TAMPERE UNIVERSITY OF TECHNOLOGY

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CUSTOMER NEED FOR MATERIAL HANDLING IN CREATING A BUSINESS MODEL

Master of Science Thesis

Prof. Miia Martinsuo has been appointed as the examiner at the Council Meeting of the Faculty of Business and Technology Management on April 8th, 2015.

ABSTRACT

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Nowadays to sustain competitiveness and continue the growth of the business, companies are focusing on analyzing the markets and customer needs of their current and potential clients. Understanding what customer value and being able to provide and grasp the value of company's offering, is one of the key issues in the corporate world. Therefore, companies are concentrating on creating business models that will respond to customer needs and fulfill their expectations.

The objective of this paper is to identify customer needs for material handling in mass incineration plants with a grate fire technology in order to create a business model. Recognized customer needs provide an overview of the market of mass incineration and serve as a base for creating a business model that should respond to the customer's needs. The study provides theoretical background on the business models and customer needs as well as key concepts in the case study. The empirical data was collected by conducting qualitative interviews with the production and maintenance managers of the mass incineration plants that are processing municipal solid waste and produce energy. To understand different points of view on material handling, waste management company, managers in companies providing turn-key solutions for mass incineration and a consultancy company were interviewed. In addition, concept of circular economy approach proposed by European Union was studied to see its possible influence on the mass incineration segment.

The results of the thesis shows that the only need for material handling is in the form of crushing machine that reduce the volume size of the bulky waste, that are large, irregular, usually broken items such as furniture, bookcases or shelves. The crushing equipment could be either stationary or mobile. By decreasing the size of those particles, mass incinerators can keep continues process of feeding the material in to the hopper and also prevent from unplanned stoppages or damages of the hopper. The thesis proposes three different business models that respond to the customer needs. Product-oriented business model with selling a single equipment of stationary or mobile crusher. Use-oriented business model in which mobile crusher is rented to the customer and finally, result oriented model wherein crushing is offered as a service.

PREFACE

This thesis gave me an excellent opportunity to broaden my knowledge about customer needs and business models in industrial environment. I was able to gain a real insight of company's operation and how crucial is to be aware of customers' desires and needs. In addition, while preparing the thesis I got a chance to represent the company and talk to many interesting people about solid waste management, customer needs and business models.

I would like to thank my supervisor prof. Miia Martinsuo for her guidance and support during the writing process. Special thanks goes to Case Company, especially to Hannu Lepomäki and Mika Suomi who gave me the chance of writing the thesis and were supporting me for several months during the journey. I would also like to thank all of my colleagues at the Case Company who were willing to help and support me during the thesis. Finally, many thanks goes to all of the participants who took their time and agreed for the discussion.

Now, I am ready to start my new journey.

Rauma, 10.10.2015

Stanisław Szczeciński

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ABBREVIATIONS

BM	Business model
BMC	Business model canvas
CRM	Customer relationship management
C&I	Commercial and industrial waste
EPC	Engineering, procurement and construction
MSW	Municipal solid waste
SRF	Solid recovery fuel
VP	Value proposition
Waste	Municipal solid waste delivered to Waste-to-Energy
WEEE	Waste electrical and electronic equipment
WtE	Waste-to-Energy

1. INTRODUCTION

1.1. Background and Motivation

In recent years the globalization and technological progress are pushing companies to the limits. The companies are innovating to maintain a competitive advantage and stay ahead of their competitors. However, besides technological and business growth, cultural evolution increases the demand for energy consumption while also increase the waste generation. Ecological changes, which occurred for last couple of decades, have forced society to think and start protecting the Earth and its environment. Constant population growth and considerable demand for the energy have a massive impact on the global warming and the consumption of natural resources may compromise environmental sustainability

Nowadays, the main part of the energy is produced from nonrenewable sources such as coal, oil or natural gas. However, due to scarce availability of those resources and increasing need for energy, alternative technologies to produce energy have been developed. One of the oldest technology is mass incineration with grate fire technology that can process municipal solid waste and generates energy in form of electricity and/or heat (Brunner, 2002). This type of technology not only helps to supply required power or heat, but also facilitates waste reduction.

The evolution of global energy business opened the possibility of new facilities to emerge. Those facilities have different needs, thus there are plenty of business opportunities for material or equipment suppliers. However to serve customers well, companies should have sufficient knowledge, necessary resources and an ability to utilize those resources in a way that it will be beneficial for their customers and profitable for their own operations. Business model canvas is a perfect tool that can help companies to create, picture, capture, analyze and transfer business logic of the firm (Osterwalder et al., 2005).

The concept of the business model has been commonly used as a buzzword and not so many companies are aware of its importance (Mäkinen and Seppänen 2007). Business model could be defined as a number of operations performed by the company to create value for its stakeholders (Casadesus-Masanell and Ricart, 2010). Whenever company is able to understand what customers' need, it is easier to fulfill customer's requirements and recognize what are the drivers that encourage the buyers to make the purchase for certain product or service (Christensen, 2010).

Purpose of this thesis is to recognize customer needs for material handling in mass incineration plants with grate fire technology. Identified customer needs will help to create a business model that will respond to the customer needs. The study will provide important overview on the mass incineration segment and its point of view on the material handling.

1.2. Research Questions

The objective of the research is to identify customer needs for material handling in mass incineration segment in order to create a business model canvas. The project should provide information about customer needs and its preferences about material handling in mass incineration plants with grate fire technology segment. The research goals can be divided into 3 research questions:

1. What are customer's needs concerning nonhazardous solid waste material handling?

2. What are potential benefits of material handling for mass incineration operators?

3. How should the technology supplier respond to the value creation to fulfill customer needs?

This research will help to understand current situation of mass incineration operators and their needs in terms of material handling. In addition, this study will present possible drivers for investment in material handling enabling possibilities to reach new customers in the mass incineration market segment. Finally, the research will help the company to adapt its capabilities to serve the business of mass incineration and provide possible suggestions to respond to the value creation.

1.3. Scope of the Research

The purpose of this thesis is to recognize possible customer needs for material handling in order to create a business model. The study focuses on business-to-business (B2B) environment, thus the discussion about concept of the business model will concentrate on the B2B settings. The case company operates in solid material handling industry and suggested business models will be designed specifically for the case company and its environment. Although the case company is operating globally, this study is limited to European customers because it is easier to contact or visit the European customers and also due to possible regulations that might be implemented by European Union.

The research will specifically focus on analyzing mass incineration facilities processing municipal solid waste (MSW). Those facilities are also called Waste-to-Energy (WtE) plants and might process commercial and industrial waste (C&I) as well. Mass

incineration facilities are using different technologies. However, the scope of the research will cover only the one with grate fire technology because of its popularity and high number around the Europe. Therefore, plants processing hazardous waste will be excluded from the research due to the use of other technology. Terms of mass incineration and Waste-to-Energy plant will be used interchangeable and both of them will refer to plants with a grate fire technology that are processing mainly municipal solid waste, with possibility of handling commercial and industrial waste (C&I), and producing energy. Although the facility itself can provide great knowledge, the main focus will be on its material handling and its possible impact on operations of the Waste-to-energy facility. Such information will help to define and understand customer needs in terms of material handling systems of those facilities.

Since there are mass incinerations located in the European Union, the paper will also partially discuss future regulation, which might affect their operations. Such information will help to define potential drivers for need or interest in material handling systems.

The aim of the research will also help to understand and learn about present or future challenges with material handling in mass incineration plants. Those problems that operators of mass incineration facilities are facing, may represent a business opportunity for the case company while solving the customer's needs.

1.4. Structure of the Thesis

The thesis has been divided into six chapters. First chapter introduce the work, the second chapter presents literature background for the study and the third chapter shows how the research was conducted. The fourth chapter presents key concepts for the case study and the fifth chapter shows the results of the research. Finally, the last chapters discuss the results and provide conclusions of the study. More specific structure of the thesis is illustrated on the Figure 1 below.

The beginning of the thesis presents the background and the motivation for the studies with the research questions as well as the scope of the research. Then, literature review provides background information about business model, customer needs in B2B settings and also discusses identification of customer needs.

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   - Scope of the research
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3. Research and methodology
   - Research and methodology and schedule
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   - Circular economy approach
5. Results
   - Cusomters' perspective on material handling
   - Benefits of material handling
   - Respond to the value creation
6. Discussion
   - Customer needs for material handling
   - Identyfing customer needs and benefits of material handling
   - Recommendations for technology supplier
7. Conclusions

Figure 1. *Structure of the thesis*

After that, methodology approach and the schedule of the research are presented. This part also discusses how the empirical data was collected and analysed. Then, the research introduces the case company, the key concept of solid waste management, Waste-to-Energy technology and circular economy to give theoretical background for the case study. Chapter five, presents final results of the research. Finally, chapter six focuses on the discussion of the results and its connection to the theoretical background, whereas last chapter conclude the studies.

2. LITERATURE REVIEW

2.1. BUSINESS MODELS IN INDUSTRIAL COMPANIES

2.1.1. Definition of Business Model

The concept of business model has many meanings and it is used widely across the business world, as well as in academic and research papers. According to Chesbrough and Rosenbloom (2002), a business model builds a logical connection between technical possibilities and recognition of monetary value that could be seized from the innovation. Furthermore, business model could be described as number of the operations performed by the company in order to create value for its stakeholders (Casadesus-Masanell and Ricart, 2010). Even though there is a strong emphasis on technical and operational factors in the business model, economic value is just as important. According to Timmers (1998), a business model is an explanation of potential benefits that brings a revenue stream, whereas Morris et al. (2005) sees business model as a source of profit generation which is connected to different variables such as pricing, costs structures, margins and volumes. Table 1, presents BM definitions with its context.

Table 1. *Business model definitions and its context*

Author	Context	Definition
Timmers (1998)	Electronic markets	A structure for the product, service and information flow, with clarification of different business actors and their roles; explanation of possible benefits for business; a description of source of revenue
Chesbrough and Rosenbloom (2002)	Technology	Consistent framework that change technological characteristics through customers and markets to economic outputs; a tool which links technology and economic value creation
Morris et al. (2005)	Entrepreneurial	Economic model with relevant variables that generate profits
Casadesus-Masanell and Ricart (2010)	Strategy	The logic of the company – how it functions and makes value for its stakeholders

As it can be seen from the table 1, there are not only many different definitions of the BM but also variety of contexts in which those models were used. The term business model is a still young concept which arose as a buzzword during the shift from traditional to electronic business (Magretta, 2002). Shafer et al. (2005), noticed that this change helped scholars to provider newer BM definitions based on different subjects such as e-business, strategy, technology or information systems.

The above mentioned definitions could mislead to the conclusion that business model it is nothing else but companies' strategy, however it is not. Osterwalder and Pigneur (2010) believe that a business model is a blueprint to a strategy while Casadesus-Masanell and Ricart (2010) claim that certain business model could reflect firm's strategy. Furthermore, they differentiate strategy, business model and tactics. Strategy gives an opportunity to create a business model in order to fulfill the company's goals. In the business model there are certain actions, called tactics, which are limited by company's business model. As seen, all of those concepts are related to each other.

Nowadays, each industry varies from the other and even within the same industry companies differ from each other, thus, it could be said that there is no general standard for the successful business model. Each company has its unique business model, which helps them to provide needed value for their customers' needs in order to capture the profits. In addition, the particular business model helps companies not only to differentiate from their competitors, but also increases the chances of outperforming them.

Individually tailored and explicitly presented business model could bring extra value to the firm, and therefore create a potential competitive advantage that could increase company's performance (Amit and Zott, 2008). However, that is not always the case as some business models might work well and help to develop company's business, but in some circumstances the same model might be a total failure and lead to the end of the company.

According to Osterwalder et al. (2005), BM has been studied on several levels. First, the top level defines the concept of business models and the elements that belongs to it. Second level describes common characteristics of BM types with it similarities. Finally, the last level discussed real world business model of a certain company. Several authors noticed that while company is dealing with product or a service, it might be necessary to have more than just one BM (Kujala et al., 2010; Magretta, 2002).

2.1.2. Elements of Business Model

Many scholars have been studying business models for last decade. Each of them suggested their own unique definition of the business models considering also different configurations. Since there is a lack of a unified definition, thus there are also many substitute terms for the components of a business model such as functions (Chesbrough

and Rosenbloom, 2002), dimensions (Schweizer, 2005) or elements (Yip, 2004). Despite the fact that there are a variety of terms that can be used interchangeably to describe the structure of the business model, all of those terms have one thing in common. The main point of elements is to define the main characteristics of the business. Furthermore, by linking all of those pieces together, companies can create their own business logic to operate in certain industry.

According to Magretta (2002), business models are so called "stories", which answer important questions; who are the customers and what do they value. Furthermore, those "stories" help to understand how the company will generate money out of the model and also, explain the logic of delivering the value to the customer with a reasonable price. With that approach it is easy to distinguish the main elements of the business model, them being customer, value proposition, cost and profit.

Chesbrough and Rosenbloom (2002), proposed six elements of the business model that connected together, help to explain how to build the business and what is the financial capital needed to organize that model. Those elements are as follow:

1. Value proposition
2. Market segment
3. Value chain
4. Cost structure and profit potential
5. Value network
6. Competitive strategy

The first element, value proposition, focuses on showing the offer and explaining the value added to the customer. Second, market segment, clarifies who is the customer and how the profits are going to be generated. Third, value chain, defines the structure for creating and distributing the company's offering as well as sets the needed resources to keep the company in the chain. Fourth, cost structure of value proposition and its potential profit created by the offering. Fifth, value networks, describes the situation and position between suppliers and customers. Finally, competitive strategy presents advantages over competitors.

According to Afuah and Tucci (2001), a business model consists of components and dynamics. They recognized components like scope of customers, scope of products and services, customer value, price, revenue sources, connected activities and sustainability of company's advantages. They emphasized that, besides components represent the core of the business model, dynamics of possible change of those components might play a vital role in the BM, thus there are situation when totally new business model needs to be created.

Hedman and Kalling (2003) also identified 6 elements: customers, competitors, offering, activities and organisation, resources and supply of factor and production

inputs. On the other hand, Osterwalder and Pigneur (2010) proposed that the business model should consist of nine blocks from four groups: offer, customers, infrastructure and financial feasibility. They defined those blocks as follow: customer segment, value proposition, channels, customer relationship, revenue streams, key resources, key activities, key partners and cost structure.

As described above, there are plenty of elements which could build a business model. All mentioned elements are presented below in Figure 2.

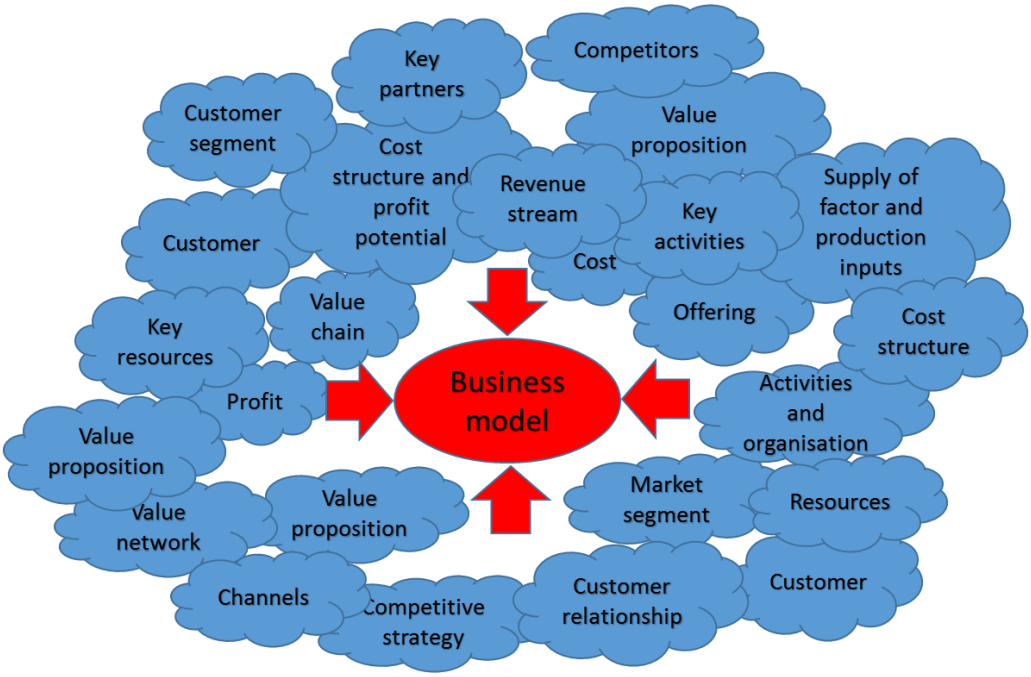

Figure 2. *List of elements included in business model*

All in all, it does not matter how those certain elements are called, but it is essential that the company would be able to create justified mix of them, which will explain the logic of how it creates and seize the customer value in order to generate profits for the company (Fielt, 2014).

2.1.3. Business Model Types

As it was mentioned, there are many different definitions of business models which are a mixture of elements, therefore there is no straight answer which business model is the best and which should be applied in any given case. Since competitiveness of worldwide businesses became more intense, more and more companies are shifting their interest towards service business, which could help to provide additional revenues. (Matzen et al. 2005; Gebauer et al. 2005). That is why newer business models are including extra services to the products, so that benefits for the clients and the supplier's profits could be increased.

Even though each BM differs from the other, it is possible to categorize BM into 3 groups: product-oriented, service-oriented and result-oriented. That classification derived from the product-service systems which has been explained by Tukker (2004) and presented in Figure 3.

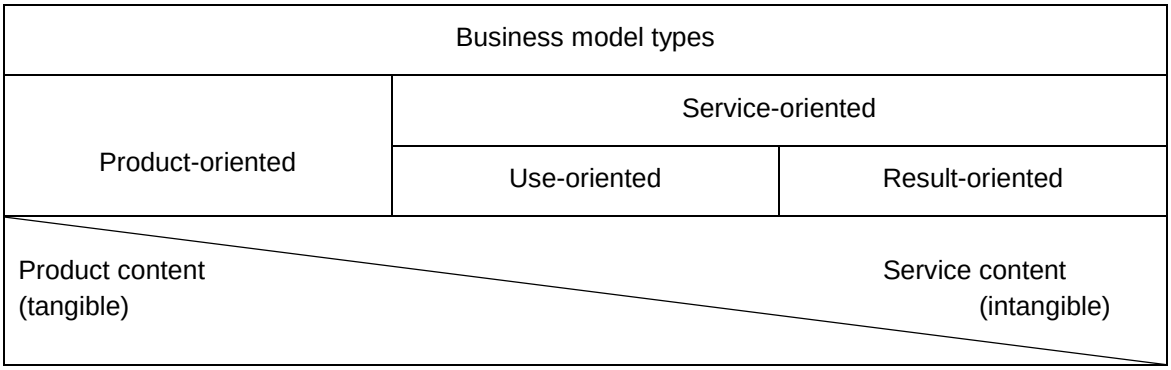

Figure 3. *Business model types (Adapted from Tukker, 2004)*

Before explaining different types of BM, it is important to define the product and the service. According to Baines et al. (2007), product could be described as something tangible such as a car or a plane, whereas service is more intangible and it refers to the offering like insurance, maintenance or repair.

As the figure 3 demonstrates, the first category is the product-oriented business model which follows traditional BM. This type of model concentrates on emphasizing the customer value mainly from the product itself. Nonetheless, service like maintenance or repair might be added in order to support and make the product more attractive. Second type, service-oriented, could be divided into two subcategories: use-oriented or result-oriented. Use-oriented BM is based on regular fees for the product, also called product leasing. Although the product is still owned and maintained by the supplier, the client has unlimited access to it. Product renting or sharing is another example of use-oriented model. The main difference between product leasing and product renting is that, while product is rented others can use the product at different times, thus the user does not have unlimited and individual access to the product. Finally, result-oriented BM focuses on performance and service rather than on a core product. Typical example of such BM is pay-per-service unit. The product is not sold to the end user, but the output of the product according the usage.

The best way to decide which model is the most suitable for the company is by practicing different scenarios in order to analyze all possible outcomes. Business model canvas is a tool that can help companies to create, picture, capture, analyze and transfer business logic of the firm (Osterwalder et al., 2005). The business model canvas (BMC) with nine simple blocks gives the best opportunity to present how the company intends to make, deliver and obtain the value of its offering, no matter if it is product, service or result orientated business model. Figure 4 presents nine blocks of BMC which

concentrate on the main business aspects which include customers, offering, infrastructure and financial feasibility.

<table>
<tr><td rowspan="2">Key Partners</td><td>Key Activities</td><td rowspan="2" colspan="2">Value proposition</td><td>Customer relationship</td><td rowspan="2">Customer segment</td></tr>
<tr><td>Key resources</td><td>Channels</td></tr>
<tr><td colspan="3">Cost stream</td><td colspan="3">Revenue Stream</td></tr>
</table>

Figure 4. *BMC (Adapted from Osterwalder et al., 2005)*

Customer segments are the starting point for the BMC. Therefore, while creating new business, it is essential to specify company's customers and customer segment. Customer segment is a group of customers with similar needs. There are several examples of customer segments such as mass market, niche market, segmented or diversified market and multi-sided markets. In mass market, company would concentrate on large group of clients with one general model, whereas in niche market, company would focus on a specific market with custom-made offering. In segmented market, company's clients would have some similar needs, when in diversified markets each customer would have different needs and problems. Finally, a company with multi-sided markets would assist two or more interconnected customers. Different customer segments have different needs and problems to be solved with the company's business model, thus it is important to define which one to serve. When the decision has been made, the company can start to prepare the value proposition for its customers. (Osterwalder et al., 2005)

Value proposition is the next element, and it is the most important one. As it can be seen in the figure, value proposition is situated in the middle of the BMC and it is not without a reason. Value proposition plays a vital role in the whole model because it describes the products and services that will help to overcome the customer's problems and generate value-added for them. Those products and services, no matter if they are similar to existing on the market or tailor made, enable the company's clients to reach full satisfaction in many ways: getting their jobs done, reduce costs or risks. It is important to remember, that very good value proposition may draw a bigger attention

amongst the clients and help to overcome fierce competition in gaining new customers. (Osterwalder et al., 2005)

When the customer segment and value proposition are defined, the company needs to determine how that value will be transferred to their customers. Channels are the company's tools to establish communication between company and the customer. Through those channels, value proposition is going to be presented to new and existing clients. There are two types of channels. First type consists of company's sales force, its web force or their own store. Second type is managed by the partner's stores or wholesalers. Both types have pros and cons in terms of costs and operations, thus company needs to be aware of the implications and choose the most suitable channel or channels for their operations. In addition, channels have several other functions such as increasing awareness of company's products and offerings, help to evaluate company's value proposition, studying purchasing and delivery options for our customers and finally take care of after sale operations. (Osterwalder et al., 2005)

After the customer is reached and the value proposition is accepted, the company needs to establish some type of relationship with the customer. Customer relationship block explains what kind of relation it is. Relationship may vary from personal or even dedicated assistance, to automated service where no assistance is needed. Furthermore, strong relation could create so called co-creation where company and customer work together in order to overcome certain problems. Nowadays, it is important for companies to established a good relationship with its customers and maintain it on the highest possible level. (Osterwalder et al., 2005)

Next in order, is obtaining revenue from company's offering. Revenue streams define how company is going to generate money from its customers. There are different ways to do it. For example selling physical product, which characterized with one-time sell or ongoing payments like usage or subscription fees, renting or leasing and licensing. Different methods enable different pricing mechanisms, thus the company needs to be aware of which type should be applied to certain customer. (Osterwalder et al., 2005)

Next block is key resources. Every company to fully operate needs to have resources, which help to build and deliver value proposition, penetrate markets, maintain relationship with its customers and earn revenues. Those key resources can be owned, leased or acquired from other partners. Moreover, resources could be classified as physical, intellectual, human or financial. Physical resources include manufacturing plants, machines and buildings, while intellectual property, patents and copyrights are intellectual resources. Human resources include not only personnel in the company but also knowledge they possess. Resources connected to financial guarantees, such as cash and line of credit are called financial resources. (Osterwalder et al., 2005)

Then, key activities are those actions that are crucial operations and functions the company needs to perform in order to keep the business model going. Activities like, production, problem solving or a platform, enable company to create and offer its value proposition. (Osterwalder et al., 2005)

Next in business model are key partners. There are several reasons to look for a partner such as decreasing costs by optimization and economy of scale. Furthermore, is good to have a trusted partner to easier reduce risk and uncertainty and keep the business stable. Finally, in case the company does not have needed resources for its operations, it is important to have a key partner from whom those certain resource could be acquired. (Osterwalder et al., 2005)

Finally, the last piece in BMC is a cost structure, which explains the costs to run that business model. Osterwalder and Pigneur (2010) define two tactics: cost-driven or value-driven. In the first one, business model is concentrating on reducing the costs wherever it is possible, when in the latter one emphasis value creation. Each tactics is affected by other costs such as fixed or variable costs and economies of scale or scope.

To conclude, all blocks of the BMC are interrelated to each other and it is important to have deep understanding of each block. Furthermore, order in which business model should be created and analyzed is also suggested, so that it is more practical to develop one and it is easier to understand it implications. In order to design the most suitable BMC for the company, it is recommended by Osterwalder and Pigneur (2010) to create as many as possible different scenarios and examples of BMC in order to test them and to choose the most suitable one.

2.2. EXPLORING CUSTOMER NEEDS IN INDUSTRIAL SETTINGS

2.2.1. Understanding Customer Value and Value Creation

Nowadays, companies are trying to create new businesses to increase profits and expand their operations. To achieve that, they are trying to fulfil all kinds of customers' needs. Although, it is very important to satisfy the customer but the key issues is to understand what customer value the most. Being able to understand customer value helps companies to identify the drivers which encourage buyers to make the purchase of certain products or services (Christensen, 2010). Having that knowledge, companies can become more successful by increasing their competitive advantage over their competitors.

Customer value has been studied for several years by many different authors, thus there are several different definitions and interpretations. According to Anderson and Narus (1998), customer value is a monetary value of technical, economic or social benefits which customer receives by paying for the offer. Moreover, they believed that changing

the price would not necessarily decrease or increase the value of the offering, but it could influence customer to accept the product or service. Since there are many aspects that should be taken into account while talking about customer value, Zeithaml (1988) built his definition based on several descriptions of customer value such as low price, getting what is wanted in desired quality or receiving something in exchange for something else. He concluded, that the customer value is a buyer's general evaluation of received benefits and given resources for those benefits. Ulaga (2003) identified four characteristics of customer values. First, customer value is a personal concept that differs from customer to customer. Second, it is a compromise between benefits and sacrifices. Third, those benefits and sacrifices can be analysed on many levels. Finally, perceiving value is in relation with competition. (Ulaga, 2003)

Marketing gurus, Kotler and Keller (2011), defined customer value as a difference between advantages that a customer will get and compromises the customer will accept while purchasing the product or service. Whenever there are more advantages over disadvantages, then the higher perceived value for the customer is and it is more likely that the customer will accept the offer. However, the same scenario is applied to the supplier perspective, because to receive some benefits supplier needs to sacrifice their resources (Walter et al., 2001).

Understanding the concept of customer value is important while companies are creating value for their customers. The more knowledge a company has about their customers, the easier it is to create value, which will persuade customers to company's offering. Ulaga (2001) observed that scholars are no longer concentrating solely on the buyer's opinion, but also on the seller's and the buyer-seller perspective. Figure 5, shows the connection between those perspectives.

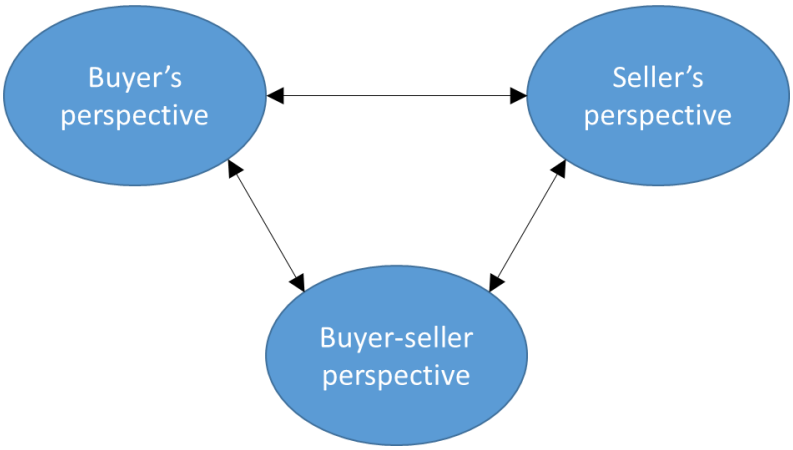

Figure 5. *Three perspective of value creation. (Adapted from Ulaga, 2001)*

In the buyer's perspective, Hogan (2001) described two drivers for the value creation. First, emphasize the value of a seller's package of products and services that buyer receives in exchange for the monetary value of the offer. This approach focuses on a

monetary value of benefits and sacrifices. Whereas second approach, concentrates on long-term costs and benefits through the relationship between customer and supplier. Despite that products or service and monetary value are the key factors of value creation in the buyer's perspective, companies should be aware that those factors may change within the time.

Flint and Woodruff (2001) distinguished two types of customer value: received and desired. Received customer value is the actual value the customer experienced. Whereas desired value, relates to the value the customer expects from certain a product or service. Ulaga and Chacour (2001) described desired value as a customer's belief in what should happen while using certain product or service, to achieve desired goals. Needless to say, that the desired value could change during the time and very seldom it is caused by an accident (Flint et al. 1997). Table 2, presents several different events which may initiate the customers' desired value change.

Table 2. *Trigger for customer value change (Adapted from Flint et al., 1997)*

Authors	**Triggers for customer change**
Gardial et al., (1996)	• Seller caused: products, services, contact people • Customer caused: strategic, operational, tactical • Environment caused: weather, other
Woodruff et al., (1993)	• Macroenvironment • Competitor innovation • Customer use situation • New markets
Perrien et al., (1995)	• Seller: internal management procedures, account management, pricing, product offering, miscellaneous • Competitor: pricing, marketing • Customer: customer behaviour, financial needs, ownership change

Above stated triggers, shows that all of the factors such as customer, seller and the environment around them might influence the change. Knowledge of potential causes of customer value change, may help companies to avoid sudden changes in customer value, but on the other it can help to influence customers and improve its offering.

Although it is very crucial to look at the buyer's perspective while creating the value, but it needs to be remembered that the seller is not only providing the value for the customer, but it is also looking for some benefits. Walter et al. (2001) studies emphasized that seller's perspective is just as important as buyer's. His research presented direct and indirect value creating functions which suppliers are pursuing

while creating the value. Obtaining a positive cash flow by securing the needed volume to reach the break-even point represent direct functions. Those functions enable companies to gain stability and control in the fierce market. Finding new ideas and penetrating new markets are linked with indirect functions of value creation.

Lapierre (2010) recognized several drivers related to product, service and relationship while looking at value creation from the seller's perspective. Despite his research identified drivers which brings benefits such as alternative solutions to the product, improved supplier's image or strengthened customer-supplier relationship there are also sacrifices which should be taken into account. For instance, price may be the main factor to be changed in order to succeed in the final agreement with the customer. Moreover, sacrificed time, effort and energy while creating the value will not be recovered even if the agreement is not reached. Finally, there is always a risk of a potential conflict, which might jeopardize customer relationship and company's image. As it was already said, creating a customer value should be perfectly balanced so that both parties (i.e. customer and supplier) can obtain maximum satisfaction.

Finally, last perspective analyzes value creation from buyer-seller perspective. Kothandaraman and Wilson (2001) noticed that in more complex business world, buyer-seller connections moved beyond just single firms towards value-creating networks. Those networks are built between several firms by using three main blocks: core capabilities, superior customer value and relationships. Figure 6, presents the model of value-creating networks.

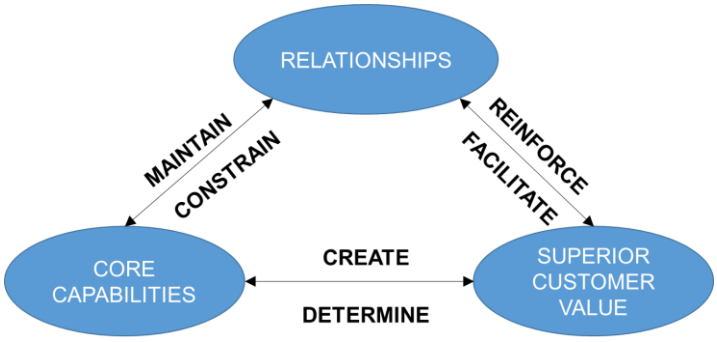

Figure 6. *A model of value-creating networks (Adapted from Kothandaraman and Wilson, 2001)*

Customer value has been studied for several years by many scholars and it could be define as an identification of main factors which persuade the customer to obtain desired product or a service in exchange for monetary value (Zeithaml 1988; Christensen 2010)**.** Nevertheless, in developing business markets where the competition is increasingly fierce, providing satisfying customer value with the purpose of making customers satisfied might not be enough to win their loyalty. Companies needs to overcome their competitors by closely working with its customers and by integrating core capabilities in order to provide superior customer value.

The ability to deliver value, which will meet the customers' requirements, will determine the value creation for the customer. The better capability of value creation, the better chance to obtain competitive advantage over the competitors, thus to reach higher satisfaction of the customer. Since relationships, core capabilities, and superior customer value are all linked together, it is important that firms combine their core capabilities to help them provide superior customer value, hence it would reinforce customer relationships (Kothandaraman and Wilson, 2001).

2.2.2. Customer Needs

Providing a customer value helps to attract the customers and that is why creating customer value is one of the most important activities for the firms. However, provided value needs to be aligned with customer needs, thus it can fulfill customer requirements and generate expected benefits for both parties. Several times it was pointed out that customer and customer value is one of the elements of the business model (Afuah and Tucci 2001; Magretta 2002; Hedman and Kalling 2003). When the main objective of the business model is to create value for stakeholders and generate profits for the company, it is easy to conclude that customer and its needs should be in the spotlight while working on a business model. Significance of collecting and understanding customer needs during development of a new product or service can be a key factor to keep company's growth (Tucker, 2001). Moreover, customers provide needed feedback which should help companies to create products and services according to its expectations.

Osterwalder et al., (2014) underlined that understanding customer needs is vital to create an outstanding value proposition. However, collecting information about customer needs is not a simple task, thus it is crucial to use different techniques to obtain customer insights. Those methods are as follow: data detective, impersonator, journalist, anthropologist, scientist and co-creator. First two techniques are the least difficult to practice. First, the data detective analyzes the customer data, which has been already collected, but also look for reports, studies and other data from the outside. Second, the impersonator tries to behave like company's customer by using company's product or services. Third, journalist talks and listens to the customer to gain the insight. Fourth, the anthropologist observes the behavior of the customer in order to assess how the customer gets the job done. Fifth, the scientist invites customer in an experiment and learn from the results. Finally, co-creator involves customer in the development of value creation to learn and create new ideas from them. All of the above mentioned techniques have strength and weakness, so it is important to use appropriate mix of them to obtain as much information as possible.

More often the customers are not aware of possessing data or information that the supplier is interested in. One way to overcome this is to place an own team member in the customer's functional area. (Anderson and Narus, 1998) By doing this, the seller is

able to obtain data that the customer believes is inexistent. However, sometimes team members are forced to look for certain information for as long as they find someone who will point out where the information is. Another possibility of collecting customer needs is to create focus groups consisting of company's representatives from different departments, which enable receiving data from different angles.

According to Ulwick (2002), most of the customers do not really know what they want. However, when they know exactly what they need, they have problems to articulate the information to the manufacturers or the suppliers. Ulwick (2002) also presented several explanation for customers' lack of knowledge about their needs. First, most of the customers have narrow point of reference in terms of their needs. Usually, they are mainly familiar with the products or the services that they are using and they might be not aware of other solutions. However, in case they are aware of other market offers then the customers compare features of the solution that is being used with the features that are offered on the market. Very often, customers emphasize need for missing features or functions that are already offered by the other manufacturers. Secondly, customers are expressing their needs and requirements in their own language and that is not always convenient for the development of a new product or a service. That is why, asking about familiar product category might help clients to articulate their needs more clearly. Lastly, customers are not capable of knowing what solutions are the best for them.

In order to address difficulties with gathering customer needs, Yang (2013) suggested six new ways of collecting customers' latent needs. Those methods are:

1. Customers as innovators
2. Customer focus
3. Customer R&D
4. Four actions framework
5. The outcome-driven method
6. The systematic CRM technologies

The first method focuses on providing certain tools to the customers so that the customer would be able to take part in the design and development of the specific aspects of the product or the service on their own. (Thomke and von Hippel, 2002) This approach differ from the traditional method where the manufacturer or the supplier are solely responsible for the design of a new product. The main advantage of using customers as innovators is that suppliers can decrease number of errors in order to successfully create new products or services. However, very often customers are unable to recognize what they need, thus they are not able to provide important input in the development processes, or the customers simply do not want to be involved in creating new solutions because it is not their business.

The second technique include customer focus journey with four stages that helps to analyze customer needs and identify important characteristics of future products. Companies concentrate on comparison of previous information received from the customers in order to develop a new product or a service more effectively. Nevertheless, it is very complicated to predict future customers' behavior with the assumptions from the previous customers' needs. (Gulati and Oldroyd, 2005)

The third practice presents using research and development (R&D) processes towards the customers. The R&D gives an opportunity to increase companies' understanding of their customers and their needs (Selden and MacMillan, 2006). The method focuses on distinguishing core customer segment and develop value proposition that could go beyond customers' expectations. This approach helps to deliver satisfying experience and establish a deep customer relationship.

The fourth method of four actions framework is based on a blue ocean strategy. Kim and Mauborgne (2005) claimed that the company should change its focus from current competition to the other alternatives such as non-customers. The approach aims to rebuild value proposition by eliminating, reducing, raising or creating attributes or values of the company offering. For instance, eliminating aspects that are taken for granted even if those aspects do not provide value or may diminish the overall value. Reducing some of the features of the product or the service that have been added in order to outperform the competitors to decrease the cost of the product. Raising the most important factors above the industry standard, to increase customer value and benefits for the company. Creating new sources of the value for the customers and new pricing structures of the business, to increase attention of current non-customers.

The fifth practice focuses on the job that needs to be done rather than on the customer itself. According to Ulwick (2002), the company that helps their clients to do their job quicker, more convenient and less expensive than before has more chances to create products or services that their customers are looking for. In order to achieve that, companies should recognize important outcomes of a given job, because customers are willing to buy the products or services that helps them to get the job done. In addition, it also beneficial for the companies to identify outcomes which are not that important so the company can focus on the more important attributes.

The final method is based on customer relationship management system that main purpose is to strengthen relationship with the customer. By using customer relationship management systems companies are able to gather trends and preferences of their customers that can be considered in the product development (Rust et al., 2010).

2.2.3. Value Proposition Design

When the customer value is known and specific needs are defined, it is essential to deliver that value to the customer in a right way. Therefore, to help clients to understand

and believe in company's offering, a value proposition needs to be designed. Sheehan and Bruni-Bossio (2015) defined a customer value proposition as a brief description of the value that is delivered through the company's offering. Barnes et al. (2009) also highlighted that the value proposition should present irresistible expression of customer's experience obtained by supplier's offering. In market management of business to business markets, value proposition is seen as a program of certain products, services or solutions that intent to improve customer's overall performance (Hutt and Speh, 2007). Definitions mentioned above already give a clear view that value proposition is not about company's activities, but about the value that is provided through the company's offering.

Osterwalder et al. (2014), stated that designing value proposition will help organization to understand the pattern of value creation, improve experience and skills of the employees and avoid wasting time and effort on ideas that will not work. Lanning and Michaels (1998), emphasized that creating a value proposition might be a key to the winning strategy, which could increase company's profits. Besides financial benefits, working on value propositions gives companies better understanding of their customers, hence it helps to assign needed resource to create new offerings. Hutt and Speh (2007) pointed out that value proposition is a necessary organizing tool, which help firm to concentrate on customer's requirements.

Anderson et al. (2006) distinguished three different types of value proposition. First, so called all benefits, when the company simply presents all benefits of the offering. The more, the better. This approach does not require a greater knowledge about the customer. Second, favourable points of difference focuses on presenting benefits which differ from next best alternative. Supplier underline why buyer should purchase company's offering instead of its competitors. Finally, the resonating focus method relies on a future long relationship with the customer. Supplier presents only few favourable benefits of the offering as well as few general benefits. However, the main difference of resonating focus is that, suppliers concentrate on further development of those few favourable points, thus it helps to provide constant greater value for the customer. (Anderson et al., 2006)

The above explanations about the different types of value proposition give an outline of the main building blocks of a successful value proposition. Anderson et al. (2006) underlined the points of parity, difference and contention as the main parts of the customer value proposition, while Barnes et al. (2009) presented several steps which all together will lead to create the value proposition. Figure 7 presents illustration of a value proposition builder.

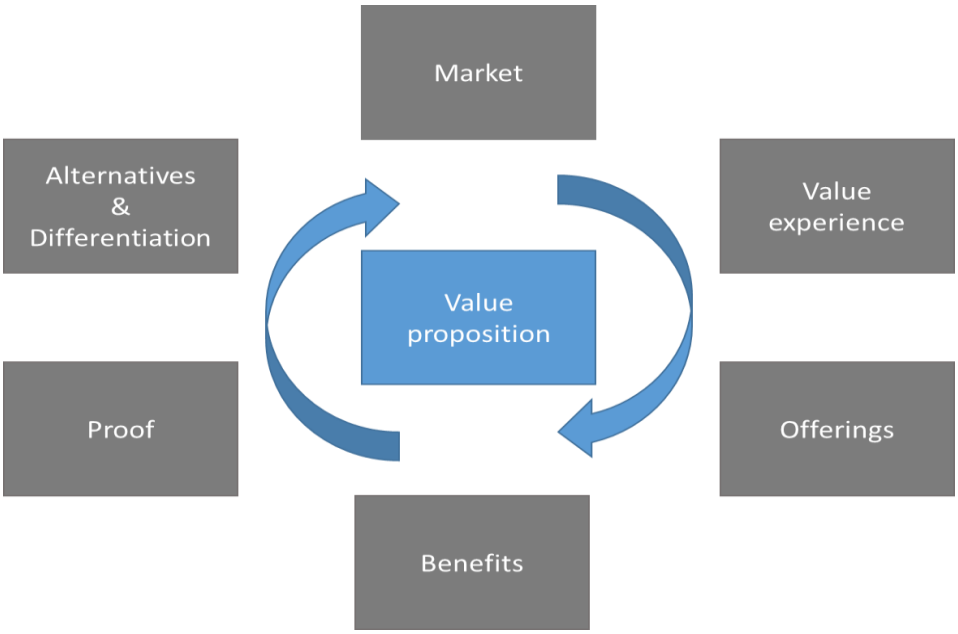

Figure 7. *Value proposition builder (Adapted from Barnes et al., 2009)*

As can be seen from the Figure 7, six different, however interrelated, steps compose value proposition. First step, analyse and recognize market segments for which company's offering will bring potential value. Identifying market segment helps to recognize customers' need and requirements. Second step, represents identification of value experience which customer is receiving from the company's current activities. Third step, defines product, service or a mix of both which will be targeted at the certain customer segment. Fourth step, assess benefits of provided offering. Fifth step, analyse possible alternatives and differentiators. Finally, the last step justifies the credibility of the offering. Barnes et al. (2009) believes that the process of designing the value proposition is the key to company's success.

Osterwalder et al. (2014) presented a slightly different approach with dividing value proposition design into two parts; customer profile and value map. Customer profile defines precise customer segment with specification of customer job whereas value map refers to value proposition design and its impact on customer job. Figure 8, shows the characteristics of VP design.

Value proposition design		
Customer profile: • Customer jobs • Pains • Gains	Value proposition	Value map: • Product and services • Pain relievers • Gain creators

Figure 8. *Value proposition design (Adapted from Osterwalder et al., 2014)*

The goal of customer profile is to identify what causes the problems in the customer's job and prevents to reach the desired goals. Therefore, first subcategory of customer jobs describes with what kind of tasks customer is dealing with in the daily routine.

Then, pains define the problems that bothers customers and prevents from gains which are the expected outcomes and benefits of the customer's job. On the other side of the value proposition is a value map which describes how company's specific product and services will mitigate customer's pains to provide expected gains.

3. KEY CONCEPTS IN CASE STUDY

3.1. Case Company

Case Company is based in Finland and it is specializing in turn-key deliveries of production plans and solid fuel handling systems for power plants and cement kilns. Company provides technology to handle a wide variety of biomass fuels such as fuel woodchips, energy willow, pellets, bark, peat and etc.

Case Company is a supplier of solutions for:

- external fuel handling
    - fuel receiving
    - screening and crushing stations,
    - automatic storage systems
    - conveying to boiler or cement kilns
- internal fuel handling
    - dosing silos
    - boiler dosing and feeding systems
- ash handling
    - bottom ash reclaiming and cooling
    - fly ash storage and preparation

In addition, Case Company is present in the Waste-to-Energy sector with its Solid Recovery Fuel production plant that refine the waste and turn it into to the high quality SRF product. Solutions delivered by Case Company provide best available technology, industrial heavy duty design and compact layout. Moreover, Case Company SRF production plant offers highest production capacity, high availability and low production costs. Case Company solution can handle several different type of waste such as municipal, industrial or commercial waste but also scrap tires, textiles and big bags, plastic films and waste paper.

Case company also provides after-sales support and spare-parts service, to guarantee customers continues operations and maximum satisfaction with provided solutions. Customer support of Case Company offers maintenance support, testing and inspection, service contracts and equipment sale of crushers, shredders, separators, screw or chain reclaimers and several different types of conveyors. Case company is present around the world with its three additional offices located in China, Sweden and Poland that are

helping to reach the customers and provide turnkey solutions in waste refining, bioenergy and recycling technologies.

3.2. Solid Waste Management

Solid waste management can be described as the discipline which involves the entire process of generation, storage, collection, transportation, processing and disposal of solid waste in the best possible standard of public health, economy, engineering and other environmental consideration. The solid waste management covers all factors such as administrative, financial, legal, planning, and engineering which are involved in solutions to all problems concerning solid waste. Typically solid waste management distinguish different type of waste based on the source of the waste. (Tchobanoglous et al., 1993) Table 5, shows source of solid waste and types within that community.

Table 3. *Types of waste (Adapted from Tchobanoglous et al., 1993)*

Source	**Facilities, activities or location where waste are generated**	**Types of solid waste**
Residential	Single-multifamily apartments, households	Food wastes, paper, cardboard, plastics, textiles, wood, glass, cans, aluminum, other metals, special waste including bulky waste, electronics, white goods, household hazardous waste
Commercial	Shops, markets, restaurants, hotels, office buildings, service stations	Paper, plastics, cardboard, wood, food waste, glass, metals, hazardous waste
Institutional	Hospitals, schools, public service, prisons	Card board, plastic, paper, wood, glass, food waste, metals, hazardous waste
Construction and demolition	Construction sites, road renovation sites	Steel, wood, concrete, dirt
Municipal services (excluding treatment facilities)	Street cleaning, parks cleanings, landscaping	Special waste, street, sweepings, landscaping, general waste from parks
Treatment plant sites; municipal incinerators	Water, wastewater, industrial processes	Treatment plant waste, residual sludge
Industrial	Construction, light and heavy manufacturing , refineries, chemical and power plants	Industrial process waste, scrap material, demolition and construction waste, special waste, hazardous waste
Agricultural	Field crops, vineyards, dairies, feedlots, farms	Spoiled food wastes, rubbish, agricultural wastes, hazardous waste

As it can be seen from the table, several same types of solid waste can come from the different source and vice versa. It is important to remember that definition of particular solid waste may vary from each other and presented types of waste with it source of origin intend to give the general overview on different type of waste and are not meant to provide detailed description. All of the waste generated in a community apart from industrial processes or agricultural solid waste are normally so called municipal solid waste (MSW) (Tchobanoglous et al., 1993).

Special type of waste such as bulky waste, white goods and hazardous waste are also included in municipal solid waste. Bulky waste are large, irregular, usually worn-out or broken items such as furniture, lamps, bookcases, shelves that do not fit into the regular waste collection bin. Bulky waste may originate from different sources like households, commercial or industrial. Due to it large dimensions bulky waste are very often collected separately for instance few times per week or within certain days during the week or they are directly brought to the proper site for disposal. Bulky waste in some countries may also contain building and demolition waste from households. (Tchobanoglous et al., 1993; Christensen, 2011)

White goods, as well as bulky waste are generated from various sources such as households, commercial and industrial. Typically, white goods include big, broken or worn-out none longer wanted items like refrigerators, stoves dishwashers or dryers. Very often those kinds of waste are called waste electrical and electronic equipment (WEEE) due to its parts which generate, transfer and measure the current. (Tchobanoglous et al., 1993; Christensen, 2011)

Hazardous waste, as the name indicates itself, are dangerous waste that more harmful for the environment and to the people who are handling them, thus handling hazardous waste required more technical and strict control. Hazardousness of the waste is measured to certain standards like explosive, oxidizing, highly flammable, irritant, harmful or toxic. (Directive 2008/98/EC)

According to Directive 2008/98/EC, the main priority of the waste management is to prevent production of any waste which means to take any actions that decrease the amount of generated waste, minimize its impact on the environment and reduce content of harmful substances in materials and products. However, when the waste has been already produced the directive specify four techniques of dealing with the waste. The main objectives of the framework is to set basic concepts related to the waste management as well as to set priorities in the waste management. Figure 10, illustrates the waste framework directive.

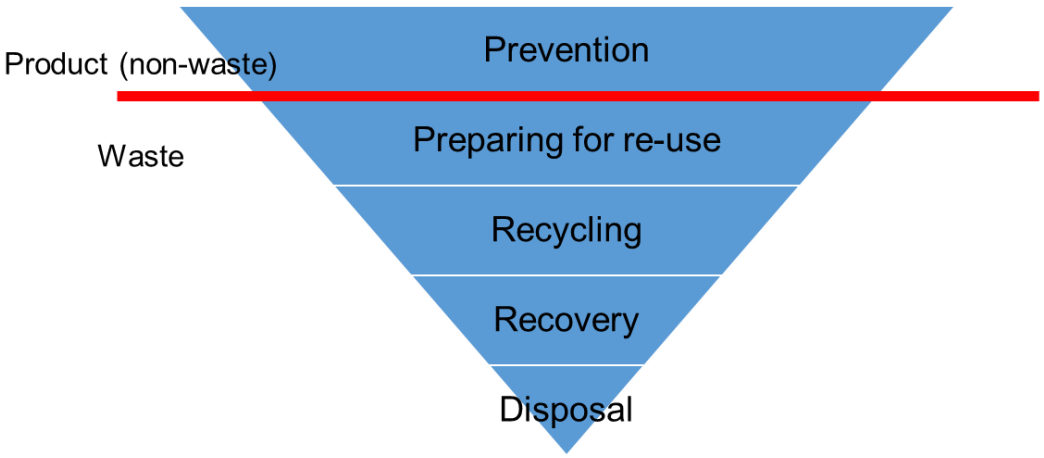

Figure 9. *Waste framework directive (Adapted from Directive 2008/98/EC)*

First, preparing for re-use concentrates on taking all possible measures such as cleaning, checking or repairing in order to re-use the product. Second, recycling focuses on operations which will reprocess waste materials to materials or products that can be used for the genuine or different purpose. Third, recovery which consists of operations intended to serve beneficial purpose by substituting other materials which would be used to perform a certain function, or preparing waste to perform that function in plants or in the economy. Finally, disposal which is any action which is not define as recovery even though it has consequence in recovering substances or energy.

There are several methods used for the processing and the recovery of individual waste fractions from the municipal solid waste like paper, plastics glass or metals. Source separation is a very popular and efficient way of improving recovery of certain fractions. It involves segregation of selected fractions at the source of generation and then disposing them into special containers that are located in large residential areas. Usually, source separated are recyclable particles such as glass, paper, plastics, however separated can be other waste like aluminium, waste food or yard waste. Source segregation highly contributes in increasing effectiveness and quality of recycling. (Tchobanoglous et al., 1993)

Although particles recovered from the source separation can be used in recycling processes, it is also possible to use them for production of solid recovery fuel (SRF) that is needed as a fuel for certain plants. However, in order to prepare the SRF fuel, several processes of mechanical treatment needs to be performed.

First, involves size reduction with the use of the hammermills or the crusher which decrease the volume of the particles. Second, size separation where the materials are separated with the use of different type of screens such as drum or disc screen. Third, density separation in which by air classifier light fractions are separated from the heavy fractions. Fourth, electric and magnetic field separation that helps isolate ferrous from

nonferrous materials. Finally, densification which include increasing the density of material by baling them into round bales or square bales. (Tchobanoglous et al., 1993)

All of the necessary equipment that helps to reduce size of the large objects, separate combustion and non-combustion fractions, separate ferrous and non-ferrous metals and transfers those fractions through each stage to its final destination, is part of the material handling. Material handling can consist of single equipment working independently, however typically it create system consisting of several equipments working together. Table 6, shows specific equipment of material and handling and its purpose.

Table 4. *Material handling for certain processes*

Material handling	**Process**
Hammermills, crusher	Reducing size
Disk or drum screen	Size separation
Air classifier	Density separation
Belt magnet, eddy current separator	Electric and magnetic field separation
Baling	Densification
Belt, chain or screw conveyors	Transporting

Mechanical treatment of waste, which consists of equipment and processes mentioned in table above, is not the only possible solution to handle municipal solid waste. Solid waste management distinguish also biological treatment and thermal treatment. The biological treatment based on composting and aerobic digestion. Composting is the transformation of solid organic matter in aerobic environment and solid state. The result of that aerobic degradation is a compost which can be used as a fertilizer for plant growth. Aerobic digestion is set of different processes such as hydrolysis, fermentation, acetogenesis and methanogensis that results in biogas and effluent. (Christensen, 2011)

Thermal treatment focuses on utilization of waste by incinerating them in appropriate plants with certain technologies. Following chapter will discussed thermal treatment in more depth.

When all possible measures of preventing, recycling or recovering of waste are taken and there are still some residues of municipal solid waste that needs to be handled, landfills are the places where those waste can be stored. In past years waste has been deposited into uncontrolled landfills or waste dump, primarily into the ground or oceans, without any regulations or consequences to this actions. However, nowadays with global awareness of what kind of threat to environment it is and increasing number of national regulations such as European Directive 1999/31/EC on the landfill of waste, helped to reduce the amount of uncontrolled landfills. Today, landfills still exists however there is a strict control of what kind of waste are being landfill and how they are disposed. (O'Leary and Tchobanoglous, 2002)

3.3. Waste-to-Energy Technology

Utilization of waste through thermal processes has been performed for more than a century and with the help of emerging technologies, the incineration processes became more efficient and environmental friendly (Christensen, 2011). According to van Schalkwyk (2013), general term incineration has a negative connotation in the public because of the poor operations and management of the old incineration plants as well as a bad impact on the environment. However, due to developing technologies, which can meet waste management and environmental requirements, term incineration is used less and term Waste-to-Energy is being used instead.

The Waste-to-Energy technologies provide several benefits to the waste management. Firstly, incineration of the waste enables a great reduction of volume and weight of the waste, particularly bulky waste with high combustible content. The decrease of the size can reach up to 90% of the volume and 75% of the weight of the material. Reduction of the volume helps to decline the amount of the waste that otherwise would be disposed into the landfills. Secondly, utilization of hazardous and toxic waste, thus preventing from spreading of harmful substances to the environment. Thirdly, avoiding of generating landfill gases by destroying organic components of biodegradable waste. Finally, recovering energy from the waste therefore reducing usage of fossil fuel for energy production. (Brunner, 2002)

Despite the fact that Waste-to-Energy is clearly beneficial for waste management and that it has an important role in waste management hierarchy, there is a general concern over the consequences of incineration to the environmental and public health, especially in areas located next to the plants (Cheremisinoff, 2003). In order to address those issues, European Union set a Directive 2000/76/EC on incinerating waste that aims to avoid or to limit as much as possible negative impact of certain pollution by emissions into air, ground, surface and groundwater causing hazard to human health and the environment from the incineration of waste. (Directive 2000/76/EC)

The most conventional Waste-to-Energy technology is a direct combustion that can use different types of incinerators such as grate incinerator, fluidized bed and rotary kiln. There are several other technologies like gasification, pyrolysis and plasma however the main differences between those technologies is that, the latter technologies are used to certain type of waste streams whereas direct combustion can be applied to highly heterogeneous material like municipal solid waste. Moreover, Waste-to-Energy with direct combustion focuses on heat generation while pyrolysis and gasification are mainly used in order to recovery certain chemical value from waste. (Bosmans et al., 2013) In addition, direct combustion with grate incinerator is the most popular technique of Waste-to-Energy and that is why this thesis will concentrate on that technology.

There are three types of direct combustion in Waste-to-Energy; grate incinerator, fluidized bed and rotary kiln. Table 7 presents main characteristics of each type.

Table 5. *Characteristics of main Waste-to-Energy incinerator types (Adapted from BREF, 2006)*

	Grate incinerator	**Fluidized bed**	**Rotary kiln**
Input	Municipal solid waste, with possibility of commercial and industrial non-hazardous waste	Solid recovery fuel (SRF), sewage sludge	Hazardous and clinical waste
Process description	Grates moves the waste over several zones in combustion chamber; process temp. 850-1100°C	In vertical cylinder sand bed on a supporting gird plate is fluidized with air onto which waste are fed; process temp. 850-950 °C, bed temp. 650°C or higher	Waste are transferred by gravity into rotating kiln in form of cylindrical vessel located on the rollers; process temp. 850-1300°C
Comments	Most widely used	3 possible types of bed: bubbling, usually used for sludge or chemicals; circulating, commonly used for dry sewage sludge; rotating, sludge and pre-treated waste	Enable to incinerate solid, liquid, gaseous waste and sludge; added post-combustion chamber to handle toxic waste

One of the main difference between grate incinerator, fludized bed and rotarty kiln is in the waste which could be fed into those incinerators. Higher process temperature of rotaty kiln gives an opportunity to utilze all toxic and hazardous waste which are more harmful for the people and the environemnt. Grate incinerator and fludized bed can be both fed with municiapal solid waste, however fluidized bed icinerator reuquries pretreament of the incoming waste. Usually this process can be perforemed either on the site of Waste-to-Energy plant or at the special plants prepared for the production of that fuel called solid recovery fuel production plant. The process include shredding of MSW to reduce the size of the material, screening to separte non-comubstile material and removing ferrous materials with magnetic separtor. In addition, air classifier can be used in order to separte light and heavy fraction. (Chandler et al., 1997)

The grate incinerator does not require so thorough prepartion of the waste and that is one of the main reasons why this technology is widely used in the world. Due to the ability of burning all kinds of waste, grate incinerator are also called mass incinirators. Typical content of incoming municipal solid waste to the Waste-to-Energy plant with mass incinerator is presented in the Table 8.

Table 6. *Typical composition and characteristics of MSW (Adapted from Tchobanoglous et al., 1993)*

Particle	Average [%]	Moisture [%]	Calorific value [MJ/kg]
Food waste	20-65	50-80	3,5-7
Paper	8-30	4-10	12,2-18,5
Cardboard	2-6	4-10	16,4
Plastics	2-10	1-4	27,9-37,2
Textile	1-4	6-15	15,1-18,6
Rubber	1-4	1-4	20,9-27,9
Leather	1-4	8-12	15,1-18,6
Wood	1-10	15-40	14,4-17,4
Glass	1-10	1-4	0
Aluminium	1-5	2-4	0
Tin cans	1-5	2-4	0
Other metals	1-5	2-6	0

As it can be seen from the table above, composition of the MSW is a mixture of combustible and non-combustible materials. Althuogh the characteristics of the MSW may differ from each other, the avarage energy content is about 10 megajoules per kilogram (MJ/kg). Grate incineration plant by processing about 45 tons of MSW is able to produce 1 megawatt (MW) of electrcity of power for 24 hours. (Cheremisinoff, 2003) Diagram with numbered operations at the Waste-to-Energy is illustarted at the Figure 11.

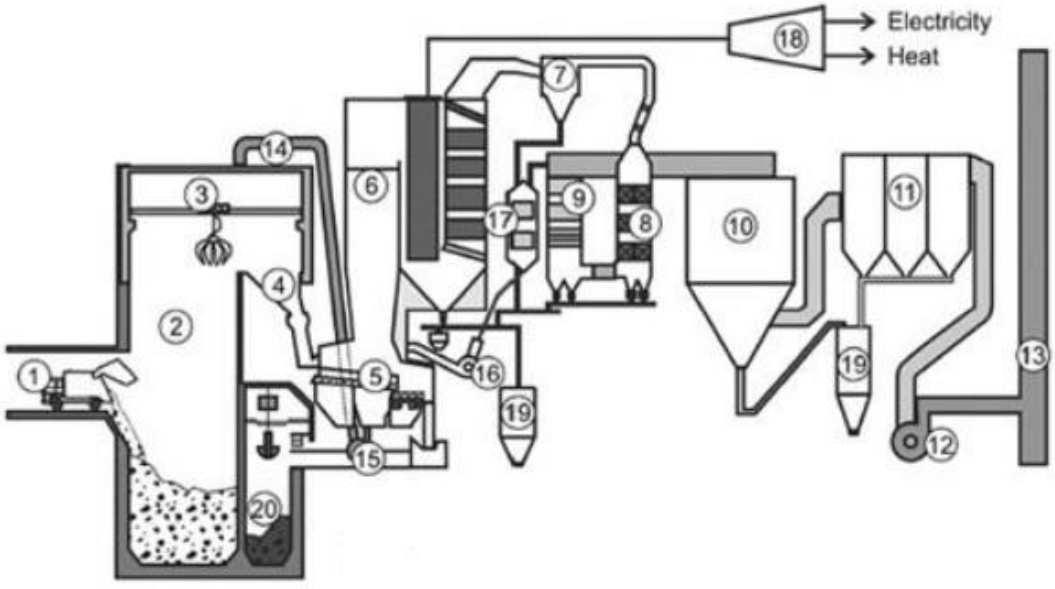

Figure 10. *Typical Waste-to-Energy plant wirh grate incinerator (Adapted from Christensen, 2011)*

The process begins with the garbage truck bringing the municipal solid waste to the tipping hall (1) of the plant. Usually, the MSW are already separated at the source.

Then, the truck dumps the waste into the bunker (2). To prevent odors escaping from the bunker into the environment, the under pressure is kept in the waste bunker. Overhead crane (3) mixes the waste to evenly distribute the waste in the bunker and also to homogenize the material. In some of the plants, the crane might be also used to remove oversized materials and transfer them to a crusher which could be located next to the hopper (4), however not all of the plants are equipped with such a machine. Then, the crane feeds the waste into the hopper (4) from which by hydraulic ram the waste are fed on to the grate (5). There are several types of grate such as reciprocating, travelling or rolling grate. Most of the WtE plants are using reciprocating grate which consists of several sections that slides back and forth when the adjacent section remain fixed (Chandler et al., 1997). While the waste are moving furhter down the grate, the icineration process with stages of drying, pyrolysis, gasificaiotn and oxidation begins. To keep the steady combustion, air is introudced in several places (14), (15), (16). Successful combustion of waste material depends on time, temperature and the degree of turbulance. Municipal waste shoulde residence in the furnace for two seconds in averagve temperature of 850°C and good turbulance in combustion zone to aovid shor circuiting in the furnace. Non-combusted material and bottom ash are discharged at the end of the grate to the quench tank to cool down and then, there are transferred to the bottom ash bunker for the futher treatment including recovering metals and final disposal to the landfill. (Tchobanoglous et al., 1993; Cheremisinoff, 2003; Bosmans et al., 2013)

During the incineration, flue gases (CO2, H2O, O2, N2) containing fuel energy as heat are generated. The walls of the combustion chamber (6) are aligned with boiler tubes in which circulating water absorbs the heat generated by the flue gases and produce the steam. That steam might be used directly for the heating or it may goes through the turbine (18) to produce the electrcity. However, every combustion forms dust and gasoues air pollutants in emissions which required proper cleaning. In order to keep below strict requirements requested in certain standards, Waste-to-Energy plants are equipped with modern flue gass cleaning systems including electrostatics preipitator (7), $DeNO_x$ catalyst (8), economiser (9), spray dryer (10), fabric filter (11) and residue silo (19). When cooled flue gases goes through the cleaning system, all of the clean gases are blown out (12) through the smokestack (13). (Tchobanoglous et al., 1993; Cheremisinoff, 2003; Bosmans et al., 2013)

3.4. Circular Economy Approach

Nowadays, there is a constant demand for the new products. However, needed resources to produce those products are increasingly disappearing. In addition, very often processes of obtaining scarce resources are not only insufficient in terms of performance but also cause a great damage to the environment. One of the reasons for such situation is that global economies developed pattern of “take-make-consume and dispose” with

the assumption of continues availability of needed resources. (European Commission, 2014)

Figure 12 presents a linear model where resources are converted into the products and after its consumption, they are disposed.

Figure 11. *Linear model*

When the product is consumed, the linear model model does not recognize value in hidden materials of the products and that is why the product is being disposed. This approach leads to loss of valuable materials and increase waste generation.

European Union has address the problem under resource efficient agenda in Europe 2020 strategy. According to European Commission (2014), in order to use the resources in more efficeint way and reduce waste production, Europe should move towards circular economy (CE). The basic concept of circular economy is prestend in the Figure 13.

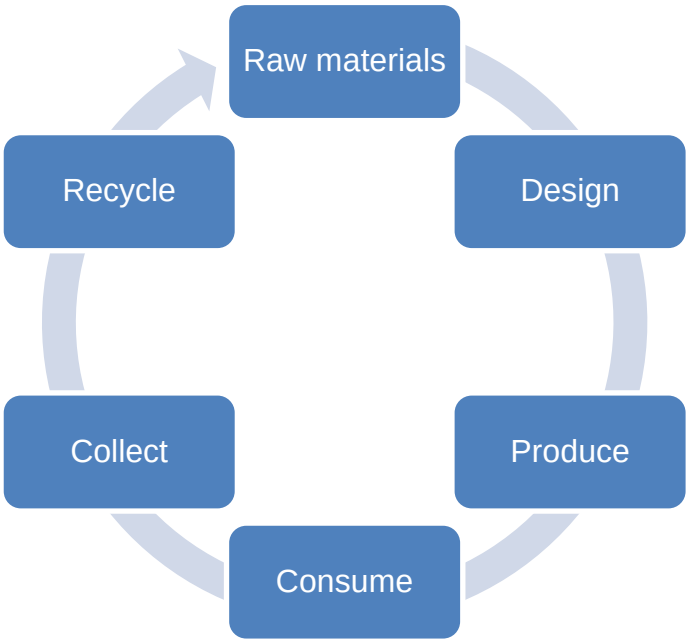

Figure 12. *Circular economy (Adapted from European Commission, 2014)*

The goal of circular economy is to maintain the value added in the products for as long as possible, so the waste generation could be minimize. This approach, gives a possibility to preserve the valuable resources in the economy and even if the product reaches its end of the life-cycle, maintained resources could be used again to create further value. In order to achieve that process, circular economy should focuses on

several aspects. First, designing products in a way that not only its life-cycle will be extended but also manufacturing them will require less raw materials, especially difficult to recycle. Moreover, designing products with the ability to be repaired, upgraded or recycled. Second, encouraging consumers to separate and decrease the waste generation and also incentivise separation and collection systems that reduce the costs of recycling. Third, support industrial groups that exchange by-products in order to prevent them from becoming waste. Finally, emphasize and encourage consumers to rent or lease instead of buying the product. (European Commission, 2014)

European Union proposal underline that turning waste into a resource is a key to a circular economy, therefore it sets high objectives such as recycling and preparing for re-use 70% of MSW and 80% of packaging waste until 2030, ban on landfilling recyclable waste by 2025 and limiting incineration to non-recyclables. (European Commission, 2014)

European Commission is going to present even more ambitious strategy for circular economy in late 2015. (European Commission, 2015)

4. RESEARCH METHOD AND MATERIAL

4.1. Research Methodology and Schedule

Writing an academic paper requires appropriate research strategy and data collection. According to Saunders et al. (2009), there are seven research strategies such as survey, experiment, case study, action research, ethnography and archival research. It is important to understand the differences between each strategy, so that the chosen strategy will give an opportunity to answer the research questions and meet the objective of the paper. Every research strategy requires suitable research method in order to gather needed information. Gummesson (1993) identified five different methods of data collection; existing material, qualitative interviews, questionnaire surveys, observation and action science.

Existing material can be described as a material that has been created for other purpose such as books, research reports, articles, archival records, mass media reports, notes letters, computer database and brochures. Since existing material was not created for this particular research, thus it might consist of inaccurate and obsolete information. (Gummesson, 1993). This type of data gathering helps to provide general understanding, however it does not present the whole truth in each situation.

Questionnaire surveys are formalized and standardized list of relevant questions, which are presented to a specific group. The main benefit of surveys is that they enable to collect lots of information from large amount of population, in very practical and inexpensive way (Saunders et al., 2009). However, if the survey is prepared poorly it may confuse the target group and lead to false answers (Gummesson, 1993).

Qualitative interviews consist of open and non-direct questions, which helps to create guided conversation with the respondent. In addition, they also give freedom to the interviewer who can react and adapt to the answers. During the discussion, interviewer can insert follow-up questions or ask for clarification (McGivern, 2009). It is appropriate method to gather more information in not so discussed topic and that is why it is one of the most used method in business and management research (Saunders et al., 2009).

Observation focuses on observing processes and taken actions by the people. It is time consuming method, but on the other hand it helps to see and analyse certain action in real time. The last method is action science allowing researcher to be fully involved in the study, actively participating and influencing the process of study. (Gummesson, 1993)

This thesis was prepared as a case study with a multi method approach with emphasis on a qualitative interviews. That methodology helped to collect and analyse several opinions from different sources such as plant operators, investors and project managers, in order to create personal opinion and reach the final objective. Table 3, shows different methods of data gathering used in the thesis.

Table 7. *Different methods of qualitative data gathering*

	Research Questions		
	Customer needs	**Business benefits**	**Respond to value creation**
Qualitative interview	X	X	
Plant visit and interview	X	X	
Company/investor visits	X	X	
Workshop	X	X	X

Qualitative interviews via phone or while visiting the plant or a company have been used to gather information about customer needs for non-hazardous solid waste material handling and its potential business benefits for the operators.

All research strategy was based on a schedule, which was set at the very beginning of the thesis work. Figure 9 presents the timeline of the research.

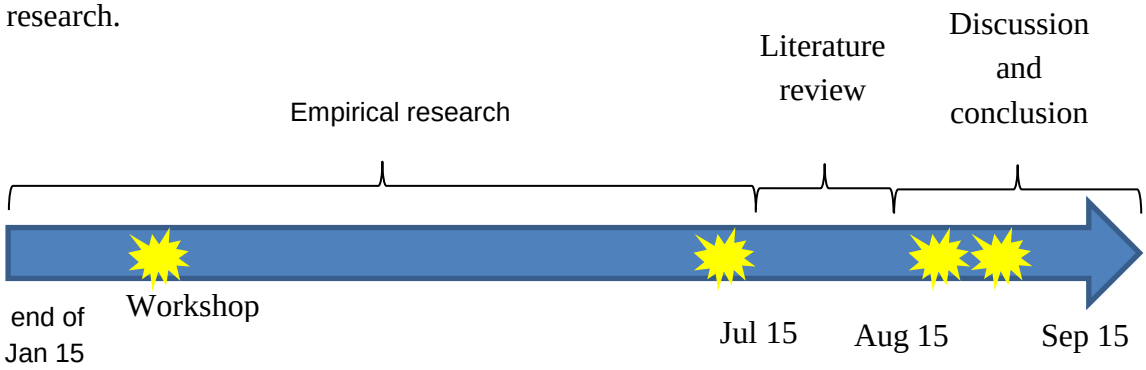

Figure 13. *Timeline of the research*

The research started at the end of January of 2015 and it was completed at the end of September. Due to concern of not gathering enough empirical data on time, empirical research has started immediately in February, after few weeks of initial research about business models and customer value concepts. Empirical research lasted until the end of June where first preliminary results have been presented and several workshops have been held. Then, during July thorough literature review have been prepared. During August and September few more workshops have been held as well as final conclusion has been prepared.

4.2. Empirical Data Collection

As it was mentioned before, empirical data was gathered primarily through the qualitative interviews. Before conducting interviews, there was a need to prepare an interview framework (Appendix 1). The goal of the interviews was to identify customer needs for non-hazardous solid waste material handling and potential business benefits of the material handling for mass incineration operators. Prepared interview framework was sent to the respondents after initial agreement for the interview.

At the same time of preparing the interview framework, search for the potential customers has begun. The research has been divided into 3 geographical markets: Finnish, Polish and the rest of Europe. First, Finnish market. Since the Case Company is located in Finland it was understandable to use knowledge and personal contacts of Case Company employees' to arrange interviews and visits at the plant site. However, there was not enough Waste-to-Energy plants to collect required data, thus the research moved on to another location. Second, Polish market was chosen due to author's nationality (Polish) which was additional advantaged that helped to organize and conduct the interviews. In addition, during the research in Polish market there was only one operating Waste-to-Energy plant but six plants were under construction. This situation gave an opportunity to interview investors and future operators of the plants in order to analyze their perspective on material handling. Finally, the last stage of the research concentrated on the rest of the European Waste-to-Energy plants which were willing to participate in the case study.

Although there is a high number of Waste-to-Energy plants in the other parts of the world, research has been narrowed so that it would be easier for the researcher to look for the plants and conduct the interviews. Table 4 presents empirical data collection.

Table 8. *Collection of empirical data*

	Finland	**Poland**	**Rest of Europe**
Interviews with Waste-to-Energy plant	2+1*	1+5*	12
Interviews with waste management company	1		
Other	1		3
Total	26		

*Waste-to-Energy under construction

As it can be seen in table 4, interviews with Waste-to-Energy plants were the main source of data collection. Interviews in Poland were mainly with plants that were still under construction. In order to understand different points of view on material handling, it was suggested to interview waste management company to see its connection with Waste-to-Energy plants. In addition, also other companies have been interviewed such as engineering, procurement and construction (EPC) contractors providing solutions and

turnkey plants for Waste-to-Energy plants as well as one of the biggest Swedish technical consulting company ÅF with its branch in Helsinki.

Each interview was schedule for around 1 hour and followed the interview framework presented in Appendix 1. The interviews were mainly conducted with production or maintenance managers. The interview started with basic questions about background and responsibilities of the interviewees. After the introduction, more specific topics were discussed such as reasons for the Waste-to-Energy plant, impact of the waste stream on several factors, incoming waste, possible effects of the Circular Economy and the future of Waste-to-Energy plants. Usually, during the discussion about the influence of waste stream on the plant, topic about material handling appeared. Further discussion helped to identified customer needs for material handling and also potential benefits of material handling equipment for Waste-to-Energy operators. At the end of the discussion, respondents were asked for the feedback about the interview structure. Collected information as well as advices from the Case Company and University supervisor contributed in developing the structure.

Interviews with Finnish and other European plants and companies were conducted in English whereas native language was used during the discussions with Polish Waste-to-Energy plants. The average time of conversation was forty-five minutes (45 min), with the longest discussion lasted for ninety minutes (90 min) and the shortest twenty minutes (20 min). Due to confidentiality names of the respondents are not revealed.

4.3. Data Analysis

The empirical data has been analyzed in several steps. Each discussion was recorded and notes were taken. The content of the recordings and notes were analysed in order to look for similarities and patterns of relevant themes. Self-memos were written in Microsoft Word documents. After several interviews, results were presented and discussed with the Case Company on internal meetings. During those meetings, notes of suggestions and opinions were taken and been used to proceed with the research.

Recordings and notes from the discussion with managers of Waste-to-Energy plants were analyzed in terms if any material handling equipment has been used at the plant. In case material handling has been used, then data was studied in regards of what kind of equipment and how it has been used at the plant. The answers were compared with previous interviews to look for resemblances.

Provided customer needs by managers of Waste-to-Energy plant were used to created potential business models that could respond to their needs for material handling equipment.

5. RESULTS

5.1. Customers' Perspective on Material Handling

Finnish Waste-to-Energy market

First, Finnish market was the starting point of data gathering, since it was possible to use Case Company's direct contacts and it was easier to arrange face-to-face interviews. Only three Waste-to-Energy plants were willing to discuss the matter of material handling. Two of those discussions were with production managers of currently operating plants, whereas the other one was conducted with a managing director of a waste management company that invested in the incineration plant.

During the interviews with Waste-to-Energy plants, production managers very seldom mention anything about material handling or needs for material handling. Both of them were emphasising that material handling is not playing an important role in Waste-to-Energy processes. When managers were asked if the plant has any equipment for material handling, only one of the mangers explained that the facility is equipped with a crushing device. During the discussion with the production manager of that facility, it came out that facility needed to be equipped with a device which can reduce the volume of the bulky waste, thus the plant invested in the equipment. This crushing machine is located in the bunker and is only used to reduce the volume of bulky waste in order to be able to fit it into the hopper and maintain a continuous feeding process. The production manager highlight that the capacity of the machine is very small and even the plant is receiving the bulky waste, the machine is not used to process them all. That is why, there is no data of actually usage of the equipment. Manager was not able to tell how many tons are being processed or how many hours the device is running. It was assumed that the equipment is used only once or few times per week, for a short period of time. Manager explained that the main objects which are being crushed are: furniture or a very long objects. According to the manager, the rest of big items can be crushed by picking them up with a crane and mixing them in the bunker. Production manager concluded that the plant could run without the crushing equipment.

In case of the plant with no material handling at all, the employee explained that the Waste-to-Energy has been designed in a way that there is no need for pre-treatment of the waste. When asked how the facility deals with the bulky waste, he explained that requirements in the contracts for receiving waste as well as strict quality system helps to minimize the receiving amount of big items. However, he also explained that in case over dimensional object will be placed in the bunker, it will be picked up and deliver

back to the supplier. The production manager summarized that the plant does not need any material handling equipment, because all needed pre-treatment is or should be done by the supplier of the waste.

Both of the production managers were asked about the future and possible change in their business and needs for material handling which might be triggered by circular economy. One of the managers expressed his opinion, that implications of the circular economy will not make any difference in Waste-to-Energy operations but it will affect suppliers who are collecting, sorting and recycling the municipal solid waste. He continued that incineration plants are solely concentrating on receiving right amount of waste, burning it and producing energy, thus he believed that it will not generate any need for material handling at the plant. Different opinion was provided by the other production manager who was more willing to speculate about circular economy. In his opinion, possible change of regulation might make Waste-to-Energy plants to invest in material handling in order to recover valuable fractions or to be able to use different fuel than municipal solid waste. Therefore, there might be a need for a plant or line, equipped with material handling equipment such as crusher, belt magnet and screen in order to sort and pick up valuable items and return them into circular economy.

Besides two interviews with production managers of Waste-to-Energy plants, interview with managing director of waste management company that invested in incineration plant was conducted. Findings are similar to the previous interviews. Although, plant is not running yet, it was already mention that there will not be any material handling installed in the Waste-to-Energy plant. However, managing director explained that the company has already solid recovery fuel production plant, located near to the future incineration plant. That plant could be used to deal with bulky waste, which might cause problems in Waste-to-Energy processes. Managing director was also asked about the future and circular economy. He understood implications of circular economy, and mentioned that the company would be willing to invest in extra material handling in order to process municipal solid waste to recover valuable fractions, however only if there would be certain demand for those material. Managing director mentioned that investment in pre-treatment of municipal solid waste is very expensive, thus it would be only consider if the demand would be high enough.

Even though that the main target of the research were Waste-to-Energy plants in order to gather extra information and different points of view, interview with another waste management company as well as with consulting firm have been conducted. In first discussion, employee of waste management company expressed that there is a reluctance towards material handling for municipal solid waste in Waste-to-Energy operators because there is not enough value in those waste. He agreed with the statements of production managers of the incineration plant, that those plants are solely designed to burn waste as they come and produce energy. Therefore, there is no need

for any pre-treatment equipment, with the exception of device to reduce the oversized particles.

Interview with consulting firm gave similar results. It was also repeated that usually incineration plants do not need any material handling because either it is not necessary or the waste are already pre-treated by the supplier, for instance by crushing the bulky waste. Consultants were underlining importance of understanding what kind of waste Waste-to-Energy is receiving and from whom. In case supplier of the waste is not equipped with the device that reduce the volume the bulky waste, there might be a need for the investment in such equipment. In addition, it was mentioned that nowadays Waste-to-Energy plants want to accept all kind of waste, thus there could be potential need for equipment to crush and separate the waste, but only if the cost of the investment could be justified.

Unfortunately the first part of data gathering did not show high demand for solid waste material handling in Waste-to-Energy plants. Nevertheless, the results from the interviews show that crushing equipment for reducing the volume of the waste might be needed in the process. In order to improve data gathering, interview framework was modified. Table 9, shows the main results of interviewing current and future Waste-to-Energy operators at the Finnish market.

Table 9. *Summary of interviews in Finnish Waste-to-Energy market.*

	Customer need	**Results**
Operating WtE 1	No need for material handling at all	No material handling at all
Operating WtE 2	Need for reducing volume of bulky waste	Stationary crushing machine located in the bunker
Under construction WtE 3	Possible need for decreasing the volume of bulky waste	Crushing machine included in already existing solid recovery fuel production plant

Polish Waste-to-Energy market

Second part of data collection focused on the Polish market. The main reasons in the studying that market were that during the research there was one operating Waste-to-Energy plant and six plants under construction. Production manager of operating plant and five investors in the Waste-to-Energy plant agreed for the discussion.

Interview with production manager of operating Waste-to-Energy plant gave an insight of a change in customer needs for material handling. Employee said, that at the very beginning of plant operations, there was a need for reducing volume of big particles in

incoming waste. To solve that problem, plant invested in hammer mill which was crushing incoming waste and then transferring it into the bunker. However, after some time problems with hammer mill started to occur. The main problem was that some kind of waste was clogging the hammer mill, thus it was needed to stop the operation, remove the material and start the operation again. Waste-to-Energy plant had to eliminate particles which were causing the clogging, for instance waste electrical and electronic equipment (WEEE), rolls of material like carpets or metal rods and cables. The company came with simple solution in form of a sorting line located before the hammer mill. Along this line there were workers who were picking up certain types of waste that could cause problems in the crushing process. Although, the solution also enabled possibility to recover valuable metals from the scrap, there were no companies willing to collect that dirty material. Production manager underlined, that this process was very expensive and time consuming, thus when the Waste-to-Energy plant was taken over by a waste management company, all of those operations; sorting line and using hammer mill has been stopped. Due to legislation changes of pre-sorting and waste collection, waste management company was able to keep delivering of household waste in relatively small pieces, thus there was no more need to crush the waste. Production manager concluded that the plant is operating very well and nowadays there is no need for material handling. However, the manager highlighted that the need for material handling in Waste-to-Energy plant could depend on the ownership of the plant. If the plant is owned by the waste management company which is delivering municipal solid waste to the plant, then the company will monitor the content of the waste in order to prevent any problems in the process. However, if the incinerating plant is not owned by the waste management company, then to minimize obstacles it is really important to have very specific requirements regarding the content of the waste which are delivered to the plant.

The rest of five interviews gave an overview on material handling from the perspective of investors and future operators of Waste-to-Energy plant. Only one out of five interviews with the investors in incineration plant showed that there is no need for material handling. In that case, future operator was explaining lack of need for the equipment because all the necessary pre-treatment such as reducing the volume of bulky waste, will be performed by the waste management company which will be responsible for delivering waste to the plant.

The rest of the future operators of Waste-to-Energy plants, explained that they want to be prepared for any content in municipal solid waste, for instance bulky waste, thus the plants are equipped with the crushing machines. Four out of five incineration plants are owned by the waste management companies that collect and deliver municipal solid waste to the plant by themselves. All respondents emphasized that, even though the companies could monitor the content of received waste, there is still a high chance of receiving oversized objects which could stuck in the hopper. Interesting fact was that,

the majority of the plants invested in mobile crushing equipment, whereas only one plant is being equipped with stationary machine.

During the discussion, several reasons for investing in mobile equipment have been brought up. Respondents highlighted that there is no need for pretreatment of the waste in their processes and material handling could be necessary only in certain cases of bulky waste, thus there is no need to block one of the tipping holes with the stationary equipment. The waste management companies that invested in Waste-to-Energy plant explained that they organize cyclic collection of bulky waste, therefore the mobile equipment can be used only in particular days on site, while during the rest of the time it can be used somewhere else. Moreover, it was mentioned that incineration plants need small capacity of the equipment, since they will use it only few times per week or month and mobile equipment was the only choice to fulfil their needs. In addition to previous reasons, one of the investors stated that there was simply no space to locate the stationary machine. Other waste management company explained, that using stationary crushing equipment may cause fire hazard in the bunker, hence by using mobile equipment and crushing bulky waste outside the Waste-to-Energy premises fire hazard can be decreased. All of the respondents concluded that the main reason for choosing mobile crushing equipment was that it is much cheaper than the stationary.

A summary of customer needs for material handling in Polish Waste-to-Energy market is presented in Table 10.

Table 10. *Summary of interviews in Polish Waste-to-Energy market*

	Customer need	**Results**
1 operating WtE plant	There was need for reducing volume of large objects Nowadays there is no need for material handling	Hammer mill located in receiving hall; disassembled after some time
5 under construction WtE plants	Need for reducing volume of large objects Need for cheap and small capacity crusher, preferably mobile	3 plants with small capacity mobile crusher; 1 plant with small capacity stationary crusher located in receiving hall; 1 plant without material handling at all

As it can be seen from the table, Waste-to-Energy plants have very limited needs concerning material handling. Plants want to be prepared to reduce the size of bulky waste, thus they are investing in crushing machines. However, those who invested in the equipment emphasize that this machines should be cheap, preferable mobile and have a small capacity.

Other European markets

Final stage of data gathering concentrated on other European Waste-to-Energy plants that were willing to discuss customer needs for material handling. The results consist of twelve interviews with several Waste-to-Energy plant from different countries such as Austria, Czech Republic, Denmark, Hungary, Italy, Norway, Sweden and Switzerland. Apart from those interviews, three discussions with EPC (Engineering, procurement and construction) contractors that deliver complete turnkey solutions for Waste-to-Energy plants were made.

Whenever Waste-to-Energy plant were expressing no need for material handling it was highlighted that incoming waste does not require pre-treatment and the incineration plant is designed to handle all kinds of municipal solid waste. However, when interviewees were asked how they are currently dealing with the bulky waste, it was explained that strict conditions in the contracts with the suppliers of the waste defines what kind of waste are acceptable and what are not. Hence, the bulky waste that are not wanted waste by those plants, are not delivered by the waste management companies. It was noted that waste management companies have or should have material handling equipment to deal with bulky waste. Besides above mentioned opinions, managers of incineration plants were underling that the crushing equipment is too expensive to buy, operate and maintain.

Despite of comments about lack of customer needs for material handling, there were several opinions that material handling is needed, however solely for the purpose of reducing the volume of oversized objects. Those comments also noted that there is actually no need for pre-treatment of the waste, however it was pointed out that within incoming waste stream, there are large particles of waste that might clog the hopper and disturb the feeding process. Therefore, there is a need for the crushing equipment. Those bulky waste are being delivered despite the requirements for the content of the waste, thus Waste-to-Energy plants are equipped with the crushing devices in order to be prepared to handle such waste.

Half of the plants using material handling equipment are using stationary machines, whereas to other half use the mobile crushing equipment. Most of the responds were not able to provide information of how many tons are processed by the crusher or how often it is used. The majority claimed that the equipment is used very rarely, once per week or even once per month. Only one of the Waste-to-Energy plants openly stated that stationary crusher is being used for two to three hours every day. It was explained, that the main reason for such usage was due to acceptance of industrial waste, which required pre-treatment in form of crushing oversized particles.

Interesting fact was mentioned by two separate Waste-to-Energy plants. Both of the plants expressed need for the equipment that crushes the oversized waste, however both of them came up with a total different solutions than just fitting the crusher into the bunker. First of the plant hired external company which provides service of crushing oversized objects. It was highlighted, that since the plant needs this service only every second or third week, this solution was cheaper and more convenient than investing in their own equipment. The second plant, in spite of being equipped with a small crusher located in the bunker also use external company to provide crushing as a service. It was explained that the small crusher is being used only in emergencies, for instance once per week. Whereas, the external company is hired few times per year to crushed large amount of bulky waste that are stored at the transfer stations.

All of the interviewees were also asked about the future and possible change of the need for material handling caused by the circular economy. Majority of comments expressed opinions that circular economy will not have a big impact on the Waste-to-Energy operations. Respondents emphasized once again, that the incineration plants do not need any pre-treatment of the incoming waste, and any change in terms of increase in recycling rates would rather impact the waste management companies than the Waste-to-Energy plants. Only few comments were speculating that there might be a need to consider processing different waste than municipal solid waste, for instance alternative fuel. In such situation, alternative fuel would require pre-treatment and therefore there might be a need for material handling equipment.

Besides interviewing Waste-to-Energy plants, also three companies providing turnkey solutions for Waste-to-Energy were contacted. Those interview helped to understand those companies point of view on material handling. Key results are aligned with the previous findings. EPC companies emphasized that there is no need for pre-treatment of the incoming waste stream. One of the respondents underlined that pre-treatment in this case, would not bring enough added value compared to the costs of the installation, thus the Waste-to-Energy plants do not want to invest in it. However, they all pointed out that the large objects may cause problems in the process, thus incineration plants should have crushing equipment but it should be relatively small because most likely it will not be used all the time.

Presented summary in Table 11, once again shows that reducing volume size is the main and the only customer need concerning material handling.

Table 11. *Summary of rest of the interviews in European Waste-to-Energy markets*

	Customer need	**Results**
12 operating WtE plants	Need for reducing volume of large objects Need for cheap and small capacity crusher, could be mobile	4 plants with small capacity stationary crusher; 4 plants with small capacity mobile crusher; 4 plants without material handling at all
3 EPC companies providing turnkey solutions for WtE	Need to handle bulky waste	Small crusher, either stationary or mobile

As it can be seen, the majority of interviewed Waste-to-Energy plants expressed need only for the equipment that can reduce the volume size of bulky waste. In addition, companies providing turnkey solutions for Waste-to-Energy also stated that equipment decreasing volume of large objects might be the only material handling needed on the site. Incineration plants invest in crushing equipment which is usually cheap and with small capacity. Some of the operators prefer to have mobile equipment over stationary.

5.2. Benefits of Material Handling

The previous chapter presented some need for equipment that can reduce volume of large particles included in municipal solid waste. Although, the Waste-to-Energy plants were not so eager to discuss the issue of material handling, further discussion revealed that the plants are equipped with some kind of a crusher. Production and maintenance managers highlighted several benefits of using crushing machine:

- Reducing volume of large particles
- Avoiding blockages and damages in the hopper
- Improve homogeneity
- Full burn out of the large particles
- Avoiding blockages and damages in the hopper
- Continues feeding process
- Accepting different types of waste
- If mobile:
    - No need to block one of the gates
    - Reduced risk of fire hazard in the bunker
    - Possible to use it in other premises
    - Cheaper compared to stationary equipment

All of the benefits of material handling mentioned above are interrelated with each other and directly connected to the process of decreasing the volume of oversized objects. Managers noted that by crushing bulky waste they are able to increase the homogeneity

of the waste in the bunker, meaning that the more waste are in the similar particles size. More homogenous waste improve the burning process and reduce the amount of bottom ash being produced. In addition, interviewees highlighted that especially big and long objects might stuck in the hopper, therefore by crushing those particles Waste-to-Energy plants minimize the possibility of damaging or clogging the hopper.

Several respondents emphasized that one of the most important issues for the mass incineration plant is to keep the continuous process. With crushing equipment, plants are prepared to handle the bulky waste and do not need to worry that oversized particles might disturb the feeding process. One of the Waste-to-Energy plants, which use stationary crusher, explained that by using this equipment plant was able to accept different kind of waste in form of construction and demolition waste. It was explained that construction and demolition waste, mainly consisted of wood and plastics, is very good fuel for the incineration however it content needs to be crushed before feeding the boiler. Other interviewees also underlined that having a crushing equipment gives the possibility to accept different kinds of waste such as construction and demolition waste.

Results presented in previous subchapter shows strong tendency towards mobile crushing equipment. Whenever Waste-to-Energy plants were equipped with a mobile machine, production managers were indicating advantages of this equipment over the stationary. It was highlighted that the mobile equipment needs less space and does not block one of the tipping holes, as the stationary equipment does. Some of the managers noted that the process of crushing bulky waste might create sparks and lead to the fire, especially if the crusher is located in the bunker. That is why, those managers believe that having a mobile equipment can reduce potential risk of fire because the crushing process can be done away from the bunker. In addition, when crushing equipment is not needed at the Waste-to-Energy site, it can be used at the other stations. Finally, all of the mobile crusher users emphasized that the investment in mobile equipment is cheaper compared to the stationary.

5.3. Alternative Solutions for Business Models in Material Handling

After analyses of the customer needs for the material handling, several possible business models are presented. The first suggested BM is a product-oriented business model based on offering a single equipment sale of a stationary crusher. The product-oriented business model canvas is presented on a Figure 14.

<table>
<tr><td rowspan="2">Key Partners
- Key manufacturers
- Key suppliers</td><td>Key Activities
- Marketing
- Sales
- Purchase</td><td rowspan="2">Value proposition
- Efficient way of handling bulky waste
- Customize specification
- Stationary equipment
- Robust and proven technology
- Low operating costs</td><td>Customer relationship
- Personal assistance
- Co-creation</td><td rowspan="2">Customer segment
- WtE plants
- Waste management companies</td></tr>
<tr><td>Key resources
- Sales people
- Technology
- Design</td><td>Channels
- Direct sales force
- Agents</td></tr>
<tr><td colspan="3">Cost stream
- Manufacturing
- Delivery
- Warranty period</td><td colspan="2">Revenue Stream
- Equipment sale
- Delivery and installation
- Maintenance and spare parts</td></tr>
</table>

Figure 14. *Product business model canvas, stationary equipment*

The targeted group are either Waste-to-Energy plants or waste management companies that need an equipment which can reduce the size of bulky items. The material handling equipment can be delivered to the plants that are handling MSW as well as industrial waste and/or construction and demolition waste. The stationary crusher gives a possibility to decrease the volume of bulky waste in an efficient way with the robust and proven technology and at the low operating costs. The customers are reached through the company's direct sales force or with a help of the company's agents. Personal assistance of a company's representative helps to create special tailored specification of the equipment that will reach the customer's requirements. Presented model generate revenue in form of the equipment sale, delivery and installation costs. In addition, there is a possibility to create extra revenue by offering maintenance and spare parts service after the warranty period.

However, in order to support that business model company needs to highly rely on its sales force, technology and design of the equipment. The design and the technology of the equipment needs to meet the requirements of the customers so that the sales managers with its marketing skills will be able to show its value and persuade the future customers to make the purchase. Furthermore, the company's purchasers needs to establish partnerships with the key manufacturers and suppliers, thus the ordered equipment will be produced on time, according to the specification and certain standards. Presented business model also generates costs such as manufacturing, delivery of the equipment and all costs related to the warranty period

The main benefit of the product-oriented business model is that the company is receiving full amount of money from the equipment sale upfront. In order to generate profit, the price should cover at least the costs of manufacturing, delivery and warranty

period. However, in this approach company might experience problems of finding a potential customers that are willing to invest in the equipment that is not used that often. Therefore, to attract customer more, the second business model is suggested.

The second BM is very similar to a product business model with a stationary equipment, however in this case it is based on a mobile crusher. Most of the building blocks of a presented BM are the same as in the BM with a stationary equipment. The main difference between stationary and mobile product oriented business model is that, the mobile equipment in some cases could deliver more value to the customer than the stationary equipment. For instance, the mobile equipment gives the possibility of moving the equipment, thus the customer has a freedom of using it wherever it is needed. Moreover, mobile equipment is usually with smaller capacity, which according to the results of the customer needs is more attractive for the customer. Finally, small and mobile equipment is less expensive than the stationary equipment. Figure 15 shows business model with a mobile equipment.

<table>
<tr>
<td rowspan="2">Key Partners
- Key manufacturers
- Key suppliers</td>
<td>Key Activities
- Marketing
- Sales
- Purchase</td>
<td rowspan="2">Value proposition
- Efficient way of handling bulky waste
- Customize specification
- Low price
- Small capacity
- Mobile equipment
- Robust and proven technology
- Low operating costs</td>
<td>Customer relationship
- Personal assistance
- Co-creation</td>
<td rowspan="2">Customer segment
- WtE plants
- Waste management companies</td>
</tr>
<tr>
<td>Key resources
- Sales people
- Technology
- Design</td>
<td>Channels
- Direct sales force
- Agents</td>
</tr>
<tr>
<td colspan="3">Cost stream
- Manufacturing
- Delivery
- Warranty period</td>
<td colspan="2">Revenue Stream
- Equipment sale
- Delivery
- Maintenance and spare parts</td>
</tr>
</table>

Figure 15. *Product oriented business model, mobile equipment*

The third BM is the use-oriented business model with a mobile crusher that is rented to the customer. Figure 16, illustrates this kind of a business model.

<table>
<tr><td rowspan="2">Key Partners
- Key manufacturers
- Key suppliers</td><td>Key Activities
- Marketing
- Distribution
- Purchase</td><td rowspan="2">Value proposition
- Efficient way of handling bulky waste
- Customize rental agreement
- Mobility
- Robust and proven technology
- Low operating costs</td><td>Customer relationship
- Personal assistance
- Co-creation</td><td rowspan="2">Customer segment
- WtE plants
- Waste management companies</td></tr>
<tr><td>Key resources
- Sales force
- Technology
- Design</td><td>Channels
- Direct sales force
- Agents</td></tr>
<tr><td colspan="3">Cost stream
- Manufacturing
- Delivery
- Maintenance of the equipment</td><td colspan="2">Revenue Stream
- Monthly fees</td></tr>
</table>

Figure 16. *Use-oriented business model, mobile equipment*

As in previous business models, primary customer segments are Waste-to-Energy plants and waste management companies. One of the main differences comparing to a product business model is that instead of a stationary crusher, company will offer a mobile crusher. This will improve value proposition by adding mobility to the product. Another change is that the sales mangers or/and sales agents, will not only approach clients but also assist them in choosing the best rental agreement for a mobile crusher. This approach will create different way of generating revenues. The mobile crusher will not be sold but it will be rented for the fixed period of time and for the monthly fees. The key resources are similar to a product business model but the key activities are enhanced with a distribution

The main advantage of the service business model is that it does not require high investment cost from the customer side. But, on the other hand that benefit for the customer creates a big disadvantage for the company because it requires high investment in manufacturing the equipment to be rented. Although, this might be seen as a threat to the company it can be also an opportunity because the monthly fees can generate revenues for several month or even years. Furthermore, when the product is rented, company is still responsible for its maintenance. Proper maintenance can extend the product life-cycle, thus when the rental agreement expire, product can be rented again. The more times product will be rented the faster revenue will cover the investment costs and the business model will start to generate revenues.

The final BM is a result-oriented business model that offers crushing as a service. Figure 17 presents the model.

<table>
<tr><td rowspan="2">Key Partners
- WtE plants
- Waste management companies</td><td>Key Activities
- Marketing
- Customer service</td><td rowspan="2">Value proposition
- Efficient way of handling bulky waste
- Easiest solution
- Reliable and safe service</td><td>Customer relationship
- Personal assistance</td><td rowspan="2">Customer segment
- WtE plants
- Waste management companies</td></tr>
<tr><td>Key resources
- Work force
- Equipment
- Technology</td><td>Channels
- Web platform
- Direct contact</td></tr>
<tr><td colspan="3">Cost stream
- Equipment
- Work force
- Operating costs</td><td colspan="2">Revenue Stream
- Fees based on a performance (€/t)</td></tr>
</table>

Figure 17. *Results-oriented business model*

In presented BM, Waste-to-Energy plants as well as waste management companies are the main target for the service. This approach might be seen as the easiest and the most convenient solution for the client. Value proposition provide efficient way of handling with bulky waste, giving very easy solution were the customer do not need to be involved in the crushing process. WtE plants or waste management companies contact the company through the web platform, which should be established by the company, and order a service of crushing a bulky waste. The fee for the service is based on euros for a ton of processed material.

To support that model, company should rely on its marketing and customer service activities that ought to be supported by its own work force, reliably equipment and proven technology. In addition, company should cooperate with its customers, WtE plants and waste management companies because the will become company's partners.

6. DISCUSSION

6.1. Customer Needs for Material Handling

The research shows that handling is not playing a vital role in operations of Waste-to-Energy plants. The results confirm opinions that there is no need for pre-treatment of the municipal solid waste in Waste-to-Energy plants (Tchobanoglous et al., 1993; Chandler et al., 1997; Cheremisinoff, 2003; Christensen, 2011; Bosmans et al., 2013). However, the results indicate that there is a need concerning material handling for the equipment that can reduce the size of the bulky waste. Oversized, irregular objects such as furniture, sofas, and shelves can create unnecessary problems in the feeding process, thus WtE plants are equipped with a crushing machine to avoid complications and to keep to feeding process continuously. The table 12, illustrates the final number of WtE plants with and without crushing equipment.

Table 12. *Number of WtE plants with and without crushing equipment*

	Crushing equipment		**No equipment at all**
Number of WtE plants	13		8
	6 (stationary)	7 (mobile)	

Even though the operators of the WtE plants emphasized that they are not so eager to invest in material handling equipment, nonetheless the interviews with currently operating and also under construction WtE plants, found out that the majority of the respondents are or will be using some kind of crushing equipment, whereas only eight (8) plants do not have any equipment to handle oversized waste.

Despite that the managers of the plants revealed the demand for crushing equipment in WtE plants, they also indicated what they value and what kind of equipment might be interesting for them. The customers, far most value the low prices of the equipment. They explained that the crushing equipment is not playing the key role in the process and they would prefer to avoid adding any additional costs to the process. Moreover, operators emphasized that the equipment is being used very seldom, thus its capacity should be rather small. This would help to decrease the operating and maintenance costs. Lastly, the results showed that the mobility of the crushing equipment is becoming more important to the WtE operators. As a matter of fact more plants are using the mobile than the stationary equipment.

Managers of the plants were explaining that the mobile equipment has more advantages than the stationary machine and therefore they are willing to invest in the mobile product. This confirms with the theory of Kotler and Keller (2011) that customer are willing to purchase a product or the service as long there are more benefits than compromises. In case of crushing equipment, customers are willing to pay the price for the machine, however they will choose cheaper one with more benefits in terms of smaller capacity and mobility than the stationary equipment. This is a clear indicator for the companies that the customers are evaluating possible obtained benefits and given resources for those benefits while deciding which product to choose (Zeithaml, 1988).

Flint and Woodruff (2001) differentiated two sorts of customer value: received and desired. Received value is the value that customer experienced, whereas desire value refers to expected value of certain products or service. References to this division can be seen also in one of the interviews. One of the mangers explained that there was a need for reducing the volume of bulky waste thus the equipment was installed. However, the value that customer experienced was not as good as desired. The machine was too big, the equipment was used rarely and the costs of operating and maintenance were high. That is why, customer made a change and hired a company providing service of crushing bulky waste that fulfilled the desired customer value. Although, the crushing service fulfil customer's requirements and increased the actual customer experience, the customer's own crushing equipment is still present at the plant and it is being used in the emergencies cases.

As it can be seen, customer value may change within the time and it can be caused by several factors (Flint et al. 1997). Woodruff et al., (1993) noted that the microenvironment events that happen outside the customer's and supplier's organization might lead to such a change. One of that event from Case Company point of view is the circular economy approach and in effects on the solid waste management. The circular economy aims to shift from the traditional linear approach of using resources as "take-make, consume and dispose" towards circular approach where the value added in products should be extended as long as possible, thus the valuable resources could be used again and the waste generation could be decreased. This could improve usage of waste as a resource. (European Commission, 2014)

The case company believes that this is a great opportunity for the Waste-to-Energy plants to make the change in their operations. Since at the moment none of the plants are pre-treating incoming waste stream, the circular economy might be the indicator for a change. Pre-treatment of the waste by using material handling equipment gives an opportunity to reduce the size of the material and then to separate it according to size, density or by electric and magnetic field. By doing so, WtE plants will not only recover valuable materials and fulfil high objectives for recycling and re-use of municipal solid waste set by the circular economy but also it will give an opportunity to create the additional revenue streams from the recyclables.

Unfortunately results shows that almost all of the responds do not share the same enthusiasms about circular economy as the Case Company. Most of the interviewees already see their operations as a part of the circular economy as they recover energy from the waste. In addition, many opinions against pre-treating MSW provide several factors why it is not worth doing it. First of all, managers emphasized that MSW are already source separated by using different bins for paper, cardboard, plastic and glass (Tchobanoglous et al., 1993). Secondly, WtE operators highlighted that separating and recycling is not their business but waste management companies is. Thirdly, even if WtE plants will invest in material handling equipment and start to pre-treat MSW, it will be so much time and money consuming that it will not be profitable for them. Lastly, some of the managers stated that there is lack of market for the recovery materials from MSW, therefore even though WtE plants would recover valuable resource there will not be any place to sell them.

Presented opinions about circular economy also shows that how much, operators of WtE plants, are against any changes even if it could be required by the European Union. They believe that Waste-to-Energy with grate fire technology is the most proven technology of recovering energy from waste and that is what the operators would like to focus on (Tchobanoglous et al., 1993; Cheremisinoff, 2003; Christensen, 2011; Bosmans et al., 2013).

As it is easy to see, the case company and the Waste-to-Energy operators have two different points of view on the circular economy approach. To make things even more complicated, circular economy is in design phase and yet another proposal with even more strict objectives should be presented during year 2015 (European Commission, 2015). Needless to say that the regulation could have an impact on a solid waste management and Waste-to-Energy plants. However, it will be very important how the final document will look like and how it would be interpreted by the European Union.

6.2. Identifying Customer Needs and Benefits of Material Handling

Important role in examining customer needs for material handling played the way in which they were identify. The reason behind discussing the method of recognizing customer need is to analyse whether the method was successful or not. Research methodology section explained that the main method for collection information was qualitative interviews that consisted of open questions in order to conduct guided conversation with the interviewee (Gummesson, 1993).

The interviews were conducted according to a framework (Appendix 1) that aimed to help to explore customer needs. Being a journalist to gain knowledge about the customers, like Osterwalder et al., (2014) suggested, was not an easy task and even created framework needed time and development to be effective. However, asking

correct questions and listening to the answers was the only reasonable method to gather as much information about customer needs as possible.

Ulwick (2002) explained that many customers struggle with expressing their needs. It was no different during discussion with managers of the WtE plants. First few interviews showed that whenever questions about material handling was asked, managers were very unwilling to discuss the issue as they believe that there is no need for material handling at all in the WtE operations. However, further discussion revealed that customers are actually using some kind of equipment. In addition, there were also situation that the customers were asking for clarification of the term of material handling. When the term was specified and few examples of the equipment were suggested, it was far easier to the respondents to discuss the topic.

In order to avoid reluctance towards discussion about material handling, framework was updated several times. The final version focused on the processes in the WtE plants. That change in the framework led to the situation that during the interview and discussion about the processes at the WtE plant, respondents themselves were introducing the topic about material handling equipment, particularly crushing machine. This approach improved the results of the discussion and increased the number of plants that were willing to participate in the study research.

Besides having problems with expressing needs for material handling, customers were also not able to clearly articulate benefits of the equipment. Managers stated that reducing the volume of large particles keep the feeding process continuously and avoid damages of the feeder. However, interviewees did not notice that crushing equipment might influence the performance of the WtE plants. Perhaps, if during the study team member could be placed at the WtE plant and analyse the usage of the crushing device and its impact on WtE processes, more benefits will be discovered and what is more important it would be easier to communicate those benefits to the current and potential customers.

6.3. Recommendations for the Technology Supplier

In this study, identified customer needs for material handling are the base for creating a business model. Different types of the business models such as product-oriented, use-oriented or result-oriented were studied and tool in form of a business model canvas, created by Osterwalder et al., (2005), was used to propose how case company could create, deliver and capture the value of its offering.

The product-oriented business model could be perceived as an easiest choice. It fulfils customer needs for reducing the volume of the bulky waste by offering a stationary or mobile crushing equipment. However, the product and its price should be design in a way that it encourages customer to choose the company’s product. Especially price,

should play a vital role as the most of the mangers during the discussion about material handling were highlighting the high price of the equipment discourage them to purchase the equipment.

The use-oriented business model is another suggestion for the case company. This approach is totally different than the product-oriented model. The main difference is that this model offers renting a mobile crushing equipment. Renting mobile equipment gives more freedom to the WtE plants. Managers of the plants could rent the machine whenever they want and for how long they want. In addition, by renting equipment the customers will not owned it thus they will not need to make a big capital investment in order to purchase the product. This approach could increase customers' interest in material handling. The use-oriented model could be also beneficial for the case company because it could provide continues revenue stream in form of monthly fees. However, in order to keep this model profitable, case company should deploy as many crushing machines as possible and for as long as possible. Of course it associates with big investment in the fleet of crushing machines but on the other hand, mobility of the equipment gives the possibility of moving the equipment from one customer to another.

Last suggested model is a results-oriented business model where the crushing is offered as a service. This is the most demanding and complicated model because company is responsible for the full process. It requires a huge investment in equipment and the work force that will provide the service. Moreover, company should establish a platform where the service could be ordered.

Proposed value propositions in each business model do not differ much from the other. Designing the value proposition started with recognizing market segment, as Barnes et al. (2009) suggested. Waste-to-Energy plants were the main segment, however there is also possibility to approach waste management companies. According to Osterwalder et al. (2014), value proposition should focus on the customer job and its pains and gains. Discussion with the managers of the WtE helped to analyse customer job and its potential problems. Each value proposition in suggested business models concentrate on efficient way of handling bulky waste, thus the WtE plans can minimize the problems caused by bulky waste such as damaging the feeding system or unplanned stoppages. In addition, being able to handle oversized particles in incoming waste give an opportunity for WtE plants to accept different kind of material.

7. CONCLUSIONS

7.1. Summary of the Findings

The purpose of this study was to identify customer's needs for material handling in creating business model. The Case Company wanted to examine potential need for material handling equipment in Waste-to-Energy plants that are utilizing municipal solid waste and produce energy out of it. By using business model canvas, recognize needs were used as a base for creating possibly new business models for the Case Company.

The first research question was "*What are customer's needs concerning nonhazardous solid waste material handling?*" The research revealed that the customers, Waste-to-Energy plants with a grate fire technology, are not that interested in the material handling equipment and the only need concerning material handling is, for an equipment that can reduce the volume size of bulky waste such as old, worn-out furniture, sofas or bookcases that are incoming in the waste stream of municipal solid waste. The equipment could be either stationary or mobile, nonetheless the most important is that it should be cheap and with a small capacity since it is not operating regularly. The managers of the WtE plants emphasized that pretreatment of the incoming waste stream is unnecessary, thus there is no need for any other material handling equipment.

The second research questions was "*What are the potential benefits of material handling for mass incineration operators?*" The operators of the WtE plants highlighted that crushing equipment help them to decrease the volume of oversized particles in incoming waste, thus they can keep continues feeding process, minimize the damages of the feeder and avoid unplanned stoppages that might be caused by large objects stuck in the feeder. Furthermore, operation of crushing bulky waste makes the waste more homogenous, thus it improve the burning process and reduce the amount of bottom ash being produced.

The final research question was "*How the technology supplier should respond to the value creation?*" The study proposed different business models such as product-oriented, use-oriented or result-oriented business model. Business model canvas was used to show general overview on the each of the business model. All suggested business model were focusing on WtE plants or waste management companies. Furthermore, in each of the presented approaches value proposition was built around equipment that can handle bulky waste. The key resources were mainly concerning

sales force, technology and design of the equipment, whereas sales, marketing and purchasing with key manufacturers were the most important activities of the model.

In the product-oriented model, the stationary or mobile equipment is directly sold to the customer. The price includes equipment sale, delivery and installation and the warranty period. Maintenance and spare parts are seen as additional source of the revenue. In the use-oriented business model, mobile crushing equipment is being rented to the customer for a monthly fee. Customer do not own the equipment and the company needs to provide maintenance and spare parts for the machine. In the result-oriented business model, company offers crushing as a service. Company with its own equipment and work force, offers service and collect the fees based amount performance (€/t).

Overall, the research helped to identify customer needs for material handling in Waste-to-Energy segment. Now, Case Company is aware of customer's needs and its expectations about the equipment. Proposed business models shows how the Case Company could approach the WtE segment. Although, the thesis does not indicate which of the business models is the most appropriate for the Case Company, but it encourages Case Company to analyze and take them into consideration while entering into the Waste-to-Energy segment with grate fire technology.

7.2. Evaluation of the Study

This thesis was set as a real life case study of the Case Company to identify customer needs for material handling in Waste-to-Energy segment and also to provide possible respond to those needs in form of a business model. This approach, enabled to provide real data of the customer needs and increase the validity of the thesis.

The research took approach of gathering empirical data by conducting qualitative interviews with the production or maintenance managers of the WtE plants that were willing to discuss the topic of material handling. In total, twenty-six (26) interviews were conducted that provided sufficient data to reach the objective. In addition, most of the discussions provided similar responses that increase the reliability of the study.

In order to explore customer needs in more depth, interviews were conducted with operating plants that are equipped with some kind of material handling as well as with operating plants without any material handling equipment. Furthermore, WtE plants that are under construction were also contacted. To understand different points of view on material handling other stakeholders were also interviewed such as waste management company, EPC companies providing turn-key solutions for WtE plants and also the consulting company. It should be noted that all of the interviews were limited to Europe, while the Case Company operates around the world. The main reason for such an approach was that it was easier for the interviewer to contact and gather information

about WtE plants. In addition, author's knowledge of Polish language and business culture helped to analyse emerging Waste-to-Energy market in Poland.

To help familiarize the reader with the environment of the study, key concepts were presented. Solid waste management with general information and specification of the municipal solid waste were analysed and the Waste-to-Energy technology with its processes was discussed. Moreover, circularly economy that is a regulation from European Union was introduced as a potential factor that might have an impact on the future operations of the WtE plants.

Recognized customer needs were used as a base for creating a business model. Although, several business models were suggested, the study do not point out which of the models is the most suitable for the Case Company. In addition, the research to do not include discussion of a feasibility of the models or the other aspects of the business environment such as competition, regulations or political situation.

Other limitations affecting validity of the study is that they literature review did not discuss exact subject studied in the thesis. There were no previous studies specifically analysing customer needs for business model creation in industrial setting. It can be assumed that this is due to lack of recognition of importance of customer needs in the creating the business model. In addition, novelty of the concepts of the business model leaves a great opportunity for futher research.

Another limitations is due to selection of empirical data gathering. Although, the qualitative interviews were set as a prime source of data collection and enabled to collect large amount of information from several sources, that approach was vulnerable to the subjective opinions of the interviewer and interviewee. In addition, discussion with only twenty-one (21) managers of WtE plants, represented only a small percentage of the WtE plants that are operating in Europe.

7.3. Future Research

Presented thesis creates an opportunity for the further research topics that might interest the Case Company or an academic researchers. For instance, analysing feasibility and viability of suggested business models in the Case Company could be one of them. Another research study could compare proposed business models with current the business model in the Case Company.

Further research could also analyse influence of shredded material on performance of the WtE plants. Yet another interesting research would be to investigate the value of municipal solid waste incoming to the WtE plants.

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APPENDICES

APPENDIX 1: INTERVIEW FRAMEWORK

My name is Stanislaw Szczecinski and I am doing my Master's Thesis for Case Company, a well-established company specializing in material handling. The goal of my thesis is to look for customer's needs or/and interests for material handling in mass incineration with grate fire boiler, in order to discover different methods to increase the efficiency and added value for Waste-to-Energy plants. With this study, Case Company will be able to see and learn about challenges as well as potential needs for material handling in Waste-to-Energy plants. In addition, conducted interview will help to find possible improvements for Waste-to-Energy operations and its business.

- Business drivers, customer value and role of Waste-to-energy plant
    - What was the main reason for investing in Waste-to-energy plant?
    - Why you chose the grate technology?
    - Have you consider any other technology (CFB/BFB, Plasma etc.)
    - What are the main sources of income (gate fees, energy…)

- Increasing efficiency of current operations
    - How does your input stream affect your operations in terms of:
        - Performance
        - Availability
        - Maintenance
        - Emissions
    - What are the main challenges for your daily operations?

- Received waste
    - From whom you receive the waste?
    - What kind of waste it is?
    - What is the average particle size of the waste, composition of the waste, particle size distribution?
    - What are the main challenges with incoming waste?

- Effects of Circular Economy to Waste to Energy operations
    - Zero waste programme is moving towards Circular Economy by e.g. boosting recycling, preventing the loss of valuable materials. It means that waste will be no longer seen as a waste but it will be a resource and only fractions which cannot be recycled or reused will be burned.
    - How you see the effects of Circular Economy to your operations?
    - Aren't you afraid that you will not get enough waste to full fill the capacity
    - Do you see possibility of coexistence of recycling and incinerating at your plant?

- Future of Waste-to-Energy plants
    - Is Waste-to-Energy the future?
    - Are there any factors (coal/oil prices, EU/national legislation) you are carefully looking at, which might affect your business?
    - Could there be possible change in energy/steam demand in future?

The interview will last around 1 hour. All answers will be confidential and the information about respondents will not be revealed. The results of the discussion will be used as part of the data collection for the Master's Thesis, which will be fully available at the end of 2015 in the library of Tampere University of Technology.

Thank you for participating.