsustainable and suffers from the limited source and unstable cost of petroleum (Jiang, Meng, & Xian, 2009). There are several advantages of using biomass as chemical building blocks and platform intermediates as alternatives to the products from the petrochemical industry. First, it relieves us from depending on more expensive petroleum and improves energy security. Second, the contribution of carbon dioxide to the atmosphere is decreased and less environmental pollution overall. Finally, operation conditions become milder (Jiang, Meng, & Xian, 2009).

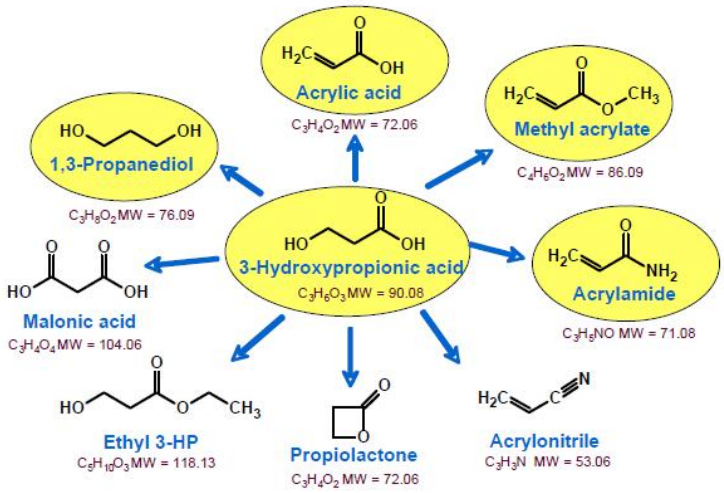

Figure 9 3HPA as a platform chemical (Werpy & Petersen, 2004)

When creating 3HPA from GGM it first has to be deconstructed into sub-components; galactose, glucose and mannose and then further processed. SCA is part of a research project together with Chalmers University of Technology, Södra and Domsjö Fabriker AB trying to use wastewater from the paper mill to produce 3HPA. This project has two distinct parts, first using enzymes to release glucose from GGM, and secondly using another enzyme to produce 3HPA from glucose. For this process to be possible the project need to find enzymes that can use the relatively impure waste water and at the same way find a way to further transform the glucose to 3HPA with a reasonable exchange rate (see 4.4.1 Bio-based production of acrylates). The exchange rate between GGM and glucose and between glucose and 3HPA is crucial for the feasibility of the processes and future use. Other actors are also working on biological production of 3HPA, for example the collaboration of BASF, Cargill and Novozymes (see 4.4.2 Acrylic Acid From Renewable Raw Materials), but any other project using waste products from the paper and pulp industry has not been identified.

3HPA needs further refinement before being able to be used in creation of SAP. Acrylic acid (AA) is an intermediate chemical before SAP which SCA currently has not any experience with creating. The largest AA producers in the world are BASF, Evonik and Nippon Shokubai, and an option could be to partner with any of these in a later stage of refinement to SAP. As basically all of the processes needed before reaching 3HPA are still under research, it is not yet clear how much of the potential development of 3HPA from TMP-water SCA can do themselves.

4.3.3 Acrylic Acid and Superabsorbent Polymers

The main use of acrylic acid is as an intermediate in the production of acrylates. Used in a wide range of consumer products such as personal care products, coatings and paint and have a total market size above 100 billion USD. In 2002 more than 3.4 million tons of acrylic acid were produced worldwide

(Ohara, o.a., 2012). The largest producers in the worlds are BASF, Nippon Shokubai, Dow and Formosa Plastics that together account for more than 50 percent of the production capacities of North America, Western Europe and Asia.

AA is an intermediate and important step if creating bio-based SAP from 3HPA. If SCA is going to use GGM taken from paper pulp wastewaters to produce sugars and 3HPA as raw materials for bio-based SAP, being able to transform 3HPA to AA and then into SAP is a must. There are two basic options for AAs from 3HPA, either SCA produces AA by themselves, or collaborate with a partner to do this. As SCA already are large buyers of SAP, contacts and partnerships with large producers of AA and SAP already exist. SCA Hygiene Products uses large amounts of SAP in their products and today they do not have any active role in the production of SAP as it is bought from large external suppliers.

As an actor on the diaper and incontinence product market, SCA is interested in SAP, as it is a large component in their products. The market for diapers is estimated to have a market size of USD 35.6 billion in 2011. The market is expected to have a compounded annual growth rate of 6.6 percent until 2017 where the market is estimated to be worth USD 52.2 billion (Transparency Market Research, 2011). The large growth is largely attributed to the fast growth experiences by emerging countries in the Asia Pacific and Latin America. The growth is driven by rising birth rates and increased hygiene awareness in emerging countries. A large market and uncertain prices for oil-based products make bio-based diapers a more and more interesting choice for producers. The diaper market is segmented into cloth diapers, swim pants, disposable diapers and training nappy. Disposable diapers are the largest segment and holds about 66 percent of the entire market share. As superabsorbent are a key component in disposable diapers, the demand for it should also rise if used in diapers in same amounts in the future (Transparency Market Research, 2011).

4.3.4 Extraction Costs and Price Comparisons

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4.4 Related Projects

This part covers other projects that are related to the process of creating bio-SAP as an alternative to the traditional petroleum-based SAP. These projects make use of different raw materials and methods in their attempt to create bio-based SAP, some which potentially are directly replaceable with materials from wastewaters from the paper mill.

There is a project SCA is involved in that directly relates to the development of bio-SAP by using forest products. The project is a collective research project with Chalmers University of Technology, Södra and Domsjö Fabriker AB to produce 3HPA from different waste waters, including TMP-water from the paper mill.. There are several other external projects going on by mainly large chemical companies that with different methods try to create bio-based chemicals that in one way or another could be used to create bio-based SAP or in some other way relates to the products and usages that the waste streams from the mill.

4.4.1 Bio-Based Production of Acrylates

This project aims to develop bio-based 3HPA and use it for developing environmentally sustainable acrylates. Biomasses used as raw materials in this project, including biomass from the paper pulp mill, are investigated whether or not they are suitable for further refinement. The aims of the project are to identify which forestry derived pulp streams that are suitable for yeast based fermentation processes to break them up into their sugar components and further deepen the cooperation between academia and industry. This project includes, besides Chalmers University of Technology, SCA, Södra and Domsjö Fabriker. The project is also partially sponsored by Vinnova, a governmental agency promoting growth and conditions of innovation.

The project ranges over in total four year, including a one-year pre-project. The budget was 2 million SEK for the pre-project and 7 million for the following three years. The group initially applied for a larger project that was denied, which resulted in a revised project proposal for the current, smaller project. The project reaches from using raw material biomass from SCA, Södra and Domsjö Fabriker and ends with 3HPA and the polymerization of 3HPA at SCA. The raw material used from SCA is TMP-water from the paper pulp mill and Södra and Domsjö Fabriker provides other raw materials sources used in the project. The different raw materials are evaluated in depending on how well they can be decomposed to sugars. Concerning the TMP-water, the Chalmers project wants it to have relatively high concentration of GGM and the aim is to have raw material biomass with a concentration of 200 g/l GGM or higher. The exchange between GGM and sugar is assumed to be around 100 percent if the project is successful. The exchange between sugar (glucose) and 3HPA is currently low, but the goal for this process at the end of the project is a 50 percent yield. With a 50 percent yield and 200 g/l sugar as input, the result would reasonable be 100 g/l 3HPA. With these goals there would theoretically be a 50 percent exchange from GGM to 3HPA. Originally there were plans for a longer project, also covering another few processes to higher value adding. At the moment there is no development in the steps after polymerization of 3HPA. Further development from 3HPA to acrylic acid is better known, and the limitations are probably in production capabilities and cost instead.

An overview of the process from biomass to acrylates that this project focuses on is shown in figure 8.

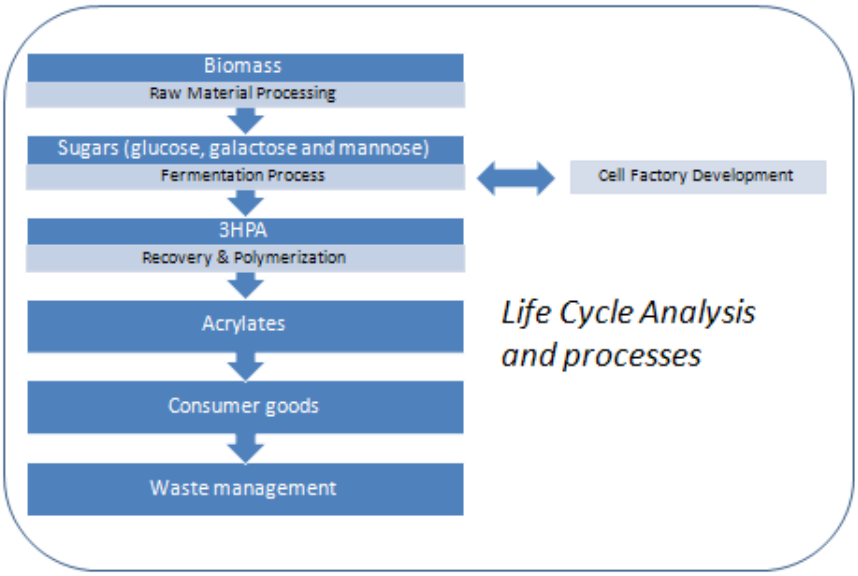

Figure 10. Life Cycle Analysis and overview of processes

The figure above describes the lifecycle from biomass to recycling of consumer goods. The project concerns the first three step, biomass, sugars and 3HPA. The steps to acrylates and consumer products are later stages are not covered in the project.

4.4.2 Acrylic Acid from Renewable Raw Materials

BASF, Cargill and Novozymes are currently collectively researching the possibilities of creating acrylic acid from renewable feedstock. Cargill and Novozymes have been collaborating on developing microorganisms that can efficiently convert renewable feedstock into 3HPA since 2008 (Comyn, 2008). The project in 4.4.1 differs from this project as it takes its resources from waste streams from the forest industry, and not from feedstock. BASF have recently joined Cargill and Novozymes' collaboration to develop the process for conversion of 3HPA into acrylic acid (BASF, 2012). BASF is the world largest producer of acrylic acid and have capabilities in production and downstream

processing. BASF's plans are to initially use the bio-based acrylic acid to manufacture superabsorbent polymers.

4.4.3 Acrylic Acid from Fermentable Sugar

Dow, one of the largest acrylic acid producers in the world, and their partner OPX Biotechnologies are also developing 3HPA, but with other raw materials. They have signed a joint development agreement to develop a bio-based acrylic acid from renewable feedstock (de Guzman, 2011). They are using fermentable sugar (such as corn and sugar cane) with the goal to create bio-based acrylic acid with equal performance as petroleum-based acrylic acid. This new product will reduce greenhouse-gas emissions compared to traditional petroleum-based acrylic acid. OPX use their proprietary EDGE (Efficiency Directed Genome Engineering) technology with the aim to rapidly develop a microbe and bioprocess that when fully optimized will produce bio-acrylic acid at the rate, concentration and yield that is needed for full commercialization.

They seek to develop a process of using the fermentable sugar to 3HPA, and later convert it into acrylic acid. 3HPA can be derived from either corn syrup or sugar cane. The engineering company Merrick & Company is designing the demonstration and commercial manufacturing plants, which are/will be operational in 2011 and 2013 respectively (OPX Biotechnologies, 2010).

4.4.4 Producing Acrylic Acid from Glycerin

Nippon Shokubai, another of the world's largest producers of acrylic acid, has been investing in other ways to create acrylic acid than the traditionally oil-based process. One such alternative way is using glycerin (or glycerol) as raw material. Commercial glycerin is most often created as a by-product from natural oil triglycerides such as palm oil and coconut oil via hydrogenation. According to Nippon Shokubai (2009), using glycerin with this new manufacturing method can reduce emission of carbon dioxide by about 1/3 compared to using petroleum-based raw materials. Nippon Shokubai have already applied for and being granted patents for the process (Zucchetto, 2011). Nippon Shokubai was planning to start constructing a pilot plant in 2011 on their plant site in Himeji, Japan (Nippon Shokubai, 2009).

4.4.5 Cellulosic Sugar

In January 2012 it was announced that BASF is cooperating with the US cellulosic sugar developer Renmatix (Renmatix, 2012). The cooperation enables Renmatix to develop a commercial scale factory, with a production capacity of more than 100 000 tons per year of cellulosic sugar. BASF is investing 30 million US dollars and other investors have invested 20 million US dollars (de Guzman, BASF invests in Renmatix, 2012).

Renmatix has developed a technology called Plantrose™ for production of cellulosic sugar that the new factory will use. The technology is patented and can break down lignocellulose biomass made of biomass such as wood, cane trash and straw. The process is according to BASF and Renmatix able to produce large amounts of industrial sugars at a competitive cost from non-edible biomass. The fact that the process uses non-edible biomass means that they do not directly compete with food and feed production. The Plantrose technology breaks down lignocellulose into sugar by heating water up to the so called supercritical point, meaning applying heating or pressure until a state where no phase boundaries (such as gas or liquid) exists. With the help from BASF and other investors, Renmatix is able to move into commercial scale of production. Renmatix plan to use their sugars in bio-based fuels, as raw materials in chemical intermediates, in polymers and other higher value products. (Renmatix, 2012)

4.5 Potential Usages for GGM

The aim of this chapter is to map potential usages of GGM that could be of interest. There can be found many uses for GGM, however not many are commercialised. It is not too hard to find suggestions for potential uses, though few have been thoroughly tested. Hence this chapter relies on assumptions that the potential usages found are also realistic. Assumptions are made where attributes

such as costs, effectiveness etc. regarding GGM is not fully explored. GGM is also in many cases a substitute for existing products such as starches and comparable data of such products can be used.

The main usages identified for GGM are as a thickener and emulsifier, broken down into sugars, as a fibre additive, a surfactant and in various other applications. Thickeners are used in markets such as food, animal feed, cosmetics and paint, which separately have different needs and wants. Emulsifiers are mostly used in food and cosmetics. Fibre additives are used in food, animal feed and in concrete. Surfactants are used in detergents, dish soap and other cleaning and sanitary products. Finally also on cloth and textiles.

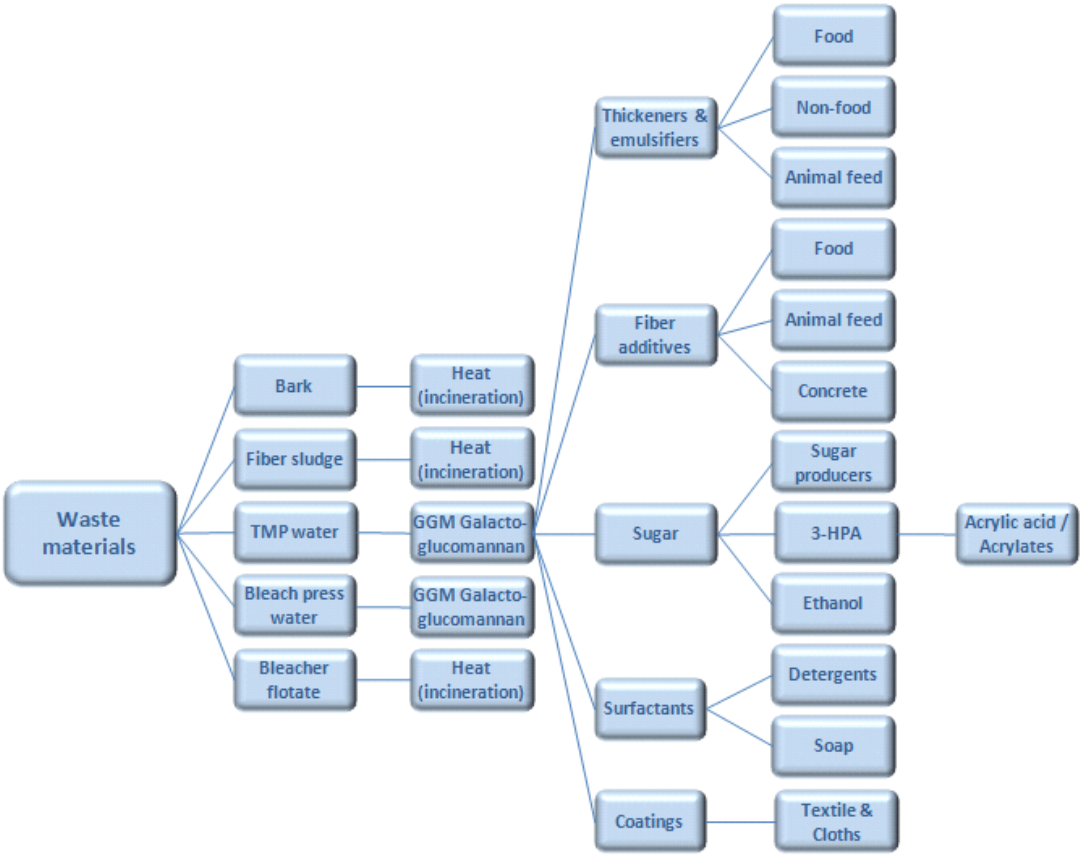

Figure 11 Potential usages for the paper mill's waste streams

The above shown picture displays the different waste flows from the paper pulp mill and potential value adding refinements and potential markets. The process' focus is on TMP-water, the extraction of GGM and potential usages for GGM.

4.5.1 Thickeners and Emulsifiers

Thickeners or thickening agents are substances that increase the viscosity of a liquid without substantially modifying its other properties. The thickeners may also improve the suspension of other ingredients that increases the stability of the product. Another substance group with more vague boundaries is stabilizers. This is because thickeners, emulsifiers and other additives often have a stabilizing function. On example for a use of stabilizers come be when stabilizers are used in strawberry jam to prevent the strawberries from floating up to the surface (Livsmedelsverket, 2007).

Emulsifiers are molecules with one oil-friendly and one water-friendly end. The oil-friendly end is called hydrophobic head and the water friendly end is called the hydrophilic head. Emulsifiers are used to unite two immiscible compounds together and if these compounds are liquids the result is

called an emulsion. In emulsions small oil droplets are surrounded by the emulsifier molecules, with the oil core hidden by the water friendly ends of the emulsifier. A natural emulsion is milk, where a mixture of fat is suspended in the liquid (Food Additives, 2012).

Emulsifiers are one of the most frequent used food additives as they have many usages. Emulsifiers can help food become more appealing as they have a large effect on structure and texture of food. They can also be used in the processing of food and help maintain quality and freshness (Understanding food additives, 2008). Emulsifiers can also help prevent the growth of moulds in food (Food Additives, 2012). Emulsifiers can be used in creams and sauces, bakery and dairy products. Emulsifiers may be derived from natural products or chemicals, but they can also be semi-synthetic.

GGM as Thickener and Emulsifier

Thickeners, emulsifiers and other food additives are very common in different food products. The total market for food additives was US$24.5 billion in 2010, making it an interesting market (Canadian Manufacturing, 2011). GGM has the potential to be used as both thickeners and as emulsifiers. As GGM is relatively untested as a thickeners there is not much research available in the subject, but the potential ability of GGM as a thickeners should be in level with that of carboxymethyl cellulose (CMC). CMC has the E-number E446 and is used both as a food additive, but also as a constituent in many non-food products, such as toothpaste, pills, paints etc. CMC is based on cellulosic materials as well as petroleum-based materials. If GGM could be used in a fraction of the usages of CMC, GGM would be of good use. As GGM probably not has the same potential molecular weight as CMC, the uses will probably be limited compared to those of CMC. Potential markets for GGM as a thickener or emulsifier is then both the food industry and non-food industries for products such as cosmetics and paint.

The demand for emulsifiers is rising and is predicted to do so the coming five years according to a report from GIA (Grey, 2012). Especially the demand for natural emulsifiers and low-fat products are rising due to a higher popularity of niche and premium positioned food, which create need for specialty emulsifiers. Emulsifiers should not only act as fat replacements, but also provide texture, flavour, structural and aerating characteristics (Grey, 2012).

In a study of GGM it was shown that GGM could be used as an emulsifier in an oil-in-water emulsion (Mikkonen, o.a., 2009). In the study different types of GGM (spray-dried or ethanol precipitated) were compared with gum arabic, corn fibre gum, locust bean gum and konjac glucomannan. GGM, especially the ethanol precipitated, had relatively high turbidity compared to the other alternatives. There is also research showing hemicellulose have gelling capabilities with potential to improve texture and structure (Xu, Willför, & Holmbom, 2008) (Söderqvist Lindblad, Albertsson, Ranucci, Laus, & Giani, 2005) (Andersson Roos, Edlund, Sjöberg, Albertsson, & Stålbrand, 2008).

If it is possible to use GGM as a thickener or emulsifier to be added into food, there are rules and laws that must be followed. For a substance to be approved as a food additive it has to pass the rules for food additives, both national rules in Sweden and rules of the EU. These are stated in the Swedish additives regulation (“Tillsatsföreskrifterna” or “LIVSFS 2010:2) and the EU additives regulation (Swedish: “Tillsatsförordningen”) (Livsmedelsverket, 2010). Another requirement for getting GGM accepted for food would be through the recognition of GRAS (“Generally Recognized As Safe”) which is administered by the U.S Food and Drug Administration (FDA) (U.S. Food and Drug Administration, 2012). If GGM is used as a chemical additive in other products, it has to follow the laws set forth by the Swedish Chemical Agency (Swedish: “Kemikalieinspektionen”), which includes the rules of EU and the REACH-regulation (Kemikalieinspektionen, 2012). If GGM is used as thickener or emulsifier in animal feeding, it is the department of agriculture that is responsible for those laws (Jordbruksverket, 2012).

A potential issue when extracting GGM from wastewater is that there will always be some extra substances that are hard to remove, which could affect the use of GGM in food. GGM in itself in not be bad for people’s health, but there will be a small part of lignin and other extractives that is hard to remove and that could be harmful. The amount of these harmful substances will be minimized when

GGM is extracted, but it will be hard to eliminate them. The amount will probably be in such a low amount that it will not prevent the use in food products, but this will not be known for sure until further refinement of GGM is done.

When adding thickeners to paint, there are many attributes that affect the choice of thickener. These attributes can be cost, spatter resistance, viscosity, gloss, water resistance etc (Paints & Coatings Industry Magazine, 2000). Depending on what attributes GGM can provide, this also affects which products it can be used in. When discussing with chemists from SCA, the issue of decomposing was identified as a potential problem. As the decomposing time is not yet investigated, risk exists that GGM-based thickeners could decompose quicker than alternatives.

4.5.2 Fibre Additive

It has long been known that fibre in food can have positive effects on structure of substances added to. They can be added for example to concrete and cement, but mainly figures in food products where they also can have positive health effects. Fibres come from plant material and are resistant to enzymatic digestion and include for example cellulose, hemicellulose and pectic substances (Dhingra, Michael, Rajput, & Patil, 2011).

GGM as a Fibre Additive in Food Products
There are findings showing that health benefits of eating fibres could be helping people with constipation, high cholesterol, acne but also type 2 diabetes (Canadian Diabetes Association, 2012) (WebMD, 2012). Studies show that GGM potentially is applicable as dietary fibre and as part of nutritional supplements and/or pharmaceuticals with immune-potentiating and modest antioxidant activity (Ebringerová, o.a., 2008). GGM potentially has the right attributes such as swelling and thickening attribute to suit the fibre additive market. GGM also could be used as a carbohydrate source for probiotic bacteria, causing potential positive health effects if added to food (Polari, Ojansivu, Mäkelä, Eckerman, Holmbom, & Salminen, 2012).

One option could be the market for health products, as GGM fibre additives have already mentioned health benefits. There are already products on the market that focuses on high fibre content, but no product identified uses GGM or any other forest based products as a raw materials, but instead fibres coming from various food products. One example of how fibre can be used in a health product is the high-fibre noodle used for weight loss, “miracle noodles” (Miracle Noodle, 2012).

GGM as a Fibre Additive in Animal Feed
As for humans, fibres can be used as a food additive for animals. Animals as well as humans can suffer from obesity and bowel problems, and there exists products especially made to contain extra fibres for animals. As animals are different, their need for fibre would logically also differ.

Obesity is a common health problem among companion animals such as dogs, and one way to help these obese dogs could be adding fibre into their food (Fahey, Merchen, Corbin, Hamilton, Lewis, & Hirakawa, 1990). Fahey et al. (1990) tests the optimal level of fibre additives to dog food using beet pulp as source of fibre. The result show that a female adult English Pointer can utilize up to 7.5 % dietary beet pulp as a fibre source without severe reductions in nutrient digestibility or energy utilization. Even in levels up to 12.5 %, no harmful effects will occur, but more and more frequently faeces will be excreted. The results of a 5 dog study of different fibre additives to dog food by Lon et.al (1994) show that finely ground cellulose, corn fibre or pectin can be used in commercial dog food without adversely affecting nutrient digestibility or gastrointestinal function (Lewis, Magerkurth, Roudebush, Morris, Mitchell, & Teeter, 1994). Another similar study where Galactoglucomannan oligosaccharide (GGMO) was used proved GGMO had several positive effects on dogs’ health (Faber, Hopkins, Middelbos, Price, & Fahey, 2011).

Adding fibre to cattle feedings can also have positive effects. Nature designed cattle to feed on grass and other high-fibre foods, and an all-grain diet can make them sick (Recer, 2001). High grain diets can cause problems such as bloating and liver failure and cause cattle to die in grain-related disorders.

The same author claims that cattle are healthiest when they are fed diets that include grass, hay or other high-fibre matter. Healthier cattle require less use of antibiotics as well (Recer, 2001).

Having fibre in cattle feed has potential positive effects on production. Highly productive cows' milk production ability is often limited by their ability to consume sufficient energy in their diet to meet their energy requirements for milk production and maintenance of body functions. In other words, highly productive cows have a limited ability to consume energy relatively to their needs. It is not so easy to just feed the cows more, but they require a balanced fermentation process in their rumen to digest feeding that has been consumed. Structured fibre can be a way to improve rumen contents, stimulate cud chewing, and produce fermentation end-products that help produce milk fat and protein. (Robinson & Putnam, 1999) (eXtensions, 2012)

Other than the so far mentioned, fibre can be added to other animals feed as well. Wild cattle for example have similar digestions systems as cattle. Pigs feed contain fibre as well. Horse feed is also a large user of fibre where it is important for their wellbeing (Awinna, 2012). For example the product Betfor contain 70 percent fibre from beets (Nordic Sugar, 2012).

GGM as a Fibre Additive to Concrete and Cement

Concrete is the most frequently used construction material in the world. Concrete have some less desirable attributes such as low tensile strength, low ductility, and low energy absorption. One way to improve the properties of concrete is to add fibres during the mixing of the concrete, usually as small as 0.5-2 percent fibre of the total volume. By using fibre reinforced concrete (FRC) the result is lighter buildings with longer life expectancy. The fibre used in concrete can vary depending on what properties that are wanted. Commonly used fibres are made of polypropylene, nylon, glass and steel, but it can also come from recycled PET, tires, carpets or cellulose (Ochi, Okubo, & Fukui, 2007) (Wang, Wu, & Li, 2000).

Fibres made from waste products from the forest industry could be used in FRC. Wastepaper, wood waste and sawdust are some previous tested materials (Soroushian, Arola, & Shah, 1992). Some potential enhancements of concrete materials by adding these fibres are enhancing weight-to-strength ratio, insulation properties and toughness characteristics (Soroushian, Arola, & Shah, 1992).

GGM in Cloth and Textiles

It is possible to use GGM as coating for cloth and textile. By mixing cellulose and plastics it is possible to make antibacterial coatings that can be used on clothing (Mirsch, 2011). Instead of using chemicals as antibacterial coating, which can cause antibiotics resistance and other environmental problems, using cellulose-based products would not risk bacteria to become resistant or create any other environmental issues. Potential market for this could be hospital clothing in paper towels for sterilizing tables without the use of chemicals.

4.5.3

OUT OF CONFIDENTIALITY REASONS THIS SECTION WILL NOT BE INCLUDED IN THIS VERSION OF THE MASTERS THESIS

4.5.4 Surfactant

Surfactants are substances that lower either the surface tension of a liquid, the interfacial tension between two liquids, or that between a liquid and a solid. Surfactants can be used in various products and application, some of them being as detergents, emulsifiers, foaming agents and dispersants.

Surfactants are amphiphiles, meaning they are of polar-apolar duality. The amphiphiles molecule consists of two parts, one polar group and one essentially apolar group. The polar group exhibits a strong affinity for polar solvents, such as water, and is often called hydrophilic or hydrophile. The other end of the molecule is called hydrophobe or lipophile, "lipos" being Greek for grease. Because of the dual nature of the surfactant, there will always be a part of it that "does not like" the solvent

environment. This causes the surfactant to migrate interfaces or surfaces so the polar part is in water and the apolar part is out of it or eventually in oil (Salager, 2002).

The global market sales for surfactants were 24.33 billion US dollars in 2008 (Acmite Market Intelligence, 2010). GGM could be used to produce surfactants in similar ways as acryl polyglycosides (APG). APG is a non-ionic surfactant made from vegetable oils and starch and is used in a variety of products such as home care and body wash, cleansing lotions, shampoos, oral care products, wipes, laundry detergent, hard surface cleaners and industrial and institutional cleaning applications according to Cognis (owned by BASF), the worlds largest producer of APG surfactants (de Guzman, Sugar-based surfactant development gains ground, riding on the success of growing demand for APG, 2011).

4.5.5 Sugar

Sugar is a commodity product in produced in high volumes. GGM could be sold directly to a sugar producer that will have to further processes GGM to its sub-components and used as sugar. SCA could also deconstruct GGM to sugar themselves and provide refined sugar made from forest materials.

Breaking GGM down into sugar is also the first step in creating 3HPA. Producing sugar is thus an activity that is essential to producing bio-based SAP. This does not exclude other potential buyers of sugar, but opens for those who want to use sugar to create bio-based chemicals. Other options include selling it to ethanol producers who can ferment the sugar into bio-fuel.

4.6 Empirical findings: Users and End-Users

This part contains information collected when interviewing external potential customers. As many markets and usages for GGM were identified, interviews were concentrated on the markets that were considered most interesting. The selection was based on information available from earlier data collection and in discussions with SCA. Other than information collected from interviews, a meeting with representatives from SCA and 3 representatives from BASF was held to discuss the potential collaborations with using the waste materials from TMP-water and the possibilities to use it in production of bio-SAP.

4.6.1 Thickeners and Emulsifiers

There are many types of thickeners and emulsifiers that are used in business and consumer products as products have different need of thickening effects depending on what attributes and affects the producer wants the product to have. Producers using many different types of thickeners and emulsifiers did so because different products and raw materials required thickeners or emulsifiers with different attributes. Mentioned thickeners and emulsifiers used by producers were starches (potatoes, corn), mono- and disaccharides (E471), Xanthan gum (E415), CMC (E466), guar gum (E412), pectins, alginate, monoglycerates and other E400s with thickening effect.

Food
Criteria for purchase and use of raw materials were several. A representative from a large producers of baking ingredients, said that the main criteria for buying raw materials was the avoidance of E-numbered products as they strived to minimize the use of E-number additives. This was important as avoiding E-number was important in being ecological and having natural products in the aspects of the consumers. A representative from a spice company also agreed to that natural ingredients were more interesting than other more altered products. Another ingredient producer and distributor for food and feeding industry argued that it was the current demands and needs that dictated which purchasing criteria that were used. They also thought that the ability to assure quality of the raw materials were of high importance. The raw materials they purchased went through internal quality assurance systems but also had to pass external food grade standards and have proven function. Several of the producers claimed that they performed bakery tests or other evaluations of new materials before accepting it into products. A representative from a spice producer mentioned several criteria such as texture, origin of

the raw material, non-allergenic, but also logistically viability. Price was one of the most important factors for almost all of the respondents.

When asked which feature that was most important for an thickener or emulsifier and would enable them to pay more for the product, an very common answer from respondents were that the raw materials should be more natural and avoiding modified materials such as modified starch and additives with E-numbers. One respondent answered that a thickener or gelling agent of vegetable origins instead of gelatin would be highly attractive. This due to the fact that gelatin is made from animal products and they seek to produce product entirely from vegetative sources. Another most important feature was the effectiveness, the ability to use less thickener or emulsifier for the same effect as earlier, a high thickening effect per volume would naturally enable a higher price.

When asked what laws and regulations they follow regarding additives in food production, frequently mentioned was simply that it had to be food grade. More specific directions to the regulations of the Swedish food agency was given from the respondents. What some also mentioned were guidelines and regulations of domestic agencies, to make export possible. One respondent said they follow what BRC, the British Retail Consortium, says, and another mentioned them following various export and foreign laws, although no specific example was given. In a third one, they said that what they follow most regarding regulations were the clear rules regarding what to declare on packaging.

Exact numbers regarding volumes and costs of thickening and emulsifying agents in the respondent's products were hard to get, however they all stated it constituted a small part of their final products. One respondent had some rough numbers, stating they paid between 5 Swedish öre to 1 Swedish krona per kilogram. This constitute about 0,5 – 15 % of final product costs, where high numbers as 15 % were rare. Similar estimations, 0,5 – 10 %, were given from the spice company as well.

The answers regarding environmental friendliness differed some among respondent. At another producer much concerned their products meeting KRAV standards, since this was pushed on from their management where an increasing demand was visible from the market. The respondent himself mentioned his own belief in locally grown produce and that they preferred buying such ingredients for their products. One interviewee was unsure what standards regarding environmental friendliness they followed but other than that their products were not to be too much of a burden on the environment he stated that they were more concerned with the additives they use being completely pure and approved. The spice company did as mentioned seek ingredients from as natural a source as possible, as did another, and the spice company wanted this to be clearly stated on their products, raw material origin etc., as a sales argument.

Answers regarding their purchase process were hard to get, but the interviewees made an attempt. At one, they always evaluated the need for new products with regards to price and efficiency of the new offer. His answer hence more concerned the process of buying new products. When doing this they used product development teams that further evaluated the use of new ingredients and then made the decisions on whether or not to incorporate it into their production. One respondent mentioned their need being continuous and purchases made in bulk. They preferred working with a few suppliers that deliver more than one product, in order to not have unnecessarily many business relations to uphold.

If having the forest-based products were of any advantage or disadvantage, the common denominator was that what was most important was how it would be seen in the eyes of customers. Being approved and proven to be a good product would not matter if the origin would deter customers. At The spice company the answer was more specifically that it should not pose a problem as long as communicating the offer to the customer was done properly, showing them the advantages of the product. This tying back to the spice company promoting the declaration of product origin on their packaging.

Many had a hard time answering the "magic wand" question. The most precise answer was given by one interviewee who sought the gelatine substitute. Other than that, the spice company would want a natural product, as did another one. They also stated their "perfect product" would be healthy,

nutritious and with a reasonable price. They also wanted as much of what they used to be classed as ingredients rather than substitutes, to avoid E-numbers as much as possible.

Animal Feed
Most animal feed sold is dry and thickeners and emulsifiers are used in only is a small niche of products. These products are mainly directed towards cats and dogs. Compared to dry feed they are also somewhat more exclusive, with a higher price. The ingredients wanted here needed gelling effects, since that is how the food was preserved. They coat the solid food in various sauces, which they then gel.

Here the main criteria's they looked for were efficiency. What they currently use only demands little to be added for sought after gelling effect. They also looked for good consistency and appearance. Important for this market was additionally that it did not add any unwanted flavouring. This of course is important for all edible applications, but since this is a more expensive product than dry feed, they put more work into taste tests.

The environmental arguments were of some interest with this market. Especially the argument of locally produced products. This since long transports were not sustainable, but also since the relatively small amounts they needed could be too costly to transport for great distances.

4.6.2 Fibre Additives

Fibres can be added into several product categories such as food, animal feed and building materials such as concrete.

Fibre in Food
Fibres used in food can be of different kinds and come from different origins. Some mentioned fibres include fruit based fibres, cereal fibres, bamboo fibres, citrus fibre, fibres from grains (wheat, oat, rye), polydextrose, and other fermented products. The choice of fibre is made depending on what fibre that suits the product and the amount of fibre needed. In many cases fibre is not added specifically to a product, but is naturally added when included in other ingredients.

As an ingredient to food, it is important that the fibre ingredient is food grade and follows related regulations. Following the Swedish Food Administration's (Swedish: Livsmedelsverket) regulations is seen as most important, but also laws for exporting and foreign countries' laws are important depending on what kind of product and where you intend to sell it. The Swedish Food Administration's regulations have during the last years more and more converged with the food regulations of the European Union. As fibre is an ingredient and not an additive, it does not have E-numbers or in under the laws of additives.

Some important attributes for fibres in food are proven function, good texture, the origin of the ingredient, non-allergenic material and logistically viable. Price was mentioned as a criterion of purchase. It is also important that ingredients are as naturally as possible, so less need for modifications made on raw materials are positive.

Using fibres from the forest industry was seen as a minor problem. A respondent from them raised worried over the purity of forest-based fibres. Three other respondents argued that it was important to inform customers when adding traditionally non-food product such as forest materials into food.

Fibres in Animal Feed
Fibre used in feed do in a larger extent come from bi-products than fibre used in food products intended for people. The fibre added to fibre can come from various sources by mainly from agricultural origins such as grains and beets, but also from waste products from apples and bi-products from the distillation process of grains. Not all animal feed producers add fibres specifically to their product, A producer of dog food, said that they only indirect add fibres. They said that the amount of fibre depended on ingredients and if extra fibre was wanted a computer calculated how much extra of that specific ingredient was to be added to reach the fibre goal. In a discussion about wanted features

of raw material fibre with a respondent from a competitor more specific fibre materials were wanted. Purer fibre materials would make the content balancing easier giving more precise and reliable contents as less extra materials would be added in the process.

When buying and using fibre in animal feed important features mentioned was getting an overall positive health affect for the animals, ingredients being non-allergenic and not causing irritation or inconvenience for the animals, good hygiene, amounts of minerals and decomposition rate. By decomposition rate meaning how fast fibre is decomposed in the animal, with varying importance and preferences depending on animal. Different fibres have different decomposition time and therefore some fibre suits some animals better than others. Usage of fibre in animal feeding differs between animals and between producers. The competitor used more fibres in their products for cattle, reindeer and other wild animals and less for pigs and chicken. According to the feed producer extra fibre mostly used for animals when performance was extra important, for example when feeding competition horses. The feed producer, a exclusive producer of dog food, did put much notice to fibre in feeding more than another component.

Rules and regulations are set up by the Swedish Department of Agriculture and the European Union to be able to sell outside Sweden. Also having rules for amount of heavy metals allowed, purity of ingredients is important. Two of the companies sets requirement on their suppliers and regards environmental issues as important. Company A even calculates the entire carbon dioxide footprint of their products from raw material to finished animal feed. They include the production cost for materials as well, and according to them the feed processing part carried out by them has a smaller part in the total carbon dioxide footprint.

Forest based products were seen as positive as being environmental friendly and locally produced. As longer transports for animal feed is costly domestic raw materials is important, also locally produced product are getting more and more interesting for customers. Fibres in animal feedings comes in large quantities, as one of the largest feedings producer in Sweden they use more than 5000 of beet fibre each month, and other fibres as well.

4.6.3 Surfactants

A wide range of surfactants exist and in interview with one of them, the owners of big Swedish detergent, they explained they used more or less the entire range. With different products, they needed different attributes, which the various surfactants can provide. He mentioned there being four main types of surfactants; anionic, cationic, non-ionic and amphoteric. Choice of which to use depended on features such as foam or no foam production, where too much foam in a washing machine can make a horrible mess.

The main criterion for them was that of price. This however relied on all materials used being approved by rules and regulations. They also look for ethically acceptable products, and want raw materials to be as environmentally sustainable and friendly as possible. The respondent at a big retailer owned brand explained they did not themselves produce their detergent but that they had demands on the product they buy from their suppliers reach the Swedish ecolabel “Svanen”, which they also mentioned as preferable, and European Union’s ecolabel “Flower”. Additionally they were trying to find alternative biological surfactants rather than the today commonly used petroleum-based ones.

With rules and regulations for use of chemicals such as surfactants, the respondent talked of the EU regulation REACH. REACH stands for Registration, Evaluation, Authorisation and Restriction of Chemicals, and surfactants need to be approved by these regulations. This regards such things as it being harmless, not being an allergenic and so on. Having chemicals approved is however a strenuous activity that can prove both costly and time consuming.

In detergents, cleaning and washing products, surfactants are a large component and the demand from this market I rather large. They use several thousands of tonnes annually for their own branded products.

If surfactants from forest raw-material would be of any advantage was a definite yes from them. For other purposes they had already used products derived from tall oil. However this was in competition of using the tall oil as fuel, hence supply could be scarce. As for the retailer and their products, he did not see any direct advantages. However, at the same time he finished by saying that finding products from biological raw material was of interest, but somewhat hard to do. Forest based surfactants could hopefully do just that.

5 Business Modelling

During the process of collecting results there was an iterative process of business modelling. The business models in this part have mainly emerged iteratively as information has been collected.

Two main focuses in business models have emerged from the process. The first is based on GGM as a raw material and the possible markets and usages that could be interesting for further investigation for SCA Forest Products. This group of business models are mostly resource-driven (Osterwalder & Pigneur, 2010), as they are founded on the raw material resources spawned from waste streams at the paper mill. These business models are only related to SCA Forest Products, not SCA Hygiene Products, as they aim at markets and usages that do not relate to the markets and products of SCA Hygiene Products.

The other focus is aimed on the potential of producing 3HPA from wastewater materials. The business models related to this are based out of how much of this process SCA themselves wants and can do. The steps required can be seen in figure 10. In the figure, the dark-blue squares are steps that SCA could possibly do by themselves, and green squares that a potential outside customer/partner will undertake. In the figure SCA is both the origin of the raw material (SCA Forest Products in the bottom-left corner) and the end-customer (SCA Hygiene Products in the upper-right corner). Even if the figure shows the entire way from TMP-water to SAP, this is in no way a must. TMP-water, GGM, sugar and 3HPA all have other potential usages and the refined materials or products might never reach SCA Hygiene Products.

The 3HPA business models illustrate the four main roads SCA can take with the TMP-wastewater, from basically not doing anything with the material stream, to extracting and refining the material stream to 3HPA. These four roads are illustrated in figure 10 by the four dark blue squares subsequent to the dark blue square with the text "SCA Forest Products" in the bottom left. The business models are seen from the view SCA Forest Products, and SCA Hygiene Products are included as potential buyer of bio-SAP further ahead in development. The business models are of an early qualitative nature, and more detailed calculations are yet to be made for determine economical feasibility in more detail.

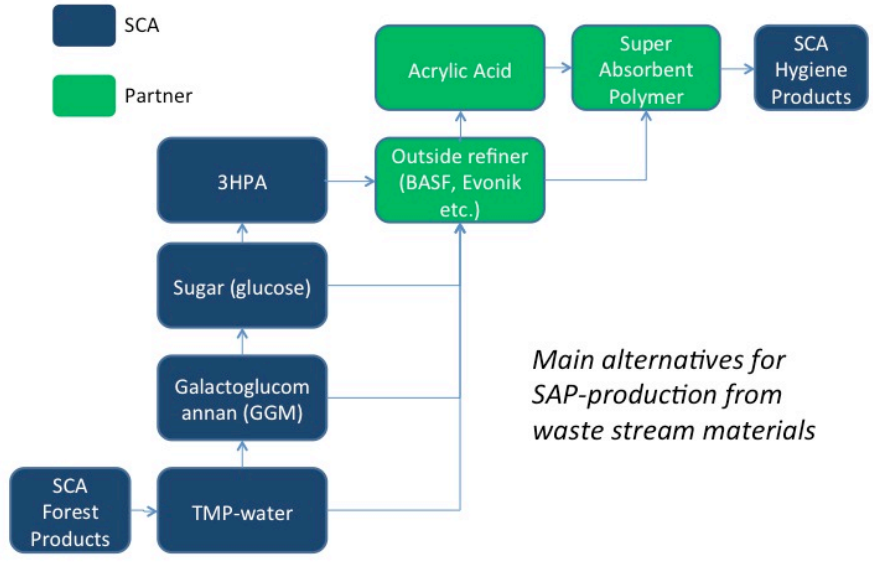

Figure 12 Model of intermediate step from TMP-water to bio-SAP

The models for 3HPA are similarly to the models based on GGM raw material resource driven, but they are also offer driven (Osterwalder & Pigneur, 2010). SCA Hygiene Products are a large customer

of SAP, and the aspect for being part of the production of bio-SAP made of renewable resources is desirable. These models have multiple drives that affects the outcome of the models.

The business models that have taken shape during the process of this project are presented in the following parts, 5.1-5.11. Each business model is presented by a brief explanation of the different building blocks and how they relate to each other. For each business model the most critical hypotheses, assumptions, and uncertainties are stated and described.

5.1 Sell the Rights to TMP-Wastewater

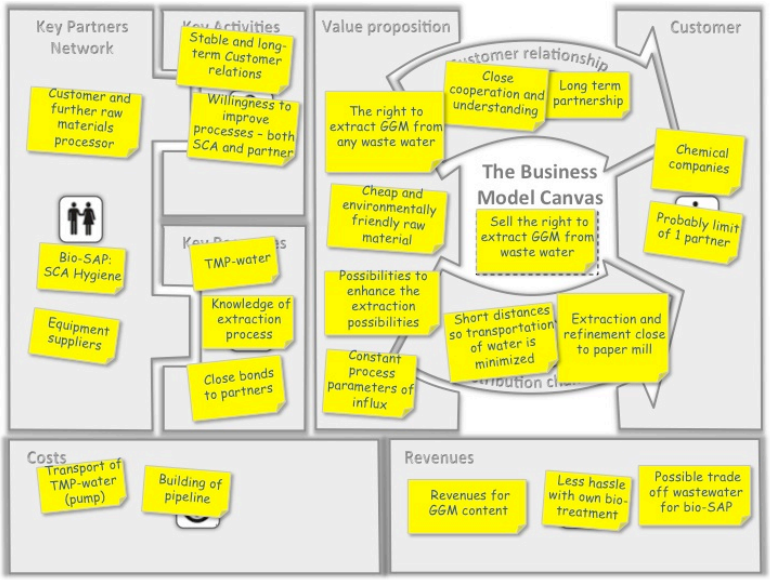

Figure 13 BM Canvas for selling rights to TMP-water

This business model might be one of the simpler from the view of SCA. The main idea is to sell the right to extract GGM from the wastewater in the paper mill to an external partner. The value proposition for the partner will therefore be the ability to by themselves extract a cheap and environmentally friendly raw material (GGM). The partner will have the ability and responsibility for the extraction process including possibilities for improving it. The partner will probably be a singular large chemical company with capabilities and resources to invest in extraction and refinement of the TMP-water.

As transports of water is to be minimized to keep costs low, extraction and refinement of GGM is preferable close to the paper pulp mill. Close collaboration and understanding is vital for success of this business model. SCA and their partner will have to invest long term for this project to be viable for both parts, especially if the partner is to invest in a facility next to SCA's paper pulp mill.

Key resources for this business model are the raw material TMP-water, knowing about the GGM-extraction process and a close bond to partners. TMP-water is naturally important, but SCA and their potential partner must also have the knowledge and ability to efficiently extract GGM from the wastewater for the business model to be feasible. As mentioned before, strong collaboration is needed for this model to work, as both parts have to commit to the model in long term. The key activities are having these stable and long term relations with the partner, but also that both parts are willing to improve the process.

Other key partners than the partner/customers, equipment suppliers for GGM-extraction are important. Also SCA Hygiene Products is a potential partner if the GGM in later stages are used to produce bio-SAP. The costs for SCA would in this business model be very few if any at all, basically only the transportation of water, maybe by building a pipeline and other redirection of water. Potential revenues would be payment for the amount of GGM extracted. The payment could potentially, if this is possible depending on partner, be in bio-SAP in exchange for the wastewater. As the partner will take care of the GGM in the wastewater, SCA will also have less hassle with the own bio-treatment of the wastewater leading to lower costs.

5.1.1 Critical Assumptions

The most critical assumptions with this business model are that a suitable solution for transports and logistics can be found. As this business model required much transports of wastewater, a potential

solution could be building a facility for extraction and refinement close to the paper pulp mill. To do this is costly, and the customer must be able to make a return on this.

As there currently does not exist a market for GGM it is also an assumption that customers are willing to take the risk related to this. A critical hypothesis is also that the potential collaboration between SCA and the customer will be possible in practice, especially as TMP-water is so widely used in other processes at the paper pulp mill.

5.2 Sell GGM to Chemical Companies

The value proposition of this business model is providing cheap and environmentally friendly raw materials (GGM) to chemical companies needing polysaccharides as raw material. As the previous model, this model also includes the opportunity to if GGM is used to produce bio-SAP, trade raw material for bio-SAP. GGM is a batch product and is sold though a few commodity contact. The customers are large companies that want to refine GGM to other chemical products.

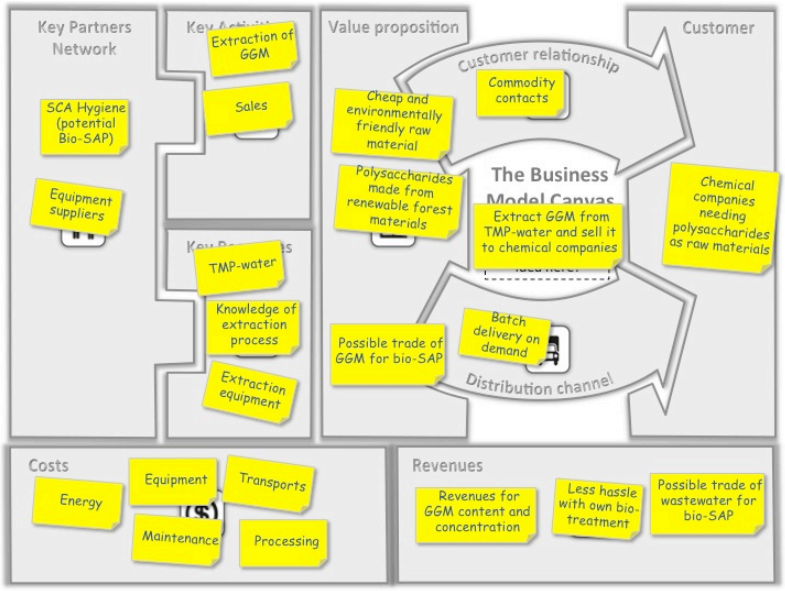

Figure 14 BM Canvas for selling GGM to chemical companies

Key resources in this business model are TMP-water, the ability to extract GGM and the equipment required for this. Key activities are except GGM extraction also sales of GGM. The key partners are equipment providers but also SCA Hygiene if GGM possibly is used for SAP production.

Costs are higher than the previous business model as SCA needs to purchase equipment and do more activities by themselves. Except purchase of equipment, costs for energy, maintenance, transports and processing are included in this model. Revenues come from the amount of GGM shipped, but also from less hassle with bio-waste.

Additionally, using the GGM rather than having to deal with more waste management of the TMP-water, comes with good savings as the waste management also costs money. This however is valid in all business models presented where GGM is extracted from TMP-water.

5.2.1 Critical Assumptions

One critical assumption in this business model is that assumption that GGM can be deconstructed to the right sugar component in sufficient high amount. Depending on customer need, there might be an unequal demand for the three components of GGM, glucose, galactose, and mannose.

GGM must either be transported long distances to be further processes or be processed on spot, this requires either much transports or new facilities close to the paper pulp mill. Assumptions are therefore that transports either are affordable or that a processing facility close to the paper pulp mill can be profitable and feasible. In discussions with the large chemical company BASF, they argued that the amount probably is to small to make investments in a processing facility viable, if not other materials streams could be added. A critical assumption for a chemical company to invest in a processing plant could therefore be that other material streams are to be found and could be added.

Another key assumption is purity of GGM that is assumed to not disrupt the processes of the customer. This includes attributes such as pH, contaminations, heavy metals etc.

5.3 GGM as Thickener & Emulsifier in Food

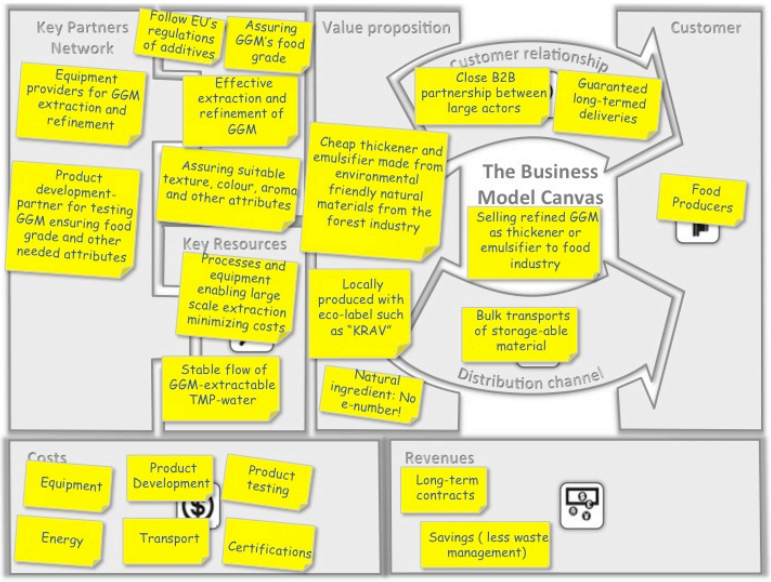

Figure 15 BM Canvas for GGM as a thickener & emulsifier in food

In this business model GGM's features of thickening and emulsifying are of interest. The GGM is to be sold refined to food producers. GGM coming from forest will not pose an argument in terms of non-food alternative since this is intended for the food industry. It does however offer a sustainable alternative to thickening and emulsifying. Many current alternatives also come from sustainable sources while there are some alternatives where the sources range from petroleum to palm oil. The offered posed would therefor be a sustainable and nearby grown alternative, assuming it will be sold within Sweden or nearby countries. Many customers also want natural ingredients that are not E-numbered, which could also be offered.

Thickening and emulsifying agents are commodity products and are sold to customers in bulk. Customers generally prefer dealing with few large distributors so distribution would be in bulk sales to large distributers and sold by them to end customers; the food producers. An important aspect of delivery is also reliability in access. There has got to be a steady flow. Hence, relationships would be close and long-term.

With the mentioned importance of a steady flow of GGM, SCA's key resources are mainly those of a steady flow of GGM extractable TMP water. To be able to utilize this, important resources are additionally that of equipment. Specialised equipment to make it possible for them to extract and purify GGM to a level satisfying to their customers. Since their customers in this case are in the food industry, the matter of purity becomes very important since product that are to be of food grade must be very pure and free of any allergens or other impurities.

Certifying the GGM as food grade will be one of the most important activities to be done. No matter how great of an environmental impact or how pure SCA would be able to tell their customers that their GGM is, no one will buy the product unless it has been proven to meet laws and regulations. Additionally it is important for the food industry, more so than in others, that the product does not present bad aroma or unwanted colouring.

The key partners of this business model concerns the two recent mentioned paragraphs. Their need for good equipment makes providers of such an important partner. Since the GGM also has to be certified in accordance with food standards there is an apparent need for a test partner. Someone who can help with getting the product approved as safe for use in food products.

With rather high demands on the product, this business model implicates rather high costs. The need for good equipment and the energy costs that comes with that. To test the product and gain all the right certifications needed. To transport to customers and also to go through necessary product development. It does however also present stable revenues. This since customers, if they choose to buy the product, want long-term and stable deliveries.

5.3.1 Critical Assumptions

Purity is the main assumption in this business model. For it to be at all viable, it is assumed that a satisfactory purification can take place. It is also assumed that this can be done without costing too much. This since substitute products are commodities and maintaining a low price is important.

Using locally produced product and making their products more natural and sustainable is something many food producers do. Therefore, the assumption that the customers find value in this is made. This model also relies on that customers are not deterred from the origin of the product. This could be an issue otherwise, if customers find non-food source products unsuitable in what they buy. In connection with this, it is assumed GGM will be classified as an ingredient and that it will not have an E-number associated with it. E-numbers are something that customers often frown upon so food producers prefer to use as little of this as possible.

5.4 GGM as Thickener & Emulsifier in Animal Feed

Other than regular food, some animal feed also use thickeners and emulsifiers. The offer here becomes much the same. Providing an environmentally friendly, nearby grown alternative. In this market, the quantities used are not huge since what they currently use require little to be added for the wanted effect. To substitute such products, similar features would be of interest. This made the locally grown argument interesting, since for something they want to use rather little of, they wanted as little transportation as possible. The offer then pushes on being locally produced.

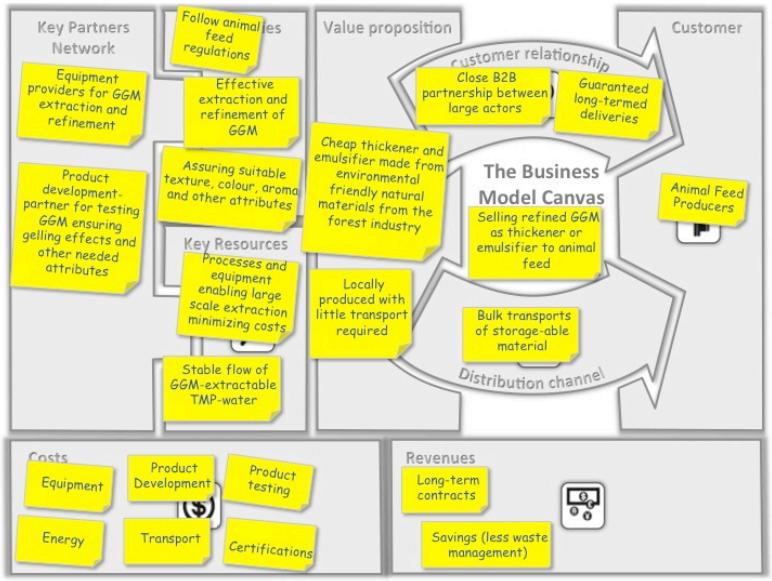

Figure 16 BM Canvas for GGM as thickener & emulsifier in animal feed

Here as with most possible markets, there are specific regulations that need to be met. They are however not as strict as in use for regular food. Meeting the regulations that do exist will however be a key activity to take this option forward.

Compared to using it in food, this market does differ some in the effect they want. Here a gelling effect is more of interest, and testing to assure and prove this feature becomes a key activity in order to attract customers.

5.4.1 Critical Assumptions

For this business model to be of any interest to take further, the assumption is made that GGM can provide the sufficient gelling effect sought after from this market. Catering to customers with somewhat higher demand than those buying dry feed, it is also assumed there are no unwanted colouring, odour or taste issues that can not be resolved.

5.5 GGM as Thickener & Emulsifier in Cosmetics and Hygiene Products

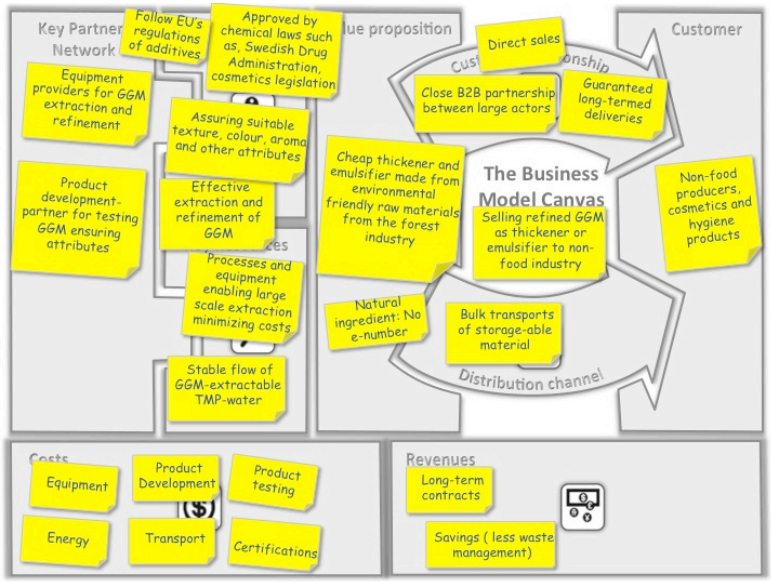

Figure 17 BM Canvas for GGM as thickener & emulsifier in cosmetics and hygiene products

Thickeners and emulsifiers can also be used outside the food industry as there are more possible applications. This business model concerns the use of thickeners and emulsifiers in cosmetics and hygiene products. As can be seen from the canvasses, much is similar to the business model for use in food. Some aspects however become different.

The offer does in this case not only use the argument of being sustainable and locally grown. It also offers an option that does not come from sources that otherwise could be used for food.

Laws and regulations surrounding production of cosmetics and hygiene products are, as in the case for food, rather strict. The products come in direct contact with the skin of the user and it is hence much important that there are no allergens present or other substances that can in any way be harmful. Therefore, a key activity in this business model is to fulfil these demands.

5.5.1 Critical Assumptions

As when used in food, it is here assumed purification can be done and to a reasonable cost. However, the greatest assumption is that this is a market where environmental arguments whey heavy. It is also assumed that GGM does not cause any discomfort, as consistency and texture of their products is very important. Further, to be interesting at all, it is assumed that GGM does not have any unwanted colouring of odour effects, or that such features can be corrected.

5.6 GGM as Fibre Additive in Food

The business model for fibre additives in food production naturally becomes very similar to that of thickeners and emulsifiers in food. Laws and regulations are governed by the same agencies, the customers are roughly the same and so on. What could differ them from each other is that thickeners and emulsifiers must prove a specific effect in terms of how well they thicken and emulsify the products they go into. The effect of fibre in food is not as specific and measurable. Other attributes not directly related to effect such as purity, is just like if using GGM as thickener or emulsifier important.

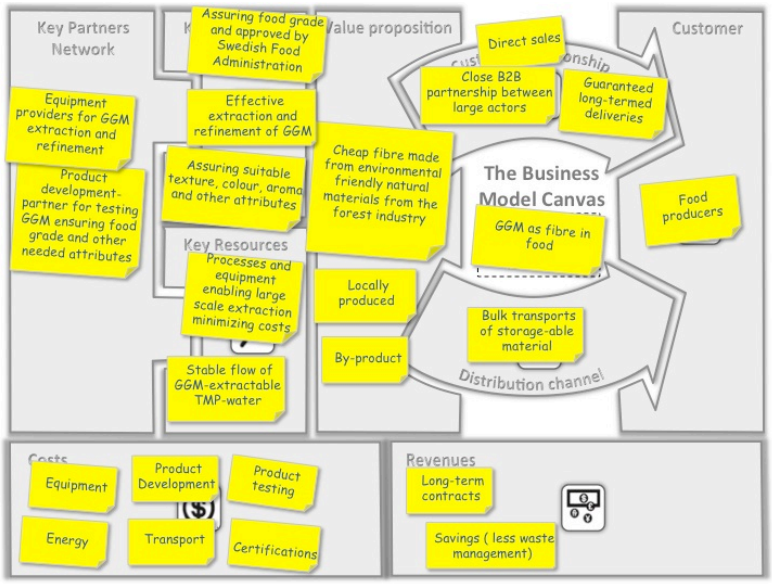

Figure 18 BM Canvas for GGM as fibre additive in food

5.6.1 Critical Assumptions

For this business model to work it is assumed that GGM can pass as food grade and be approved by both the Swedish Food Administration's laws and EU's laws. Purity is important for being approved and it is assumed that GGM can be purified without costing too much. As substitutes are commodity products it is important to maintain a low price.

Customers try to use locally produced and natural products and assumption is than that customer find value in this. It is also important the customers are not deterred from the origin of the product. This can otherwise be unfortunate if it affects the sales of the product.

5.7 GGM as Fibre Additive in Animal Feed

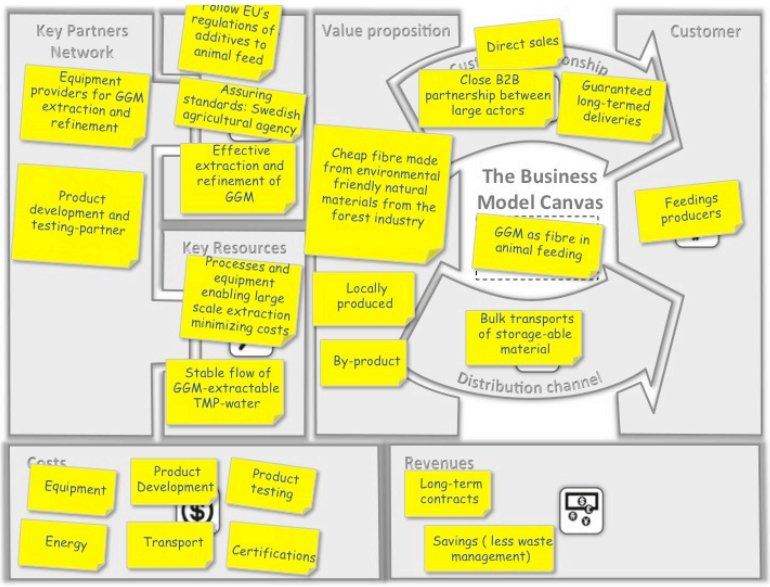

Figure 19 BM Canvas for GGM as fibre additive in animal feed

In the case of selling GGM as a fibre additive to animal feed producers much is as with the previous cases. The regulations are not so tough compared to food, but there are still restrictions that should be followed.

In food the need were continuous and it demands a stable flow. With animal feed, the recipes are more variable and adjusted continuously. The use of fibre additives then varied between batches and there is not the same need for a certain continuous flow. The same need for long-term contracts are hence not present here.

Being locally produced is an important feature for the value proposition, minimizing transportations and keeping emissions downs. Low transports also makes it more attractive as prices for transports can be kept low.

5.7.1 Critical Assumptions

As laws and regulations are less tough than for food intended for humans, this is less of a challenge. There is however regulations put forward by the Swedish department of agriculture and it is assumed that GGM have no issues of being approved.

Environmental friendliness and being locally produced is something that is of importance for this business model and it is assumed that customers also value this, as initial interviews have showed signs of it.

5.8

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5.9 GGM as Surfactant

In this business model GGM is to be used as a surfactant in cleaning, washing and detergents. The value proposition is based on an idea of low price and environmental friendliness. Low prices are assumed as GGM is only needed to be extracted from TMP-water and environmental friendliness as this is an important feature for products in this market. Both these attributes are seen as important for customers. The environmental friendliness of GGM should be labelled with some kind of eco-labelling if possible; "Svanen" or the "EU-flower" on the end product is a way to show consumers this. As many products that are labelled with these eco-labels still have raw materials based on petroleum, other options to show the advantages of GGM should be considered. Cleaning, washing and detergent products contain surfactants to a high degree, and exchanging GGM with petroleum products will have large effect on the environmental friendliness of the end product. As surfactants are bulk products in high amounts, GGM needs to be relatively dry and shipped in large amounts. Guaranteeing long-term availability for product developers is a way to show that GGM is a raw material that does not go away.

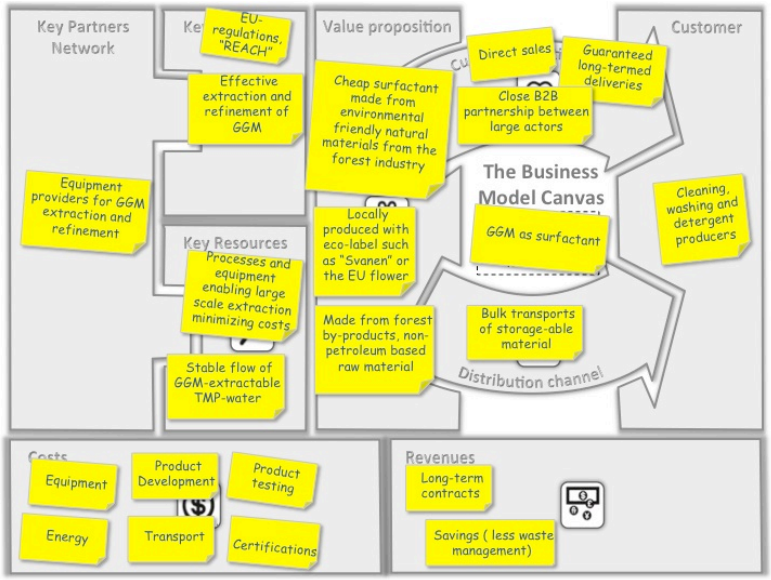


Figure 21 BM Canvas for using GGM as surfactant

Key resources are as other GGM-based business models extraction and processing equipment and a stable flow of TMP-water. Key activities are except an efficient extraction of GGM also being approved by regulations. EU-regulation including REACH is important if GGM supposed to be used as a surfactant. If GGM is proven a good surfactant, these regulations should not be forgotten, as they can be an expensive extra cost. Key partners are equipment providers.

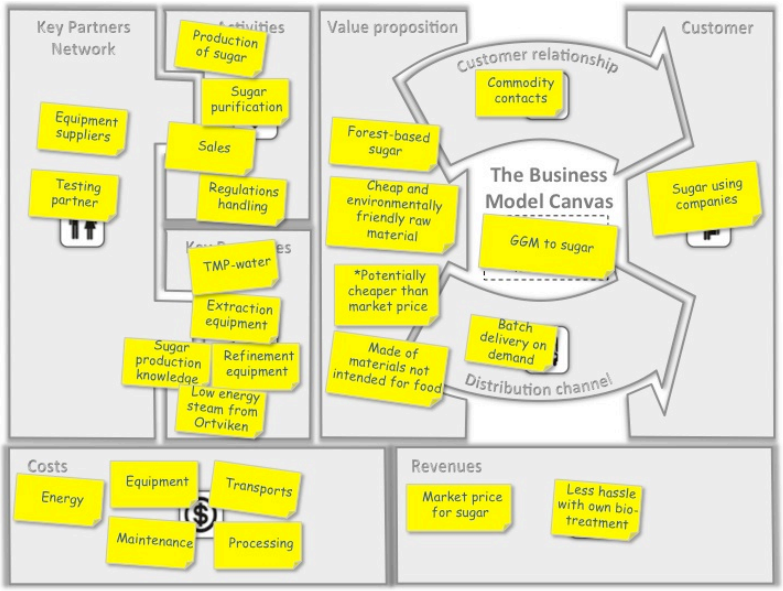
Costs related to this business model are costs for equipment, energy, transport, certifications, and testing. Revenues are based on the GGM content and concentration. Additional savings are from decreased amount of hassle with treatment of wastewater.

5.9.1 Critical Assumptions

As surfactants is a bulk material sold for a relatively low price it is assumed that being approved by EU-regulations such as REACH is not too expensive. It is also assumed that GGM can pass the chemical regulations of the EU.

As eco-labels are important on products made of surfactants, it is assumed that using GGM compared to alternatives is more environmental friendly. This will help the products to meet requirement of labels.

5.10 Refine GGM to Sugar



This business model includes breaking down GGM to sugar to a lower price than other sugar producers. In difference from normal sugar producers, this sugar is forest-based and not made of materials intended for food. An idea could therefore be to especially aim to sell this product to companies that use sugar for non-food purposes such as fuels. As sugar is a commodity product that is handled in large quantities, batch delivery with commodity contacts would in the case of this business model be suitable.

Figure 22 BM Canvas for refining GGM to sugar

Key resources is having raw material in TMP-water/GGM but also the ability and capabilities for extraction of GGM and refinement into sugar. Both being able to extract GGM and refine into sugar must be efficient for this to be feasible. Using low energy steam from the paper mill can be a way to decrease energy costs. The key activities are linked to the key resources, being GGM extraction, production of sugar and sugar refinement. Also handling sales and keeping up with laws and regulations are key activities. Key partners are equipment suppliers for both GGM extraction and sugar refinement, but could also be external testing partners to unsure that GGM can be refined to sugar efficiently with a tolerably amount of extractives.

Costs are related to equipment, extraction of GGM and refinement to sugar. Maintenance of equipment and transports of sugar is also costs. Revenues will be in levels of the market price for sugar, and the simplifications due to less hassle with bio-treatment of waste.

5.10.1 Critical Assumptions

Extracting GGM and refine it to sugar has assumptions related to some uncertainties. As this refinement process is still untested, costs and efficiency are uncertain. For this business model to be viable, costs for refining GGM to sugar are assumed to be lower than market prices. The efficiency is assumed to be almost 100 percent. As GGM has three different ingredients of sugar components, it is assumed that the customer can use all three in similar way.

5.11 3HPA from GGM-sugar

This is probably the most technology-intensive business model for SCA. The business idea is to extract GGM from TMP-water, break it down to sugar and produce 3HPA from the sugar. 3HPA is environmentally friendly and potentially cheaper than petroleum-based alternatives, and can be used for many uses, e.g. making acrylic acid and SAP. The customer is preferably a producer of AA and/or SAP, but maybe also a producer of other chemicals that could use 3HPA as an intermediate chemical. 3HPA is still a commodity product and should be delivered in batches on demand through commodity contacts.

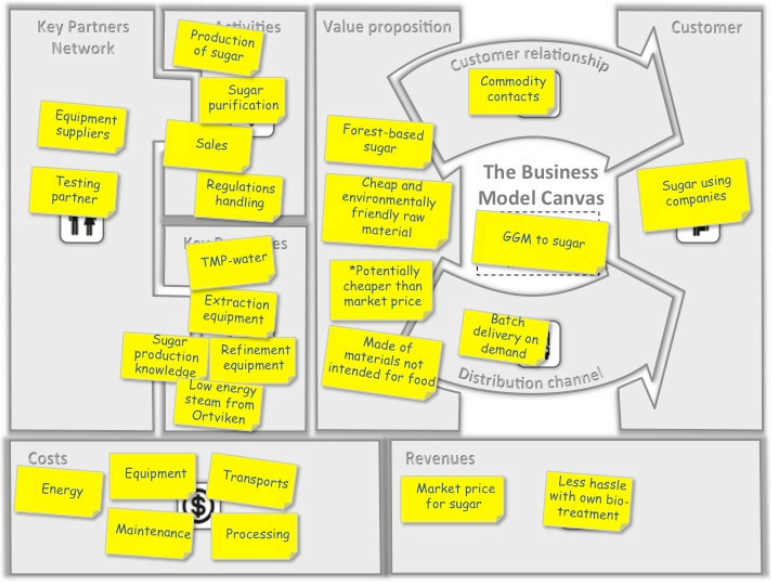


Figure 23 BM Canvas for making 3HPA from GGM-sugar

This business model is dependent of being able to create 3HPA by wastewater, which still are being developed. Patents for this is a key resource as well equipment and production capabilities. Equipment for GGM-extraction from wastewater and sugar refinement is also needed. Cheap energy, from low energy steam at the paper mill, is a key resource as well. Key activities are the extraction of GGM, refinement and fermentation to 3HPA. Sales are also a key activity. Key partners are the technology enablers, in this case the 3HPA-project together with Chalmers University of Technology, and equipment providers for the different processes.

Costs are related to equipment, extraction of GGM, refinement to sugar, and further fermentation to 3HPA. Maintenance of equipment and transports of 3HPA is also costs. Revenues will be in levels of the market price for 3HPA (or acrylic acid), and the simplifications due to less hassle with bio-treatment of waste.

5.11.1 Critical Assumptions

For this business model to work the most critical assumptions are those relating to the technology in creating 3HPA. SCA does not have the knowledge of this but they are included in a project with Chalmers University of Technology and a few other companies trying to do this. Chalmers have a patent for this technology, but the efficiency is still low. In this business model it is assumed that SCA can use Chalmers' patent and build processes for creating 3HPA.

6 Discussion

In the discussion, the empirical findings and proposed business models are discussed with the aim of getting closer to reaching the goals of this study. The discussion is composed of two parts, Business Model evaluation and Future Challenges with New Business Models. Business Model Evaluation discusses the feasibility of the business models presented in chapter 5 by selected criteria. In Future Challenges with New Business Models, several challenges that SCA faces when continue to work with the proposed business models are discussed.

6.1 Business Model Evaluation

This part discusses the feasibility of the proposed business models from 5 Business Models. The business models are evaluated with a number of criteria. The purpose of these criteria is to shed light to important aspects of the business models. By clarifying these aspects guidance is given when prioritising between business models. The criteria as follows:

1. **Sales quantity and suitable market size**
   As production of GGM at the current level is around 4400 tons annually (approximately 12 tons each day), the market size cannot be too small or too big to be manageable. Depending on business model, different amount of customers are desirable.
2. **Laws and regulations**
   Laws and regulations are different for different products and market. Tougher laws and regulations might make the potential market less attractive.
3. **Earlier relationship/trust with customer**
   It is positive if SCA already have a customer base in the prospected market to build upon, which can be used for exploring the business model.
4. **Environmental friendliness**
   As the raw material from the paper mill is forest-based and comes from unused waste flows, the extra cost for extraction is low and environmentally friendly. It is preferable if the market prefers environmental friendly products as this is an advantage of the materials.
5. **Locally produced**
   The forest-based materials from SCA could be attractive as locally produced. This is valid if sold to customers in Sweden that otherwise buys materials that need to be transported longer distances.
6. **SCA's image**
   Does the market give any positive effect on SCA's brand or image? E.g. improves SCA's image as environmental friendly.
7. **Value adding**
   How much value (profit/savings) is the business model able to deliver in this product/market if successful? This relates to prices of competing alternative materials in the market.
8. **Risk**
   How uncertain is the market/product? Are the market and technology risks (Blank & Dorf, 2012) (Furr & Ahlstrom, 2011) estimated as high or low?

These criteria have been chosen to evaluate the different aspects of the business models to identify advantages and disadvantages for each model. The aim of the criteria is to provide help of answering which model that qualitatively is most attractive for SCA with the current knowledge of markets and the technical properties. They aim at bringing forward external as well as internal possibilities for SCA. Additionally they are used to help clarify what uncertainties there are and how well the alternatives match SCA strategic goals.

Criteria 1 and 2 are external factors and measures how attractive the business model is for the different raw materials. Criteria 3, 4, and 5 are potential strengths of SCA and the raw materials and measures how the business model make use of these. Criteria 6 and 7 measure how well the business model would benefit the company SCA in terms of image and profits. Criteria 8 measures how uncertain the business model is related to different risks and which critical assumptions it includes.

Criteria are not counted quantitatively as they are weighted differently depending on model discussed, but they are given a value depending how well the criteria fits the business model. Values 1,2 or 3 are given each attribute as an evaluation of how well the business model answers to the specific criteria. 3 are given to criteria that are considered suitable and make the business model more attractive, 2 for criteria that are neutral to the attractiveness of the market and 1 for criteria making the business model less attractive.

After the business models have been discussed one by one, they are presented together in part 6.1.12 Summary.

6.1.1 Sell the Rights to TMP-Wastewater

The market size is estimated to be large enough for the quantity of GGM in the wastewater. The environmental friendliness required for products potentially using GGM is depending on end product and will vary depending on customer.

Criteria	
Market size	3
Laws & regulations	3
Customer relationship	3
Environment	2
Locally produced	2
Image	2
Value adding	1
Risk	2

Table 4 Criteria ranking for BM 1

As SCA Hygiene Products already is a large customer of several of the large chemical companies, they already have built a strong relationship with the potential customers of this business model. The laws and regulation related to chemicals and the content of TMP-water is in this model is the direct concern of the customer, as SCA do only provide the most basic waste flow. Being locally produced is a must to minimize transports of water in this model, and does probably not give any direct advantage. The revenues are estimated as low, as rights to extract GGM is very basic. SCA is not providing any major value adding and the price initially for TMP-water is expected to be low. If executed, this business model can be defined as a start-up creating a new market (Blank & Dorf, 2012). The risk is supposedly low as SCA themselves do not invest in anything major, the customer does this instead. On the other hand is the market risk (Blank & Dorf, 2012) higher, as it not known how easy it is to find a partner. As GGM still is untested it is uncertain if outside partners are willing to invest in extracting it.

6.1.2 Sell GGM to Chemical Companies

Selling the GGM sludge to a chemical company would largely be with the interest of seeing it utilised for production of bio-SAPs. Currently, SCA buys SAPs from the chemical company BASF. This business model hence concerns itself much with setting up a partnership for sustainable SAPs, partnering with BASF being an option especially since BASF are already looking for ways to do this in several other projects. SCA could therefore both supply raw material and be the customer of the finished product.

Criteria	
Market size	3
Laws & regulations	2
Customer relationship	3
Environment	3
Locally produced	1
Image	3
Value adding	2
Risk	1

Table 5 Criteria ranking for BM 2

The amount of SAPs that BASF currently produce far exceeds what SCA could ever supply in terms of raw material from the paper mill. The market size is therefore large enough for their entire supply. Rather, it provides a market risk. Since it would be such a small portion of their production, BASF might not deem it worthwhile.

This alternative has the advantage of existing relationships. The majority of the other business model requires much work put into building new relationships, where this is not needed here. This is helpful as it increases the success rate of the business model (Koen, Bertels, & Elsum, 2011). The aims of both firms are also in line. Both are very interested in finding sustainable ways of creating SAPs, moving away from the current petrol-based alternatives. There is no doubt that the environmental friendliness of GGM is a strong argument here.

A problem could however be that of logistics. For many other markets, locally produced is an interesting argument. Large chemical companies to work with are not as common in Sweden like for example food producers. BASF for example are situated in Germany. Shipping the GGM sludge and the water it contains could prove too costly and not sustainable enough. This brings down both the locally produced factor as well as creates some technology risk, since the possible concentration of the GGM sludge is not yet fully explored. Adding on technology risk is the fact that the process for creating 3HPA, the precursor for bio-SAPs, is delicate. Factors such as pH levels, salt levels, various containments and so on could disturb the process and make it impossible to use GGM without extensive purification. In discussions with BASF is also was made clear that the amount of 4400 tons of GGM is a small amount when considering building an refinement capabilities close to the mill to minimize transports. As a single material flow this amount of GGM might be too small, but there is still potential of it can be combined with other material flows.

6.1.3 GGM as Thickener & Emulsifier in Food

When contacting market representatives it became clear that thickening and emulsifying agents were something used by most food producers. There were many consumers and some used substantial amounts. The market size and possible sales quantity could therefore be determined as good.

Criteria	
Market size	3
Laws & regulations	1
Customer relationship	1
Environment	2
Locally produced	3
Image	2
Value adding	2
Risk	2

Table 6 Criteria ranking for BM 3

Despite there being a potentially large market, getting to it might prove a bit tricky. When it comes to what goes into food, the requirements are high. Anything used for food must be of food grade and proving this so that you meet laws and regulations could be costly.

Currently the food industry is one SCA has no ties to and hence any existing relationships. A large and costly part of business is setting up and nurturing good relationships. This would have to be done from the ground up if pursuing this business model. A way of penetrating the market however and setting up partnerships could be though the environmental argument. It is renewable, and it is locally produced for the Swedish market and these could be arguments that would make SCA an attractive partner.

Could SCA enter this market, there is a possibility it could not only create an additional revenue stream but also promote SCA as an environmentally friendly company. If partnerships were to be set up so that food producers used SCA's name and the fact that the Swedish forest helped make their products more environmentally friendly, SCA could benefit from this.

Extracting GGM is not a very value adding activity, just a matter of collecting what is already there. To use it in food however it needs much work with purifying and certifying, activities that could elevate it's worth. Certifying it could especially be an important activity, since it was apparent through interviews that there was a market risk. Customers might be deterred by the origin of GGM, scaring them from buying the products if it is not well proven that GGM is good and safe.

6.1.4 GGM as Thickener & Emulsifier in Animal Feed

Looking at producers of animal feed, very few use any thickeners or emulsifiers at all. Majority of products are dry feed where the use of such additives is of no use. Some cat and dog food however were wet products, preserved in jelly etc. but this market could still be considered small. Neither do SCA have any existing ties to this market, meaning they would have to put money and energy into creating such.

Criteria	
Market size	1
Laws & regulations	3
Customer relationship	1
Environment	1
Locally produced	3
Image	1
Value adding	1
Risk	2

Table 7 Criteria ranking for BM 4

The upside compared to using GGM for its thickening or emulsifying features in other applications is that the laws and

regulations are not as strict here. It still has to be safe and meet certain set standards, but these are not as hard to meet as they are in food or cosmetics.

From interviews it was indicated that environmental arguments were not as valued as in other markets. They did react somewhat positive to the fact that it was locally grown thought. This however was mainly due to them not wanting to buy products that had to be transported from too far away since they needed such small quantities.

Since it would be such small quantities used, combined with them not being too interested in the environmental benefits, this market would probably not boost SCA's image. The lower regulations would also mean less need for value adding since extracting the GGM would be the main activity. Purifying and certifying would of course still be a needed activity, but in a smaller degree than in other applications.

With it not being used very much there is a clear risk concerning the market not being interested or big enough. There should however not be too much of a risk that it wall be hindered by technology, as GGM does have thickening and emulsifying features. There still remains the activity of making sure it is completely free of allergens etc., but with regulations not being too strict the technology risk should be rather low.

6.1.5 GGM as Thickener & Emulsifier in Cosmetics and Hygiene Products

The cosmetics and hygiene product market is not a significantly big one in Sweden, but they did express some interest. One interviewee expressed they were already looking for such a products. This lessens market risk in terms of demand, however the demand might not cover a big enough quantity to make it interesting.

Criteria	
Market size	2
Laws & regulations	1
Customer relationship	1
Environment	2
Locally produced	1
Image	2
Value adding	2
Risk	2

Table 8 Criteria ranking for BM 5

As when adding GGM in food, the laws and regulations here are strict. The product comes in direct contact with the skin of the user and this put high demand on it not being dangerous. This is not something that has been tested or considered much yet, creating some technology risk. This would also put demand on much testing and possibly co-development with actors on a market they currently have no ties to.

The thoughts regarding environmental friendliness differed some between interviewees. Finding the right customer or partner could probably make it a strong argument, while others think it constitutes a too small part of their entire products to make any real impact. Whether SCA's image would benefit or not depends much if they could work with a customer that would put much focus on their products environmental friendliness or not. There's a risk though that thickeners and emulsifiers are such a small component that SCA's contribution would go unnoticed.

As in the case for using GGM in food as thickener and emulsifier, the value adding is similar here. Only extracting GGM is not a very value adding activity. Purifying it and certifying it however could be. If products additionally would be co-developed with the customer, this could increase even more.

6.1.6 GGM as Fibre Additive in Food

In regular food, fibre seemed to rarely be added solely for the purpose of fibre enriching the product. What fibre could be found in the interviewee's products was mainly added for other purposes. There are though specialized health products that aim only at adding fibre to people's diet, such as pills. However since it is seldom added to food, the market is not as big as that of thickening and emulsifying.

Criteria	
Market size	1
Laws & regulations	2
Customer relationship	1
Environment	2
Locally produced	3
Image	2
Value adding	2
Risk	2

Table 9 Criteria ranking for BM 6

Here the laws and regulations are more or less the same as when using it as thickener or emulsifier, somewhat strict since the customer will ingest it. Not being an additive but an ingredient might make it a bit less strict however, with regulations differing somewhat between those two definitions. The same goes for what value adding it present. It needs to be purified and certified just as in the thickening and emulsifying case, however it does not have the same pressure on proving a specific effect as does the other alternative.

For the environmental and locally produced criteria's, this market offer good opportunities. Both, in particular the locally produced aspect, were factors interviewees responded to with great interest. This would make it a market where SCA could really push for these arguments and also boost their own image.

Since it is uncertain if demand from the market is big enough, this alternative does present some market risk. As for the functionality, the technology risk is rather low. GGM works as a fibre and how to use fibres is well known.

6.1.7 GGM as Fibre Additive in Animal Feed

In animal feed, especially cattle feed, fibre additives are a relatively large component. There are also dietary products for pets that contain extra fibre, and it is present in others animal feed such as pig feed, game feed, horse feed and so on. But for cattle especially it is widely used, this since high fibre contents is something they are used to and should have much of in their diet. The market is therefore potentially large.

Criteria	
Market size	3
Laws & regulations	3
Customer relationship	1
Environment	2
Locally produced	3
Image	2
Value adding	1
Risk	3

Table 10 Criteria ranking for BM 7

The laws and regulations are as mentioned before not that strict for animal feed, nowhere near what they are for regular food. And using it as fibre additive should neither present any concerns regarding functionality, hence creating very little technology risk. The market risk could also be considered very low since this is an existing market with a visible want and need for a product such as this one. To gain customers is of course not easy just because of this though. SCA does not at all work with this market today and have no existing relationships.

A way of overcoming the problem of not having any existing relationships could be with the environment arguments. Market interviewee's expressed interest around these features, especially concerning that of locally produced. Some marked their products with what carbon footprint it had left and were constantly looking for better alternatives since more and more farmers requested this.

6.1.8

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6.1.9 GGM as Surfactant

Using GGM as a surfactant is especially interesting as it is a main ingredient of end products and has a high effect on the end product's traits. The market for surfactants is large, and a capacity of a couple of thousand tons of GGM annually would not be considered too much, neither too small amount for potential customers.

Criteria	
Market size	3
Laws & regulations	1
Customer relationship	2
Environment	3
Locally produced	3
Image	3
Value adding	1
Risk	2

Table 11 Criteria ranking for BM 9

In interviews a potential problems were mentioned if GGM were to be seen as a new chemical, it would have to be approved by EQ legislation to be allowed for use. Achieving these approvals could be a hurdle for this business model as they according to an interviewee are costly. Being tested and approved for use is important and could if too costly or in some other way unavailable, this could be a potential deal-breaker.

As tall oil, a rest product from other chemical pulping mills, is used for example in soap, SCA already have some customer contact with companies making these kinds of products. SCA could possibly leverage old relationships in this industry to test how good GGM works as a surfactant. Having a customer network already decreases the hassle in order to build a new one (Koen, Bertels, & Elsum, 2011).

As surfactants on the market today much is based of petroleum-based raw materials, and environmental friendliness is attractive for all cleaning and washing products, GGM would be an excellent raw material in the environmental and location aspects. SCA would also possible to use this to raise their environmental friendliness-image. Environmental labels are popular, and with forest product the environmental impact of the products could be further reduced and help drive new environmental standards. As surfactant is a bulk product sold in large quantities, the value adding and potential prices would probably be relatively low. This has to be concerned in the decision process if testing and getting GGM approved to use is feasible.

6.1.10 Refine GGM to Sugar

The market for sugar is vast, and a commodity over the world. If producing sugar from GGM, the customers are sugar-using companies, and this business model is to compete by price. An option to price would be to compete in industries where forest-based sugar is advantageous over food-based sugars. Ethanol production could be one potential industry were forest-based products have advantages over food-based sugars. Yet another option is to sell sugar refined from GGM to a chemical company with the aim for further refinement into 3HPA. In discussions with BASF, one potential customer, they are interested in raw materials to create 3HPA, especially non-food products that they also currently are working with. There are however some criteria that could be potential deal-breakers such as purity, contaminations and too low quantities. Further tests have to be made to determine if this is a potential usage or not.

Criteria	
Market size	2
Laws & regulations	2
Customer relationship	1
Environment	2
Locally produced	2
Image	2
Value adding	2
Risk	2

Table 12 Criteria ranking for BM 10

Depending on what the sugar is used for, in food or non-food, laws and other attributes such as attractiveness for environmental friendliness differ. As SCA does not have any experience of producing and selling sugar new customer relations is important for this business model. Except for if using sugar for producing 3HPA were SCA have a network of contacts, sales and new networks have to be built up.

This business model has a higher technology risk than models based on GGM, as there is an extra process of refining GGM to sugar. As this step is not tested with GGM, there are uncertainties on how

efficient this step can become. On the other hand, as this is based on known technology and nothing radical, this should not too big an issue.

6.1.11 Make 3HPA of GGM-sugar

A still very unexplored option is that of SCA making 3HPA themselves after having broken down the GGM into sugars. With 3HPA being a precursor to AA and bio-SAPs, this would also be a business model in line with getting a sustainable SAP for SCA Hygiene's diapers. This is still a radical technology and technology is still in early development and technology risks are high (Blank & Dorf, 2012).

Criteria	
Market size	3
Laws & regulations	2
Customer relationship	3
Environment	3
Locally produced	2
Image	3
Value adding	3
Risk	1

Table 13 Criteria ranking for BM 11

Since it is fairly unexplored, the risks must be deemed high, but would it prove possible it could really be an attractive offer. Comparing it to letting for example a chemical partner such as BASF create the 3HPA, this alternative could eliminate problems with long transportation etc. Finding a process of their own, for example through the project presented in 4.4.1, would serve as great value adders compared to selling GGM raw or refined as sugar. Trying to find such methods however is something that usually demands much time and large investments, creating as mentioned high risks.

Potential market size for 3HPA and markets for chemicals such as AA and SAP are large enough for the total production possible from GGM. The possible bio-SAP created by 3HPA from GGM is for example is not enough to satisfy the demand for SAP at SCA Hygiene Products, but it could substitute a large quota. Possible attributes of this business model are also customer networks that already exists, a possible benefit of being environmental friendly and the enhanced image of this, and the high potential value adding if sold as further a refinement material.

6.1.12 Summary

The different business models clearly show that different business models have very different potential yields with basically similar technology (Chesbrough, 2010).

Criteria/Model	1	2	3	4	5	6	7	8	9	10	11
Market size	3	3	3	1	2	1	3	3	3	2	3
Laws& regulations	3	2	1	3	1	2	3	3	1	2	2
Customer relationship	3	3	1	1	1	1	1	3	2	1	3
Environment	2	3	2	1	2	2	2	2	3	2	3
Locally produced	2	1	3	3	1	3	3	2	3	2	2
Image	2	3	2	1	2	2	2	2	3	2	3
Value adding	1	2	2	1	2	2	1	2	1	2	3
Risk	3	1	2	2	2	2	3	3	2	2	1

Table 14 Summary of criteria ranking for all BMs

For an easier overview, here the ratings for all business models are summarised in the table to the right. Looking merely at this, some models show more and some less attractiveness. Using GGM as thickener or emulsifier in animal feed, shows little promise as many criteria decrease the attractiveness of the model.

It can also be seen that most models show low score with customer relationship. This since these are markets currently unexplored by SCA. Most models also are low value adders and deliver low value to potential customers, limiting the competitive power of the raw material except for price. These models basically require SCA to re-segment an existing market, entering as a low-cost entrant (Blank & Dorf, 2012). Knowing what the alternatives are you are competing with decreases market risks, but competing only by price also limits higher profits and value capture. The set of waste streams at the mill is unique, and as initial calculations have shown, GGM is less expensive than possible

alternatives, being an advantage. These models create relatively low value for customers, as being bulk materials, which limits value capture for SCA (Chesbrough, 2010).

Environmental friendliness is mostly beneficial in business models were alternatives are based on petroleum. Using GGM as a substitute of a food-based product, such in the case of thickeners, emulsifiers, and fibres, was not seen as much more environmental friendly to food-based products. Being locally produced was in some cases seen as positive even if environmental friendliness was not as important, mainly because this allows less transports and cheaper materials.

6.2 Future Challenges With New Business Models

This section discusses overall challenges for SCA that have to be considered in the near future when working with any of the proposed business models. These challenges origins from uncertainties and unknowns related to business model innovation and the testing of business models.

Using the waste streams from the mill offers many opportunities but also challenges. As seen in 6.1 there are many possible ways to make use of the waste streams, and further process of testing the models is important to achieve success. In the process of building a sustainable business by resources from the waste streams in terms of Blank and Dorf's (2012) CDP, the first step has been started but not finished. A broad mapping of potential usages and markets has been made and initial testing begun. Further testing in the first step is needed to validate a business model. The second step of the process, customer validation, testing the business models to confirm sustainable and scalability of the process is still to be further investigated when the first step is finished.

As business model innovation and business modelling is an iterative process, problems and challenges will appear when uncertainties and assumptions are being tested. Here we present some identified challenges that is important to highlight when the work is continued.

6.2.1 Financial Challenges

Financial viability (Osterwalder & Pigneur, 2010), in the business model canvas illustrated as revenues streams and cost structure must be further investigated. Costs for refining waste streams are made with initial data given, but there still are uncertainties about this. First of all, calculations about extractions costs do not include any other costs than the initial investment cost and energy costs for operations. Additional costs need to be added to the calculations in order to make the results more realistic.

As attributes for especially GGM, but also GGM-refined sugar and 3HPA made of GGM, not is investigated in detail, it is difficult to decide pricing for these materials just yet. Lowest feasible prices can be based on extraction and refinement costs, or depending on prices of alternative materials. As no respondent in the interviews with end-users said that they would pay a lot extra for a forest-based raw materials, the possibilities for charging a premium price for related attributes such as environmental friendliness is low. If investments in extraction materials from the wastewaters do not reach SCA's cost structure or traditional rate of return, this could be a hurdle that can hinder investments (Koen, Bertels, & Elsum, 2011).

6.2.2 Technology Challenges

These challenges are highly affecting the value proposition building block in the business model canvas (Osterwalder & Pigneur, 2010). As the raw materials from the mill and the related 3HPA-project still are in an early fuzzy front end phase, there exists technology risks (Blank & Dorf, 2012) (Furr & Ahlstrom, 2011). Assumptions about extraction and refinements processes have been made when creating business models. In the areas of discipline in discovery driven planning, MacGrath & MacMillan (1999) argues that is important not to step into traps such as assuming technologies would perform better than that can be shown (McGrath & MacMillan, 1999). This can be problematic if benchmarking with alternative materials, if the performance of the materials and technology used is assumed to be too high which can give misleading results.

Other technological assumptions made are the possible extraction and exchange rate. It is assumed that all GGM can be extracted and is useful. Exchange rates to sugar is assumed to be 100 percent, but if one specific type of sugar is needed, such as glucose, it is not known what the exchange rates are as GGM consists of three different sugar types. This also affects the 50 percent exchange rate to 3HPA. Either if SCA would want to produce 3HPA by themselves or cooperate with a partner, such as BASF or any other potential partner, there are technology risks about if and when the technology will be enough efficient.

In the technology-dimension in the Business Model Innovation Typology model (Koen, Bertels, & Elsum, 2011) extracting GGM could be counted as an incremental innovation as it is an improvement of the waste management of the TMP-water. Refinement of GGM to sugar and 3HPA can be counted as radical innovation as these are more complicated and not part of any core process at the paper pulp mill. The technology risk (Blank & Dorf, 2012) (Furr & Ahlstrom, 2011) for these business models including are higher, but also higher potential gain if successful. Finding a usage for GGM could be a way of establishing the first extraction processes before investing in more technological uncertain processes.

Key resources (Osterwalder & Pigneur, 2010) for all business models are related to the right equipment for extracting GGM. Equipment such as filters for GGM extraction that can efficiently extract GGM to sufficient dryness is essential for all business models. Equipment manufacturer are also potential key partner (Osterwalder & Pigneur, 2010) and should be further evaluated.

6.2.3 Customer Challenges

Some business models have antilogs (Mullins & Komisar, 2009), mainly alternative raw materials such as starch and CMC. If GGM is produced cheaper than alternatives, as initial calculations have showed, there are many existing markets that GGM can compete in. The customers of these products know what they want, and customer discovery and validation is in this case not as important as when the market is new. On the other hand the value network is still new (Koen, Bertels, & Elsum, 2011), and a challenge compared to incumbents on the market. Keeping track of the costs and attributes of GGM (in the case of those business models) and benchmarking with alternatives is important when judging a market's potential.

As attributes of GGM from the wastewaters are not yet tested and determined, there is a market risk (Blank & Dorf, 2012) (Furr & Ahlstrom, 2011) that customers are not interested in the real attributes of the materials. The process of finding customers has begun by starting the first step of the customer discovery process (Blank & Dorf, 2012), and some validated learning (Ries, 2011) have been made. This is not enough to say that that a customer or market has been validated, and there are still activities to be done before a market can be said to be validated and SCA can start selling the raw material. As many attributes that are important for customers are still not tested and validated, there is also risk that some of the markets and usages investigated in this thesis may not be realistic.

6.2.4 Imitation and Competition Challenges

An issue of new businesses is imitation of business models (Teece, 2010). Using waste flows from the paper mill as raw materials is depending on business models more or less exposed for imitation. Of the three factors mentioned by Teece (2010) that impede copycat behaviour, the three of them are more or less active in the business models presented in the previous chapter. The first factor, having systems, processes and assets that are hard to replicate is active in all business models. TMP-water is a resource that is the essential component in all proposed business models, and most obvious competitors with similar resources are other paper pulp mills. For other paper pulp mills it is possible to copy the use of TMP-water, but for others accessing the same kind of raw materials is hard. Another strength is the difficulty to copy the processes, experience and scale related to the handling of TMP-water. Aside alternative resources, competitors with GGM-extractable TMP-water are limited to other paper-pulp mills. The second factor, the business model's opacity, differs from low to high depending on business model. Extraction of GGM, which is required in all except one business model, is not hard to replicate, as this is not a novel activity. How to best optimise the process for extracting GGM has not been

examined but has potentially higher opacity. In the business models including more activities, as refining GGM to sugar and producing 3HPA, the process has increased opacity. The third factor, the cannibalising or upsetting of current revenues for the imitator, is in some cases valid. In the case of refining GGM to sugar or 3HPA, these can act as substitutes to traditional sugar and acrylic acid respectively. The effects of cannibalising revenues for acrylic acids might not stop competition to imitate this process, as many other projects and large companies (see section 4.4) pursue similar projects.

Projects described in 4.4 are potential competitors, but also potential partners for SCA if using waste materials in the process to make 3HPA. Initial discussions have been made with BASF about a potential collaboration, and there are possibilities if a number of criteria can be matched. SCA does not have the capabilities or experience of creating end-products from GGM, sugar or 3HPA, other projects should be kept in sight as they could affect GGM both positive and negative. Further developing technologies for creating bio-based materials could hasten the development and decrease technology risks, but this can also spawn competition and force prices and margins down.

6.2.5 Experimenting and Work Process Challenges

The process of finding a sustainable business model is still in an exploration stage, and further experimenting and customer research is needed to achieve more validated learning (Ries, 2011) about the potential usages of the wastewater and the markets in which it can be used. It is important to finish the customer validation phase (Blank & Dorf, 2012) before investing in production facilities and starting building a customer base, to avoid wasting too much time and money before customers have been validated (Ries, 2011). As attributes of raw materials GGM, sugar made of GGM and 3HPA are not fully concluded, it can be hard to gain customers with certain demands on attributes yet determined. Learning more about the attributes of the raw materials are essential when presenting them to these kinds of customers.

Thinking through the five areas of disciplines of discovery driven planning (McGrath & MacMillan, 1999) is useful when continuing the work of testing business models. Having clear goals and avoiding unambiguous terms is a way to make clear to all participants what the goal of a business model is. Specifying the business model's deliverables is a way of doing this. Being careful with assumptions is another important discipline to avoid doing mistakes of overestimating technology and markets and underestimating competition and hardships. Having suitable milestones can be a way of testing concepts, hypothesis and uncertainties of business models one at a time. These milestones could be seen as learning or insights in and should be used in an iterative process, such as illustrated in for example the Build-Measure-Learn Feedback Loop (Ries, 2011). As still being in an early phase of development, being flexible is important as a business models can be discarded or forces to iteration if new information is discovered. Being observant for deal-breakers (Sull, 2004) is important as many business models are built on assumptions that if proven wrong will cripple the same business model.

7 Recommendations for SCA

What SCA should do with their waste streams and which markets are most attractive is what will be answered in this part. This will be done in two aspects. What is most attractive short-term and what is most attractive long-term. This since there are alternatives that could be easier to start up quickly, while others that show great promise are not possible quite yet. The following sections form a suggested plan of actions for SCA.

7.1 Short-term

It would not have to be approved by strict regulations such as when using GGM in food or cosmetics. It can be used on site with minimal transportation required. When not having to rely on other actors, it would be easy to evaluate if it is suitable or not..

What this business model also allows is a way of starting to extract GGM with little risk involved. Doing this also enables SCA to further evaluate the long-term possibility of GGM to be used in other products and markets. Hence pursuing this option also open up the possibility to explore some of the other business models later on. In short-term they have a good way to earn savings, while in the long-term they can gain revenues from further enhancing GGM for other uses.

What SCA needs to do first is taking the business model through the next appropriate test in accordance with the model presented in analytical framework. This needs to be done to validate or reject the critical assumptions made regarding this business model.

7.2 Long-term

Some of the uses of GGM explored in this report show great potential in terms of market, interest in environmental friendliness etc. They are however shrouded in much uncertainty since it has not been explored if it is practically possible yet. Many also require to be approved by intricate laws and regulations. Therefore they are not an option for what SCA could start doing immediately, but require significant time and research to be conducted first.

In the long-term two alternatives have been identified as more interesting than the others; using GGM to eventually acquire bio-SAPs or producing surfactants to be used in detergents. These are both large markets with interest in transforming their offers to more sustainable alternatives. Currently they both rely on petroleum as a raw material, something interviewees expressed they wanted to move away from.

To follow the bio-SAP lead means putting effort into evaluating thoroughly the features of the GGM that can be extracted at the paper mill. Of the alternatives investigated in this report of acquiring bio-SAPs, setting up a partnership with BASF would be of most interest as SCA already have a strong collaboration with them. They are already looking into the issue with existing projects and they also currently work with SCA. Investigating if GGM can be used in their processes would therefore be a joint effort where SCA needs to allow BASF access to their waste stream materials in the development stage. What also needs to be pointed out is that BASF are working on developing a process in a joint project, they are however not yet approaching completion. The process GGM could be incorporated into is thus not yet investigated or developed, hence the long-term time horizon for this alternative.

This alternative is deemed to be of most interest since it is not merely a way of slightly improving margins by some additional revenue. This alternative also helps improve SCA's entire image and gives an opportunity to take a whole new product to market. A product in line with SCA's vision of working for sustainability.

An additional option that through the business model evaluation proved interesting is that of using GGM to produce surfactants. The market for detergents showed promise, with interest in finding sustainable alternatives and a good market size. For many uses of GGM, its application would serve as only a very small part in the final products. Surfactants however are the main ingredients in detergents and constitute a significant part of the final product. It could therefore make more of an impact on the

products it would be used for. Detergents and similar products also put value in environmental friendliness, making GGM an interesting alternative material.

What to do next is to better investigate this alternative is to learn more of regulations GGM must pass and find out what costs that are related to these. Furthermore, learning what attributes GGM have in greater detail is important to be able to talk to customer and explain the materials and the potential benefits by using it. Using the working process describes in the analytical framework of this study can be of use in the search for a business model suitable from the surfactant market.

One must consider the possibility of the above-recommended directions might come to dead ends. Both those alternatives are associated with good potentials in terms of markets and profits, but also with risks and uncertainties.

8 Conclusion

The general purpose of this thesis was:

To investigate how a business modelling approach can explore and evaluate new business opportunities based on by-products from the core business within an established firm.

A case study was set up to investigate the purpose operationalized in the following three goals:

1. *Identifying which the waste streams are and how can they be used.*
2. *Assess which usages and markets show best potential for success.*
3. *State how SCA should continue with the work utilizing their waste streams.*

An analytical framework was created from theory to describe a process of working with business modelling and achieving the three goals. To accomplish the first goal the first stage of the analytical framework was carried out. Information was gathered and five waste streams and their current usages were identified. Of the waste streams, TMP-water was seen as the waste stream with the highest potential. From TMP-water, a material called GGM with many potential usages can be extracted. The second goal, to assess usages, was done by prioritising business models by different criteria. In the long-term using GGM as a surfactant and further investigate the potential use in bio-SAP was seen as having highest potential. The third goal, how SCA should continue the work utilizing the waste streams, was to test the most critical assumptions of the recommended business models as a first step of validation.

Using a business modelling approach by following a framework for creating and testing business model canvases was concluded a passable way to explore, compare, and evaluate business ideas. In the case study of this thesis focus has been on exploring and stating hypotheses in business model canvases. Initial testing on market viability has begun, and assumptions was either validated or rejected. This work showed that testing and pivoting business models was a viable process for exploring and optimising new business opportunities before costly investments are made. We would argue that the analytical framework is quite generalizable for new business ideas if hypotheses and tests easily can be synthesized and performed. In business areas where tests take longer time a model of constant iteration like the framework used might not be suitable. To give an example, the framework might not be very suitable in the pharmaceutical industry. Here development takes many years and success of companies often relies on large early bets.

As this study have put much focus on creating hypotheses and narrowing down business models, it would be interesting to try using a business modelling approach to go further in the business modelling process. Further research could be investigating how a business modelling approach, when a business model already have been validated, can help to implement business models and build business.

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Appendices

Appendices include the interview template used for semi-structures interviews, summaries from the semi-structured interviews, and a list of the interviews conducted in this study.

Appendix 1: Interview Questions

- What do you currently use? What is it made from?
  - Thickeners (Polyvinylacetate, CMC/carboxymethyl cellulose, polyacrylamide, EHEC/ethylhydroxyethyl cellulose, methyl cellulose??)
  - Emulsifiers
  - Starch/flour, from what raw material?
  - Fibre additive
- What are your current purchase criteria's when buying [thickeners/emulsifiers/fibre additives] / What features do you find of most importance for [thickeners/emulsifiers/fibre additives]?
  - Price
  - Environmental friendliness
  - Raw material/origin
  - Convenience
  - Rules and regulations
  - Purity
  - Concentration effect
  - Partnerships
  - Other
- Would any specific features make it of interest to pay more than you currently are?
- Are the any specific rules and regulations you follow regarding [thickeners/emulsifiers/fibre additives]?
  - Demands regarding purity?
  - Demands regarding origin?
- What volumes do you currently purchase? Does it constitute a large cost of the final product?
- Do you have any specific demands regarding environmental friendliness?
- "How" does your current purchase process look? (JIT, bulk purchases, …)
- Who do you currently buy these products from?
  - Do you only order this or do you have a close collaboration/more products?
- Would you find any advantage in a product made from raw material from other sources (forest) over regular food sources (for example industrially grown corn)? Disadvantages?
- Other: What is the biggest current problem with [thickeners/emulsifiers/fibre additives]? Ponder you would have a magic wand, what would you have changed today for the prefect product?

Appendix 2: Interviews with Potential Customers

This section will summarise interviews conducted with representatives of potential markets. Following this short introduction are the questions posed to the interviewee. Here they are presented in English, however during the actual interviews they were posed in Swedish since all interviewees were from Sweden.

Production Manager, Baking company, 6/12 -12
They use a range of different products for thickening and emulsifying. For emulsifying they for example use distilled monoglycerates. As for thickeners they use exatan, keltrol and others.

Criteria's for purchasing were mainly that the additive has no E-number. This is something customers do not appreciate. Products have to be as ecological as possible. Other than that, the price was the main criteria they looked at. If they were to start buying something new however, it would have to replace something they currently used by being cheaper, have better nutritional features or potentially replace some E-numbered product.

When asked if any specific features would enable a higher price, the answer was more to the last question of the interview. If one was to be able to develop a product with the same functionality as gelatine this would be highly attractive. This since they seek completely vegetable-based products, where gelatine is an animalistic product.

The interviewee did not consider himself the best person to be asking regarding what rules and regulations they follow, but mentioned products they use have to be food grade. He also mentioned them following the guidelines of BRC, the British Retail Consortium.

The volumes they purchase for their production was something the interviewee could not answer since he did not know. The answer to whether it was a big expense or not was a clear no however, where he did not have any specific numbers but explained that the cost of thickening, emulsifying or fibre additives did not constitute a large expense seen to the entire complete products.

When asked how their purchasing process worked, he answer in terms of buying new products. Here they considered if such a product was needed, if the features of it were any better or if the price was interesting, if so, they put a team of product developers on the case to further evaluate if the new product could add anything. The results they got decided on whether or not to move forward or not.

It was clear that the interviewee's opinion was that anything would be better than industrially grown corn when asked if he saw any advantages or disadvantages in using alternative raw material. This due to consumers not wanting to buy any GMO's, genetically modified organisms. He had however some doubts regarding a product taken from the paper pulp industry, since this might deter some customers. Currently they mainly used starch derived from potatoes so the bad name corn has gotten had no real implication for them.

To conclude the interview he summed up the fact that much demand is put on delivering KRAV-labelled products. While they had not seen a great demand for this when they first started offering such products, it had become more and more popular over time. He himself believed more in locally grown produces opposed to certifications such as KRAV, but as a whole saw an interest for both in today's markets.

Product Manager, Food ingredient supplier 1, 6/12 -12
At this company they currently use hydrocolloids such as pectins, alginate and other E400's for thickening purposes. They also use starch derived from potatoe, corn, wheat and other sources. For fibre additives they use a range of functional fibres he explained. They use fruit based fibres, cereal fibres, bamboo fibres, inulin from cikeria roots, citrus fibres, oat fibres, polydextroses and other fermented products for fibre additives. They also produce fibre additives that are sold for animal feed as well, where they mainly use fruit based fibres derived from the waste of apples.

Being a distributor for large producers of finished products, the wants and needs of them dictate much the criteria's of what they purchase. They also have internal quality assurance systems. More specific, fibres and emulsifiers they buy need to be of food grade, have good proven functions and have a reasonable price.

For them to pay more for any of these products they would have to be of better function such as better effect of thickening so they could use less. For a higher price they would look more at price in comparison to effect rather than price in comparison to weight. Alternatively if some other product could add some improved functionality.

When asked what rules and regulations they followed, he referred to "tillsatsförordningen". A regulatory script of livsmedelsverket, the Swedish food administration.

Since he knew of other thickening agents derived from cellulose, when asked if he saw any pros or cons with using raw material from forest products he saw no problems. If anything only that it would have to be purified properly.

He was not sure regarding their standards on environmental friendliness. He did mention though their product could not be a large environmental burden. That they were well purified and approved additives was of more importance to them.

As for the previous interview, the expense any of these products constituted of their entire production was small. He did however have some rough numbers on what they paid as well. They paid all from 5 Swedish öre to 1 Swedish krona per kilogram, and this cost could constitute all in between 0,5% to 15% of final product costs. He mentioned in the area of thickening there were some very expensive alternative, from 100 to 200 Swedish kronor per kilogram, however using these required an extremely small amount.

The need for these products is continuous and purchases are made in bulk. They prefer dealing with as few suppliers as possible and therefor want one supplier to deliver not just one product. When asked if he could mention some of the suppliers they work with today he mentioned some names; One for emulsifiers, thickeners etc, another for fibre additives and a third one for fruit based fibres.

Answering the "magic wand" he stated the perfect product would be from natural ingredients, be healthy, nutritious and reasonably priced. They also preferred it to be a raw material and not an additive, since E-numbered products are somewhat frowned upon among customers, no matter what they actually contain.

R&D manager, Food ingredient supplier 2, 10/12 -12
They currently use several different types of thickeners in their food. They use starches from potatoes and corn but also mono- and disaccharides (E471) and xanthan gum (E415). They use fiber in their wholegrain bread made of wheat bran, but they are considering to use other fibers such as fiber from apples in their products.

The purchasing decision is made depending on which product is considered; the difference of cold-swelling (soluble in cold water) and warm-swelling (requires high temperature to be soluble) products was mentioned as a criteria. Other important attributes were texture, origin of material, non-allergenic, as natural as possible and logistically viability (for Europe).

When asked which attributes of raw materials that would enable a higher price, the respondent answered that more "natural" raw materials always is welcomed. This could mean avoiding modifier starch or avoiding the need to mix several starches to achieve a desirable thickening effect.

When asked about volumes the respondent did not know exactly any numbers but said that large amounts of raw materials are bought and put into storage. The amount of either thickener, emulsifier or fiber was in the products that included them (not all do) in the amount of 0.5-10 percent. The respondent said that the amount of suppliers usually is limited to one or two for each product, and

preferably the suppliers supplied more than one product to avoid too much administration and extra audits.

The respondent did not know what the environmental requirements that is made in the purchasing decision, but said that environmental issues generally is regarded in any product. When asked if he saw any advantages or disadvantages with a raw material originating from the forest he said that it is important that this is communicated to the customer in the right way to ensure the satisfaction of the customer. He thought it was important that the packaging would tell where the raw materials came from in order to sell it.

On the question about what he would do if he had a magic wand, the responded that he did not know any specific big issue, but that overall more natural products would be well received. This was concerned thickeners, emulsifiers and fiber alike.

R&D Manager, Food supplier 1, 10/12 -12
This comany is using thickeners made out of CMC (E466) and guar gum (E412). Emulsifying agents was different mono- and disaccharides (E471). The fibre in their product were from rye and was indirect added when rye was added, no fiber was directly added to the products.

The respondent said that she did not know what the criteria from purchasing decisions were, as they were made from a team at their office in Italy. She on the other hand said that they performed test baking for suppliers when trying out new ingredients/raw materials to check whether or not new types of ingredients and raw materials worked or not.

Attributes that was considered extra important for thickeners/emulsifiers/fiber was that if it could be considered as natural in the eyes of the consumer. Additives that do not have e-numbers were seen as positive as this makes the product more natural and less artificial.

The respondent did not know if there were any special laws and regulations that was considered in the purchasing decision as this was done by the earlier mentioned team in Italy. She said that there are clear rules for what to type on the packaging and they followed those rules.

As she was not part of purchasing she did not know how big volumes and how the purchasing process was conducted. She did also not know if there were any environmental guidelines when buying raw material.

When asked what she thought of raw material from the forest industry she said it was hard to answer, as she never earlier thought about it. She thought it was important to think about how the consumer would react and perceive it.

When asked about any problem that a magic wand could possible solve she could not think of any larger problem that she had experienced that was related to additives such as thickeners, emulsifiers and fibers.

Raw material specialist, Bakery supplier 2, 13/12 -12
They use thickeners, emulsifiers and fibres in different products. The only thickener used currently is in very low amount in a specialty product. The product is in need of a stable water binder, similar to the effects of CMC. They use mono- and disaccharides as emulsifiers. Fibers are made of soluble dietary fiber the origins from grains, corn and algae. Depending on product and production, different amount of thickener, emulsifier and fiber is used.

The criteria for buying these materials are the aimed application it is used for, markings and labels of the products, origin for the material and that the function the material or additive is used for has an affordable price. If the ingredient or additive has an E-number, the ingredient or additive must have a clear function as E-numbered products otherwise is not wanted.

When asked about laws and regulations that is they must follow when handling with thickeners, emulsifiers and fibers, They follow the laws of the Swedish food administration (livsmedelsverket), the laws of using E-numbered products, exporting laws and foreign laws to countries exporting to.

When asked about if They set up any environmental requirements on ingredient, the response was that when they introduce new materials or ingredients they do the evaluation from case to case. Depending on product the

When asked about an opinion of food-based ingredients it was important that the ingredient was approved by the food administration. The respondent also though there could possibly be issues with media if using forest-based products in food if not handles correctly.

Quality Assurance Manager, Food supplier 3, 20/12 -12
At This company, the use and need for thickeners and fibre additives was non-existing. They did however use an emulsifier for their production of cheese doodles, a range of emulsifiers produced from sunflower, rapeseed, palm and soya bean oil.

The purchase criteria they had mainly concerned efficiency. The emulsifiers they use must do a good job in relation to how much they cost. They were however also ISO-14000 certified so products they use have to meet demands from this standard. They also, beyond the demands on environmental friendliness ISO-14000 put on their products, try to use ingredients with as little environmental impact as possible, as long as product efficiency is adequate.

As long as the product has been proven safe and food grade, she saw no issues with using products from the forest industry in their food products. If it would be better in term of environmental friendliness she saw it as something potentially positive. This much depended on customer acceptance however. The risk of it being badly received among customers is ever present and then environmental arguments might not matter. She related this issue to what the demands on ingredient marking. Whether or not it is even visible to customers or not.

Owner Cosmetics company, 11/12 -12
In cosmetics many different thickeners are used; various acrylates, cellulose based thickeners such as carboxymethyl cellulose and ethylhydroxy cellulose, silicon and others. This since different products can call for different features. He mentioned cellulose based thickeners for example often had better lubricating effect, hence used in products where this feature would be sought after. Most often they use a variety of different alternatives in one and the same product to gain all features desired. Often more than five thickening agents in the same products to get the different effects they provide. With this many alternatives and always mixing to get the sought after features, he had a hard time finding any particular feature in an additional alternative that would entice them to pay more than they currently are.

When asked what rules and regulations they follow, if any, the answer was specific. The Swedish drug administration, läkemedelsverket, have specific legislation regarding cosmetics. He pointed to this the kosmetikalagstiftningen as the legislation they followed in their work with creating new products. Combined with this his answer regarding what environmental demands they put on products was that nothing was mentioned of this in regulation and hence did not dictate their choice much. Only that they would not mind choosing environmentally friendly products if they existed and were approved.

The volumes of thickeners used by them in their products constituted a small share. Not being a large actor, their consumption is only around 500kg annually, and to give an example he mentioned creams where 0,2 – 0,25% was all thickeners constituted of the entire product.

R&D Manager, Cosmetics company 2 11/12 -12
At This company the topic of thickeners and emulsifiers derived from the environmentally friendly forest industry was not unheard of. In fact, they are already searching for just such alternatives. She mentions them having been in contact with potential suppliers and definitely expressed an interest.

Other than the attractiveness to them in a product with environmentally friendly aspects, she mentioned them looking for certain specifications in term of the structure of the actual fibres. If the fibres are too long they are felt in their products, leaving the user of for example their face creams with an unwanted sensation.

Product Manager, Feed company 1, 11/12 -12
At this company they produce dry fodder and consequently have no need for thickeners or emulsifiers. They do use a variety of fibre additives however, mainly from agricultural origin such as wheat and oat. They also use DDGS, a by-product from distillation processes. Common for all fibre additives they use is the by-product feature, what they purchase from the agricultural industry is what would not be used in normal food.

The criteria they consider when purchasing fibre additives is based on gaining as good effect for the animals as possible. A proven benefit for the well being of the animals eating it is essential for choosing a particular additive. Of course, he went on to mention, non-allergenic products is also a must. As important as it is to see benefits from eating the additive, it cannot cause any irritation or inconvenience for them.

Regarding rules and regulations however he could not recall anything in particular they follow other than being approved by the agricultural department of Sweden, Jordbruksverket. In terms of environmental demands, they do not express any particular standards for the specific products they buy, but they have demands on their suppliers. Those demand include how they deliver, how they produce their products and also some environmental requirements.

The main positive feature of using a fibre additive with origin from forestry would be that of it being a renewable and resource friendly product he thought. However as they currently only use domestic products from the agricultural industry, products that just as GGM otherwise would only be waste, it might not give any substantial advantages toward what they already use. He also pushed on the fact that it was extremely rare that they purchased anything from outside of Sweden, with transports etc. not making it worth it.

To summarise the interview, he did express positivity regarding the use of GGM, a material with good environmental potentials. He also referred back to rules and regulations, where they are strict with what they use in their products, but the regulations are not as rigorous as for food produced for people. This, in his opinion, could probably make the animal feed industry a bit more susceptible to a new product such as this.

CEO, Feed company 2 12/12 -12
In the animal feed at this company they do not use as thickeners or emulsifiers as they only produce dry feeding, but they have fiber in the products. The fibers comes from different types of vegetable sources and the content of fiber in products depend on products and what kind of materials is used. Fiber in feedings is called plant thread and computer calculates the amount of plant thread in feeding. If a specific amount of plant thread is specified, the computer program gives the amount of materials that should be used to achieve that. The materials that provides fiber used in their feedings are wheat, beet, corn. If there is not enough fiber in the feedings, some of these ingredients are added depending on product.

The laws and regulations for feeding is set up by the department of agriculture and they try to follow them. The company does not by themselves any specific checks for ensuring environmental friendliness, but trust that their suppliers in this.

The respondent was very sceptic of adding something coming from the forest into the products. It has to be accepted by the department of agriculture to be even considered.

Product Development manager, Food company 4, 14/12 -12
This man is in charge of developing new fodder for cattle, poultry etc. Production of food for cats and dogs is made under other labels of theirs, and since fodder in the agricultural industry is almost only

dry feed, almost no thickeners or emulsifiers are used. Fibre additives however can constitute a large portion of their products, specifically in that of cattle feed. For the few applications of liquid feed additives they had, he mentioned them using emulsifying products called Bredol from Akzo Nobel and polysorbate. For their regular dry fodder they use fibre additives derived from a number of sources, among them beats and grains. The company is a cooperative of Swedish farmers and the majority of products they use is from their members, apart from some additives needed to optimise their products.

When purchasing additives to their products, they have demands regarding hygiene, amounts of minerals and decomposition rate. The latter is in regard to how quickly the animals can digest the fibres they eat, with the additives they use ranging all in between 1 – 8% per hour. When asked if there additionally was any feature in a product that could incite them to pay more than current offerings, he said they were looking for a purer fibre additive. With this he meant an additive that was mainly only fibres, without additional content. When optimising their products they have strict goals on how much fibre, sugar and so on the final product need to contain, and a fibre additive that also contain additional substances forces them to put much work into balancing the final content to get exactly the levels they want, work they would prefer not to do. Having a pure source of fibre would make it easier for them to produce products with precise and reliable contents.

Rules and regulations around how they produce their animal feed followed the normal Swedish directions and also EU-regulations so it could be sold abroad. They follow standards regarding heavy metals, hence purity of products are of great importance to them. As for how they work with environmental issues, they calculate the carbon footprint of all their products. For all ingredient that goes into the products, and for their own production processes, they calculate the carbon dioxide emissions and are declared on their products. Some calculations can be very elaborate, for example in those cases they purchase ingredient from above, and in particular when using products that has caused for example rain forest to be cut down to make room for plantations. This work however is something they feel is worthwhile to be able to show what impact all products have had on the environment, and to really know where they can make improvements. More of their customers, farmers, also tend to run more environmentally conscious farms, hence knowing these numbers becomes an important issue in their work of reducing their environmental impact.

For animal feed the amount of fibres in a product tends to be rather high, with some variations between what animal they will be used for. Cattle, game etc. have rather high fibre contents; with their stomachs being best suited to digest the fibres. As estimation he said they used about 5000 tonnes of beet fibres each month, for a total animal feed production of 1000000 tonnes annually. With beet fibres not being the only fibre they use in their products, their consumption and demand is rather high.

When asked whether he would see the origin of the GGM as something negative or positive, he definitely stated he saw it as something positive. He saw environmental benefits both in that it is from a renewable source and also much in that it is locally grown here in Sweden. In the 90s there were high goals set from the government that 20% of everything produced should be KRAV approved. This is something the industry is not even close, and his opinion was that reaching such goals are both very hard and not as important as putting focus on locally produced products. This he therefore saw as an advantage in the origin of GGM.

R&D Manager, Feed provider 3 21/12 -12

At this company they produce food mainly for dogs but also cats. Here they do not only produce dry feed but also wet alternatives. Food in jelly and sauces, which makes them consumers of thickeners and emulsifiers. She mentioned them using a gelling agent called cassia gum.

Purchasing thickening and emulsifying products, they mainly look at appearance, consistency and binding effects. Additionally to this, they also do taste tests. It is important here that the products are appetising to the animals that are to consume them. Especially since these wet alternatives are more exclusive and cost more than the dry feed alternative. Other than this, criteria's for purchasing are also guided by regulations and she mentions "foderlagstiftningen", which is the regulation for animal feed. They also follow the European labelling regulations.

The volumes used of gelling agents were not large she stated. She did not have any specific numbers regarding how much. She did though say that the mixture they currently used did not require much to be added either.

When it came to the environmental factors, she mentioned them being certified with ISO-1400. She thought that natural sources of materials were interesting, although the above mentioned criteria's weighed heavier in their decision. Some of what they currently used was from algae. These products are not produced in Sweden however and she thought a locally produced, natural option would be of interest. The locally produced interest had however also to do with transports easily get unnecessarily expensive. When using such small amounts, the freight costs per unit becomes high when transporting it great distances.

R&D Manager, Cosmetics and cleaning company 13/12 -12
This company produces different cleaning and washing products through their brand. The according to the respondent they use "the entire scale" of surfactants in their products depending on what effects they want to achieve. There are four types of surfactants, anionic, cationic, nonionic and amphoteric, and the company used them all. Different types give different attributes, such as foam or no foam.

The main purchasing criterion of surfactant is price but there are many other criteria that affect the purchasing process. First of all the materials have to be allowed by rules and regulation. The respondent mentioned that raw materials should be validated through REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals), a EU regulation for chemicals and their safe use[1]. New products need to be registered under REACH to prove that they are harmless to be uses in any of their products. The product needs to be proven in REACH to be harmless in the application it is supposed to be used for. The material is for example not allowed to be allergenic or endocrinal disruptive to be accepted for REACH. The respondent mentioned that the new regulations through REACH will make it harder to develop new products as testing usually is very expensive. Other features for surfactants are that the production is ethically acceptable (child labor and raw materials devastating the rainforest is not good) and that the raw materials are environmentally friendly and sustainable. Ecolabels such as Svanen[2] is positive as well.

Cleaning and washing products is in a high degree made of surfactants and it makes up a high cost in terms of the products total cost. They use several thousands of tons surfactants per year. They use many different surfactants, a main surfactant called Sodium laureth ethyl sulfate, but also several other supplementary surfactants, each more than a thousand tons each year.

Products from the forest was seen as something positive, and they have already during a long time been using tall oil in some of their products. This tall oil is a byproduct from the kraft pulp industry. The problem with tall oil was that it can also be used as a fuel, which according to the respondent med it harder to get by.

Product Manager,Cleaning company 2, 18/12 -12
Their branded series covers different kinds of washing and cleaning products such as dish soap, cleaners and detergents. Even with their own brand, they do not themselves manufacture any products. They instead use an outside supplier, Akzo Nobel, as a supplier of products and then sell them under their own label. The surfactants in their products come from petroleum-based processes in Akzo Nobel's cracking plants but also to some extent from biological materials.

They only uses products and raw materials that have been approved by law. They also follow environmental regulations for their products to be able to be classified by the Swedish ecolabel "Svanen" and the European Union's ecolabel "Flower". In addition to external requirements, they also follow their own goals to minimize preservatives and other additives.

[1] http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm

[2] http://www.svanen.se/en/

The respondent did not se any specific advantage of using surfactants based of forest products, but he also said biological raw materials was demanded and not easy to find. They used surfactants based both on petroleum and biological sources depending on product, and they had a close collaboration with Akzo Nobel in this area. The product and the effect of the product were most important, independent of origin of raw materials. Price was also an important criterion for the desirability of forest-based surfactants.