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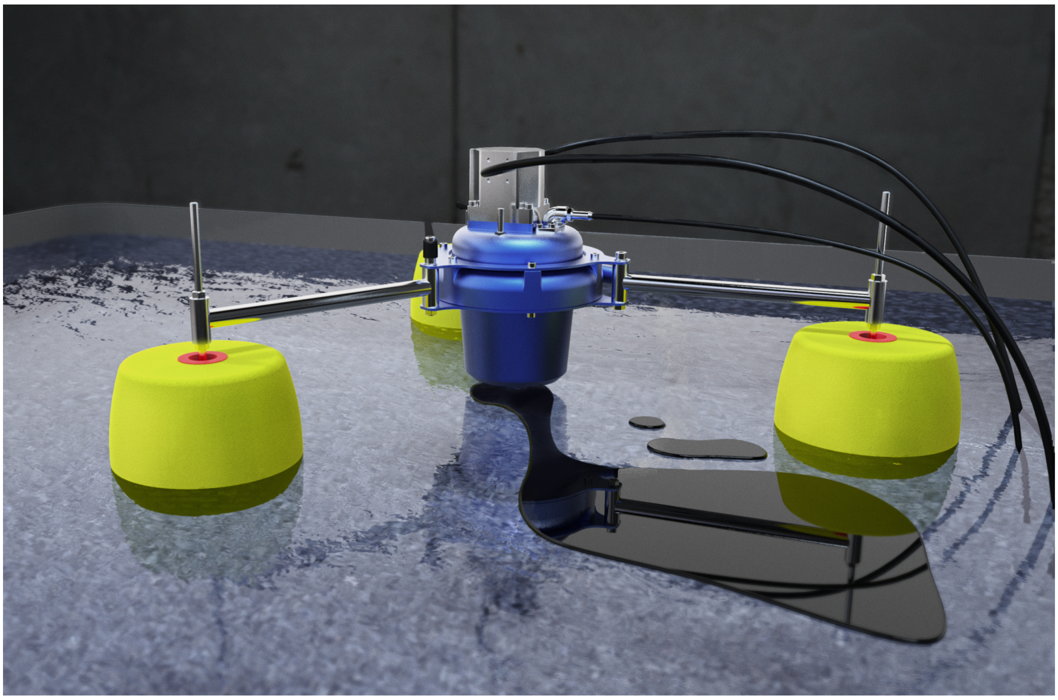

Evaluating a New Business Opportunity for Alfa Laval

Master of Science Thesis

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PREFACE

The thesis was conducted during the spring and summer of 2014 within the master programs Management and Economics of Innovation and Supply Chain Management at Chalmers University of Technology. The thesis was conducted on behalf of Alfa Laval AB.

We would like to thank our tutors Klas Bertilsson and Tommy Norén at Alfa Laval in Lund for sharing their knowledge, providing their support and for all inspiring meetings throughout the research process. Additionally, we would like to thank all employees of Alfa Laval in Lund and Tumba whom gave their time to aid and guide us through our work.

Furthermore, we would like to thank all interviewees that participated in the research study by sharing their valuable knowledge. We are especially grateful for the generous welcome we received by the attendants of the *International Oil Spill Conference* in Savannah.

Finally, we want to extend our gratitude to Sofia Börjesson, our supervisor and examiner at Chalmers University of Technology, for strong commitment, intelligent feedback and inspiring meetings.

Gothenburg, September 2014

Madeleine Gilborne & Carl Rosell

ABSTRACT

When major oil spill incidents occur, the consequences are devastating. A recent such event is the *Deepwater Horizon* in 2010 where the estimated oil leakage was 500 000 tons of crude oil. Only a mere fraction of the oil was mechanically recovered from the sea at this incident. The response technologies that were used in this incident were the same as those used 25 years ago, in the *Exxon Valdez* oil spill in Alaska. Moreover, the world's oil consumption is increasing as the demand in new emergent markets are enhanced, implying a change in oil movements as well as increased sea vessel traffic. Thus, the risk for collisions and groundings of vessels are increased. Conclusively, it is not a matter of *if* a major oil spill incident of the magnitude of the Deepwater Horizon will occur again, rather *where* and *when*.

The thesis is conducted on behalf of Alfa Laval, a global market leader within separation technology. Alfa Laval has developed a new technology and wants to evaluate its business potential. The possibility to use it as a skimmer equipment in the Oil spill response industry naturally came into mind. The purpose of the thesis is thus to evaluate this business opportunity and provide Alfa Laval with knowledge about the industry as basis for decision making regarding whether they should enter the Oil spill response industry with their new skimmer equipment. The thesis furthermore provides recommendations regarding strategic-fit and proposes a business model for the new technology.

The authors conclude that there is a strategic-fit between the analysis of the external business environment of the Oil spill response industry and the internal business environment of Alfa Laval. The Oil spill response industry is attractive and profitable, and Alfa Laval in combination with their recent acquisition Frank Mohn, possess resources and capabilities that are essential for achieving the industry's key success factors and can be utilised as a competitive advantage. Furthermore, the new skimmer equipment has several advantages compared to current skimmer technologies within the industry. Thus, there is a business opportunity for Alfa Laval. Hence, the thesis recommend Alfa Laval to enter the Oil spill response industry and, jointly with Frank Mohn, launch the new skimmer equipment, co-branded to utilise their respectively competitive advantages.

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1 INTRODUCTION

The chapter begins with the background that aims to introduce the reader to the Oil spill response industry, the case company Alfa Laval and their new skimmer equipment. Thereafter, the purpose and the research questions, the ones the thesis aims to answer, are presented.

1.1 Background

Water risk being contaminated with oil in many situations, business areas and activities. When major leakages occur, such as incidents when enormous, uncontrolled amounts of oil is spilt from e.g. shipping vessels or oil rigs, the consequences are devastating. A recent such event is the *Deepwater Horizon* in 2010, when a drilling operation failure at an oil rig caused a well blow-out[1] in the Gulf of Mexico. The estimated oil leakage was 500 000 tons of crude oil (Fingas, 2013, p.10). A mere fraction, only three percentages of the oil was mechanically recovered from the sea at this incident. The response technologies of booms, dispersants and skimmers that were used in this incident, were the same as those used 25 years ago, in the *Exxon Valdez* oil spill in Alaska. The capacity and efficiency of these equipment were again limited (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011, p.168). Recovery, cleanup and decontamination of the environment from oils spills after incidents are activities within the Oil spill response industry.

Moreover, the world's oil consumption is increasing as the demand in new emergent markets are enhanced, implying a change in oil movements as well as increased sea vessel traffic. As a consequence, the risk for collisions and groundings of vessels are increased (ITOPF, 2014). Additionally, current oil reserves are being depleted. Thus, the enhanced demand forces the companies of the oil and gas industry into searching for oils in new areas, often with tougher conditions, such as in deeper waters and in Arctic regions. From an historical point of view, in the last 50 years, 85 percentages of all drilling incidents have occurred due to explorative offshore drilling (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011, p.41). Thereby, in line with the enhanced demand, the risk for oil spills increases, caused by the higher risk for sea vessel collisions and groundings as well as well blow-outs from explorative offshore drilling. Conclusively, it is not a matter of *if* a major oil spill incident of the magnitude of the Deepwater Horizon will occur again, rather *where* and *when*.

The case company of the thesis is the Swedish company Alfa Laval AB. They are a global industry market leader within three key technologies; separators, heat exchangers and fluid handling. Their goal is to have annual growth rate of eight percentages, with organic growth accounting for four to five percentages and acquisitions of the remaining parts (Alfa Laval, 2013). In order to achieve this goal, Alfa Laval continuously needs to evaluate new business opportunities, launch new products as well as finding new markets for both existing and new products. Moreover, the corporate vision of Alfa Laval is *"help to create better everyday*

[1] A well blow-out is defined as the uncontrolled flow of oil resulting from failure in equipment or procedures at an oil rig.

conditions for people by design a product portfolio that saves energy, protect the environment and optimize the use of natural resources" (Alfa Laval, 2013, p.7).

In the year 1996, Alfa Laval developed a technique, originally designed as an oil mist generator in lubricant systems for a centrifugal separator[2]. The technology was further elaborated and other application areas came into mind. One area, in particular, was to use the technology as a skimmer device for removing a surface layer of oil in contaminated water during an oil spill. The concept has since in the late 90's been kept in Alfa Laval's 'idea bank' and it is patented in a few countries. Rough estimation shows that a number approximately 500 units of this concept could, in theory, have recovered the oil at Deepwater Horizon in 2010 in less than 30 days.

Alfa Laval has decided to investigate the opportunity with the centrifugal separator technology as skimmer equipment and explore the business potentials that it might contribute. The Oil spill response industry comes naturally in mind and could be a diversification where Alfa Laval can utilise their knowledge of how to separate oil from water, while simultaneously contribute to the protection of the environment. However, both the market of oil spill response equipment and the new skimmer equipment are new for Alfa Laval since the company does not have any businesses in the Oil spill response industry. Furthermore, Alfa Laval does not possess sufficient experience or knowledge for strategic decision basis concerning the Oil spill response industry.

1.2 Purpose

As a basis for decision making regarding whether the case company Alfa Laval should enter the Oil spill response industry with their new skimmer equipment, the purpose of the thesis is to evaluate the business opportunity and provide knowledge about this industry. The thesis furthermore provides recommendations regarding the strategic-fit of the business opportunity and proposes a business model for the new skimmer equipment.

[2] Oil mist lubrications are oils applied in mists to moving parts, such as bearings. Alfa Laval's original idea was to use oil mists as lubrication to their centrifugal separators. To get the oil vertically to the separators, they used spinning cones, with the edge pointed downwards, and by the centripetal force move the oil to the moving parts in the separators.

1.3 Research Questions

The evaluation of whether Alfa Laval should enter the industry or not requires business opportunity appraisals, both from external- and internal business environment perspectives. The external perspective concerns analysis of the Oil spill response industry and identification of the industry's key drivers of change, profitability and competitiveness, and key success factors. The internal perspective aims to identify the resources and capabilities that Alfa Laval possesses, the new skimmer equipment in particular, which can be utilised as a competitive advantage in the Oil spill response industry. Furthermore, the analysis of the external- and internal business environment serve as a foundation to provide recommendations regarding strategic-fit and propose a business model for the new skimmer equipment.

Hence, the purpose of the thesis culminates into answer the following two research questions:

1. *What are the key drivers of change, the profitability and competitiveness, and the key success factors of the Oil spill response industry?*

2. *What resources and capabilities does Alfa Laval possess that can be utilised as a competitive advantage in the Oil spill response industry?*

2 ALFA LAVAL

The aim of the chapter is to introduce and provide the reader with basic facts about the case company Alfa Laval. It primarily concerns financial data, sales, markets, geographical presence and corporate strategies.

Alfa Laval was founded by Gustaf de Laval in 1883, who launched Sweden's first milk separator. Today, Alfa Laval is a world-leading supplier of products and solutions within the key technologies of heat transfer, separation, and fluid handling. They are furthermore market leader within these technologies. Alfa Laval is present in more than 100 countries and have above 16 300 employees. In 2013, they had an order intake of SEK 30 335 million, with an operation margin of 16 percentages (Alfa Laval, 2013).

Separation, including separators and decanters, has been part of Alfa Laval since the establishment in 1883. The portfolio contains products that can separate liquids, solid particles from liquids, as well as particles and liquids from gases. Alfa Laval has approximately 30 percentages of the world market of separators. The new skimmer equipment is within the separation technology, described in further detail in Section 5.2.2. The second technology, *Heat transfer*, includes products within heating, cooling, refrigeration, ventilation, evaporation, and condensation. Alfa Laval has 30 percentages of the world market for heat transfer. The third technology, *Fluid Handling,* includes pumps and valves for transportation of fluids. Alfa Laval has up to twelve percentages of the world market for fluid handling. In 2013, heat transfer accounted for the largest part of sales with 53 percentages, followed by separation products of 22 percentages and fluid handling of eleven percentages. Service accounts for the remaining sales. Based on the three key technologies, Alfa Laval's business concept is to offer products and solutions that "*optimise the performance of our customers' processes, time and time again*" (Alfa Laval, 2013, p.11).

The three key technologies are used to heat, cool, separate and transport products in industries that produce food, beverages, fuel, chemicals, pharmaceuticals, starch, sugar and ethanol. Their products are also used aboard vessels, in power plants, in engineering industries, for treating sludge and wastewater as well as for heating and cooling. Alfa Laval's products are considered among customers to be of high-quality and premium products, with long service lives. Furthermore, it is important that the products are signalling robustness and high performance. Alfa Laval has their strongest present in Asia accounting for 32 percentages of their sales, followed by Western Europe with 22 percentages and North America with 19 percentages. However, the highest growth areas are Latin America, Middle East and Asia.

Alfa Laval's organisation is structured as a matrix organisation, in which the sales divisions and segments are presented vertically, intersecting with the geographical regions presented horizontally. The Operation division serves as a shared supply chain for the sales divisions (Alfa Laval, 2013). The organisational structure is illustrated in Figure 2.1 and described in more detail in the following paragraphs.

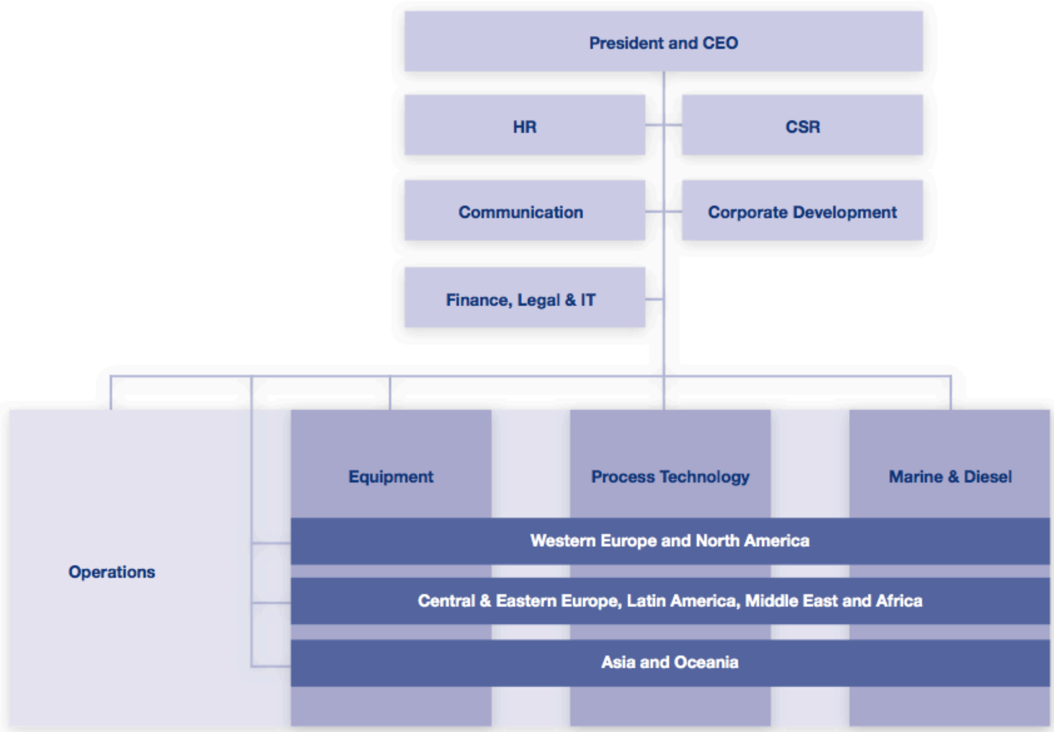

Figure 2.1 *The organisational structure of Alfa Laval (Alfa Laval, 2013, p.56).*

Alfa Laval has three main sales divisions; Marine & Diesel, Equipment and Process Technology. These sales divisions have different business models designed to meet specific customer requirements and purchasing habits. The three key technologies are each sold within the three sales divisions. The *Marine & Diesel* division offers products, solutions and systems for customers in the marine and offshore markets. They offer their solutions through Alfa Laval's sales organisation directly to shipowners, shipyards and offshore customers respectively. *Process Technology* division serves customers that require customised solutions and systems to enhance their efficiency of their own processes. They offer their solutions directly to end-customers through Alfa Laval's own sales companies and contractors. *Equipment* division is characterised by a fast-moving business, with customers having well-defined needs and recurring requirements. They offer components through various sales channels, such as system builders, contracting companies and distributors. The Marine & Diesel division accounts for 22 percentages, Process technology for 46 percentages and Equipment for 32 percentages of Alfa Laval's order intake 2013 (Alfa Laval, 2013).

Alfa Laval has a centralised, coordinated and global supply chain system through their division *Operations*. This division is responsible for production-related procurement, manufacturing, distribution and logistics for the other sales divisions. In total, they have 34 productions facilities and eight distribution centres across Europe, Asia, United States and Latin America, illustrated in Figure 2.1. The production is based on manufacturing technology, product group and size, not on the final application of the product. Thus, some are specialised in large-scale separators, while others manufacturer small to medium-sized separators (Alfa Laval, 2013).

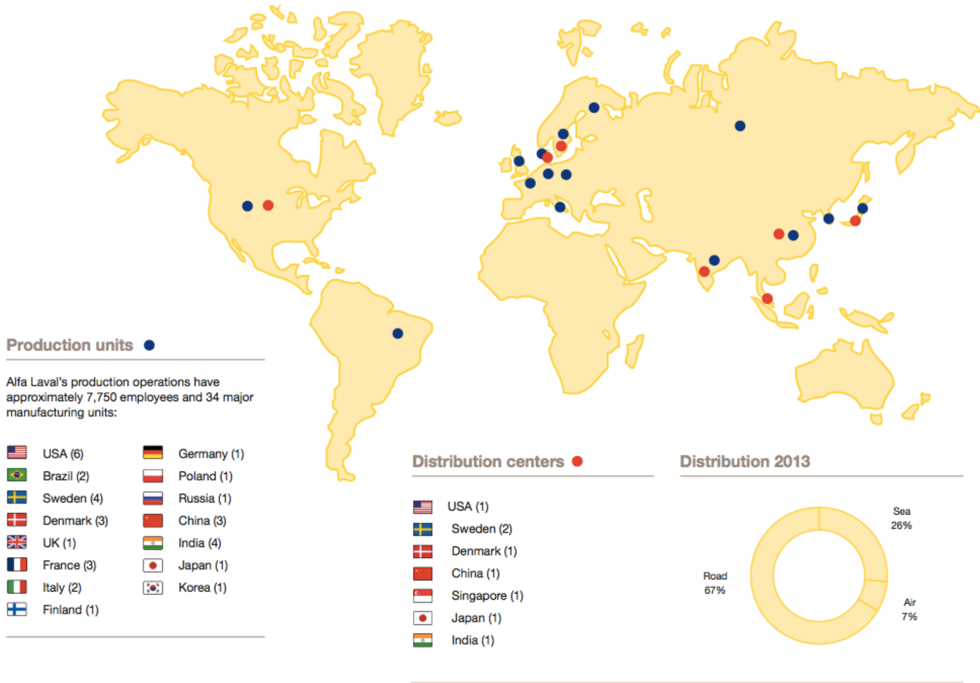

Figure 2.2 *Alfa Laval's production facilities and distribution centres (Alfa Laval, 2013, p.37).*

Alfa Laval offers a broad range of services, from replacement of spare parts, maintenance and upgrades. Service accounts for 27 percentages of the order intake of Alfa Laval. Out of these, the Marine & Diesel division accounts for largest part, 38 percentages, followed by Process technology with 29 percentages and Equipment with 18 percentages. Alfa Laval has 106 service centres world-wide, illustrated in Figure 2.3. The dark (blue) areas represent a large and mature installed base. The medium (blue) are areas with a combination of fast-growing markets and established nice applications. Lastly, the light (blue) areas are new installed base that is growing rapidly (Alfa Laval, 2013). The after-market sales are becoming of increasingly importance for Alfa Laval's profitability.

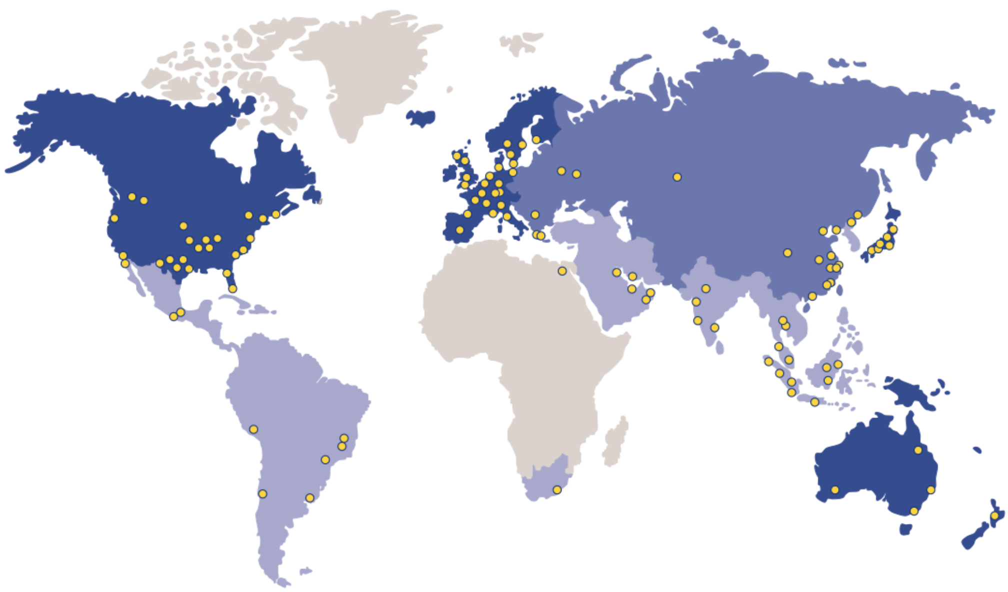

Figure 2.3 *Service centres of Alfa Laval (Alfa Laval, 2013, p.39).*

The financial goal for Alfa Laval is to have an annual growth rate of at least eight percentages over a business cycle. From these, organic growth aims to account for four to five percentages and acquisitions for the remaining part (Alfa Laval, 2013). In order to achieve the growth strategy, Alfa Laval needs to continuously expand their product offering and market presence, both organically and through acquisitions, according to their official strategy.

For the organic growth, Alfa Laval continuously invests in research and development. In 2013, the investment was accounted for SEK 732 million, corresponding to 2.5 percentages of the annual sales (Alfa Laval, 2013). The aim is to improve the current product portfolio, to meet customers new requirements and, equally important, to find new application areas for current products. In order to retain its position as market leader within their key technologies, Alfa Laval needs to launch new innovative products.

The process of how Alfa Laval takes innovative ideas to the market is illustrated in Figure 2.4. In the first step, Alfa Laval seeks new innovative ideas both internally as well as externally, such as customers, suppliers and universities. Ideas are thereafter evaluated and compared to the business strategy before decision is made whether to fund a project or not. The Corporate Development department (see Figure 2.1), is responsible for evaluating the ideas and present them for general managers who make the decision of 'go' or 'no go'. If a 'go' decision is made, an organisation is set up to run the project. The final step of the process is to incorporate the new product into the line organisation. Alfa Laval has historically had internal challenges with launching of new products, in particular, for them considered, relatively inexpensive and of simple technologies. Furthermore, technologies that do not fit well within the current organisation have difficulties to find their way to markets.

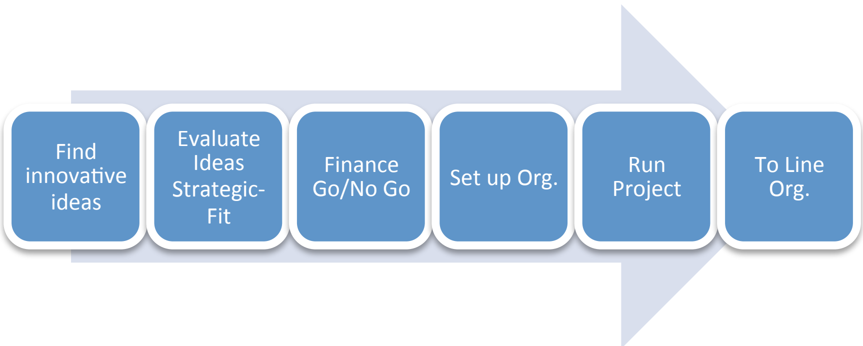

Figure 2.4 *Alfa Laval's innovation process. The thesis is predominantly focused on the second step, to evaluate ideas and strategic-fit.*

The launch of new products requires patent protection according to corporate strategy. Currently, Alfa Laval possesses more than 2 000 patents within their three key technologies (Alfa Laval, 2013).

Finally, as stated earlier, acquisition is an important part of Alfa Laval's strategy. Between 2009 and 2013, Alfa Laval has acquired 20 companies with combined sales of SEK 7 540 million. A recent acquisition was the Norwegian company Frank Mohn AS in May 22, 2014 (Alfa Laval, 2014a). A further description of the company is presented in the Empirical Findings, Section 5.2.1.

3 THEORETICAL FRAMEWORK

The aim of the chapter is to outline the theoretical areas that are applied in order to analyse the empirical findings. The theoretical framework chapter consists of three sections. The first section presents theory and models, applied for analysing the external business environment of the Oil spill response industry. Thereafter, the second section presents theory and models, applied for analysing the internal business environment, i.e. the case company Alfa Laval. The third and final section presents the business model canvas, applied for proposing a business model for the new skimmer equipment to be launched in the Oil spill response industry.

3.1 Theory for the External Business Environment

The first section aims to present theory and models for analysing the external business environment applied in Section 6.1. To better grasp the environmental factors of a business opportunity, the external theory in this section is based on a three layer framework, inspired by Johnson *et al*. (2011, p.49) and is illustrated in Figure 3.1. These are (1) Macro-Environment, the highest level layer which lays the foundation for the context and foresight of the business opportunity, (2) Industry Environment, the next layer by which the competitive analysis is explored in broad, and (3) Competitors and Markets, the layer closest to the company. The organisation, the company in question, is located in the centre of the figure, is further described in Section 3.2, Theory for the Internal Business Environment. Theory for the macro-environment, industry environment, and competitor and markets are presented in the three following sections, respectively. The terms *industry* and *market* in this context are defined accordingly to Grant (2013, p.77). An industry is a group of companies that supplies a market and thus create a co-dependence between markets and industries.

Figure 3.1 *Layers of the business environment (Johnson et al., 2011, p.49).*

3.1.1 Macro-Environment

The macro-environment is the highest level of context in which a company operates. This level consists of a number of broad environmental factors that to various extents influence a company. A commonly used framework to evaluate the macro-environment is to use the acronym PESTEL[3] (Political, Economic, Social, Technological, Environmental and Legal) (Maylor, 2010, p.27; Johnson *et al*., 2011, p.49; Grant, 2013, p.60; Cook, 2005). These factors are illustrated in Figure 3.2 and the content of these factors are described in the next paragraph.

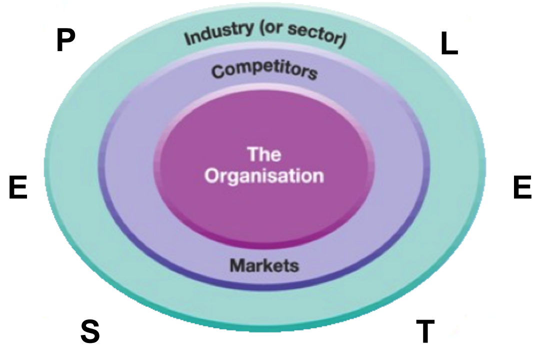

Figure 3.2 *Illustration of the PESTEL factors of the industry.*

Political influences are related to governmental or constitutional policies that might affect business (Cook, 2005). For instance, this could imply what the government fund and, equally important, what the government decides not to fund (Maylor, 2010, p.27). *Economic* aspects relates to the prevailing conjuncture, inflation, unemployment rate et cetera. Another economic aspect is the current capital market condition, explaining the funding possibilities on the market (Osterwalder and Pigneur, 2010, p.208). The Socio-economic aspects, on the other hand, include the demographic trends, the distribution of wealth and disposable income of the market and the general spending pattern (Osterwalder and Pigneur, 2010, p.206). *Social and cultural* aspects affect communication and thus how to communicate the business opportunity, both internally and externally. Furthermore, these aspects influence buyer behaviour (Osterwalder and Pigneur, 2010, p.206). *Technological* aspects include possible competitive technologies that could threaten a business opportunity (Osterwalder and Pigneur, 2010, p.206). Furthermore, *environmental* aspects concern pollution and waste. Another aspect of increasing importance, related to environmental issues is corporate social responsibility (Cook, 2005). Finally, *legal* and regulatory aspects include regulations affecting intellectual property, government procurements, legislations and legal pressures (Maylor, 2010, p.28).

A PESTEL analysis aims to provide information from which *key drivers of change* can be identified (Johnson *et al*., 2011, p.49). The key drivers of change are the expected contextual aspects which have high influence on the success and failure on strategy. The PESTEL factors are usually aspects that the company cannot control or influence. Large companies in particular, need to forecast and react to the changes in PESTEL and how it impacts business. The company strategy ought to be adopted to fit the prevailing PESTEL conditions, which usually differs between geographical areas (PEST Analysis, 2004).

[3] The PESTEL analysis is an expanded version of the PEST, with the added environmental and legal concerns. The concept was coined by Francis J. Aguilar in 1965 who discusses 'ETPS' for 'Formulating Company Strategy: Scanning the Environment' (Aguilar, 1967).

3.1.2 Industry Environment

The industry environment is the second layer in Figure 3.1, in which a company operates. An industry can be divided into four stages; Introduction, Growth, Maturity and Decline (Grant, 2013, p.209). These stages are described within the *Industry lifecycle*, illustrated in Figure 3.3. The introduction stage is characterised by low sales and few customers which are generally unaware of the products. Furthermore, the technology is novel, produced in small scale and customers that do purchase are considered to be risk-tolerant. The growth stage is characterised by an accelerating market penetration as the performance of the technique and the efficiency to manufacturer the product are improved. The technology advance rapidly and competition is primarily between alternative technologies and design configurations (Grant, 2013, p.210). Increasing market saturation leads eventually to the maturity stage, characterised by high competition as well as mergers and acquisition among companies. Finally, the industry becomes challenged by new industries that can produce superior substituting technologies and eventually the industry begins to decline (Grant, 2013, p.209).

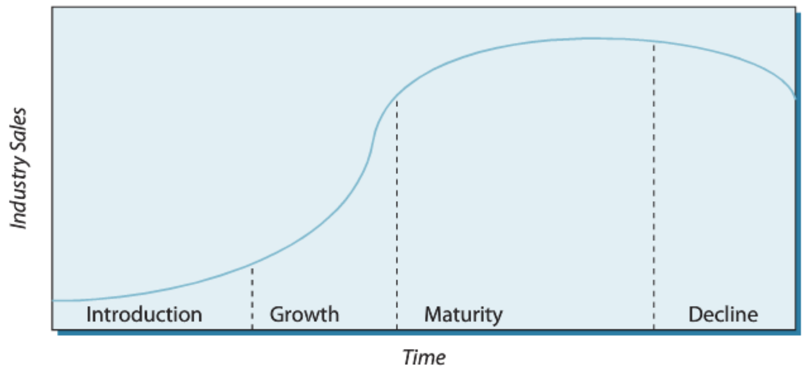

Figure 3.3 The *Industry Lifecycle (Grant, 2013, p.210).*

The outcomes of competition between rival designs and technologies in the growth stage eventually converge by the industry around a *dominant design*. A dominant design can be defined as a product architecture that defines the look, functionality and production method for the product and becomes accepted by the industry (Grant, 2013, p.210). Once an industry has set around a dominant design, the product innovations generally shift to process innovations. The shift is characterised by economics of scale in productions with the purpose of reducing cost as well as standardisation of the processes. Furthermore, the perceived risk for customers to purchase reduces during this stage (Grant, 2013, p.211). When industries reach maturity, customers become aware of the performance attributes of rival manufacturers' products and services and thus become more price sensitive (Grant, 2013, p.212).

When analysing an industry, the attractiveness of an industry in particular, common factors that are naturally to consider are the prevailing competition and profitability[4] in that industry. According to Grant (2013, p.65), the *Porter's five forces*, developed by Michael Porter in 1979 (Porter, 1979), is still the most widely used framework for classifying and analysing these two factors. The framework can be viewed as a competition framework, regarding profitability

[4] Here, the profitability is defined as the rate of return on capital relative the cost of capital.

determined by five sources of competitiveness. These five forces are (1) Threat of new entrants, (2) Threat of substitute products or services, (3) Bargaining power of buyers, (4) Bargaining power of suppliers, and lastly (5) Rivalry among existing organisations. These are illustrated in Figure 3.4 and the content of each force is described in more detail in the following paragraphs. The strongest competitive forces ultimately determine the profitability and become the most important ones when formulating strategy (Porter, 2008).

Figure 3.4 *The Five Forces that shape industry competition (Porter, 2008, p.80).*

Threat of new entrants – This force is related to the entry barriers of the industry, factors that new entrants must overcome (Johnson *et al*., 2011, p.55). This in turn relates to a number of aspects. Experience curve effects can give incumbents critical advantages since they have the required knowledge and expertise of the industry. Brand recognition and customer loyalty could also provide entry barriers (Grant, 2013, p.68). In some industries, access to supply and distribution channel can be of strategic importance and vertical integration is one common way to control these (Johnson et *al*., 2011, p.57). Other aspects of entry barriers are governmental- and legal barriers and the retaliation expectation from the incumbents in the industry.

Threat of substitute products and services – The price a customer is willing to pay is subjective to the availability of other products and services. For instance, the absence of substitutes in a market implies that the demand is inelastic with respect to price, and vice versa (Grant, 2013, p.65). Moreover, the price/performance ratio is related to substitution threats. If, for instance, a substitute is considerably more expensive, it is considered a threat if it offers performance advantages that the customer value (Johnson *et al*., 2011, p.57).

Bargaining power of buyers – The buyers in this context is the organisations first tire customers and thus not necessary end customer. The buyer power is related to the supplying company's price sensitiveness, implying if the buyers are powerful, they demand lower prices (Johnson *et al*., 2011, p.58; Porter, 2008). The power of a buyer depends on; the concentration of buyers, i.e. if there are a few large customer groups that accounts for most of the sales, low switching costs and increasing competition for buyers (Grant, 2013, p.71).

Bargaining power of suppliers – Analysis of what determents the relative power of the supplier is according to Grant (2013, p.72) analogous to the relationship of a company towards its buyers. In this case, the company in question is the buyer. In contrast to the power of buyer, the power of supplier increases in the reversed case, i.e. the concentration of suppliers, high switching costs and increasing competition for suppliers (Johnson *et al*., 2011, p.59).

Rivalry among existing competitors – The four forces presented so far all affect the direct competitive rivalry among the competitors in an industry (Johnson *et al*., 2011, p.60), illustrated as arrows pointing towards this final force in Figure 3.4. This is often the main determinant force of competition and thus profitability within most industries according to Grant (2013, p.69). The intensity of competitive rivalry is highest if; there are many competitors of roughly equal sizes and the industry growth is low (Porter, 2008).

In summary, Porter's five forces model aims to provide organisations with analysis to determine strategies. It emphasises five structural industry features that determines the competitiveness of an industry and thus its profitability opportunity. The purpose of this model is to allow a company to find and establish the organisation in profitable industries and efficiently spot and react to the competitive forces in that industry (Grant, 2013, p.65).

3.1.3 Key Success Factors

The third layer in Figure 3.1, Competitors and Markets, is related to an industry's *key success factors*. This model, illustrated in Figure 3.5, includes analysis of demand, which is related to the market, and analysis of competition, which obviously is related to the competitors.

With the Porter's five forces framework that allows determination of an industry's profitability potential, the question of how this profit is shared among the competing companies in that industry remains. Grant (2013, p.79) suggests that those factors within the industry environment that affects a company's ability to outperform its rivals, ought to be identified – the industry's key success factors[5]. These are factors that management can control and influence through strategy (Hofer and Schendel, 1977, p.77), in contrast to the key drivers of change described by the acronym PESTEL in Section 3.1.1.

For a company to survive and stay profitable it needs to meet two fundamental criteria; to supply the need and to stay competitive. The approach to identify the key success factors of the industry is according to Grant (2013, p.79) to answer the following two questions: (1) *What do the customer want?* and (2) *How does the firm survive competition?* The first question relates to analysis of the demand and from this question, three additional sub-questions arise: *Who are the customers? What are their needs?* and *How do they react to competing offerings?* These sub-questions aim to provide sufficient information of the customers so that those factors that award success to the company can be identified. The second question relates to the competition in the industry and gives rise to a four sub-questions: *What drives competition in the industry? What are the main dimensions of competition? How intense is the competition?* and finally

[5] This term Key success factor was used for the first time by Chuch Hofer and Dan Schendel in 1977.

How can a superior competitive position be obtained? (Grant, 2013, p.79). The framework for the identification of the key success factors of an industry is summarised in Figure 3.5.

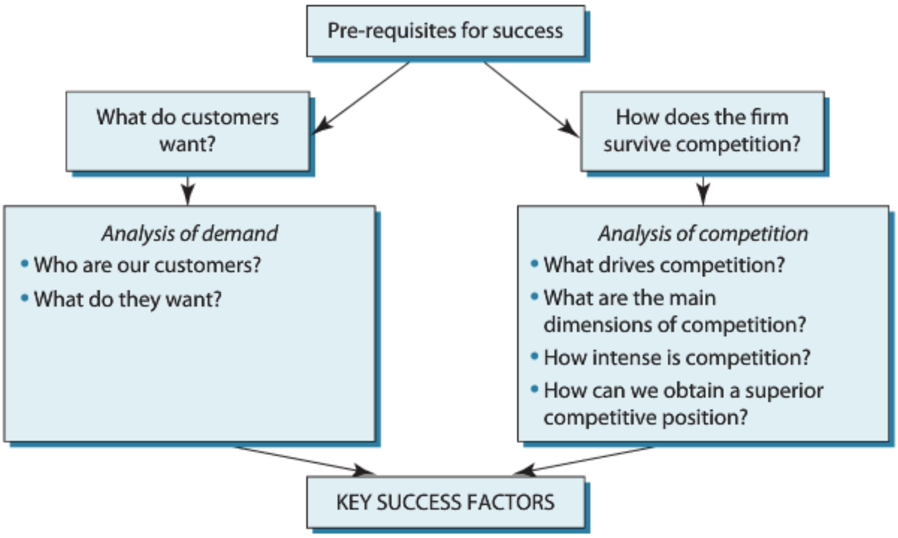

Figure 3.5 *Identifying Key Success Factors (Grant, 2013 p.93).*

Conclusively, the external business environment analyses an industry from a macro-environment, industry environment as well as a competitor- and market perspective and ought to identify an industry's key drivers of change, profitability and competiveness, and key success factors.

3.2 Theory for the Internal Business Environment

The second section aims to present theory and models for analysing the internal business environment applied in Section 6.2. This section presents the centre of the business environment, the company in question, illustrated in Figure 3.1.

3.2.1 Resources and Capabilities

During the 1990s, strategy analysis shifted focus from sources of profit in the external environment to sources of profit within the company, which have been referred to as the *Resource-based view of the firm* (Grant, 2013, p.14). The resource-based view emphasises that each company possesses a unique set of resources and capabilities. Superior profitability is thus achieved by creating a *Competitive advantage*, thus implementing strategies that exploit company's unique strengths (Grant, 2013, p.115). The role of resources and capabilities for formulating strategy has become increasingly important as it has been more apparent for companies that competitive advantages, rather than industry attractiveness, is the primary source of profitability (Grant, 2013, p.112).

A *Resource* is defined as "*the assets that organisations have or can call upon*" and a *Capability*[6] is defined as "*the way those assets are used or deployed effectively*" (Johnson *et*

[6] Capability can also be referred to as *Capacity* or *Competence*, interchangeably, within literature (Hamel and Prahalad, 1992).

al., 2011, p.84). Individual resources are not a competitive advantage in itself, they need to work together to create an organisational capability (Grant, 2013, p.116). Resources can thereby be seen as the source of the company's capabilities, and capabilities the main source of the competitive advantage (Grant, 1991).

Resources can be divided into Tangible-, Intangible- and Human resources (Grant, 2013, p.117). Tangible resources include both financial, such as solidity and liquidity, as well as physical resources such as plants, equipment and land (Grant, 2013, p.118). Intangible resources include technology such as patents and copyrights, reputation such as brands and relationships as well as the organisational culture (Grant, 2013, p.119). For many companies, the intangible resources are considered more valuable than the tangible. Human resources include skills, knowledge and productive effort offered by a company's employees. The human resources are affected by the organisational culture, e.g. the communication and collaboration between employees and their motivation (Grant, 2013, p.120).

Capabilities that are central to a company's strategy and performance can be regarded as *core* (Prahalad and Hamel, 1990) or *distinctive* (Grant, 2013, p.121). These are capabilities that are of outmost importance when generating customer value, for instance to open up for new markets and products, and ought to be difficult for competitors to imitate (Prahalad and Hamel, 1990). In contrast to physical resources, capabilities are enhanced as they are applied and shared. However, they need to be nurtured and protected as knowledge fades if not used (Prahalad and Hamel, 1990). Capabilities that are identified within companies have a tendency to often be broadly defined, for instance manufacturing-, marketing- and supply chain management capability (Grant, 2013, p.124).

To have a *sustainable competitive advantage*, resources and capabilities needs to have four attributes; valuable, rare, inimitable and non-substitutable (Barney, 1991). These resource and capabilities need to be *valuable* in the sense that they exploit opportunities and neutralises threats in company environments. Furthermore, they need to provide value for the customers (Barney, 1991). Moreover, they need to be *rare* among the company's current and potential competitors, thus possessed uniquely by the company. Furthermore, they need to be *inimitable* in the sense that competitors find it difficult to imitate and obtain the resource or capability. Lastly, they need to be *non-substitutable* implying that no other equivalent resource or capacity can function as a substitute (Barney, 1991). For instance, resources that are rare and valuable may be of competitive advantage though the advantage may not be sustainable if the company is incapable of keeping that resource, or if competitors are capable of imitating (Schilling, 2010, p.119).

A company's resources and capabilities can further be appraised in terms of their 'Strategic importance' and 'Relative strength' compared to competitors (Grant, 2013, p.131). The matrix presented in Figure 3.6 illustrates this relation and consists of four quadrants; Key Strengths, Key Weaknesses, Zone of Irrelevance and Superfluous Strengths. *Key Strengths* are those resources and capabilities in which a company has particular strength, while at the same time are important source of the sustainable competitive advantage (Grant, 2013, p.132). In the *Zone of Irrelevance* are resources or capabilities that have low strategic importance as well as low relative strength. *Superfluous strengths* are resources and capabilities that have high relative strength but are not considered strategic important for the sustainable competitive advantage. The level of investments can either be reduced for these resources or a company can develop innovative strategies that turn apparently inconsequential strengths into key strategy differentiators (Grant, 2013, p.133). *Key weaknesses*, on the other hand, are resources and capabilities that have high strategic importance but low relative strength (Grant, 2013, p.132). Furthermore, the appraisal of a company's resources and capabilities are context specific, depending on the competitive environment (Grant, 2013, p.133).

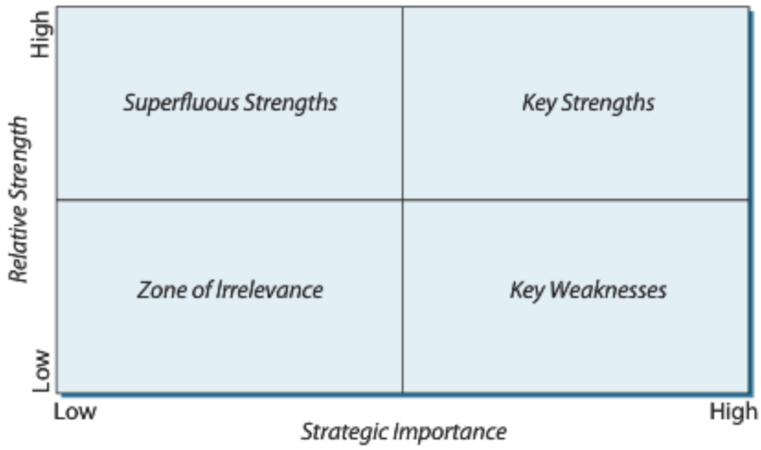

Figure 3.6 *Appraising Resources and Capabilities (Grant, 2013, p.131).*

3.3 The Business Model Canvas

A technology innovation has no single objective value as the economic value of a technology remains latent until it is commercialised through a business model (Chesbrough, 2010). Furthermore, a technology that is launched by different business models, yields different economic outcomes (Chesbrough, 2010). A business model, is defined by Osterwalder and Pigneur (2010, p.14) as "*A business model describes the rationale of how an organization creates, delivers and captures value*".

There are different definitions and composition of business models within literature, e.g. Johnson *et al.* (2008) and, Chesbrough and Rosenbloom (2002), however within the thesis Osterwalder and Pigneur (2010)'s business model is presented and applied. This is due to the fact that it is a widely accepted and applied model, both among academia and industry, including the case company Alfa Laval.

The aim for Osterwalder and Pigneur (2010, p.15) were to create a general, simple and understandable model for describing, generating and visualising business models. The *Business model canvas* consists of nine building blocks that are interlinked among each other; Customer Segments, Customer Relationships, Channels, Value Propositions, Revenue Stream, Cost Structure, Key Partners, Key Activities, and Key Resources (Osterwalder, 2010, pp.16-17). The business model canvas can further be divided into two parts; the front side, consisting of the five first building blocks, that provides value and the backside, consisting of the four remaining building blocks, that provides efficiency (Osterwalder and Pigneur, 2010, p.49). The business model canvas is presented in Figure 3.7 and a description of each building block's content and characteristics is presented in the following two paragraphs and builds upon Osterwalder and Pigneur (2010, pp.20-44).

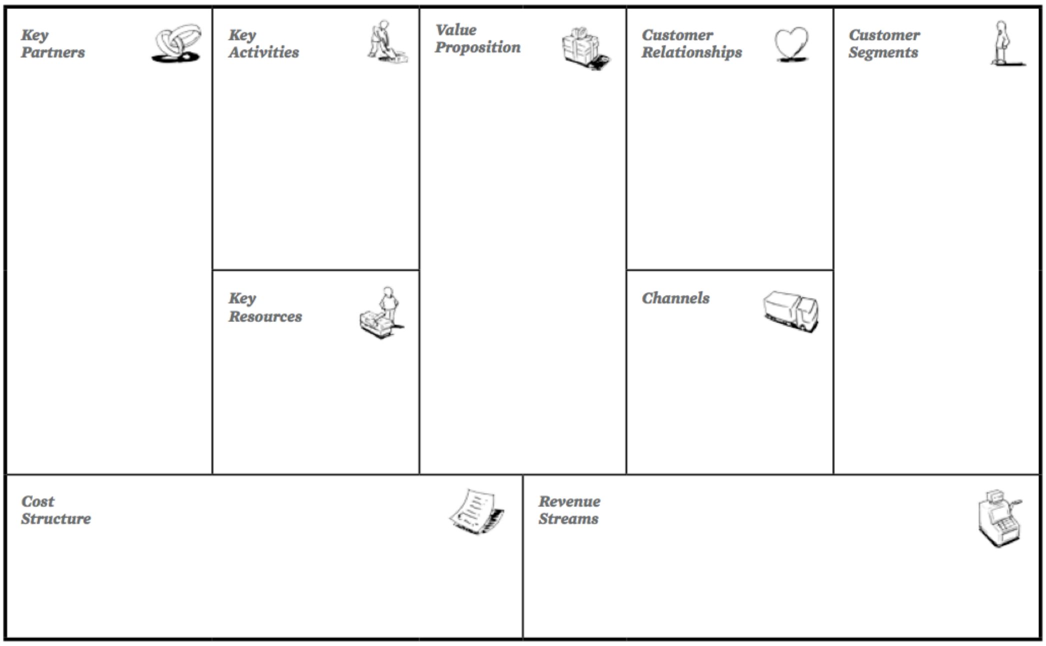

Figure 3.7 *The Business Model Canvas (Osterwalder and Pigneur, 2010, p.44).*

The *Customer Segments* block is the heart of the business model since no company can survive without profitable customers. Thus, it is naturally to begin with defining these segments. These consist of different individuals, groups or organisations that the company aims to supply. The *Value Propositions* seek to solve specific customer problems and satisfy their needs through products and services by the company. It is a bundle of benefits that the company offers its customers, for instance newness, performance, customisation, price, brand and usability. The *Channels* describe a company's interface with the customers, how to communicate and reach each customer segments through distribution and sales channels to deliver the value propositions. The type of relationship a company establish with a specific customers segment is described in the *Customer Relationships* block, which can vary from co-creation and personal sales to self- and automated services. As a result from the successfully delivered value propositions in the front side of the business model, *Revenue Streams* are the payments that the company receives. There are several ways to generate revenue streams, fixed or dynamic pricing as well as licensing, asset sale and usage fees.

On the backside of the canvas, *Key Resources* are the assets of most important to the company that are required to make the business model viable, i.e. to supply the value propositions to the customer segments. *Key Activities* describes the most important actions a company must take to successfully manage its operations. The resources and activities allow the company to create and offer value propositions, reach markets, maintain relationships with customers and capture revenue. The *Key Partnership* building block describes the network of suppliers and partners that the company uses to optimise the business model, reduce risks and acquire resources. Finally, the *Cost Structure* block describes all costs incurred to operate the model and could either be value-driven or cost-driven.

4 METHOD

The aim of the chapter is to outline the research design, the research process and the data collection applied in the thesis. The chapter furthermore describes how the data has been collected and analysed for evaluating the new business opportunity, externally within the Oil spill response industry as well as internally within Alfa Laval. The chapter ends with a discussion of the quality of the research in terms of validity and reliability.

4.1 Research Design

The purpose of the thesis is to provide knowledge about the Oil spill response industry as a basis for decision making regarding whether the case company Alfa Laval should enter the industry with their new skimmer equipment or not. Furthermore, the thesis aims to provide recommendations regarding strategic-fit and proposes a business model for the new skimmer equipment. Thus, a descriptive practice oriented research study is required. A qualitative research approach has been selected since, in line with Bryman and Bell (2011, p.286), it provides a rich and descriptive understanding of the environment and its possibilities, which is necessary in order to fulfil the purpose of the thesis.

Research designs provide frameworks for how to collect and analyse data in a study (Bryman and Bell, 2011, p.40). When the aim of a study is descriptive or explorative in nature, a case study is useful as research design (Yin, 2003). A case study can be defined as "*An in-depth empirical investigation of a single instance or setting to explain the processes of a phenomenon in context*" (Tharenou *et al*., 2007, p.74). In business research, a case study research is particularly useful when the phenomenon under investigation is difficult to study outside its natural setting and when the concepts and variables are difficult to quantify (Ghauri and Gronhaug, 2011, p.40).

In the thesis, the research consists of a single case study since it allows in-depth examination of questions of the type 'how' and 'why' (Yin, 2003). These questions are important to extensively evaluate the business opportunity with the new skimmer equipment, both internally within Alfa Laval as well as externally within the Oil spill response industry. However, as discussed further in the Research Quality Section 4.4, due to its nature, a case study has limited generalisability from its context. The advantage of using a case study research in the thesis is though that it provides thick descriptions and the ability to study the Oil spill response industry and the company Alfa Laval in a practical context.

4.2 Research Process

The research process describes the overall process and its different parts. The research process is divided into four parts; external business environment, internal business environment, strategic-fit and business model canvas, respectively, illustrated in Figure 4.1.

The first part, the external business environment, aims to identify key drivers of change from a macro-environmental perspective, profitability and competitiveness from an industry perspective and key success factors from a competitor- and market perspective within the Oil spill response industry. The second part, the internal business environment, aims to identify and appraise the resources and capabilities that Alfa Laval possesses, which can be utilised as a competitive advantage in the Oil spill response industry. In particular, their recent acquisition of Frank Mohn and the functionality of the new skimmer equipment. The first and second part of the research process aim to answer the two research questions of the thesis, respectively and are the main parts of the thesis. Furthermore, these two parts are dealt with independently.

The third part of the research process evaluates if there is a strategic-fit between the analysis of the external- and internal business environment and aims to provide recommendations whether Alfa Laval should enter the Oil spill response industry or not. The fourth and final part aims to propose a business model for the launch of their new skimmer equipment that utilises Alfa Laval's competitive advantage. In combination, the four parts of the thesis aim to answer the two research questions and thus fulfil the purpose of the thesis.

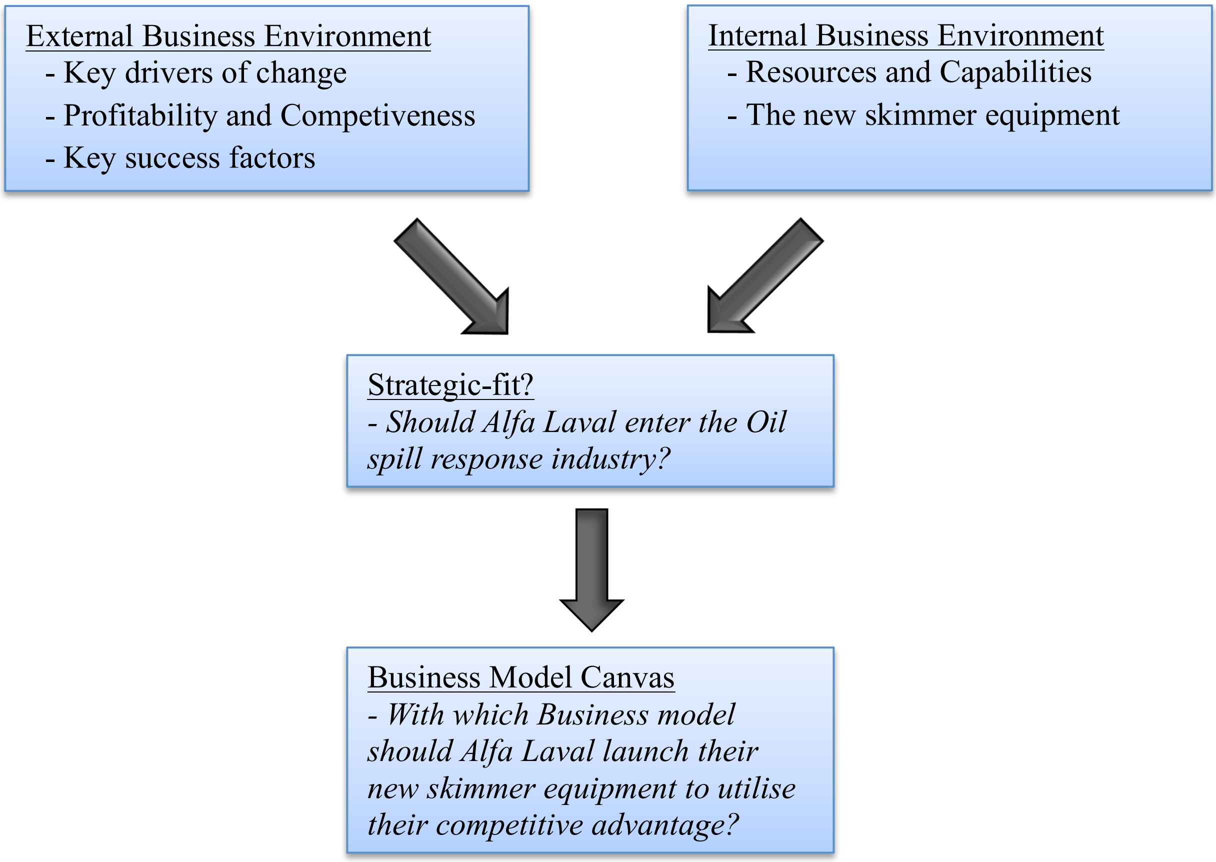

Figure 4.1 *Summary of the Research Process.*

4.3 Data Collection

Since research design is the framework for how to collect and analyse data, research methods are the preferable techniques used for collecting the data (Bryman and Bell, 2011, p.41). An exploratory and qualitative research method is required, in order to answer the research questions of the thesis, as stated earlier. Open interviews are preferable when the objective is to explore a new area where the researchers have limited prior knowledge (Bryman and Bell, 2011, p.249). This method allows the researchers to acquire the respondents' knowledge and understanding of the subject since it is revealed in their own terms as no suggested answers are given (Bryman and Bell, 2011, p.249). Furthermore, semi-structured interviews were chosen prior to unstructured interviews since they allow the researches to address the more specific issues and enable a degree of comparability (Bryman and Bell, 2011, p.467). At the same time, it provides the interviewer the possibility to deviate from the interview guide by varying the sequence of questions and use follow-up questions into particularly interesting topics resulting from the interviewees' answers (Bryman and Bell, 2011, pp.466-473). Moreover, public- and organisational documents have been used as a complementary research method in order to triangulate the results from the semi-structured interviews.

The data collection for the thesis entails both primary and secondary data. Primary data consists of semi-structured interviews, both internally within Alfa Laval as well as different actors within the Oil spill response industry. Secondary data consists of articles, books, websites, patents and publications of the subject.

In order to provide Alfa Laval with recommendations regarding strategic-fit and propose a business model for their new skimmer equipment, the research process consists of two main parts, as stated. The first part aims to evaluate the opportunity externally in order to identify key drivers of change, profitability and competitiveness, and key success factors of the Oil spill response industry. The second part aims to evaluate the opportunity internally in order to identify and appraise resources and capabilities that Alfa Laval possesses that can be utilised as a competitive advantage in the Oil spill response industry. The way data was collected and samples groups selected for the two separate parts are described in further detail in the following two sections.

4.3.1 External Business Environment - Oil Spill Response Industry

The aim of the first part of the research process was to analyse the Oil spill response industry from macro-environment, industry environment, and competitor- and market perspective in order to identify the key drivers of change, the profitability and competiveness and the key success factors of the industry. The first part of the research process can further be divided into three phases, each described in more detail in the following paragraphs.

The first phase was explorative with the objective to provide knowledge and an overview the industry as well as to identify customer segments. A combination of semi-structured interviews and documents where used as research methods. To provide valid statistics for the analysis of the external business environment of the Oil spill response industry, documents from *International Petroleum Industry Environmental Conservation Association* (IPIECA) and *International Tanker Owners Pollution Federation* (ITOPF) as well as the books by Merv Fingas[7] (2010) and (2013) have been studied. Semi-structured interviews were conducted with interviewees that possessed broad industry knowledge as well as different customer segments.

The second phase intends to probe deeper into understanding the different customer segments' wants and needs as well as their purchasing behaviour. Semi-structured interviews were

[7] Merv Fingas is a well-respected expert and scientist with more than 30 years of experience within the Oil spill response industry.

conducted with Coast guards, Ports authorities, Remediation firms as well as a manufacturer of oil spill response equipment. The main focus was Sweden, due to convenience and ability to access interviewees.

The third and final phase aims to provide a more global perspective of the industry. The authors attended the *International Oil Spill Conference* (IOSC) in Savannah, United States, May 5th until 8th, 2014. Semi-structured interviews were conducted with different customer segments, skimmer equipment competitors, suppliers, and people with broad industry knowledge. The interviewees were selected and booked in advance. Besides the booked semi-structured interviews, the conference had more than 2000 attendants from 67 nations and during the week the authors had the ability to discuss the industry, business opportunities, challenges and technologies in an informal context. The IOSC conference also provided the opportunity of attending conference sessions. In total, nine sessions including 35 presentations were attended. The sessions extended the knowledge of the industry by identifying the most currently prevalent topics, issues and experts within the Oil spill response industry. The sessions, speaker and topic for each attended presentation are summarised in Section 10.3 in Appendix.

The sample groups of the three phases for the analysis of the external business environment of the Oil spill response industry were selected by *purposive*, *convenience* and *snowballing*. Purposive samples are when the interviewees were chosen based on their ability to contribute to the subject (Bryman and Bell, 2011, p.441). Convenience samples are the ones that are available to the research by virtue of its accessibility (Bryman and Bell, 2011, p.190). Furthermore, snowballing is a form of convenience sampling where the researchers use the initial contacts that have been selected for the research topic to establish contacts with others (Bryman and Bell, 2011, p.192). In total, 37 interviews were conducted with actors in the Oil spill response industry in the three described phases. Out of these, 18 were with potential customers, eight with competitors and eleven to provide in-deep industry knowledge. The time for each interview varied between 30 minutes to three hours. Further details of the different interviews, location and dates are found in Appendix, Section 10.1. Semi-structured interviews were conducted as it provided the ability to discuss predetermined topics, comparability between interviews as well as the ability to ask follow-up questions during the interviews (Bryman and Bell, 2011, p.468). Additionally, all interviews were conducted face-to-face to be able to observe physical response to questions (Bryman and Bell, 2011, p.489) and none of the interviews were recorded to ensure that the interviewee felt comfortable to reveal as much information as possible (Bryman and Bell, 2011, p.487).

4.3.2 Internal Business Environment - Alfa Laval

The aim of the second part of the research process was to evaluate the business opportunity internally, by identifying and appraising resources and capabilities that Alfa Laval possesses, in particular, the functionality of the new skimmer equipment.

To analyse the resources and capabilities of Alfa Laval and understand the functionality of the new skimmer equipment, semi-structured interviews were conducted. Semi-structured interviews were chosen to provide comparability and allow follow-up questions during the interviews. Furthermore, all interviews were conducted face-to-face to be able to observe body language and the interviewee's physical response to questions (Bryman and Bell, 2011, p.489). During the interviews both interviewers were present, one responsible for leading the interview and one for taking notes. A decision was made, in accordance with Bryman and Bell (2011, p.487) that no interviews where recorded as it could lead to that interviewees felt uncomfortable and revealed less information than they would have otherwise. Instead notes where taken and it was convinced that the interviewers were able to return to the interviewee for further clarifications. Each interview was carefully prepared and booked in advance. The time for each interview was approximately one hour.

The sample for the internal semi-structured interviews consisted of 16 people from Alfa Laval in Lund and Tumba, Sweden. It was a purposive sample, applying that is was chosen based on the interviewee's ability to contribute to the subject (Bryman and Bell, 2011, p.441). Furthermore, the selection of the interviewees was made in cooperation with the tutors from Alfa Laval in combination with recommendations from the interviewees. The knowledge about the new skimmer equipment and the Oil spill response industry lies outside the company boundaries, it was thus important that the selection provided a broad range of people from different divisions that could provide different inputs and perspectives. The sample consisted for instance of concept- and business managers, sales managers, engineers, as well as a merge and acquisition manager. Furthermore, the range of people provided sufficient insights into the identification and appraisal of the company's resources and capabilities. Further details of the different positions, location and dates of the interviews are found in Appendix, Section 10.2.

4.4 Research Quality

The quality of the research is in general evaluated based on *validity* and *reliability*. The validity concerns the integrity of the conclusions in a research (Bryman and Bell, 2011, p.42). There are several types of validity, though, for qualitative research studies *external validity* and *ecological validity* are most applicable. Reliability, on the other hand, concerns whether the results of the study are repeatable or not (Bryman and Bell, 2011, p.41).

External validity regards if the results of the study can be generalised beyond the specific research context (Bryman and Bell, 2011, p.43). For a single case study, the generalisability is considered to be low since it is situation specific (Bryman and Bell, 2011, p.61). Additionally, all samples for the study were non-probability samples, which make it less representative for the entire populations and thus the generalisability (Bryman and Bell, 2011, p.190). Rather than to generalise, the main purpose of the semi-structured interviews was to provide a thick description of the case company Alfa Laval and the actors within the Oil spill response industry in order to provide recommendations of whether Alfa Laval should enter the industry or not with their new skimmer equipment. Thick descriptions have been enabled by extensive interview samples for the analysis of the external- and internal business environment. Thus, the recommendations and results of the study concern solely the case company Alfa Laval. However, the analysis of the external business environment of the Oil spill response industry could be regarded as general and thus have high external validity. The identified key drivers of change, the analysis of profitability and competiveness, and the identified key success factors could be regarded as general in the sense that they are applicable for any company that aims to enter the Oil spill response industry as equipment manufacturer or supplier.

Moreover, ecological validity regards if the results are applicable to the intended environment, and not only technically valid (Bryman and Bell, 2011, p.43). The ecological validity can be regarded as high for the thesis as both the case company Alfa Laval and the different customer segments within the Oil spill response industry have been analysed in their natural settings. Furthermore, all interviews, both externally in the Oil spill response industry and internally within Alfa Laval, have been conducted face-to-face in the interviewees' working environment, which enhance the ecological validity. Additionally, the research study was conducted in close cooperation with Alfa Laval, in association with their ordinary activities, and thus providing an important contextual understanding in order to evaluate the new business opportunity.

As stated above, reliability is whether the results of the study are repeatable (Bryman and Bell, 2011, p.41). An issue with qualitative research and case studies in particular, are that they are considered to be subjective, difficult to replicate and lack transparency (Bryman and Bell, 2011, p.408). The reliability of the study is thus considered to be low, as the results are dependent on many momentary forces. However, the authors have tried to overcome these criticisms by thoroughly describe research design, research process, selected methods, data collection and samples.

5 EMPIRICAL FINDINGS

The aim of the chapter is to present the empirical findings, the foundation for the analysis in Chapter 6. The first section presents the Oil spill response industry, including oil properties, oil spill recovery technologies, customer segments, customer buying behaviours, manufacturers of skimmer equipment and geographical differences in the market for oil spill response equipment. These subjects are described in different sub-sections, respectively. The second section presents two important resources of Alfa Laval for the Oil spill response industry; their recent acquisition of Frank Mohn AS and the functionality of the new skimmer equipment. All empirical findings are based on external- and internal interviews as well as conference sessions, presented in the appendix, if nothing else is stated.

5.1 The Oil Spill Response Industry

The first major and public aware oil spill was the *Torrey Canyon* on the southwest coasts of United Kingdom in 1967. The incident was caused by a wreck in a tanker, which resulted in 130 000 tons of spilled crude oil and consequently, 15 000 seabirds were killed and 300 kilometres of oil reached the coastlines of England and France (Fingas, 2010, p.11). The incident is still considered as one of the most catastrophic oil spills and lead to international legal and environmental legacy. Furthermore, the incident could be seen as the foundation for the Oil spill response industry. In the 1970s, other significant oil spills around the world brought wider attention to the issue on an international scale. The tanker incident *Exxon Valdez* in Alaska 1989 is one of the most notorious spill incidents in history. The oil spill was by no mean the largest, however the environmental consequences were catastrophic. Since year 2000, several major incidents have occurred; the tanker incident *Prestige* in Spain 2002, the pipeline breakage *Prudhoe Bay* in Alaska 2006, the tanker incident *Hebei Spirit* in Korea 2007, and the most recent example, the well blow-out *Deepwater Horizon* in Gulf of Mexico 2010, which is the largest oil spill incident so far with 500 000 tons of spilled oil (Fingas, 2013, p.10).

Major oil spills attract the attention of the public and media. In recent years, this attention has created a global awareness of the risk for oil spills and the environment consequences. Furthermore, the public are aware of major oil spills, however, many are generally unaware that hundreds to thousands of oil spills occur every day world-wide (Fingas, 2010, p.7). In United States alone, 15 incidents with more than 4 000 litres of oil are spilt every day at sea (Fingas, 2013, p.4).

Moreover, oil is a necessity in industrial societies and the world's oil consumption is increasing, with over 20 million tons of oil consumed each day (Fingas, 2013, p.2). The movement of oil from the oil field and drilling operations to consumers involves as many as 10 to 15 transfers, including production, transportation, storage and consumption (Fingas, 2013, p.1). Thus, oil spills occur anywhere from incidents during explorative drilling operations, production at oil rigs, pipeline breakages, collisions and groundings of tankers during transportation as well as incidents with vehicles and ships that use petroleum products as fuel (Fingas, 2010, p.15). In addition, oil spills and discharges occur from shipwrecks located at the bottom of the seas. There are more than 8 500 recorded shipwrecks world-wide, estimated to contain over 20 million tons of oil (Fingas, 2010, p.40).

Furthermore, as a consequence of the enhanced demand for oil in new emergent countries, more tankers are required in the transportation of oil and thus the risk for collisions and groundings are increased (ITOPF, 2014). Moreover, current oil reserves are being depleted. The enhanced demand forces the oil and gas industry into searching for oils in new areas, often with tougher conditions, such as in deeper waters and in Arctic regions. From an historical point of view, in the last 50 years, 85 percentages of all drilling incidents have occurred due to explorative offshore drilling (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011, p.41). However, despite the increased risk for oil spills, the amount of oil that is spilt into sea has decreased significantly from 635 000 tons annually in 1960s to 300 000 tons today. Even the number of oil spills has decreased since then. This is related to significant spill prevention within the industry and liability legislation as a consequence of the oil spills of Torrey Canyon in 1967 and Exxon Valdez in 1989 (Fingas, 2010, p.12). The most extensive legislation, the *International Convention on Oil Pollution Preparedness, Response and Co-operation 1990* (OPRC) aims to facilitate international co-operation and mutual assistance in preparing for and responding to major oil spills (IMO, 2014). The convention is ratified in 84 nations, representing 65 percentages of the world's oil consumption (IPIECA, 2005). However, despite significant progress in reducing the number of oil spills and the amount of oil spilt into sea, the risk for major oil spill incidents remains (Fingas, 2010, p.8).

A major oil spill, such as the Deepwater Horizon, has none the less economic-, socioeconomic- and environmental consequences. The average cost for cleanup operation from an oil spill of this magnitude is often under stated, ranging from US $40 to $400 per litre, depending on type of oil and where the spill is located (Fingas, 2013, p.1). Oil spills located close to shorelines are ten times more expensive to clean up and sanitise than if they were located offshore, and furthermore, located inland is a hundred times more expensive. Efforts are therefore directed towards prevention of oil spills from reaching shoreline and inland. The total costs for oil spill cleanup after a major incident could be substantial. For instance, the costs for recovering the oil at Deepwater Horizon were according to analysts more than US $60 billions, not included the externalities, i.e. the costs for the environmental damages (Reuters, 2012). Furthermore, the direct costs from oil spill response, such as the recovery operation, are often compensated by international fund conventions. *The International Oil Pollution Compensation Fund* can compensate up to US $306 million and the *Supplementary Fund Protocol* can compensate up to US $1 billion (IPIECA, 2005).

In addition to the direct costs for recovery operations of an oil spill, the economic sectors that rely on clean seawater and coastal areas can experience substantial economic losses. The greatest economic impact are often felt in commercial fisheries and tourism, although other sectors such as power plants, refineries, shipping, ports and chemical production can be affected (ITOPF, 2013a). Additionally, media reports from an oil spill can result in loss of market confidence, which might deter tourists from visiting the areas as well as purchasing or eat seafood, even long after the oil has been cleaned up (ITOPF, 2013b).

Moreover, oil spills can cause a wide range of impacts on the marine environment by two mechanisms; physical smoothing or chemical toxicity (ITOPF, 2013a). Large quantities of highly viscous oils, such as crude oil, can cause widespread damage in the intertidal zones of shoreline through smothering, resulting in higher mortality of animals. Low viscous oils, such as diesel and gasoline, on the other hand, have high biological availability and can cause subtle damage to behaviour, feeding, growth and reproduction of organisms (ITOPF, 2013c). Further description of different type of oils and their viscosity properties are presented in Section 5.1.1. The environmental consequences from an oil spill are furthermore dependent on the biological composition of the affected area and its sensitivity to oil pollution. Regions with high amounts of plankton, fish, seabirds, reptiles, seaweed, marshes and coral reefs are all particularly sensitive to oil spills (ITOPF, 2013c). Furthermore, the occurrence of contamination in seafood and organisms results in public health concerns and may give rise to the imposition of fishing restrictions (ITOPF, 2013b).

Lastly, an oil spill can be classified into three categories depending on the size and location of the spill; Tier 1, 2 and 3 preparedness and response are illustrated in Figure 5.1 (IPIECA, 2007). *Tier 1* spills are operational in nature and occur at or near the operator's facility, as a consequence of their own activities. Thus, the operator is expected to respond with their own resources. *Tier 2* spills are larger in size and affect a wider geographical area. Thereby, additional resources and support from other local facilities or dedicated equipment stockpiles are required. Lastly, *Tier 3* spills are those that, due to their scale and likelihood to cause major impact, require resources and support from a range of national and international sources (IPIECA, 2007). These responses are often government led and involves Tier 3 response centres, strategically located stockpiles for oil spill response (IPIECA, 2005) The reliance on the different tiers differ in jurisdictions, for instance, Trinidad and Tobago solely rely on Tier 1 preparedness and response.

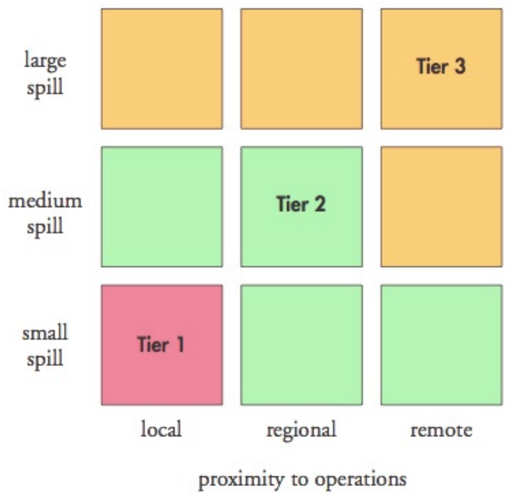

Figure 5.1 *Tier classification of Preparedness and Response (IPIECA, 2007, p.5).*

5.1.1 Oil properties

Oil is the collective term of a massive number of products consisting of various chemical substances, carbon and hydrogen in particular. There are many applications in which various oil types are used, such as cooking, cosmetic, painting, heat transfer, lubrication and fuel. In this section, only petroleum oils and products are discussed.

Crude oils are unprocessed oils and thus consist of a mixture of hydrocarbon compounds, ranging from smaller, more volatile compounds to very large, non-volatile compounds. This mixture of compounds depends on where the oil was originally found, i.e. the geological formation of that area (Fingas, 2013, p.33). Furthermore, the mixtures of hydrocarbon compounds strongly influence the properties of oil and determine the requirements and difficulties when attempting to recover it from an oil spill incident. However, refined oils, such as gasoline or diesel fuel are mixtures of fewer compounds and thus their properties do not vary as much as crude oils (ITOPF, 2013d). In terms of number oil spills and volume spilt, the most common oil spills are diesels, though, in total volume, bunker oils are more common (Fingas, 2013, p.5). Bunker oil is the heaviest fuel oil that is processed from crude oil. Furthermore, oils can be described in terms of their physical properties, determining how oils react when spilled into water. The properties of interest affecting the recovery to high extents are *density* and *viscosity* as well as how these properties change over time due to *weathering* processes.

Density

The density of a substance is its mass relative the volume. This is the most important unit measurement when analysing and specifying oils (Fingas, 2013, p.37). The density of oil surrounded by water determines whether it floats on the surface or sink. Oils of higher density than water, rounded up to 1.00 $kg \cdot dm^{-3}$ in this context, sink and oils of lower density float. However, the density of seawater is higher, around 1.03 $kg \cdot dm^{-3}$, which allows heavier oils to float. The density of seawater depends mostly on its concentration of salt.

Since oil consists of a mixture of smaller and larger hydrocarbon compounds, the lighter fractions evaporate quicker and the density of oil increases with time (ITOPF, 2013d). Hence, the risk that the oil sinks increase over time. Moreover, density is the property used by the petroleum industry to define crude oils from light to heavy.

A specific density measurement for oils, relative the density compared to water at 15.5°C, is denoted *specific gravity* (SG). The SG for oil is the same as its density at that temperature. Another gravity scale is the *API gravity* (American Petroleum Institute). This scale is based on the density of water, which has an arbitrarily assigned API gravity value of 10 (10 degrees) (Fingas, 2013, p.39). Thus, oils with lower SG have higher API gravities. API gravity is calculated with the following formula: API gravity = 141.5 ÷ SG – 131.5. Thus, oils with high densities have low API gravities and vice versa. This measurement is occasionally the base for the oil price in the UNITED STATES (Fingas, 2013, p.39). Moreover, the API scale is often used when classifying oils into groups; Gasoline, Diesel, Light crude, Heavy crude, Intermediate fuel oil, and Bunker (Fingas, 2013, p.38).

Viscosity

The viscosity[8] of a liquid is the liquid's internal resistance to flow and influences the spread of the oil surrounded by water. A liquid of low viscosity implies a more readily spread (Fingas,

[8] Viscosity is a physical phenomenon that is either kinematic or dynamic. Kinematic viscosity = dynamic viscosity ÷ density.

2013, p.35). In terms of oil spill response, it is the physical property that determines which method and equipment that can be applied during recovery. Viscosity is measured in Stoke (St), 1 St = 1 $cm^2 \cdot s^{-1}$, and water at 20°C has a kinematic viscosity of about 1 cSt. The viscosity of liquids is logarithmic dependent on the ambient temperature, as the temperature raises the viscosity decreases and vice versa (ITOPF, 2013d).

Furthermore, the viscosity of oils is determined by the content of lighter and heavier fractions. A greater percentage of lighter fractions imply a lower viscosity and thus a more readily spread. Oils can further be classified into low-, medium- and high viscosity oils. Low viscosity oils, e.g. gasoline, diesel and other marine fuel oils, have a range of 1 to 10 cSt (15°C). Medium viscosity oils, e.g. light crude oils, have a range of 10 to 1 000 cSt (15°C). Finally, high viscosity oils, e.g. heavy crude oil, intermediate fuel oil and bunker, have a range of 1 000 to 50 000 cSt (15°C) (Fingas, 2013, p.38).

Moreover, the *surface tension*, i.e. the force of attraction or repulsion between the surface molecules of two liquids, must be considered along with the viscosity since surface tension alone does not account for spreading behaviour of a liquid. This property, together with viscosity, gives an indication of the speed and to what extent a surface liquid spreads. Thus, lower surface tension with water implies higher extents of spreading (Fingas, 2013, p.40).

There are a number of other properties describing the characteristics of oils. These are the *pour point* of an oil, i.e. the temperature at which the oil becomes semi-solid and thus loses its spread characteristics, the *flash point* of an oil, i.e. the temperature at which oil ignites upon exposure to fire, the content of *asphaltenes*, the *solubility* is the measure of how much of an oil dissolves in the water, and the *distillation fractions* of an oil, representing the parts of an oil that are separated at given temperatures. However, these do not affect the recovery operation as much as the density and viscosity properties.

Weathering Processes

Once oil is spilt into the sea it undergoes a number of chemical and physical processes. These processes are referred to as weathering processes and have high impact on the properties of oils over time (ITOPF, 2013d). For instance, recently spilt oil can be burned, though, after a couple of hours, depending on the type of oil and ambient conditions, this is no longer optional. An understanding of these weathering processes is thus important since these factors are fundamental to all aspects of oil spill response (ITOPF, 2013d). The weathering processes of *spreading*, *evaporation* and *emulsification* are further discussed in more detail, since these have the most impact on oil properties and thus the oil spill response operations.

As soon as oil is spilt, it immediately begins to spread over the surface area. The speed of the spread depends to high extent on the viscosity of the oil and the volume that is spilt (ITOPF, 2013d). As the oil spreads, the thickness of the oil slick is reduced. Furthermore, the more volatile components of the oil evaporate quicker to the atmosphere. The spreading rate affects the rate of evaporation, as a higher surface area enhance the process of evaporation. The evaporation rate furthermore depends on the type of oil, in particular its volatility, the ambient temperature and wind strength (ITOPF, 2013d). Moreover, as lighter fractions evaporates, the remaining oil increase in density and viscosity. Over a period of days, light fuels such as gasoline entirely evaporate at temperatures above 0°C, whereas only a small part of heavier bunker oils evaporate (Fingas, 2013, p. 44). In addition to the weathering process, oil spills drift according to prevailing currents and winds (ITOPF, 2013d).

Emulsification is in many ways considered as the weathering process that affects oil spill response operations the most. It is the process in which oil is mixed with and takes up water, and subsequently forms water-in-oil emulsions (ITOPF, 2013d). Emulsions require that the product has a certain amount of stability, otherwise, the process is called *water uptake* (Fingas, 2013, p.43). An emulsion is mixtures of liquids that normally are immiscible. The less viscous the oil is, the faster it tends to take up water. As the amount of water that oil incorporates increases, the density of the emulsion approaches that of sea water and thus eventually sinks. Stable emulsions contain up to 80 percentages of water, are often semi-solid and take the colour of red/brown or yellow/orange (ITOPF, 2013d). These are highly persistent and may remain emulsified indefinitely. Less stable emulsion may though be separated back into oil and water. Oils with viscosity of common motor oils can triple in volume and become practically solid through the process of emulsification (Fingas, 2013, p.49). As the oil is taking up water, the volume increases to as much as five times, which has obvious impacts and difficulties for cleanup operations. Furthermore, the viscosity of emulsified oil increases by as much as a thousand times, depending on the type of emulsion that is formed, and can be up to 1 000 000 cSt (ITOPF, 2013e).

5.1.2 Oil Spill Recovery Technologies

Once an oil spill has occurred there are various methods to manage and recover the oil. These are mechanical recovery through skimmers, in-situ burning or chemical dispersants. Mechanical recovery with skimmers is further part of a larger system, the Oil spill recovery systems. These are described in further detail in the following paragraphs.

Mechanical Recovery: Skimmers

A skimmer is a mechanical device designed to recover oil from a surface of water by skimming the oil (Fingas, 2013, p.97). Thus, a skimmer can only recover oils with densities below water, i.e. those that float. The functionality of a skimmer is dependent on a number of factors; the type of oil, its properties such as viscosity, thickness of the oil layer, weathering such as the progression of emulsification, the presence of debris and ice, ambient temperature, and sea conditions such as currents and winds (Fingas, 2013, p.98). Skimmer performances are evaluated by two criteria; *Oil recovery rate*, the volume of oil recovered by time unit, and *Oil recovery efficiency*, the volume of recovered oil in relation to total volume (ASTM, 2014). The performance of skimmer can be tested and evaluated at either Ohmsett, a large outdoor testing facility located in United States, or SINTEF, an indoor testing facility in Norway. At these two testing sites, large oil spills can be simulated. Additionally, the Norwegian response organisation NOFO, has an annual on-water demonstration at sea for testing and evaluating new oil spill response equipment.

Skimmers can further be classified into *oleophilic-* and *non-oleophilic* skimmers. Oleophilic skimmers use surface materials to which oil can adhere. The oleophilic skimmers consist of five main groups; disc-, drum-, brush-, belt-, and rope skimmers. The most common non-oleophilic skimmer is the weir skimmer, although suction skimmers can be used in some occasions (Fingas, 2013, p.99). The six different skimmers are further described, as they all have distinct advantages and disadvantages respectively. A summary of these skimmers are presented in Table 1 on page 31.

Disc skimmers consist of rotating discs that oil adheres to and is scraped off by wiper blades into a collection well, illustrated in Figure 5.2. Disc skimmers operate most efficiently on medium viscosity oils, such as light crude oils, and are suited to work in conditions of relatively calm waters with small waves and among weeds or debris. Disadvantages are though the low recovery rate and that they work poorly with low- and high viscosity oils (Fingas, 2013, p.99). *Drum skimmers* operate in similar manners, although they use drums where oils adhere to, instead of discs, illustrated in Figure 5.2 (ITOPF, 2013e). The drum skimmers operate effectively with low- and medium viscosity oils, such as fuels and light crude oil, and similar to disc skimmers, these are ineffective at recovering high viscosity oils (Fingas, 2013, p.99). It is common that manufacturers use grooved discs and drums to provide a higher surface interface, which improves the recovery rate of the skimmers (Broje, 2006). Additionally, disc- and drum skimmers both require a relatively thick oil slick to operate efficiently (ITOPF, 2013e). *Brush skimmers* use plastic tufts attached to drums, chains or belts where oils adheres to. As for disc- and drum skimmers, the oil is scraped off into a collection well, illustrated in Figure 5.2 (Fingas, 2013, p.100). However, brush skimmers are most efficient for high viscosity oils, such as bunker and crude oils, and ineffective for low- and medium viscosity oils (Fingas, 2013, p.101).

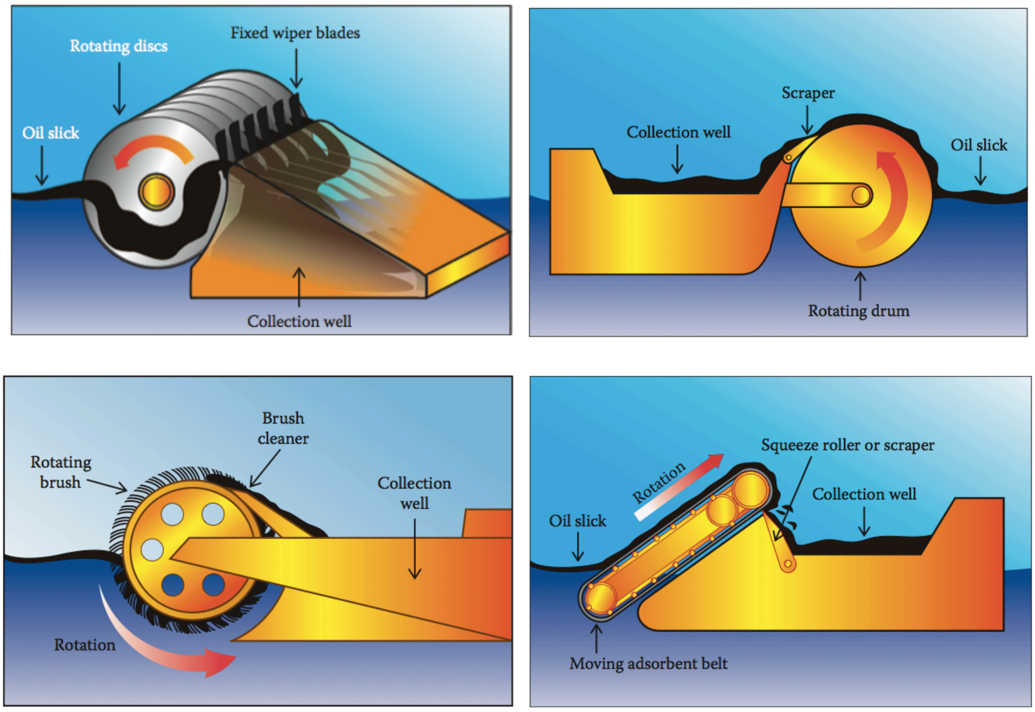

Figure 5.2 *To the upper left is a Disc skimmer, to the upper right a Drum skimmer, to the lower left a Brush skimmer and to the lower right is a Belt skimmer illustrated (Fingas, 2013, p.100).*

Belt skimmers lift the oil from the water by belts and the oil is then removed by scarpers or squeeze rollers into a collection well, illustrated in Figure 5.2 (ITOPF, 2013e). However, the motion of the belt causes turbulence on the water and thus drives the oil away from the skimmer. Thereby, oil is required to be forced to the belt, either manually or by water spray. New skimmers have overcome this issue by an inverted belt skimmer, which operates under the water surface (Fingas, 2013, p.99). Belt skimmers of all types operate most efficiently in high viscosity oils and are as brush skimmers ineffective with low- and medium viscosity oils. Belt skimmers are incorporated in cleanup vessels since they are larger in size than disc-, drum- and brush skimmers. *Rope skimmers* operate in similar manner to belt skimmers, using oleophilic rotating ropes instead of the belt. The ropes are rotating either horizontally, as illustrated in Figure 5.3, or vertically. Rope skimmers operate most efficiently with medium viscosity oils and are particularly useful for recovery of oil in the presence of debris and ice (Fingas, 2013, p.102).

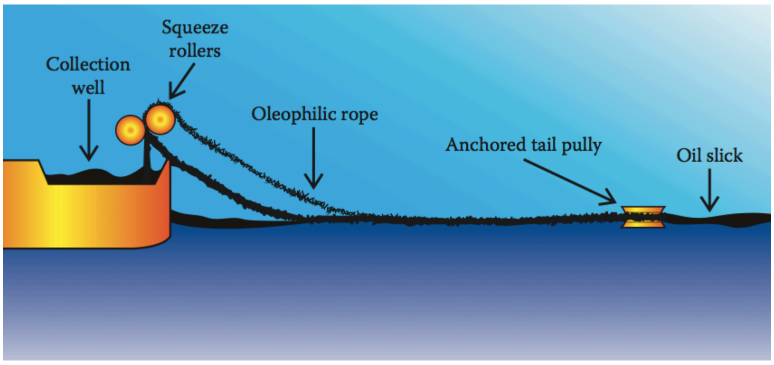

Figure 5.3 *Horizontal Rope skimmer (Fingas, 2013, p.105).*

Concerning all oleophilic skimmers, as the progression of weathering increases and the oil emulsifies, the ability for the oil to adhere to the surface decreases, as the oleophilic surface only adheres to oil. Thereby, the recovery rate and the efficiency of oleophilic skimmers are decreased during the progression of weathering processes (ITOPF, 2013e).

Weir skimmers, in contrast to the skimmers described, are non-oleophilic and rely on gravity to drain the oil from the surface of water into collection wells, illustrated in Figure 5.4 (ITOPF, 2013e). The advantages with weir skimmers are their high recovery rate capacity and their ability to recover oils with higher degree of emulsification. Although, the disadvantage is that they operate poorly in rough waters. As the weir skimmer rock back and forth by waves, it alternatively sucks in air or water, instead of oil and thus reduces the oil recovery efficiency. New weir skimmers have three or more floats to keep the weir at the oil-water interface. The floats keep the skimmer horizontally with the surface and thus reduce the amount of water that is collected and improves the oil recovery efficiency. Moreover, weir skimmers operate ineffectively with high viscosity oils and in the presence of ice or debris. Conclusively, they have their highest capacity for low- to medium viscosity oils in calm waters (Fingas, 2013, p.105).

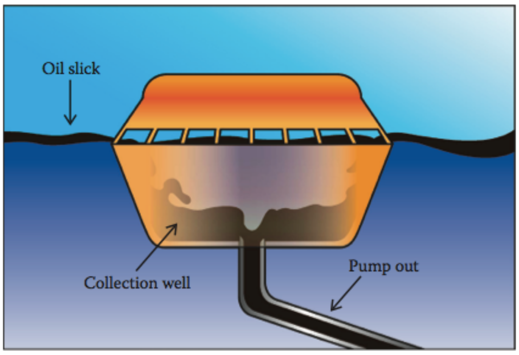

Figure 5.4 *Weir Skimmer (Fingas, 2013, p.107).*

To sum up, the six presented skimmers all have distinct advantages and disadvantages for different conditions, illustrated in Table 1. Thus, no single skimmer can cope with all encountered situations and therefore stockpiles of resources for oil spill response often consist of selections of different skimmers (ITOPF, 2013e). In an oil spill response operation, the skimmers that are used are often changed during the operation as conditions change due to weathering (ITOPF, 2013d). Furthermore, in common for all skimmers are that they operate optimally in calm areas and as long as the oil is non-weathered (Fingas, 2013, p.98). However, current skimmer equipment cannot work efficiently in following four conditions; in the presence of large amount of ice and debris, in wind above 5 m/s, weathered oil and with high range of different viscosities. Customers demand skimmer equipment that is able to operate under at least one of these circumstances. However, during other conditions, there are a range of different skimmers available from oil spill response equipment manufacturers (see Section 5.1.4) and these competes based on price per recovered unit of oil.

Table 1 *A summary of the six different skimmers' performances.*

Skimmer	Oil Type	Sea State	Debris/Ice	Recovery Rate
Disc	Medium viscosity oils	Sensitive to waves and current	Clogged by high amount of debris	Low capacity
Drum	Low- to Medium viscosity oils	Sensitive to waves and current	Clogged by debris	Low capacity
Brush	High viscosity oils	Sensitive to large waves	Effective in small debris but clogged by large debris	Medium capacity
Belt	High viscosity oils	Not sensitive	Effective in small debris but clogged by large debris	High capacity due to its size
Rope	Medium viscosity oils	Not sensitive	Can handle significant debris and ice	Low capacity
Weir	Low- to Medium viscosity oils	Very sensitive to waves and currents	Clogged by debris	High capacity

Moreover, skimmer technologies can be classified into one or both of two patent classes of IPC, C02F 1/40 or E02B 15/04. C02F is "*Treatment of water, waste water, sewage or sludge*" and 1/40 is further specified in "*Devices for separating or removing fatty or oily substances or similar floating material*". E02B is "*Hydraulic Engineering*" and 15/04 is further specified in "*Devices for cleaning or keeping clear the surface of open water from oil or like floating materials by separating or removing these materials*". In total, 15 000 patents have been filed within the two IPC classes and 540 patents including both IPC classes[9]. However, no assignee has more than one percentage of these patents. The top assignee is Ronald De Strulle, a researcher at a non-profit research institute Hasso-Plattner Institute. Patent applications filed within the two IPC classes in year 2000 to 2014 are presented in Figure 5.5.

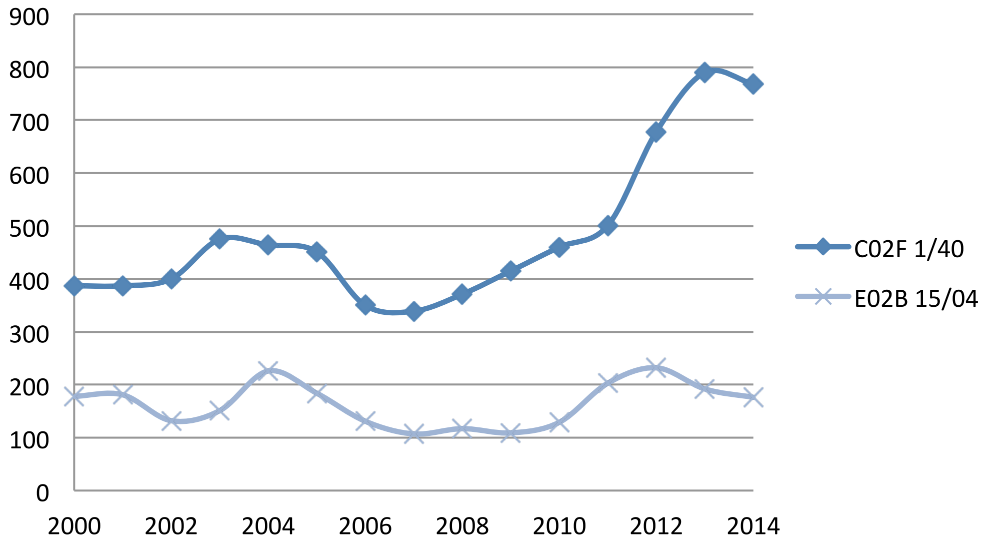

Figure 5.5 *Patent Applications filed in the two IPC codes between 2000 and 2014.*

Oil Spill Recovery System

Customers generally demand system solutions and not only a particular type of skimmers and since the skimmers are part of recovery systems. It is thus important to discuss these systems as well. Oil spill recovery system is a combination of devices that operate together to recover oil during an oil spill response operation. The system includes some, or all, of the following components; (1) Skimmer, (2) Containment boom, (3) Support vessels to deploy and operate the boom and skimmer, (4) Discharge/transfer pump, (5) Power supply, (6) Temporary storage device, (7) Oil-water separator, and (8) Shore based storage/disposal (ASTM, 2010).

As stated earlier, skimmers operate most efficiently when the oil slick is thick. Containment booms are floating mechanical barriers designed to divert oil movement on water. These are used to concentrate the oil and thus improve the oil recovery efficiency (Fingas, 2013, p.80). Additionally, booms are used to enclose oil to prevent it from spreading as well as to protect critical and sensitive areas such as harbours, bays or biological areas (Fingas, 2013, p.83). The functionality of the booms is though limited. When currents are strong enough the oil slips under the boom or when the waves are high enough the oil escapes over the booms. Moreover,

[9] Homepage and tool are found at http://worldwide.espacenet.com/

the skimmer, containment boom and support vessels operate together in different deployment configurations to recover oil, illustrated in Figure 5.6.

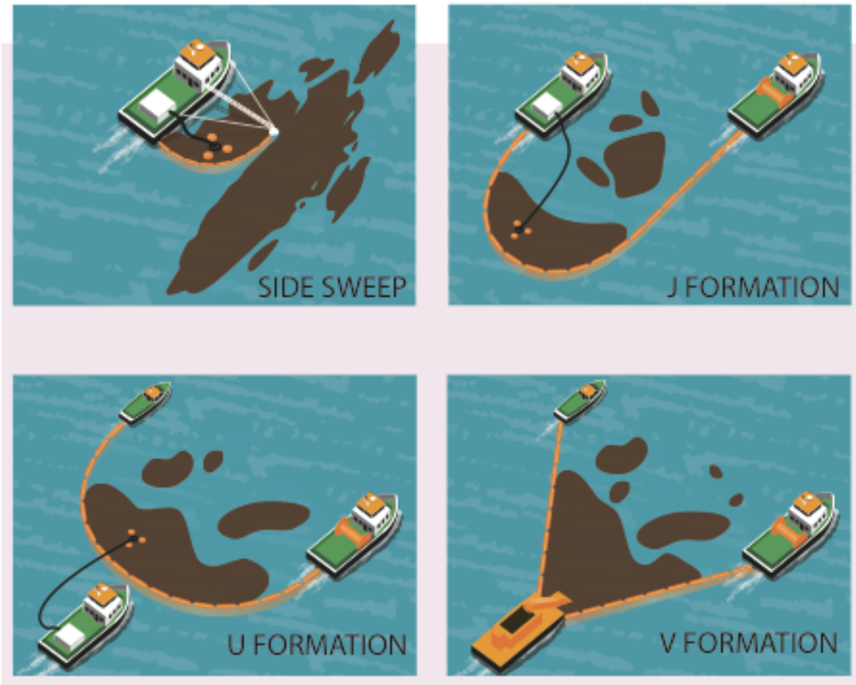

Figure 5.6 *Different deployments of skimmer, containment boom and support vessels to recover oil (Oil Spill Response Limited, 2014, p.16).*

The most common deployment is the U-configuration, achieved by anchoring the boom behind two vessels. In this configuration, the skimmer is positioned where the concentration and thickness of oil is maximised and thus improving the recovery rate and recovery efficiency. A version of the U-configuration is the J-configuration, which can be easily interchanged among each other. The V-configuration consists of two booms, anchored in support vessels, and uses a counterforce from a larger skimmer device. Lastly, the side sweep consists of a boom positioned at the side of a support vessel (Fingas, 2013, p.85).

To transfer the oil from the skimmer devices aboard the support vessel into storage tanks, pumps are required. These have to be capable of pumping a range of different oils and managing debris, air and water (Fingas, 2013, p.120). Furthermore, skimmers and pumps require power supply and most commonly used are diesel power packs in combination with hydraulic systems (ITOPF, 2013e).

The recovered oil is collected in temporary storage devices prior to port discharge. Storage tanks can be positioned either aboard the support vessels, in barges, or as floatable storage tanks at sea (Fingas, 2013, p.117). The bottle neck during an oil spill recovery operation is often the capacity of the storage tanks (ITOPF, 2013e). All skimmers recover water to some extent and therefore, the amount of water has to be kept to a minimum in order to optimise the storage and increase the overall recovery capacity. An oil-water separator can be used to concentrate recovered oil and maximise the use of storage tanks. Smaller vessels use centrifugal separators aboard and larger vessels make use of large incorporated settling tanks, which roughly separate the oil from water by gravity (Fingas, 2013, p.123). However, the ability to discharge the separated water may be limited in jurisdiction. Once the oil and water have been recovered aboard the vessel, the water is not allowed to be discharged into sea unless it contains below 15 ppm by weight of oil (ITOPF, 2013f).

The oil has to be disposed once recovered. The disposal of recovered oil and debris are often the most time-consuming and costly part of oil spill response operations (ITOPF, 2013f). Depending on the quality of the recovered oil, there are different disposal alternatives. The quality is dependent on the amount of water and debris, including vegetation, sand, branches and garbage. The ultimate alternative is to reuse the oil, for instance, by reprocessing in a refinery or to use it as heating fuel. This alternative requires that the oils contain minimum amounts of water and debris (Fingas, 2013, p.127). High viscosity oils could be used as road cover when mixed with asphalt. If the oil is of lower quality, i.e. containing high amounts of water and debris, incineration is the most common disposal method, though an expensive alternative (Fingas, 2013, p.128). Conclusively, the amount of water that is recovered with oil ought to be kept to a minimum in order to optimise the storage and thus increase the overall recovery capacity as well as to reduce subsequent processing costs for disposal.

Alternative Response Methods

There are alternative methods to mechanical recovery for treating oil directly on the water surface. These are in-situ burning, dispersants and controversial methods such as bacteria and fungus. However, dispersants, in-situ burning and skimmers are the most common alternative methods for oil spill cleanup (Fingas, 2013, p.97).

In-situ Burning implies controlled burning of the oil at or near the oil spill site, visualised in Figure 5.7 (Fingas, 2013, p.147). The advantage with burning is the ability to remove large amounts of oil in a short time period. Additionally, it is a one-step solution implying that the oil does not need to be recovered, transported, stored or disposed. Thereby, this technique requires less equipment and personnel compared to other methods (Fingas, 2013, p.148). Although, the disadvantage is the formation of toxic emissions and the method is thus more applicable for oil spills offshore than near shorelines (Fingas, 2013, p.148). The efficiency of the method is dependent on the properties of the oil and the progression of weathering since low viscosity oils have a tendency to ignite more easily than high viscosity oils. When the lighter fractions of oil evaporate, the oil begins to emulsify and the efficiency of burning decreases. Additionally, oils can only be burnt if the slick is thick enough and since oil begins to spread, the efficiency decreases. In general, in-situ burning can only be applied during the first day of the oil spill response operation (ITOPF, 2013d). Although, in-situ burning is a frequently used method, especially in Arctic regions when no other method is yet applicable (Fingas, 2013, p.150).

Figure 5.7 *In-situ Burning at Deepwater Horizon 2010 (Fingas, 2013, p.148).*

Dispersants are chemical agents that aim to break up an oil slick into droplets, which become rapidly diluted into water and thereafter subsequently degraded by naturally occurring microorganisms (ITOPF, 2013g). The chemical agents are a combination of solvent and surfactant, which can adhere to both the hydrophilic water and the oleophilic oil (ITOPF, 2013g). Dispersants can be applied and spread from sea vessels or aircrafts, illustrated in Figure 5.8. The effectiveness of dispersants is dependent on oil properties, as well as the progression of weathering, similarly to in-situ burning. For low viscosity oil, such as diesel and gasoline, dispersants can be effective while high viscosity oils, such as bunker and crude oils, are more difficult to disperse (Fingas, 2013, p.132). As the progression of weathering increases, the effectiveness of dispersants is decreasing. However, when dispersants have been applied to an oil spill, neither in-situ burning or skimmers can be used to recover oil since the chemical agents change the properties of oils (ITOPF, 2013g). Moreover, the toxicity of these chemical substances has been extensively discussed. Although, currently available dispersants are not as toxic as those that were used in the 60s and 70s, although, this method remains controversial. Special permission from national authorities is required before use. However, for most jurisdictions they are not legal to use during oil spills (Fingas, 2013, p.142).

Figure 5.8 *The use of Dispersants unloaded from an aircraft (ITOPF, 2013g, p.6).*

Lastly, properties of oil can change to such large extent, due to weathering progressions, that none of the described methods can recover or cleanup the oil during an incident. In these cases, manual recoveries in form of grabs or excavators are required (ITOPF, 2013e). Furthermore, if oils reach shorelines, manual recovery by shovels and rakes needs to be applied (Fingas, 2013, p.115).

5.1.3 Customers Segments

There are three main customer segments for oil spill response equipment; National coast guards, Response organisations and Private remediation firms. In addition to these, within some areas of the world, there are additionally three customer segments; Oil companies, Port authorities and Fire brigades. These six customer segments have different requirements and needs for skimmers and oil spill response systems. These are further described in the following paragraphs.

National coast guard is the largest customer segment since most nations rely on coast guards for their Tier 2 preparedness and response, described in Section 5.1. Coast guards are often governmentally regulated and have strategically located stockpiles around national coastlines. However, oil spill response is not their only liability. Emergency response, ensure security in ports and waterways, drug interdiction, customs- and border protection, among other things are within their area of responsibility. As a consequence of their broad range of responsibilities, there is often only a few employees have sufficient knowledge in oil spill response. Usability and simplicity are therefore important aspects when they purchase new equipment. Additionally, coasts guards do not have the resources to oversee the oil spill operation and prefer solutions that are automatic. The bottle neck in their operations are the volume of the storage tanks aboard their vessels, thus as high oil recovery efficiency as possible is preferable when they purchase new skimmer equipment. Furthermore, coasts guards demand system solutions, rather than skimmer equipment and thereby it is important that new technologies can be incorporated into current systems. Moreover, coast guards have limited budgets, in most nations controlled by authorities and governments. To purchase new equipment, they need to present the risk for oil spills in that area and apply for funding from responsible authorities.

Recently, the money that have been allocated, have been emphasised on oil spill response planning and management as well as spill detection and surveillance (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2010).

Response organisations, also known as Cooperatives, are collectively owned by oil companies as non-profit organisations for preparedness and response to oil spills. The majority of the world's oil companies take part in these and are members of response organisations (IPIECA, 2007). The stockpiles of resources that response organisations possess are referred to as Tier 3 response centres, described in Section 5.1. These are strategically located in areas with high risk for oil spills. While stockpiles of equipment remain key feature, there is also a high emphasise on training, expertise and support. By pooling resources and expertise, these response organisations have developed effective and financially viable response programs (Fingas, 2013, p.30). There are eight major response organisations world-wide; *Oil Spill Response Limited* (OSRL), *Norwegian Clean Seas Association for Operating Companies* (NOFO), *Alaska Clean Seas* (ACS), *Australian Marine Oil Spill Centre* (AMOSC), *Western Canada Marine Response Corporation* (WCMRC), *Eastern Canada Response Corporation* (ECRC), *Marine Spill Response Corporation* (MSRC), and *National Response Corporation* (NRC). These response organisations are not competitors. Rather, they complement each other and are located at different geographical areas and jointly form the *Global Response Network* (IPIECA, 2007). These organisations share equipment, personnel and expertise during incidents (Fingas, 2013, p.30).

The response organisations keep stockpiles in most geographical areas and only purchase new equipment if they expand geographically. Moreover, new purchases might be made if there is a significant simplification in operation, i.e. if there is a substantial difference in work load or time saving compared to current technologies. Furthermore, response organisations only purchase new equipment that has been demonstrated to work during an oil spill incident. Moreover, when oil spill incidents occur, equipment are transferred by aircrafts from the strategically located stockpiles to incident site. Thereby, an additional requirement is that the response equipment is mobile. Response organisations often have limited funding for purchase of new products and equipment. For instance, even though MSRC's funding from oil companies remains constant at US $90 million annually, their budget to purchase new equipment is limited to on average US $200 thousands (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2010).

Private remediation firms also provide oil spill containment and cleanup services. These often respond to Tier 1 oil spills by a contractor, located in industry facilities, harbours, lakes, rivers and shoreline. In some occasions, they provide support during Tier 2 or Tier 3 response since these firms possess high knowledge of oil spills, as it is their main business. The response equipment is required to be mobile in the sense that they can easily transfer skimmer equipment to oil spill sites by vehicles.

In some nations, there is a high reliance on Tier 1 preparedness and response. Thereby, *oil companies*, *port authorities* and *fire brigade* are required to keep stockpiles of response equipment for oil spill incidents. For instance, in Trinidad and Tobago, oil companies are obligated to have response equipment during drilling operations. Although, in most regions, oil companies are represented by response organisations by paying annual member fees, as described. Furthermore, port authorities are obligated by law to acquire oil spill response equipment, in e.g. Australia and China. However, in most nations, they are only responsible for preventing the oil from spreading in case of an incident, not to recover the oil. Lastly, fire brigades acquire response equipment for minor oil spills in public lakes, harbours, rivers et cetera. In common for these three customer segments are that the operating personnel have limited knowledge and experience of oil spill response since it is not within their main business.

Buying Behaviour of Customers

There are three common channels in which the six presented customer segments purchase new equipment. First of all, representatives from most nations attend and exhibit the annual conferences. These are the *International Oil Spill Conference* (IOSC), *Interspill* and *Spillcon,* in which each is held every third year respectively. It is undoubtedly the main forum for presenting new technologies, establishing new contacts, purchasing new equipment and for manufacturers to scan competitors' offerings. Secondly, oil spill response equipment manufacturers schedule meetings at customers' offices when they have a new technology under development or want to launch a new product. Thirdly, customers evaluate technologies based on their performance at NOFO's annual on-water demonstration. In contrast to Ohmsett and SINTEF, the on-water demonstrations for new technologies are considered to be more accurate. Although, to be interested in the first place, customers demand new technologies to be tested at testing facilities. To purchase however, they require new equipment to have proven functionality during an actual oil spill or at the on-water demonstration.

Moreover, all six customer segments make purchases seldom, which is related to their limited budgets for purchasing new equipment and consequently, they are price sensitive. For instance, MSRC only has 0.2 percentages of their funding allocated for purchasing of new equipment. As a consequence, customers usually make new equipment purchases during oil spill incidents, as these direct costs are compensated by international fund conventions.

Furthermore, when customers do make new skimmer equipment purchases they are evaluated according to *Estimated Daily Recovery Efficiency*, which is 20 percentages of the equipment manufacturers rated oil recovery rate over 24 hours. New ideas are though under development that aims to evaluate the skimmer technology capacity within the oil spill recovery system. This is due to the fact that the bottle neck for the capacity is often other equipment than the actual skimmers, such as storage tanks and pumps. Furthermore, when customers choose between manufacturer's equipment their decisions are generally based on the relationship with the manufacturer, the experience of the manufacturer to be part of major oil spills, their knowledge and expertise in the area and finally, their ability to provide training and support. It is important to emphasise that customers are not interested in skimmer equipment per se since they demand solutions and systems for recovery of the oil during incidents. Thereby, service, support and training are equally important for customers as the equipment they acquire, in particular for coast guards and response organisations.

However, when major oil spill incidents occur and are of Tier 2 or 3, as illustrated in Figure 5.1, all requirements from customers, stated earlier, change. Then the relationship becomes basic demand-supply relationships. For instance, during the Deepwater Horizon incident the demand for new equipment was extreme. All oil spill response equipment that could be delivered at site was bought, more or less directly, by customers. Thus, the customers were no longer price sensitive as authorities provided them with tremendous resources. Furthermore, the direct costs, such as acquisitions of new skimmer equipment, were to high extents compensated by international fund conventions. During major oil spills, relationships to oil spill response equipment manufacturers and suppliers are still of importance since customers value service and support during operations, however, it is no longer the most important order winner. Moreover, the occurrence of major incidents provides opportunities for new technologies and firms to enter this industry.

In summary, when there are no major oil spill incidents, the six customer segments make purchases of oil spill response equipment seldom, based on relationships and already proven technologies. However, when major oil spill incidents occur, the demand for equipment is extreme and practically unlimited. For the manufacturers, it basically comes down to how much equipment they can produce and deliver in the shortest amount of time.

5.1.4 Oil Spill Response Equipment Manufacturers

There are seven main oil spill response equipment manufacturers who dominate the industry. *Vikoma* is a British company originally founded by British Petroleum in 1967 after the Torrey Canyon oil spill. *Lamor Corporation*, is a Finish company founded in 1982 in collaboration with the Finnish environment institute. *Elastec* is an American company founded in 1989 after the Exxon Valdez oil spill. *Markleen* is a Norwegian company with more than 20 years of experience in oil spill response industry. Another Norwegian company is the family company *Frank Mohn*, originally founded in 1938. They were recently acquired by Alfa Laval and more information of Frank Mohn and the acquisition is found in Section 5.2.1. *Desmi Ro-clean* is a Danish company founded in 1834 and has since the end of the 70's been part of the oil spill response industry. Finally, *Aqua-Guard*, is a Canadian company, founded in 1968 also after the Torrey Canyon oil spill.

The customers of oil spill response equipment require system solution and not skimmer equipment per se, as described in Section 5.1.3. Thus, the product portfolios consist of skimmer equipment of different sizes, containment booms, pumps, hydraulic power packs, storage tanks, vessels, workboats, dispersants, aircrafts and ancillary equipment. Additionally, the offerings consist of training and support as well as service and maintenance. Thus, these companies do not only manufacturer skimmer equipment rather, they furthermore develop and supply oil spill response equipment, training and support to their customers. Although, in the thesis they are referred to as oil spill response equipment manufacturers. These companies use suppliers to complete their offerings and system solutions, e.g. sourcing of vessels and aircrafts. However, these products and equipment are branded by the oil spill response equipment manufacturer. Moreover, the manufacturers of the oil spill response equipment do not have very diversified product- and service portfolios from which they compete with. They all have more or less the same supplies and offerings. It is not uncommonly that they imitate each other. In particular, the annual conferences are where they usually scan the competition and offerings.

However, what that distinguishes the oil spill response equipment manufacturers is whether their business solely focus on the Oil spill response industry. For instance, Frank Mohn's and Desmi Ro-clean's oil spill response divisions only consist of a minor part of their respectively corporate groups. Both these companies have their main business within pumps for the marine and offshore industry. However, the other five oil spill response manufacturers are solely within the oil spill response industry. If the company has diversified businesses or not, impacts their turnover and profitability. The annual turnover for three oil spill response equipment manufacturers, Desmi, Lamor and Vikoma[10], is illustrated in Figure 5.9.

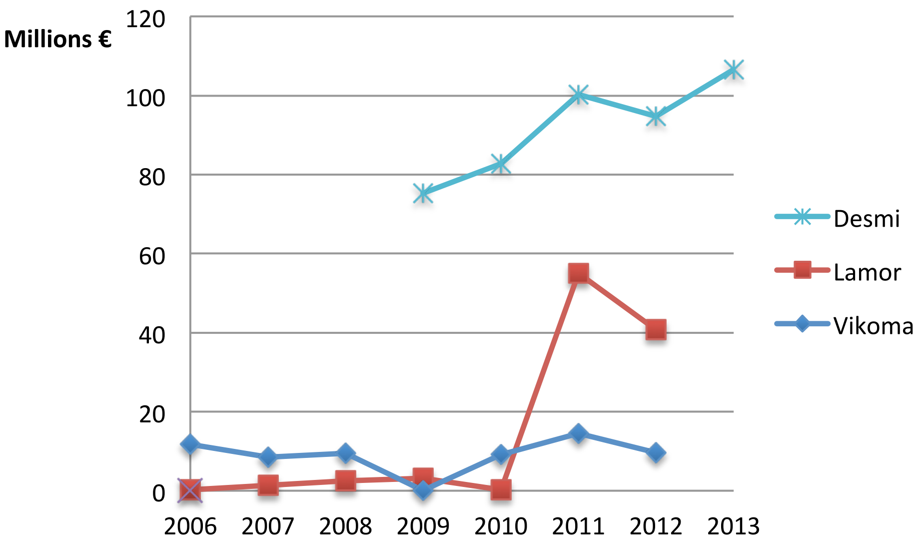

Figure 5.9 *The Turnover (€) for three oil spill response equipment manufacturers.*

The graph illustrates that the turnover for oil spill response equipment manufacturers is heavily affected by fluctuations in customer demand. All three companies have a significant increase in sales after the Deepwater Horizon oil spill 2010. A difference however, is that the fluctuations do not have the same impact on Desmi Ro-clean, which has a diversified business, as it has for Lamor. The same phenomenon could be illustrated, if not even more clear, in the profit margin for the three oil spill response equipment manufacturers, presented in Figure 5.10. Lamor and Vikoma have large fluctuations in profit margin, from negative balance of 80 percentages to profit margins of 35 percentages, while Desmi Ro-clean have more stable profit margin around 10 to 15 percentages.

[10] The turnover and profit margin in the two figures, 5.8 and 5.9, only illustrate three of the seven oil spill response equipment manufacturers, since these are only publically available. Furthermore, the data from Desmi could not be acquired until 2009.

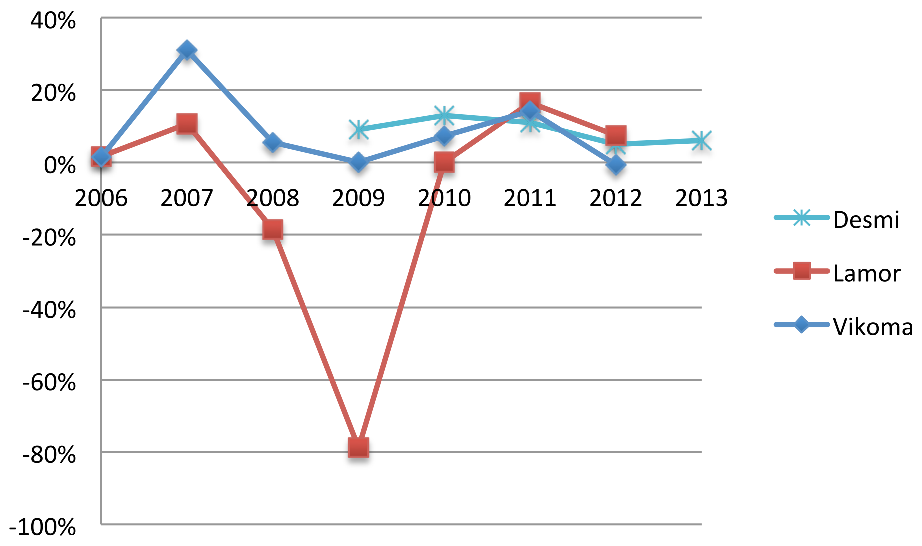

Figure 5.10 *The profit margin (%) for three oil spill response equipment manufacturers.*

Furthermore, the manufacturers tend to differ when it comes to marketing. For instance, Elastec and Lamor focus heavily on marketing and invest significant amount in advertising. The five remaining equipment manufacturers on the other hand, are rather the direct opposite and do not invest much in marketing. They believe that the customers in this industry do not care for marketing activities rather, these manufacturers believe that trust and relationships are keys in this industry.

Moreover, these manufacturers are all world-wide present. They have strategically located sales offices within their main market based on their origin of foundation and complementary agent- and distribution networks. Additionally, these companies tend to collaborate in different geographical areas. For instance, Elastec supply their products under different brands in other markets, e.g. Markleen in Sweden.

5.1.5 Geographical Differences

Many of the world's nations have national contingency plans, a plan for how to prevent, prepare and respond to oil spills[11] (IPIECA, 2005). However, the stockpiles of response equipment differ among nations and regions and thus their ability to manage major oil spills. The market for oil spill response could be divided into; Mature markets, Emergent markets and Forthcoming markets. *Mature markets* are nations and regions with well-established response capability and thus possess extensive stockpiles of resources. *Emergent markets* are nations and regions with high demand for oil spill response equipment since their stockpiles of resources currently are under development. Lastly, *forthcoming markets* are nations and regions which recently have recognised that the risk for oil spills cannot be negligible and taken initiatives in regional agreements and in development of national contingency plans.

[11] ITOPF has a database consisting of 160 country profiles for prevention, preparedness and response, http://www.itopf.com/knowledge-resources/countries-regions/ (2014-07-24)

These nations are expected to have a higher demand for oil spill response equipment in the years to come, since they have no current stockpiles of response equipment.

Regions that could be considered as mature are United States, Canada, Australia and West Europe, and in particular United Kingdom, Norway, Baltic, France and Germany. Most oil spill response equipment manufacturers are present in these nations. Although, they allocate limited efforts in marketing and sales since the markets are considered saturated with equipment. Historically, these nations have all experienced major oil spills which have had impact on their preparedness and response. However, as the demand for oil is increasing in new regions, the risk for oil spills is more prevailing in other areas. As illustrated in Figure 5.11, the traffic of oil tankers is highest around South East Asia and Africa. The thin (yellow) routes respond to low traffic, 10 to 50 million tons, the (orange) routes 50 to 200 million tons, the dark (orange) 200 to 300 million tons, and the darkest (red) respond to routes with more than 300 million tons of oil. As a consequence, the risk for oil spills in relation to oil movements are not where current stockpiles of response equipment is located, rather in emergent- or forthcoming markets.

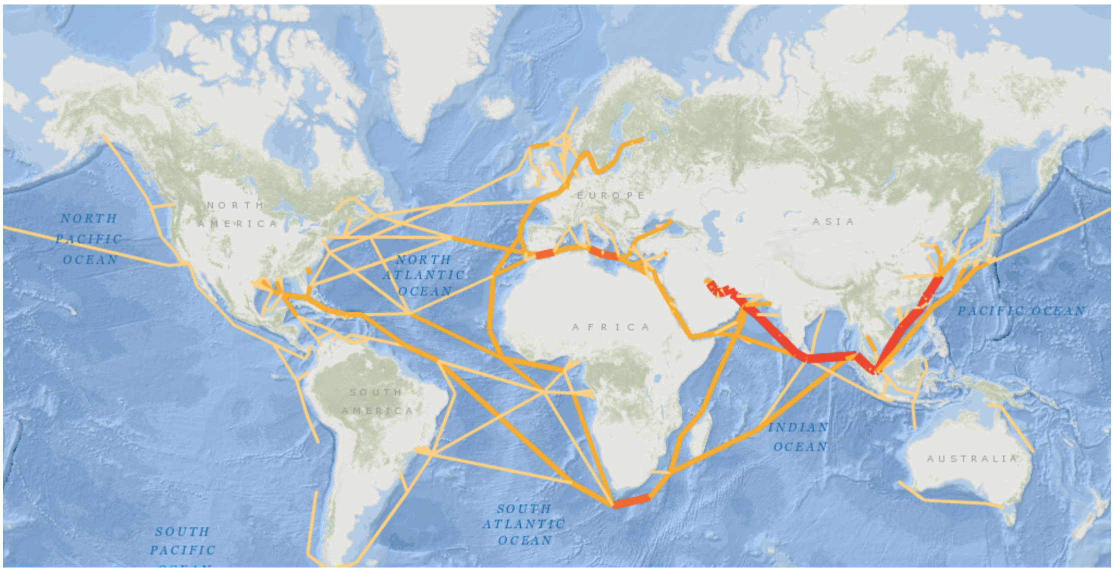

Figure 5.11 *Oil Tanker Traffic (ITOPF, 2014).*

Regions that could be considered as emergent markets are Latin America with Brazil in particular, Caribbean, nations around Mediterranean, China, and the Arctic regions (IPIECA, 2011). The tanker traffic as well as the oil and gas activity have increased the risk for oil spills in these regions and thus, customers are currently purchasing new equipment for establishing stockpiles there. Most manufacturers of oil spill response equipment have initiated establishment of sales offices and representatives in these emergent markets. Furthermore, the explorative offshore drilling in the Arctic regions has increased the risk for oil spills in new conditions, in the presence of large amount of ice. However, as described in Section 5.1.2, current skimmer technologies cannot operate efficiently during these conditions.

Lastly, regions that can be considered as forthcoming markets are nations around the Black- and Caspian Sea, South East Asia, and East-, West- and Central Africa (IPIECA, 2011). *Global Initiatives* are improving the response capacity in these regions, which are currently considered to underdeveloped. Global Initiatives was launched in 1996 as collaboration between *International Maritime Organization* (IMO), part of *United Nations* (UN), and *International Petroleum Industry Environment Conservation Association* (IPIECA) to enhance the global preparedness and response capability for oil spills. Furthermore, these regions are all high risk areas for oil spills and possess sensitive coastlines. For instance, the most important trade route is through South China Sea, as 30 percentages of the world's crude oil and 50 percentages of all natural gas passes through. An oil spill in these regions could have catastrophic effects in nations such as Malaysia, Indonesia, Philippines and Thailand that relies on fishery and tourism. Furthermore, the regions consist of a number of nations that need to collaborate in case of a major oil spill incident. However, among most of these nations there exist political disagreements and mistrusts which enhance the complexity of cooperation. A few oil spill response equipment manufacturers have initiated sales offices and representatives in these regions, though so far to a limited extent.

5.2 Alfa Laval's Resources for the Oil Spill Response Industry

The case company Alfa Laval was introduced and presented in Chapter 2. However, there are two main resources of the company considered of importance for the Oil spill response industry. First, their recent acquisition of Frank Mohn, a Norwegian company that has one division focused on the Oil spill response industry as an equipment manufacturer and secondly the new skimmer equipment. These are presented in the three following sections, respectively.

5.2.1 Frank Mohn

Frank Mohn AS[12] is a global market leader in marine and offshore pumping systems. They are positioned in Bergen, Norway and has about 1 200 employees. The company had in 2013 an order intake of NOK 6.1 billions and an operating margin significantly above Alfa Laval's 16 percentages[13] (Alfa Laval, 2014b).

Frank Mohn consists of four divisions; Marine pumping, Offshore pumping, Oil recovery systems and Service. Marine pumping accounts for 50 percentages, offshore pumping for 23 percentages, oil recovery systems for 6 percentages, and service for the remaining 21 percentages of Frank Mohn's annual sales (Alfa Laval, 2014b). Their production facility is located in Bergen, Norway and their sales organisation is illustrated in Figure 5.12 (Frank Mohn, 2014a).

[12] The empirical findings of Frank Mohn are solely based on secondary data, such as press releases by Alfa Laval. This is due to confidentiality and strategic reasons, but primarily since the acquisition was not completely finalised until May 22, 2014. Hence, the authors of the thesis was not aware of the acquisition and could thus not take this into consideration at the beginning and outline of the project.

[13] The operation margin is confidential.

Figure 5.12 *Sales office and production facility of Frank Mohn (Frank Mohn, 2014a).*

The aim of the acquisition was to partly reinforce Alfa Laval's position as leading supplier in the marine and offshore segment and in particularly strengthen the fluid handling portfolio. The new acquisition is incorporated as a business segment within Alfa Laval's Marine & Diesel division (Alfa Laval, 2014b). Besides the marine and offshore segment, Frank Mohn is market leader within the Oil spill response industry as an oil spill response equipment manufacturer of skimmer equipment, as described in Section 5.1.4.

Frank Mohn's product portfolio for oil spill response is branded FRAMO and consists of the *TransRec* system with three types of skimmers, illustrated in Figure 5.13. The TransRec system is an oil recovery, transfer and off-loading system for sea vessels. This system uses Frank Mohn's core competence of marine pumps, i.e. to pump oil aboard sea vessels during oil spills. The TransRec system can be equipped with different skimmer heads, depending on ambient situation and oil type. The *HiVisc skimmer* is a drum skimmer specialised to recover large quantities of extremely high viscous oil of 10 000 to 1 000 000 cSt. The *Weir skimmer* is designed to recover light to medium viscous oil of 1 to 15 000 cSt. The *Polaris skimmer* is specialised to recover oil in Arctic regions and is capable of recovering emulsified oil of 10 000 to 1 000 000 cSt (Frank Mohn, 2014b). The TransRec system has been sold and installed to more than 200 customers.

Figure 5.13 *The product portfolio of Frank Mohn; included the TransRec system at the top, the weir skimmer at the bottom, the HiVisc skimmer to the left and the Polaris skimmer to the right in the picture (Frank Mohn, 2014b).*

5.2.2 Alfa Laval's New Skimmer Equipment

The new skimmer equipment is a skimming device based on a rotating cone dipped into a surface layer of liquid, usually oil on water, attached to a centrifugal separator, illustrated in Figure 5.14. The device aims to recover the surface liquid from the base liquid by the centripetal force caused by conical rotation. Since oil generally has a lower density than water and thus floats, the cone, spinning on the surface, removes a higher concentration of the surface liquid relative the base liquid. This property, together with differences in viscosity, is prerequisites for the functionality of the technology. Properties and behaviour of oil when spilt into water is described in Section 5.1.1.

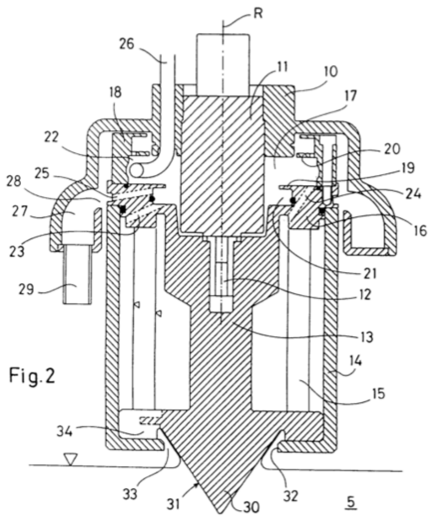

Figure 5.14 *Design of the centrifugal separator (US-7118521 B2).*

The rotating cone drags the surface liquid vertically from the base liquid. As a consequence of the differences in viscosity of the two liquids, the surface liquid centres around the cone while the surface tension forces the surface liquid to the cone, as the surface liquid is being recovered. Hence, the cone can be remained in a fixed position as the surface liquid is being dragged towards it. Visually, the cone ‘grabs’ the upper liquid by its surface tension layer and thus separates it from the base liquid. Though, the cone might not only pull the surface liquid, but some of the base liquid as well. In addition, particles of different sizes follow the surface tension towards the cone. However, particles of larger size do not follow the oil into the centrifugal separator, however smaller particles do.

The centripetal force pushes the liquids vertically into the attached centrifugal separator. Here, the liquids are being comminuted and thus allowing reunification of the separated base liquid in a way that causes little or no turbulence on the surface. The surface liquid is recovered. Furthermore, the skimming device connects to a floating device with floats, channels for the separated liquids and a power source. A sketch of the new skimmer equipment is illustrated in Figure 5.15. The skimming device is separable from to the floating device for maintenance and cleaning purposes.

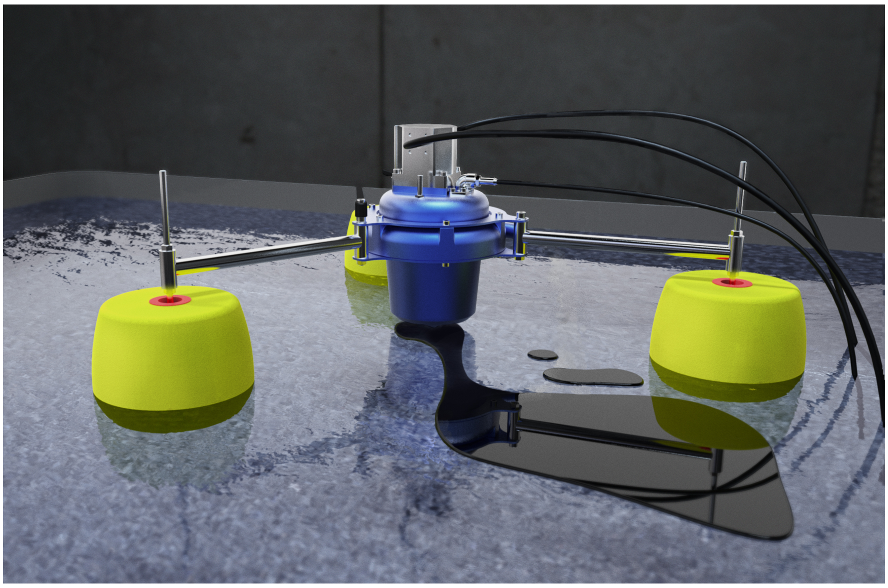

Figure 5.15 *Illustration of the new skimmer equipment.*

The amount of fluid that can be recovered by the skimmer technology depends on the rotation power, i.e. the speed of revolutions in the centrifugal separator and the radius of the cone, which in turn depends on the angle of the cone. The technology is thereby scalable in capacity. Furthermore, the new skimmer equipment recovers fluids of low- to medium viscosity, i.e. fluid phase. Fluids of high viscosity are in this context fluids that are considered practically solid. Finally, the new skimmer equipment is patented in a few countries and the protection is considered strong and broad.

6 ANALYSIS AND DISCUSSION

The aim of the chapter is to answer the two research questions of the thesis. The chapter begins with an analysis of the external business environment, with the objective to identify key drivers of change, profitability and competitiveness, and key success factors of the Oil spill response industry. This analysis aims to answer the first question of the thesis. Thereafter, an analysis of the internal business environment with the objective to identify and appraise resources and capabilities that Alfa Laval possesses, which in turn can be utilised as a competitive advantage in the Oil spill response industry. In particular, the functionality of the new skimmer equipment and their recent acquisition of Frank Mohn are of interest and scrutinised. This analysis aims to answer the second question of the thesis.

6.1 Analysis of the External Business Environment

The section aims to analyse the Oil spill response industry from a macro-environment, industry environment as well as a competitor- and market perspective in order to identify the industry's key drivers of change, profitability and competiveness, and key success factors, respectively. The structure of the section follows the one in the theoretical framework, Section 3.1.

6.1.1 Key Drivers of Change

The analysis is based on the acronym *PESTEL*, a commonly used analysis tool with the purpose of analysing an industry from a macro-environmental perspective (Maylor, 2010, p.27; Johnson *et al*., 2011, p.49; Grant, 2013, p.60; Cook, 2005). The aim of the analysis is to identify the *key drivers of change* of the Oil spill response industry, i.e. the contextual aspects that have high influence on the company strategy's success and failure. The acronym consists of aspects concerning Political, Economic, Social, Technological, Environmental and Legal. These are discussed and analysed in the following paragraphs. The analysis begins with studying the political influences, ends with the legal and then concludes with a summary of those considered most important to the industry.

The *political* influences in the Oil spill response industry are considered to be of importance to the industry. The largest customer segment in this industry is the national coasts guards since most nations rely on their Tier 2 preparedness and response on them, illustrated in Figure 5.1 on page 25. These organisations are regulated by authorities and are governmentally funded. Thus, it is of importance that oil spill preparedness and response lies within the governments' interest. However, the funding varies dependent on the nation in question. There are nations that do not consider this as important, partly for natural reasons since they might not have coasts to open seas or oil activities, such as tanker traffic or drilling. Other nations on the other hand find this industry to be of great importance, e.g. mature and stable markets such as Norway and Canada. Lastly, there are nations with high risk for oil spills that currently have underdeveloped resources for preparedness and response due to lack of governmental funding.

The *economic* aspects of the Oil spill response industry are considered to be of high importance. The event of major oil spills has tremendously direct- and indirect costs that affect; sectors that rely on clean seawater and coasts, oil companies, actors that are responsible for recovery and cleanup and to some extent the global economy, such as stock exchanges et cetera. For instance, the costs associated with the cleanup operations of the Deepwater Horizon incident amounted to more than US $60 billions. This affected the oil company British Petroleum's economy and trust comprehensively since they were responsible for the well blow-out. Furthermore, nations, companies and customers have become aware of the costs associated with oil spills during major incidents. As a consequence, they develop contingency plans and acquire stockpiles as insurances for future oil spill incidents. As stated, some nations have underdeveloped preparedness and response since they lack of governmental funding. Although, there are nations that may not have the ability to acquire these stockpiles of resources due to prevailing capital market conditions.

The *social and cultural* aspect of the Oil spill response industry is to some extent of importance. Media is an important actor that enables public awareness, which is considered as an essential aspect to this industry. This is what mainly drives large oil companies to take preventative actions in this matter. The increasing importance of corporate social responsibility is another enabler. Furthermore, media informs the society about risks and consequences from oil spills, which in turn forces governments and nations to develop contingency plans for oil spills. Thus, a nation's social and cultural approach to the environment influences the level of preparedness and response.

The *technological* aspects of the Oil spill response industry is considered to be of no concern relative the other aspects discussed in this section. There are no distinct technologies that could threaten the industry, nor are there any disruptive innovations in a foreseeable future. However, there are alternative methods that could potentially threaten current recovery technologies, which is further analysed in the following Section 6.1.2. Moreover, the level of technology innovations within the industry is regarded as low. An example of this is the Deepwater Horizon oil spill in 2010. In this incident, skimmers, containment booms and other related equipment were to high extent the same as those used during Exxon Valdez oil spill in 1989. Although, the innovativeness increases after major oil spill incidents. The number of patent applications that were filed within the two patent categories, IPC codes within recovery of floating oil on a water surface, illustrates significant increases after the Prestige incident in 2002, the Hebei Spirit incident in 2007 and the Deepwater Horizon incident in 2010, illustrated as dashed lines in Figure 6.1. However, few of these were launched as new products within the industry.

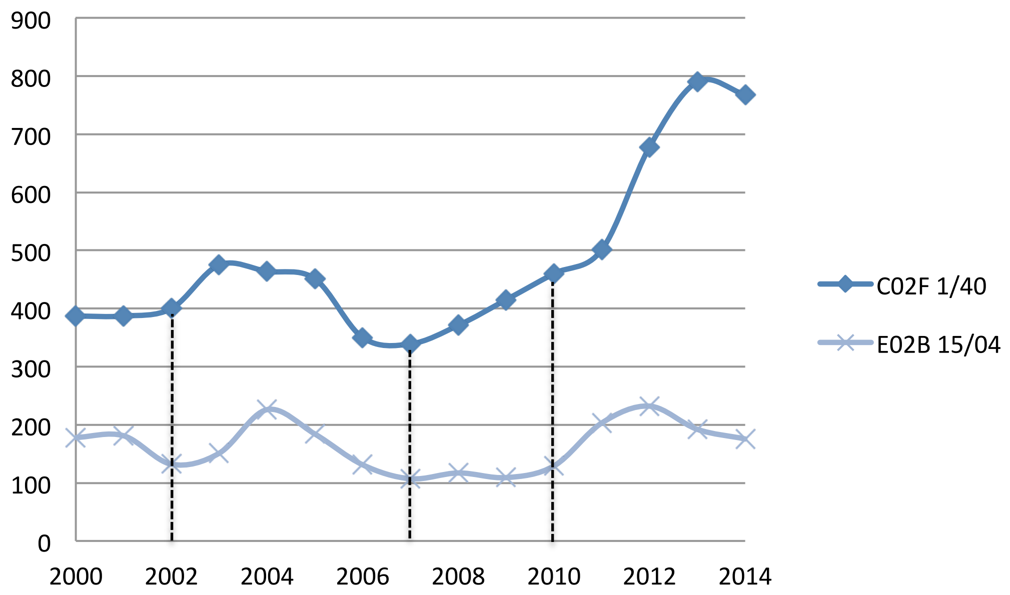

Figure 6.1 *Increase in patent applications after major oil spills in 2002, 2007 and 2010.*

The *environmental* aspects are also of high importance, though in three different ways. First of all, the consequences of major oil spills on the marine environment are devastating especially in sensitive coastlines with corals, seabirds, fishes and marshes. As concluded in the social and cultural aspect, a nation's approach to the environment influences their level of preparedness and response. Moreover, an industry driver is to recover the highest amount of oil as possible without compromising the environment. The applied methods for managing spilt oil are therefore chosen based on their ability to be environmentally friendly. For instance, dispersants are not legal in most jurisdictions due to the controversial effect on the environment. Lastly, actors of the Oil spill response industry do not make profit on behalf of negative environmental consequences, rather their main focus are to aid and protect the environment, which furthermore have positive impact on their corporate social responsibility.

Finally, the *legal* aspects of the Oil spill response industry are furthermore of high concern. Historically, as direct consequence to major oil spill incidents, both new laws for oil spill prevention by the industry and liability legislation have followed. For instance, the OPRC convention was founded as a consequence of the Exxon Valdez incident in 1989 with the aim of international co-operation and assistance in preparing for and responding to future oil spill incidents. Furthermore, global initiatives from IPIECA and IMO, i.e. the United Nations, force new regions and nations to develop contingency plans to prepare and respond to oil spills. These initiatives thus determine, to a large extent, which nations that develop stockpiles of response equipment since large regions of the world are currently underdeveloped.

To sum up the analysis, the main key driver of change is the frequency and impacts of *major oil spills*, which is a matter of *where* and *when* rather than *if* they will occur. These incidents influence three factors which in turn have the highest impact on the Oil spill response industry; the *environmental* consequences, the *economic* impact and the *legal* factors. Nations and government regards contingency plans and stockpiles of resources as insurance to future incidents due to the economic impact and environmental consequences the major incidents have on the nation of interest. Furthermore, new laws that aim to prevent incidents from occurring as well as to increase the collaboration among nations naturally follows from major oil spills.

6.1.2 Profitability and Competitiveness

The profitability and competitiveness analyse the attractiveness of the Oil spill response industry from an industry environmental perspective by *the industry lifecycle* and *Porter's five forces.*

Industry Life Cycle

The Oil spill response industry is considered to have reached the maturity stage of the industry lifecycle. This stage is characterised by high competition among competitors and that the industry has set around dominant designs (Grant, 2013, p.209). The competition within the industry of oil spill response is considered high since there are seven major equipment manufacturers of roughly equal size, whom offers the same kinds of products and services as well as they are present in the same geographical markets. Furthermore, the industry has set around six dominant designs; disc-, drum-, brush-, belt-, rope- and weir skimmers, respectively. Even though the designated skimmers are of competing technologies to some extent, these are used in different conditions as no single skimmer can cope with all encountered situations. Stockpiles thus consists of several different skimmers used within different stages and types of oil spill response operations, as illustrated in Table 1 on page 31. Furthermore, the level of technology innovation is low, due to the fact that the same technologies are currently used as those 25 years ago.

Customers characterise the maturity stage in the sense that they are aware of the attributes of the response equipment manufacturer's products and services and are price sensitive. The three main customer segments; national coasts guards, response organisations and private remediation firms, all make purchases seldom and are price sensitive due to their limited budgets. Furthermore, they are aware of the equipment manufacturer's competing offerings, and since these do not differ much, their decisions are based on relationships, trust and experience of the equipment manufacturers.

Moreover, the industry is not near the decline stage of the industry lifecycle since it is not challenged by new industries, superior substituting technologies or other energy sources. Oil is a necessity in industrial societies and we claim that it remains in that way as long as oil reserves are not depleted and as no other energy source can currently sustainable replace it. Even though the amount of oil spilt into sea has decreased significantly since the 1960s, due to prevention and legislation, Fingas (2010, p.8) claims that the risk for major oil spills remains and thus the industry of oil spill response. Conclusively, the Oil spill response industry could be regarded as mature since there is high competition among the seven equipment manufacturers, the industry has set around dominant designs for the skimmer technologies, customers are aware of competitors' offerings and they are price sensitive. The maturity of the oil spill response industry is illustrated in Figure 6.2.

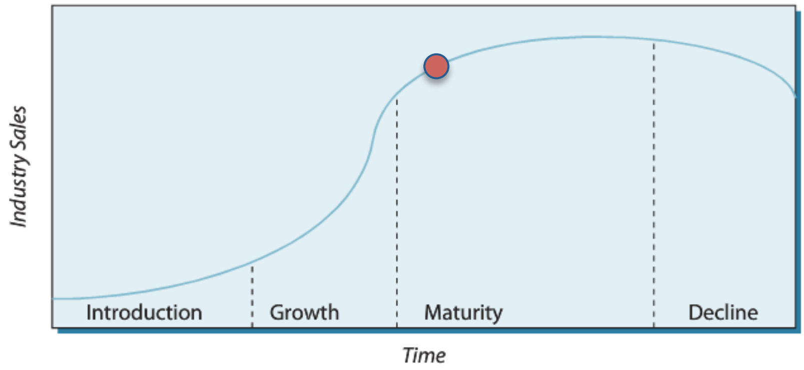

Figure 6.2 *The Oil spill response industry has reached the maturity stage of the industry life cycle. The industry is though far from the decline stage.*

Industry Profitability and Competiveness

The Porter's five forces model is the most widely used framework to analyse the profitability and competiveness, ergo the attractiveness of the industry, according to Grant (2013, p.65). It is a competition framework, regarding profitability determined by five sources of competiveness; Threat of new entrants, Threat of substitute products and services, Bargaining power of buyers, Bargaining power of suppliers, and lastly, Rivalry among existing firms (Porter, 2008).

The *threat of new entrants* is considered low since the entry barriers of the Oil spill response industry are high. Even though factors such as economics of scale, capital requirement and access to supply and distribution channel are of importance, the most distinctive factor is the experience curve effect, i.e. the knowledge and expertise of the industry. Current equipment manufacturers have been established since the Torrey Canyon incident in 1967 and the Exxon Valdez in 1989. Thus, they do not only possess broad product portfolios, they have extensive knowledge and expertise in how to prepare and respond to major oil spills since they all have participated in at least one. Thereby, equally important as equipment in their offerings are training, support and services. Furthermore, customers regard trust, relationship, expertise and experience of their manufacturers as order winners when purchasing new equipment. Thus, switching of supplier is unlikely for customers since most of them have established relationships with their respectively equipment manufacturers. Additionally, customers only purchase new equipment that has proven functionality during an oil spill incident. Well-established brands and customer loyalty are thereby two important factors to the high entry barriers within the industry. Moreover, entry barriers are regarded as high for the mature markets and emergent markets where most equipment manufacturers are established and markets are saturated with equipment. However, few equipment manufacturers have initiated establishment in forthcoming markets and thus the entry barriers are lower there than for mature markets.

The *threat of substitute products and services* is considered low. Although there are alternative methods to the recovery of oil by skimmers, such as in-situ burning and dispersants, these are rather complementary methods than substitutes. For instance, in-situ burning has the advantage of removing large quantities of oil and in a one-step solution, though the method could only be applied during the first day of incident and for low viscosity oils. Dispersants on the other hand are more controversial and are not legal in most jurisdictions. This regards whether the chemical substances cause more damage on the environment than the oil itself. However, if these are considered environmental friendly and approved in jurisdiction in the future, dispersant could be a threat to skimmers and other recovery methods due to their simplicity of use and capability to handle large quantities of oil. Furthermore, even though customers are price sensitive they value performance of the technology since they make purchases seldom and require long service lives. Thus, since performance is more important than price, new superior technologies could be future threats to current equipment.

The *bargaining power of buyers* force is considered a high threat. The buyers bargaining power is high since the customer segments of national coats guards and response organisations account for most of the sales. These make purchases seldom and are considered price sensitive due to their limited budgets. For instance, customers only purchase equipment that has proven functionality during an actual oil spill incident. Furthermore, there is a low differentiation among equipment manufacturers offering and thus the switching cost is considered low. However, it is unlikely that customers switch supplier since they value brands, loyalty and relationship, ergo trust. Additionally, they are not interested in new equipment per se, but rather in system solutions which make them reliant on their equipment manufacturers' knowledge and expertise.

The *bargaining power of suppliers* is considered low in this industry. Equipment manufacturers develop, manufacture and supply equipment, training and support and thus the vertical integration in this industry is high. Although, they use suppliers or partners to complete their broad product offerings, e.g. sourcing of aircrafts and vessels. However, these are branded by the equipment manufacturer. The reason for this is since customers are generally confident in their equipment manufacturers and are thus not particularly interested in their respectively suppliers. Hence, the suppliers bargaining power is considered low.

The *rivalry among existing firms* is considered high. The industry has seven main oil spill response equipment manufacturers, as stated. These are large corporations of roughly equal size, offer the same kinds of product and services and are all present in the same geographical markets. Furthermore, the growth of the industry is rather low in mature markets and their growth is therefore related to expansion into new nations and regions. As Grant (2013, p.69) stated, the rivalry is highest if there are many competitors of equal size and the industry growth is low. Thus, the rivalry is high among the established equipment manufacturers of the Oil spill response industry. Moreover, the rivalry among existing firms is the main determinant force of competition and thus the profitability of an industry.

Conclusively, the Oil spill response industry is not profitable as there are high entry barriers, customers possess high bargaining power as well as there is high rivalry among incumbents. Intuitively, the Oil spill response industry is not an attractive industry to enter. However, when major oil spill incidents do occur, these three forces change dramatically. The entry barriers of the industry are no longer high and thus *the threats of new entrants* are high. The current equipment manufacturers have all entered the industry during a major oil spill. For instance, Aqua-Guard and Vikoma entered during the Torrey Canyon oil spill 1967 and Elastec during the Exxon Valdez oil spill 1989. There are also recent examples of companies that currently are large established ones within the industry that did not exist before the Deepwater Horizon oil spill 2010. Thus, the industry opens up for new entrants during major oil spills. Furthermore the *bargaining power of buyers* is low since their demand for new equipment is then extreme. Additionally, customers are no longer price sensitive since governments provide funding and the direct costs are compensated by international fund conventions. Lastly, the *rivalry among existing firms* is no longer high, as the demand for new equipment is extreme and practically unlimited. It mainly comes down to how much equipment the equipment manufacturer delivers in the shortest amount of time. The competition during a major incident is considered negligible and thus the profitability among equipment manufacturers is high.

The attractiveness of the industry during major oil spills is illustrated by the turnover and profit margin for three oil spill response equipment manufacturers, presented in Figure 5.9 and Figure 5.10 on page 40. After the Deepwater Horizon oil spill in 2010, all three equipment manufacturers increased in sales and profit margins. For instance, Lamor Corporation went from a negative balance of 80 percentages to a profit margin of 20 percentages in one year. Within the same period, they also increased their sales from around €150 000 to €55 000 000, an increase of 37 thousand percentages, illustrated in Figure 6.3. Furthermore, the graphs also illustrate, as the analysis concluded, the low profitability due to the high industry rivalry between major oil spills. Companies with diversified business such as Desmi Ro-clean, have not as dramatic fluctuations in turnover and profit margin as its competitors.

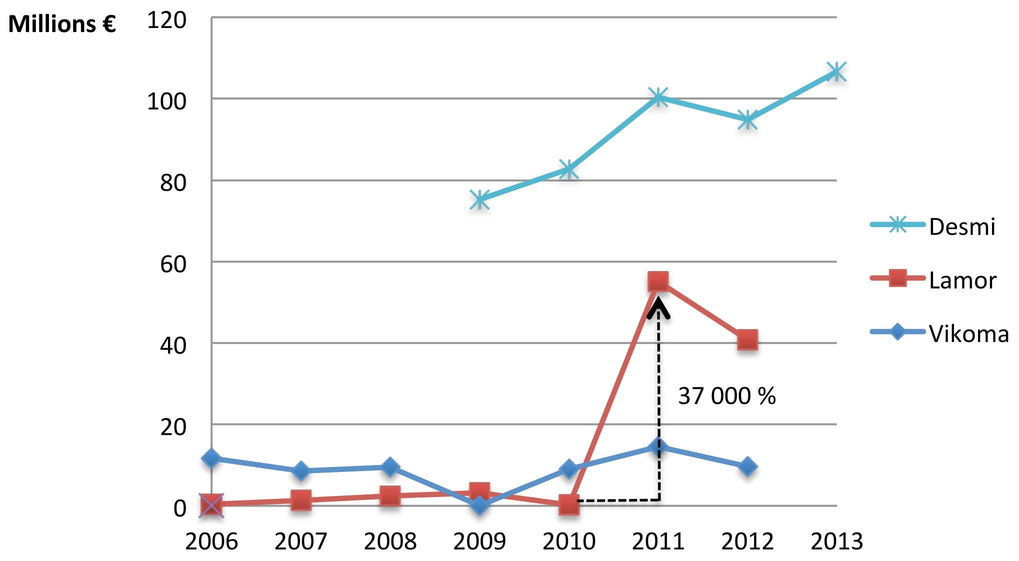

Figure 6.3 *The turnover for all of the three skimmer equipment manufacturers increased during the Deepwater Horizon in 2010. Notably, Lamor's turnover increased by 37 000 % during this incident.*

In summary, when major oil spill incidents occur the profitability of the industry is high since there is no considerable competition among equipment manufacturers, due to the extreme demand. However, in between these incidents the competition is high and thus the profitability low. Thus, we find the industry to be considered as bisectional; either during major incidents or in between the incidents.

6.1.3 Key Success Factors

The analysis of the external business environment of the Oil spill response industry culminates into finding the *key success factors* of the industry. The framework for analysing these factors are illustrated in the figure presented in Section 3.1.3 on page 13. The model includes analysis of demand, which is related to the market, and analysis of competition, which obviously is related to the competitors (Grant, 2013, p.79). It is thus a two legged analytical tool, merged into finding the key success factors of the Oil spill response industry.

Analysis of the Demand

The first leg of the key success factor model is the analysis of the demand in the Oil spill response industry. This analysis involves answering the following three questions; *Who are the customers? What are their needs?* and *How do they react to competing offerings?*

There are three main customer segments for oil spill response equipment; National coast guards, Response organisations and Private remediation firms. Furthermore, in some regions, there are three additional customer segments; Oil companies, Port authorities and Fire brigades.

The second question, regarding the customer needs, does not differ considerably among the customer segments. They all have most of their respectively demands and requirements in common. Most importantly, all customers require skimmers with high *oil recovery rate* and *oil recovery efficiency*. Thus, the amount of water that is collected is preferred to be kept to a minimum in order to optimise the storage tanks and reduce subsequent processing costs for disposals. The storage tanks are often considered as the bottle neck in operations and reduced amount of water thus increase the overall recovery capacity. Additionally, customers need skimmers with high levels of *usability* and *simplicity*, in particular for those where oil spill response is not within their main business. Customers do not want skimmer equipment per se, rather solutions for their needs, thus a *system solution* to oil spill response. Thereby, they need *training*, *support* and others *services* beside the skimmer equipment. These are particularly important for customers where oil spill response is not within their main business since their experience of major oil spills is limited. Moreover, response organisations and private remediation firms value *mobility* more than other preferences since they transfer equipment to incident site. Coast guards, on the other hand, value *automatic* solutions more than any other segment since they have limited resources to oversee operations.

The third and final question in the analysis of demand involves customer reactions to competing offerings. Since national coasts guards and response organisations both have limited budgets for purchasing new equipment, they are price sensitive. However, as they make purchases seldom, they value performance over price in the sense that response equipment are required to have long service lives. Furthermore, customers are generally not interested in new equipment unless they provide significant simplifications in the overall response system. Although, they require the new skimmer equipment to have *proven functionality* from on-water demonstrations or even more preferable, during an actual oil spill. Moreover, customers are aware of equipment manufacturer's competing offerings and since these do not differ much, there are other order winners. When customers choose between manufacturer's equipment their decisions are based on the *relationship* with the manufacturer, their *experience* of being part of major oil spills, their *expertise* in the area and their ability to provide *training* and *support*. Thus the order winner is the established *trust* that the equipment manufacturers can provide their customers with.

However, when major oil spill incidents occur, these customer segments value, above more than anything, new equipment delivered immediately. Although, relationship, trust and support are still of importance, if their current equipment manufacturer cannot deliver the amount equipment they require, they switch to additional suppliers.

Analysis of the Competition

The other leg of the key success factor model is the analysis of the competition in the Oil spill response industry. This analysis involves answering the following four questions; *What drives competition in the industry? What are the main dimensions of competition? How intense is the competition?* and *How can a superior competitive position be obtained?*

The main drivers of competition for the manufacturers of oil spill response equipment are predominantly the prevailing *low profitability* and *slow industry growth* in between the major oil spill incidents. Then, the market is seemingly oversaturated since demands are low, manufacturers are many and well-established. There are *high entry barriers* to the industry as discussed in the analysis in Section 6.1.2, due to high supplier trust, customer loyalty et cetera, which prevents new entrants to challenge the incumbents. Furthermore, the industry is characterised as mature with low levels of innovations.

The main dimension of competition in the Oil spill response industry is predominated by the fact that the customers do not demand skimmer equipment per se, but system solutions as stated before. Furthermore, the industry is characterised with a limited supply of different offerings of products and services since competitors imitate each other's offerings. The reason for this is, as discussed, because the customers demand proven technologies and solutions and do not value untested innovative products. Since the customers value trust from *close relationships*, they make their new purchase from established manufacturers. All of these manufacturers have been in the industry for many years, often decades and thus from experience of oil spill incidents, they possess the demanded *knowledge* and *expertise* and hence can provide *trust*.

The competition within the industry of oil spill response is considered *intense* since there are seven major equipment manufacturers of roughly equal size. These offer the same kinds of products and services as well as are all present in the same geographical markets, as discussed in Section 6.1.2. Although, during major oil spill incidents, the competition is instead low, profitability high and the industry is open for new entrants et cetera.

To obtain a superior competitive position in this industry, is undoubtedly for a company to possess the skill to *keep losses low* in between major oil spills while *maximising profits* during incidents. The equipment manufacturer Lamor Corporation for instance, bled heavily financially prior to the Deepwater Horizon incident. Then, when the industry characteristic changed as a consequence of the incident, the company boomed and made tremendously profits. Furthermore, the annually oil spill response *conferences* is an important forum to attend. It is essential for the manufacturers to stand out in these occasions and position themselves well among the customers and ventures. In principle, all actors of the industry attend these events and manufacturers take the opportunity to exhibit. Here, customers take the occasion to make their purchases of products and services. Additionally, some manufacturers invest more than others on marketing activities and thus believe that this is an important competitive activity.

Key Success Factors of the Oil Spill Response Industry

To sum up the identified key success factors of the Oil spill response industry, we found three distinctive factors of importance, i.e. of key success;

- Established manufacturer that can supply proven products and services and thus gain customer loyalty, i.e. trust through close relationships. Hence, new entrants are recommended to wait the entering of this industry until the occurrence of a major oil spill incident. Then, new entrants can present their assortment of equipment and prove their functionality.

- Solution oriented system approaches including service, support and training are demanded in this industry and thus not only a new product per se. Though, the offered skimmers should be of high oil recovery rate and oil recovery efficiency as well as high levels of usability and simplicity.

- To obtain a superior competitive position and survive in this industry is undoubtedly for a company to possess the skill to keep losses low in between major oil spills while maximising profits during incidents.

6.1.4 Summary of the External Business Environment Analysis

The aim of the section is to answer the first research question of the thesis, i.e. to analyse the Oil spill response industry from a macro-environment, industry environment as well as competitor- and market perspective to identify the industry's key drivers of change, profitability and competitiveness, and key success factors.

The main key driver of change is the frequency and impact of *major oil spills* which influence three factors that have the highest impact on the Oil spill response industry; the *environmental* consequences, the *economic* impact and the *legal* factors. Furthermore, the industry could be considered as bisectional; either during major incidents or in between incidents. During major incidents the profitability is high since there is no considerable competition among equipment manufacturers due to the extreme demand from customers. However, in between these incidents the competition is high and thus the profitability low. Moreover, there are three key success factors of the Oil spill response industry. First, it is essential to be an established manufacturer that can supply proven products and services and thus gain customer loyalty, i.e. trust through close relationships. Secondly, to have a solution oriented approach including service, support and training as well as skimmer technologies with high oil recovery rate and oil recovery efficiency. Thirdly, companies need to possess the skill of how to keep losses low in between major oil spills while maximising profits during incidents.

6.2 Analysis of the Internal Business Environment

The aim of the section is to analyse the case company Alfa Laval in order to identify and appraise resources and capabilities that they possess, which in turn can be utilised as competitive advantage in the Oil spill response industry. In particular, the functionality of the new skimmer equipment and their acquisition of Frank Mohn are of interest and thus scrutinised. The analysis of the internal business environment begins by analysing the new skimmer equipment and concludes with resources and capabilities of Alfa Laval and Frank Mohn.

6.2.1 The New Skimmer Equipment

Since no skimmer can cope with all encountered situations it is important to analyse in which situations the new skimmer equipment from Alfa Laval is suitable and with which skimmer technologies it competes with.

The new skimmer equipment from Alfa Laval, in not similar to any of the six dominant designs and is thus here denoted as a seventh design, a '*Conical skimmer'*. The skimmer device is based on a rotating cone, dipped into a surface layer of oil, and attached to a centrifugal separator, illustrated in Figure 6.4. The equipment recovers oil from the surface by a centripetal force caused by the conical rotation. Furthermore, the surface layer is dragged towards the cone by surface tension. Then, the centrifugal separator separates the recovered oil and water, collects the oil and discharges the water back into the sea. The conical skimmer is thereby classified as a non-oleophilic skimmer.

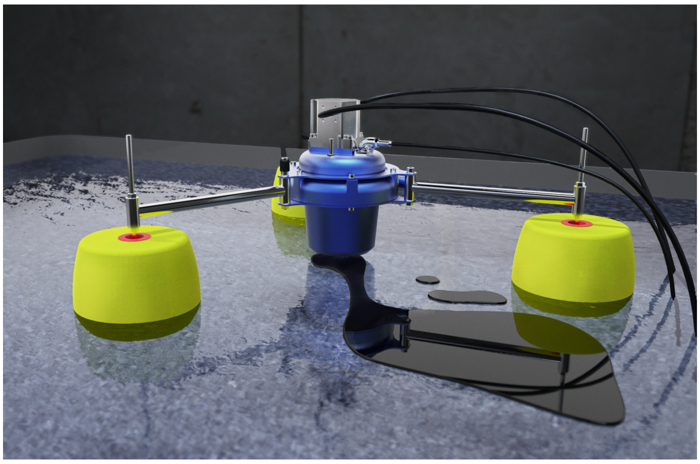

Figure 6.4 *The conical skimmer of Alfa Laval consisting of the cone, centrifugal separator and floats to keep the cone at the surface.*

This conical skimmer recovers low- to medium viscosity oils. It is to some extent sensitive to waves and current since the cone needs to be in contact with the surface in order to recover the oil. As the oil is dragged towards the cone by surface tension, debris and ice follows and thus risk of being centred around the cone. The effectiveness of the skimmer might then be reduced. However, the debris and ice does not follow the oil and clog the centrifugal separator. The capacity of the skimmer is scalable and thus considered to be of high oil recovery rate. The performance of the conical skimmer and the six current skimmer technologies, i.e. disc-, drum-, brush-, belt-, rope- and weir skimmer, are all summarised in Table 2.

Table 2 *The performance of the conical skimmer compared to current technologies.*

Skimmer	Oil Type	Sea State	Debris/Ice	Recovery Rate
Conical	Low- to Medium viscosity oils	Sensitive to waves and current	Less sensitive by high amount of debris	High capacity
Disc	Medium viscosity oils	Sensitive to waves and current	Clogged by high amount of debris	Low capacity
Drum	Low- to Medium viscosity oils	Sensitive to waves and current	Clogged by debris	Low capacity
Weir	Low- to Medium viscosity oils	Very sensitive to waves and currents	Clogged by debris	High capacity
Brush	High viscosity oils	Sensitive to large waves	Effective in small debris but clogged by large debris	Medium capacity
Belt	High viscosity oils	Not sensitive	Effective in small debris but clogged by large debris	High capacity due to its size
Rope	Medium viscosity oils	Not sensitive	Can handle significant debris and ice	Low capacity

The conical skimmer can, as disc-, drum- and weir skimmers, recover low- to medium viscosity oils. At some point due to the progression of weathering, the centripetal force caused by the conical rotation can no longer recover oil from the surface because of too high viscosity. Thus, the conical skimmer cannot compete with belt- or brush skimmers that recover high viscosity oils, which are practically solid. Furthermore, the skimmer cannot compete with belt skimmers, which are designed to operate during high amounts of debris and ice. Conclusively, the new conical skimmer competes and may in fact replace the disc-, drum- and weir skimmers.

The advantage of the conical skimmer compared to disc- and drum skimmers is that the functionality of non-oleophilic skimmers are not as sensitive to weathering processes. As the weathering processes progresses, the oleophilic skimmers no longer adhere oils to surfaces because of too high amounts of incorporated water, which reduces the oil recovery rate. Although, at some point during the progression of weathering, the viscosity of oils becomes too high and thus cannot be recovered by conical skimmers either. Furthermore, disc- and drum skimmers require a relatively thick oil slick to operate efficiently. Since the conical skimmer only needs to be in contact with the surface it also has the advantage of not requiring the same thickness of oil slicks. Conclusively, the conical skimmer has the advantage of a higher oil recovery rate compared to disc- and drum skimmers.

The main advantage with the conical skimmer compared to weir skimmers is that the recovery efficiency remains high even during rough sea conditions, i.e. waves and currents. As weir skimmers rock back and forth by waves, they alternatively suck in large amounts of water and air, which reduce the oil recovery efficiency significantly. Even though the conical skimmer rock back and forth similarly to a weir skimmer and thereby recover water to higher extent, the conical skimmer separates and discharges back the water to sea by the centrifugal separator. Therefore, during rough sea conditions the oil recovery rate is reduced though the oil recovery efficiency remains high.

Moreover, from the oil spill recovery system approach, the new conical skimmer has several advantages compared to current skimmer technologies. The design of current systems has limitations partly since the bottle neck during an oil spill recovery operation is the capacity of storage tanks. Thus, high oil recovery efficiency is desired to optimise the storage and to increase the overall recovery capacity. Oil-water separators are often used aboard vessels to concentrate the recovered oil. However, the ability to discharge the separated water into sea from a vessel is limited in most jurisdictions. Therefore, high oil recovery efficiency is desired to increase the overall oil recovery capacity and reduce subsequent processing costs for disposal.

The conical skimmer has the advantage of being an integrated system with a centrifugal separator and a skimmer in one. The skimmer recovers the surface layer and then separates the recovered water from the oil directly. The integrated system is thereby within the jurisdictions since the water is not brought aboard a vessel and the separated water can be discharged back into the sea. Thus, the skimmer collects high concentrations of oil which implies higher oil recovery efficiency. High oil recovery efficiency has several advantages within the oil spill recovery system and industry. First of all, a high concentration of oil saves valuable space in the storage tanks, which improves the overall recovery capacity of the operation. It is also more time-efficient for operators since they are able to recover more oil before they have to return to port for disposal. Furthermore, the costs for disposal are less when the oils are of higher quality, i.e. low levels of water. Conclusively, the conical skimmer has higher oil recover efficiency, implying a higher overall recovery capacity since the bottle neck is reduced and the price per recovered unit of oil is less than the competing technologies.

6.2.2 Resources and Capabilities

The analysis of the internal business environment culminates into identification of resources and capabilities of Alfa Laval. The analysis is based on the *resource-based view*, which emphasises that competitive advantage is achieved by strategies that exploit a company's unique set of resources and capabilities (Grant, 2013, p.115). The role of resources and capabilities for formulating strategy is important since companies' competitive advantages, rather than attractiveness of the industry, is the primary source of profitability (Grant, 2013, p.112). Although, an industry requires to be considered attractive to some extent for the sake of consideration of entering. The aim of the analysis is to identify and appraise resources and capabilities that Alfa Laval possesses, which can be utilised as competitive advantage in the Oil spill response industry.

The recent acquisition of the Norwegian company Frank Mohn is of most importance when regarding Alfa Laval's resources and capabilities in this context. Since Frank Mohn already is an established equipment manufacturer in the Oil spill response industry and has been so for decades, the company is a resource of outmost importance. Thus, the analysis consists of identifying and appraising the resource and capabilities of both Alfa Laval and Frank Mohn.

Resources can be divided into tangible-, intangible- and human resources. Tangible resources include both financial, e.g. solidity and liquidity, and physical resources, e.g. plants, equipment and land. The financial strength of Alfa Laval is considered strong. An example of this is their acquisition strategy and, nevertheless, their recent acquisition Frank Mohn, a Norwegian family company of more than 1 200 employees with order intakes of NOK 6.1 billions. A profit margin above 16 percentages over a business cycle further exemplifies Alfa Laval’s financial strength. Frank Mohn is also considered to have a strong financial position, with a profit margin significantly above Alfa Laval’s. Furthermore, the financial position is related to companies’ ability to keep losses low in between major oil spills while maximising profits during major oil spill incidents, i.e. a key success factor of the Oil spill response industry.

Regarding the physical resources, Alfa Laval has 34 production facilities, eight distribution centres and additionally 106 service centres around the world. In addition, Frank Mohn has a production facility in Norway and eight sales- and service centres world-wide. These are central resources in the Oil spill response industry since it is important to be globally present, which the two companies are considered to be, relative competitors. Furthermore, Alfa Laval possesses an extensive product portfolio within their three key technologies. Although, for the Oil spill response industry, the new conical skimmer technology are of most importance. As concluded in Section 6.2.1, the new skimmer equipment has several advantages compared to current technologies within the industry. In addition to the new conical skimmer, Frank Mohn has a product portfolio of equipment and system solutions for oil spill response that have proven functionality. Thus, the financial and physical resources are both considered strong and of importance.

The intangible resources include technology, e.g. patents, and reputation, e.g. brands and relationships. The patent portfolio of Alfa Laval currently consists of more than 2 000 patents. Furthermore, Alfa Laval invests 2.5 percentages of their sales in research and development annually. Thus, innovative technologies are of high priority within the company since they want to retain their position as market leader within their three key technologies. For the Oil spill response industry, the protection of the new conical skimmer is of most importance. The protection of the technology is considered broad and strong.

The reputation and credibility of Alfa Laval and Frank Mohn are considered as one of their respectively key resources. Brand and trust are important customer preferences in the Oil spill response industry, as stated. Frank Mohn is ranked high in the industry and is particularly known for its robustness and complete system solutions. Alfa Laval is a well-known brand in many other industries and is often associated with high-quality and premium products with long service lives. Furthermore, their separation technologies are considered to be robust and of high performance even among customers for oil spill response equipment. Thus, technology and reputation are also strong resources which Alfa Laval and Frank Mohn possess.

Human resources include skills and knowledge offered by the company’s employees. Alfa Laval possesses specialised knowledge and expertise in separation technologies, particularly regarding separation of oil from water. Separation has been part of Alfa Laval since the establishments in 1883 and the company is currently market leader with 30 percentages of the world market. Furthermore, Frank Mohn possesses the required experience and expertise from major oil spill incidents. The company has established relationships with customers, essential for customer loyalty and trust, which is one of the key success factors of the Oil spill response industry.

Lastly, core capabilities are those that are central to a company's strategy and performance, i.e. for Alfa Laval to the enter Oil spill response industry. A capability of outmost importance for the Oil spill response industry is the ability to keep losses low in between major oil spills while maximising profits during incidents. This activity is undoubtedly related to supply chain management. Alfa Laval possesses a centralised, coordinated and global supply chain system through the division Operations, shared among the three sales divisions. Another capability of importance is their innovativeness and ability to launch new products, which is related to their financial strength. However, Alfa Laval has historically had internal challenges with launching of new products that their employees considered to be relative inexpensive and of simple technologies. Furthermore, technologies that do not fit well within the current organisational structure have difficulties to find their way to markets.

Moreover, resources and capabilities are appraised in terms of their 'Strategic importance' and 'Relative strength' compared to equipment manufacturers of the Oil spill response industry. The framework for appraising resources and capabilities are illustrated in the figure presented in Section 3.2.1 on page 15. Important to notify is that the appraising of resources is context specific and thus only applied for the Oil spill response industry.

The most important resources and capabilities that Alfa Laval and Frank Mohn possess are appraised and illustrated in Figure 6.5, with each number corresponding to respectively resource or capability. The identified resources and capabilities of Alfa Laval that are of most importance for entering the Oil spill response industry are; the brand Alfa Laval [1], the new conical skimmer technology [2], patents of the new skimmer equipment [3], their knowledge and expertise in separation of oil from water [4], their capability of supply chain management [5] and lastly, their capability to launch new innovative products [6]. Furthermore, identified resources and capabilities of Frank Mohn that are of most importance for the entering the Oil spill response industry are; the brand Frank Mohn [7], their product portfolio of proven functionality [8], their knowledge and expertise in oil spill response [9] and lastly, their experience of major oil spill incidents [10]. In common for both of these companies are their financial strength [11] and global presence [12].

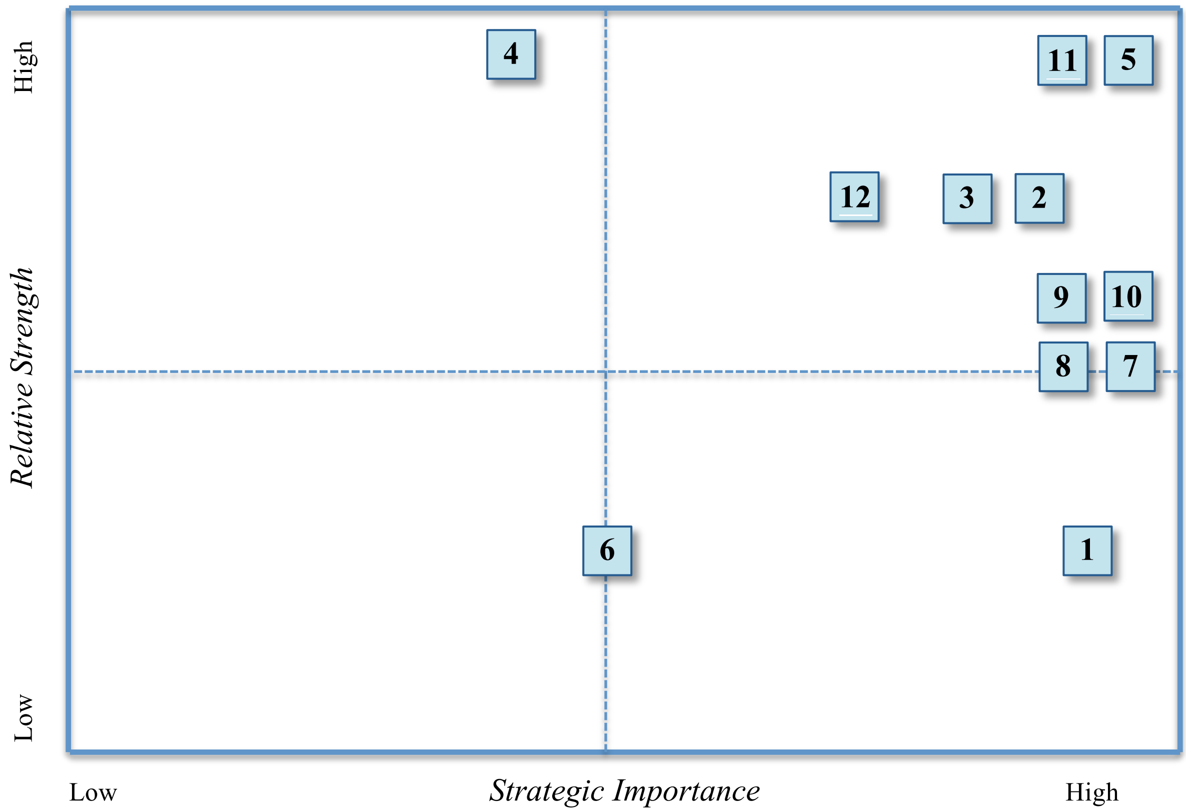

Figure 6.5 *Appraising resources and capabilities of Alfa Laval and Frank Mohn concerning the Oil spill response industry; [1] The brand Alfa Laval, [2] The new conical skimmer technology, [3] Patents of the new skimmer equipment, [4] Alfa Laval's knowledge and expertise in separation of oil from water, [5] Alfa Laval's capability of supply chain management, [6] Alfa Laval's capability to launch new innovative products, [7] The brand Frank Mohn, [8] Frank Mohn's product portfolio of proven functionality, [9] Frank Mohn's knowledge and expertise in oil spill response, [10] Frank Mohn's experience of major oil spill incidents, [11] the companies' financial strength and [12] the companies' global presence.*

Resources that are considered to be of high strategic importance and neither of low or high relative strength are concerning Frank Mohn; the brand [7], their product portfolio of proven functionality [8], their knowledge and expertise in oil spill response [9], and their experience of major oil spills [10]. These are all required in order to achieve the three key success factors of the Oil spill response industry, presented in Section 6.1.3. However, these are not uniquely possessed by Frank Mohn, rather by all seven incumbents, more or less.

Resources that are considered to be of high relative strength compared to competitors but not of the same strategic importance are; the new conical skimmer technology [2], patents of the new skimmer equipment [3] and, Alfa Laval's and Frank Mohn's global presence [12]. As concluded in Section 6.2.1, the conical skimmer has several advantages compared to current technologies. However, customers do not demand skimmer equipment per se, rather system solutions for oil spill response operations and thus these resources are not considered of equal strategic importance as those recently discussed. Furthermore, even though Alfa Laval and Frank Mohn are more globally present than the incumbents, it is not within the *key* success factors of the Oil spill response industry and thus of lower strategic importance.

Moreover, Alfa Laval's knowledge and expertise in separation of oil from water [4] is considered of high relative strength but not of high strategic importance, thus a superfluous strength in this industry. On the other hand, the brand Alfa Laval [1] is of high strategic importance but of low relative strength, thus a key weakness. Though the brand is not weak out of context but rather unknown relative other equipment manufacturers in the Oil spill response industry. According to Grant (2013, p.133) the level of investment could be either be reduced for these or an innovative strategy can turn these superfluous strengths and key weaknesses into key strategic differentiators.

Resources and capabilities that are considered to be of high relative strength compared to incumbents and also of high strategic importance are; Alfa Laval's capability of supply chain management [5] as well as Alfa Laval's and Frank Mohn's financial strengths [11]. These two are uniquely possessed by Alfa Laval and Frank Mohn and at the same time critical to achieve the key success factor of keeping losses low in between major oil spills while maximising profits during major oil spill incidents.

Conclusively, a competitive advantage is achieved by utilising resources and capabilities that are uniquely possessed by the company. As concluded, the resources of Frank Mohn are of high strategic importance since these are essential for achieving the key success factors of the Oil spill response industry. However, these are not uniquely possessed by Frank Mohn and can thus not be utilised as a competitive advantage. Although, Alfa Laval has resources and capabilities that are of high relative strength and are uniquely possessed. Most important are the financial strength and supply chain management capability. Although, their new patent protected conical skimmer and their global presence can also be utilised as competitive advantage. Additionally, their unique knowledge and expertise in separation of oil from water, which currently is considered superfluous, can be utilised as a key differentiator.

Resources and capabilities that are rare and valuable can be of competitive advantage though the advantage may not be sustainable if Alfa Laval is incapable of keeping them, or if competitors are capable of imitating them. Although equipment manufacturers of oil spill response equipment are prone to imitate each other's offerings, a strong patent protection prevents such imitations of the new conical skimmer. On the other hand, a global presence is considered to be rather easy to imitate if a company has the financial strength. However, the supply chain management capability, their financial strengths, and their knowledge and expertise in separation of oil from water are all considered inimitable and non-substitutable and thus, it is a sustainable competitive advantage.

6.2.3 Summary of the Internal Business Environment Analysis

The aim of the section is to answer the second research question of the thesis, i.e. to analyse the case company Alfa Laval to identify and appraise resources and capabilities that they possess, which can be utilised as competitive advantage in the Oil spill response industry. In particular, the new skimmer equipment and their acquisition of Frank Mohn are of interest.

The new skimmer equipment does not fit within the current six dominant designs and are thereby denoted as a seventh design, a 'conical skimmer'. This skimmer recovers low- to medium viscosity oils and thus competes, or in fact replaces, disc-, drum- and weir skimmers. The conical skimmer has several advantages compared to current technologies within the industry, most importantly, it has higher oil recovery efficiency. This implies higher overall recovery capacity since the operational bottle neck is reduced, more time-efficient solution for customers and the price per recovered unit of oil is less than the competing technologies.

Alfa Laval, together with their recent acquisition Frank Mohn, possess resources and capabilities that are of importance within the Oil spill response industry. Frank Mohn's resources are their knowledge and expertise of oil spill response, their experience of oil spill incidents, their product portfolio of proven functionality and their brand. These four are all of high strategic importance since these are essential for achieving the key success factors of the industry. However, these are not uniquely possessed by Frank Mohn and can thus not be utilised as a competitive advantage. Although, Alfa Laval has resources and capabilities that are of high relative strength and are uniquely possessed. Most importantly, the financial strength and supply chain management capability but also their new patent protected conical skimmer and their global presence, are resources that can be utilised as competitive advantage. Additionally, their unique knowledge and expertise in separation of oil from water, which currently is considered superfluous, can be utilised as a key differentiator.

7 RECOMMENDATIONS

The aim of the chapter is to provide Alfa Laval with recommendations regarding the business opportunity with their new conical skimmer within the Oil spill response industry. The chapter begins by evaluating if there is a strategic-fit between the analysis of the external- and the internal business environment in Chapter 6, and thus provide Alfa Laval with recommendation regarding whether to enter the Oil spill response industry or not. The chapter ends with a proposal of a business model for their new skimmer equipment that utilises Alfa Laval's competitive advantage.

7.1 Strategic-Fit

Prior to entries of new markets, a company's strategy requires evaluation in order to see if there is a fit in entering a specific market. Alfa Laval's official product strategy is to "create better conditions" such as "protecting the environment", as discussed in the introduction of the thesis. Furthermore, due to the fact that the company has experience from oil separation techniques since the establishment in 1883, the Oil spill response industry should not be considered as too foreign for them. The industry might as well be of strategic interest and could be a diversification where they can utilities their knowledge of how to separate oil from water, while simultaneously contribute to the protection of the environment. Furthermore, to achieve the financial goal of a growth rate of at least eight percentages annually, Alfa Laval needs to continuously expand their product offering and market presence, both organically and through acquisitions.

The Oil spill response industry is though rather unique since it is bisectional; during major oil spill incidents and in between incidents. These two industry conditions have completely different characteristics, caused by the main key driver of change, i.e. the frequency and impact of major oil spill incidents. During major oil spills, the industry is characterised by high profitability since there is no considerable competition among equipment manufacturers of oil spill response equipment due to the extreme demand from customers. However, in between major oil spills, the industry is characterised by high competition and low profitability.

As concluded, there are three key success factors of the Oil spill response industry. First, it is essential to be an established manufacturer that can supply proven products and services and thus gain customer loyalty, i.e. trust through close relationships. Secondly, to have a solution oriented approach including service, support and training as well as skimmer technologies with high oil recovery rate and oil recovery efficiency. Thirdly, companies need to possess the ability to keep losses low in between major oil spills while maximising profits during incidents. These three are concluded to be of strategic importance and need to be addressed in order to succeed in this industry.

Since the entry barriers of the Oil spill response industry are high, it is difficult for Alfa Laval to enter the industry alone. The reason for this is because the key success factors of the industry are system oriented solutions in combination with providing expertise and trust to customers. The new conical skimmer equipment is not such a system solution and Alfa Laval does not possess the knowledge or expertise required by the industry to succeed since they have no experience of major oil spills and thus, is not able to provide satisfactory trust to customers. It is thus not recommended for Alfa Laval to enter this industry alone. However, recommendation of how to enter this industry would involve acquisition of an already established company. A recent such acquisition was made by Alfa Laval during the spring of 2014, Frank Mohn, which is an established manufacturer of oil spill response equipment. Then, the industry is profitable and attractive provided that the three success factors discussed are achieved.

Frank Mohn has the knowledge and expertise that are required by the industry. The acquisition of Frank Mohn thus provides the ability to access and enter the Oil spill response industry. However, Frank Mohn, or any other equipment manufacturer of oil spill response equipment for that matter, do not possess any competitive advantage in these key success factors. However, Alfa Laval has resources and capabilities that could be utilised as competitive advantage, if they decide to enter the Oil spill response industry. Their financial strength and supply chain management capability, in combination, provide a relative strength towards competitors to handle losses in between major oil spills and maximising profits during incident. Furthermore, their knowledge and expertise of separation techniques is another resource that is utilisable and can provide a unique competitive advantage in the Oil spill response industry.

Finally, regarding the evaluated conical skimmer equipment, it was discussed that this had direct competitive advantages relative at least three of the six studied skimmer techniques. However, it is not of much value alone since system solutions are demanded by the industry. Though a co-branded conical skimmer, integrated in a system by Frank Mohn, with a centrifugal separator by Alfa Laval can combine their two strengths and provide a competitive advantage in the Oil spill response industry.

Conclusively, there is a strategic-fit from our analysis and thus, we recommend Alfa Laval to enter the Oil spill response industry. They are furthermore recommended to do so jointly, or with assistance from Frank Mohn, and launch their new conical skimmer equipment, co-branded by both Frank Mohn and Alfa Laval to utilise their respectively competitive advantages.

7.2 Business Model Canvas

A business model defines how companies create, deliver and capture value from e.g. new technologies, since the same technology launched with different business models yield different economic outcomes. Osterwalder and Pigneur's *Business model canvas* is a widely accepted and applied model, both among academia and industry, including the case company Alfa Laval. The model is illustrated in the figure presented in Section 3.3 on page 16. The business model canvas consists of nine building blocks; Customer Segments, Customer Relationships, Channels, Value Propositions, Revenue Streams, Cost Structure, Key Partners, Key Activities and Key Resources. The business model canvas that we recommend Alfa Laval to use in their launch of the new conical skimmer, in the Oil spill response industry, is presented in Figure 7.1. The building blocks Customer Segments, Value Propositions, Customer Relationships, Channels, Key Partners and Key Resources are described in more detail in the following paragraphs, respectively[14].

Customer Segments

There are three main customer segments for oil spill response equipment, i.e. the conical skimmer; National coast guards, Response Organisations and Private remediation firms. Furthermore, in some regions, there are three additional customers segments; Oil companies, Port authorities and Fire brigades.

Value Propositions

The new conical skimmer offer customers several advantages, i.e. value propositions, compared to current solutions, which are recommended to be highlighted during the launch of the conical skimmer. An advantage is that the device includes a skimmer and a centrifugal separator in one integrated system. The solution allows discharge of separated water directly back into the sea since it is within jurisdictions and thus provides higher oil recovery efficiency, which is an industry key success factor. Skimmers of high oil recovery efficiency reduce the main bottle neck, the size of the storage containers, in oil spill recovery operation and have thereby higher overall oil recovery rate. The solution is also more time-efficient for customers, provides less disposal costs and reduces the price per recovered unit of oil.

Since the conical skimmer recovers low- to medium viscosity oils it competes or in fact replaces disc-, drum- and weir skimmers. Compared to disc- and drum skimmers, the conical skimmer is not as sensitive to weathering processes and thus remains a high oil recovery rate over a longer period of time. Compared to weir skimmers, it remains high oil recovery efficiency during rough sea conditions. These are additional advantages with the conical skimmer.

Moreover, the brands of Alfa Laval and Frank Mohn indicate robustness, reliability and high-quality. These attributes are valued by customers of oil spill response equipment, even higher than price since they need products with high performance and of long service lives. The reason is because customers of this industry generally make purchases seldom. Thereby, the new conical skimmer is recommended to be co-branded; a conical skimmer by Frank Mohn with a centrifugal separator by Alfa Laval. Furthermore, Alfa Laval's currently superfluous strength of knowledge and expertise in separation of oil from water are recommended to be a key differentiator. Since no other equipment manufacturer possess that knowledge and in combination with the new conical skimmer of higher oil recovery efficiency, it is a competitive advantage for Alfa Laval.

Customer Relationships

The relationships toward customers in this industry is recommended to be close and interactive since customers demand solutions for how to recover spilt oil from water rather than equipment per se. Furthermore, customers base their purchasing decisions on relationship with their respectively equipment manufacturer, thus it is important to establish trust.

[14] Revenue Streams, Key Activities and Cost Structure are disclosed due to confidentiality.

Channels

There are four main channels for Alfa Laval to reach their customers in this industry. As stated, the main forum for oil spill response equipment is the annual conferences; IOSC, Interspill and Spillcon, which each is held every third year respectively. Here, customers purchase new equipment, establish new relationships and equipment manufacturers launch new products and technologies. Thus, it is the main forum and channel for launching and marketing the new conical skimmer. The geographically widespread sale offices are also of importance in order to be close to customers when incidents occur and to be able to provide other services, such as training and support. It is furthermore recommended to book sale meetings with future customers to describe and present the new conical skimmer. Finally, to test the conical skimmer at NOFO's on-water demonstration provides valuable knowledge to customers about the new technology.

Key Partners

There are two key partners of interest in order to successfully launch the new conical skimmer. As concluded, Frank Mohn possesses the required resources and capabilities that are required to succeed in the Oil spill response industry. Thus, we recommend Alfa Laval to launch their skimmer jointly or with assistance from Frank Mohn. Another partner of interest is to establish relationship with some of the main customer segments. Since customers require proven technologies, it is of importance to establish closer relationship with a customer that is willing to test the equipment. That customer might then be a reference customer.

Key Resources

As concluded in the resource and capabilities analysis in Section 6.2.2, Alfa Laval possesses resources that can be utilised as a competitive advantage in the Oil spill response industry. First of all, Frank Mohn is a resource in itself since it possesses the resources and capabilities that are essential for achieving the key success factors of the Oil spill response industry. Alfa Laval's financial strength and supply chain management capability, in combination, provide a relative strength towards competitors to manage losses in between major oil spills and maximising profits during incidents. Furthermore, their knowledge and expertise in separation of oil from water, which currently is considered as superfluous in the Oil spill response industry, are recommended to be used as a key differentiator.

Moreover, the conical skimmer technology is a key resource since it has several direct competitive advantages compared to current solutions and skimmer technologies. Furthermore, in order to prevent equipment manufacturers to imitate the conical skimmer, the patents of the technology are of importance.

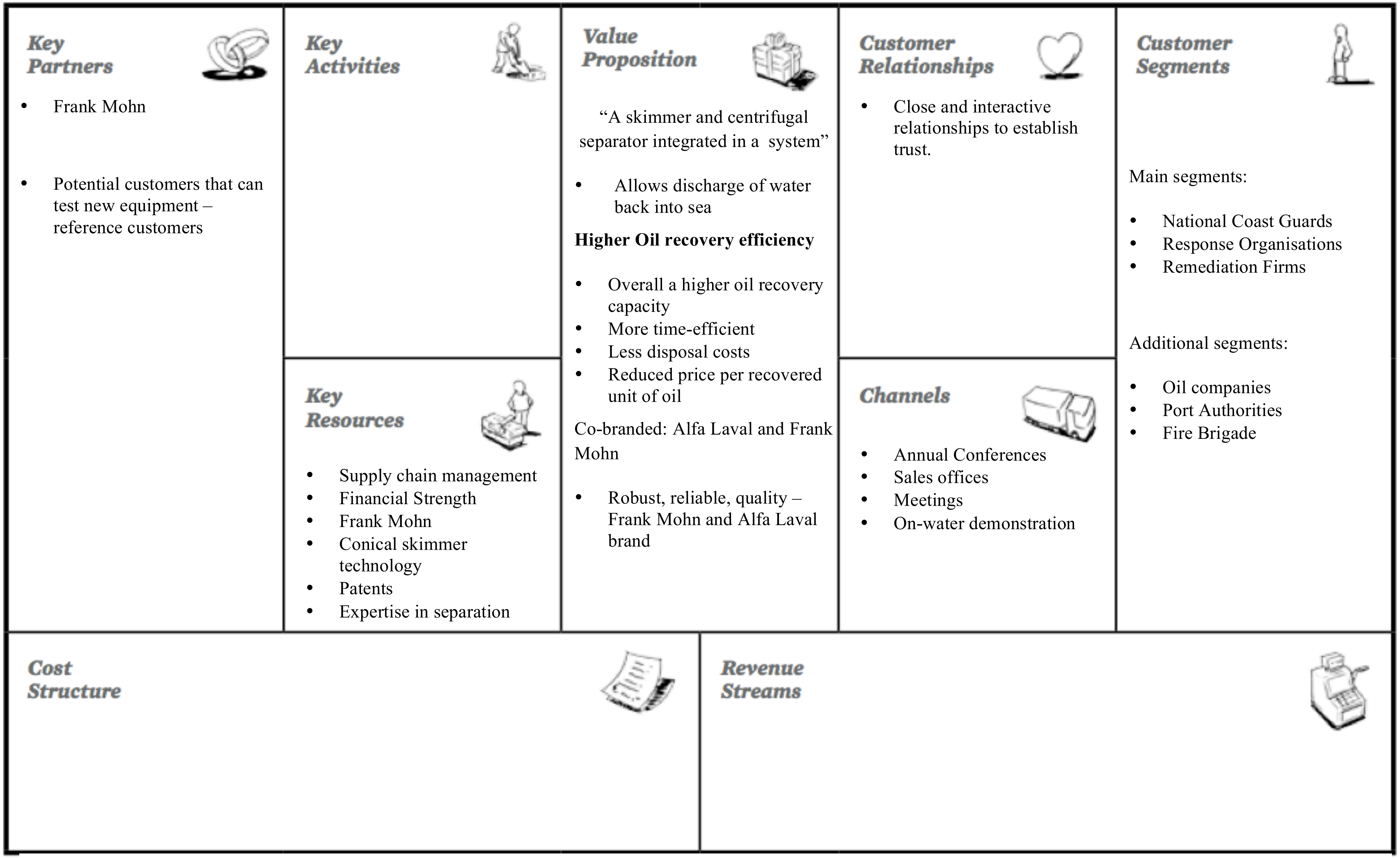

Figure 7.1 *The Business Model Canvas for the new Conical skimmer by Alfa Laval.*

8 CONCLUSIONS

This chapter concludes the thesis by answering the two research questions and fulfils the purpose; to evaluate the business opportunity of the new skimmer equipment and provide Alfa Laval with knowledge about the Oil spill response industry.

The first research question was to identify the key drivers of change, the profitability and competitiveness, and the key success factors of the Oil spill response industry. From an analysis of the external business environment, we concluded that the main key driver of change is the frequency and impact of major oil spills which influence three factors of the highest impact on the industry; the environmental consequences, the economic impact and the legal factors. Since the industry is considered bisectional, the profitability and competitiveness varies and depend on the prevalence of major incidents. During major incidents the profitability is high since there is no considerable competition from customers, while in between incidents the competition is high and thus the profitability low. Regarding the key success factors of the Oil spill response industry, we conclude that there are three such factors. First, it is essential to be an established manufacturer and has the customer's trust. Secondly, a solution oriented approach with skimmer technologies of high oil recovery rate and oil recovery efficiency is of importance. Thirdly, the ability to keep losses low in between major oil spills while maximising profits during incidents is key.

The second research question was to identify and appraise resources and capabilities that Alfa Laval possesses, which can be utilised as competitive advantage in the Oil spill response industry. From an analysis of the internal business environment, i.e. Alfa Laval, we found that these are the new skimmer equipment and their acquisition of Frank Mohn. The new skimmer equipment has several advantages compared to current technologies within the industry. Most importantly, it has higher oil recovery efficiency and aids in reducing the bottle neck of oil recovery operations. The patent protection of the skimmer equipment is broad and strong. Furthermore, Frank Mohn possesses resources and capabilities essential for achieving the key success factors of the Oil spill response industry. Alfa Laval has additionally, uniquely possessed, resources and capabilities of high relative strength and these are utilisable as competitive advantage. These are the financial strengths, supply chain management capability and their knowledge of separation techniques.

We furthermore concluded that there is a strategic-fit between the analysis of the external- and internal business environment and thus, there is a business opportunity for Alfa Laval. Hence, we recommend Alfa Laval to enter the Oil spill response industry and, jointly with Frank Mohn, launch the new skimmer equipment, co-branded by both Frank Mohn and Alfa Laval, and thus utilise their respectively competitive advantages.

Since we concluded that there is a business opportunity, we furthermore proposed a business model for the new skimmer equipment. This is found in the end of Chapter 7, on the previous page.

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9.2.1 Electronic

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ITOPF (2013b) *Effects on Oil Pollution on Fisheries and Mariculture*. http://www.itopf.com/fileadmin/data/Documents/TIPS%20TAPS/TIP11EffectsofOilPollutionnFisheriesandMariculture.pdf (2014-06-28)

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10 APPENDIX

10.1 Interviews with Actors in the Oil Spill Response Industry

Environmental Officer, Port of Helsingborg (2014-03-19)

COO, Fire Brigade, Sweden (2014-03-20)

Rescue Engineers, Swedish Coast Guard, Gothenburg (2014-03-20)

CEO, PetroBell (2014-03-21)

Eco toxicologist and Arctic campaigner, Greenpeace Nordic (2014-03-21)

Project Director, Swedish Environmental Research Institute, Gothenburg (2014-03-24)

Consultants, SWECO Environment, Stockholm (2014-03-25)

Oil Administrator, Swedish Civil Contingencies Agency, Stockholm (2014-03-26)

Head of Response, Swedish Coast Guard (2014-03-26)

Fire Engineers, Fire Brigade Sweden (2014-03-26)

Senior Advisor, Swedish Agency for Marine and Water Management (2014-03-27)

CEO, Markleen Sweden, Gothenburg (2014-03-27)

Owners and Founders, SP Marine Technology, Gothenburg (2014-03-27)

Oil Administrator, Swedish Coast Guard, Karlskrona (2014-03-28)

Fire Engineer, Fire Brigade, Gothenburg (2014-04-02)

Environmental Engineer, Port of Gothenburg (2014-04-03)

Foreman, AB Göta Kanalbolag (2014-04-04)

COO, PetroPort, Stenungsund (2014-04-11)

COO, Copenhagen Malmö Port, Copenhagen (2014-04-14)

Technical Engagement Coordinator, Oil Spill Response Limited (2014-05-05)

Research Assistant, Maritime Environmental Research Group, World Maritime University (2014-05-06)

Managing Director, Foilex Engineering AB (2014-05-06)

Ohmsett Manager, Bureau of Safety and Environmental Enforcement (2014-05-06)

Regional Manager, Aqua-Guard Spill Response (2014-05-07)

Vice President, Lamor Corporation (2014-05-07)

Sales and Project, Oil Recovery Systems, Frank Mohn AS (2014-05-07)

General Manager, Australian Maritime Safety Authority (2014-05-07)

Preparedness Advisor, US Coast Guard, Seattle (2014-05-07)

Sales and Marketing Director, Vikoma (2014-05-07)

President and General Manager, Alaska Clean Seas (2014-05-08)

General Manager, Marine Spill Response Organization (2014-05-08)

Development and Assurance Lead, Oil Spill Response Limited (2014-05-08)

Executive Marketing Director, Norlense (2014-05-08)

Commandant, US Coast Guard, Washington (2014-05-08)

President, Oil Spill Response, DESMI Ro-Clean A/S (2014-05-08)

Sales Manager, Oil Spill Response Equipment, Elastec (2014-05-08)

Executive Director, Spill Control Association of America (2014-05-08)

10.2 Interviews of Personnel at Alfa Laval

Senior Manager Technologies, Corporate Development, Alfa Laval Lund (continuously)

Concept manager/Innovation Management Processes, Product Centre, Alfa Laval Lund (continuously)

Application Development, Business Centre Separators Systems, Alfa Laval Lund (continuously)

Senior Patent Attorney, Patent Department, Alfa Laval Tumba (2014-02-11)

Patent Information Specialist, Patent Department, Alfa Laval Lund (2014-02-19)

Business Manager, EFU, Alfa Laval Tumba (2014-02-25)

Research and Development manager, Application Development, Alfa Laval Tumba (2014-02-25) and (2014-03-06)

Senior Research Scientist, Fluid Dynamics and Separation Technology, Alfa Laval Tumba (2014-02-25) and (2014-03-06)

Business Development Engineer, EFU, Alfa Laval Tumba (2014-02-25) and (2014-03-06)

Concept Manager, Concept Development, Alfa Laval Tumba (2014-02-25)

Manager Merger and Acquisitions, Corporate Development, Alfa Laval Lund (2014-02-27)

Team Manager Patent, Patent Department, Alfa Laval Tumba (2014-03-06)

Concept Manager, Concept Development, Alfa Laval Tumba (2014-03-06)

Manager, Technology, Alfa Laval Tumba (2014-03-06)

Portfolio Manager, Service Marine and Diesel Equipment, Alfa Laval Tumba (2014-03-06)

Oil and Gas Business Manager, Disc Stack Centrifuges, Alfa Laval Tumba (2014-03-06)

Process Engineer, Oil and Gas Technology, Alfa Laval Lund (2014-04-15)

Regional Business Manager, Oil and Gas Technology, Alfa Laval Lund (2014-04-15)

Senior Gas Process Engineer, Oil and Gas Technology, Alfa Laval Lund (2014-04-15)

10.3 Conference Sessions

The list below includes conference sessions that the two authors attended during the International Oil Spill Conference (IOSC) in Savannah, Georgia (United States), May 5th until 8th in 2014.

Session 1: Latin America and Caribbean Issues 2014-05-05

Maggi, P. (IBAMA – Brazilian Federal Environmental Agency). *Offshore Spill Incidents: Creating a Database in Brazil.*

Rudder, M. (Ministry of Energy and Energy Affairs). *A Decision-Making Process for the Election of a Tier II Oil Spill Response Mechanism.*

Sagrera, C. (MTC Consulting). *New Challenges in Latin America and Caribbean Oil Spill Control: Offshore Prevention and Response after the DWH Milestone.*

Fantinato, L. (O´Brien's do Brasil). *Brazil Case Study – Tactical Response Plans and VoO's Program – A New Approach to Shoreline Protection Preparedness.*

Schuler, P. (Oil Spill Response Limited). *MOBEX Cayenne 2013: Lessons Learned & response Enhancements Derived from the International Mobilization, Preparedness & Response Exercise in French Guiana.*

Session 3: Exercises and Drills – Case Reviews and Best Practices 2014-05-06

Wieliczkiewicz, E. (BP Exploration Alaska). *Mutual Interests, Mutual Training, Results in Mutual Aid and Respect.*

DeCole, E. (Nuka Research and Planning Group, LLC). *Oil Spill Simulants Workshop Process and Outcomes.*

Gleason, J. (US Coast Guards). *Getting Big Results by Going Small – The importance of Tabletop Exercises and Workshops.*

Callahan, T. (Waypoint Environmental Consulting, LLC). *Resource Ordering and Tracking: Getting It Right in Exercises and Incidents.*

Session 6: International Guidelines for Spill Planning 2014-05-06

Nissen, T.R. (DNV GL). *Developing a Guideline for Oil Spill Risk Assessment and Response Planning for Offshore Installations.*

Knutson, S. and Dougans, C. (US Coast Guards). *Canada – Untied States (Salish Sea) Spill Response Organizations: A Comparison.*

Parker, H. (US Coast Guards). *International Offers of Assistance Guidelines – Developing an IMO Tool to 'Internationalize' Oil Spill Readiness and Response.*

Session 8: Cutting Edge Techniques and Research 1 2014-05-07

Vandenbussche, V. (DNV GL). *Best Available Techniques Applied to the Offshore Oil and Gas Industry.*

Batubara, D. (Louisiana State University). *A Laboratory Mesocosm as a Tool to Study Pah Degradation in a Coastal Marsh Westland.*

Parscal, B. (Parscal Pacific, LLC). *A Field Evaluation of Unmanned Aircraft Systems for Oil Spill Response.*

Heatley, J.J. (Texas A&M University). *Saving Lives: Critical Blood* Analytes for Coastal Avian Species.

Session 13: Cutting Edge Techniques and Research 2 2014-05-07

Kerambrun, L. (Cedre). *Hoverspill: A New Amphibious Vehicle for Responding in Difficult-to-Access Sites.*

Nixon, Z. (Research Planning, Inc). *Tactical Predictions of Shoreline Oiling Probability via Machine Learning Models and Satellite-Derived Surface Oil Analysis Products.*

Meyer, P. (Ohmsett). *Testing of Oil Recovery Skimmers in Ice at Ohmsett, The national Oil Spill Response Research & Renewable Energy Test Facility.*

Maj, G. (YLEC Consultants). *TURBYLEC: Development and Experimental Validation of an Innovative Centrifugal Oil-Water Separator.*

Session 17: Asian Pacific Region 2014-05-07

Storrie, J. (Australian Maritime Safety Authority). *A National Review of Australian's Maritime Environmental Emergency Response Arrangements.*

Chunchang, Z. (Dalian Maritime University). *Oil Spill Response Capability Building in China and Her Road Map.*

Tan, Y. (Oil Spill Response Limited). *The Growth in Energy Activities in The South China Sea – Are We Truly Prepared?.*

Varghese, G. (Oil Spill Response Limited). *An Assessment of the Increasing Risk of Marine Oil Spills and the Existing Preparedness Capability in South East Asian Region.*

Session 27: Global Initiatives and APREL RETOS 2014-05-07

Coolbaugh, T. (ExxonMobile Research and Engineering). *The IMO/IPIECA Global Initiative: Expanding Government and Industry Cooperation into New Regions.*

Taylor, P. (IPIECA). *Developments in International Cooperation and National Planning in the Caspian Sea and Black Sea.*

Rhodes, A. (IPIECA). *Oil Spill Preparedness and Response Capability in West, Central and Southern Africa: Sustaining Momentum in a Changing World of Oil Spill Risks.*

Guevarra, J. (IPIECA). *The Global Initiatives for South East Asia.*

Taylor, E. (Polaris Applied Sciences Inc.) *Upgraded RETOS: An International Tool to Assess Oil Spill Response Planning and Readiness.*

Session 35: EDRC and Alternative Response Capacity Assessment 2014-05-08

Miller, S. (Alaska Department of Environmental Conservation). *Alaska's Approach to Determining Oil Recovery Rates and Efficiencies.*

Mattox, A. (Nuka Research and Planning Group, LLC). *Using the Response Options Calculator to Estimate Mechanical Oil Recovery for Response Forces.*

Foley, P. (Oil Spill Response Limited). *The Risk Based Alternative to the Prescriptive Approach to the Development of Oil Spill Preparedness and Response.*

Casey, D. (US Coast Guard). *Designing a New Planning Standard for Mechanical Skimming Systems.*

Session 42: Prevention, Preparedness & Response: Tools and Techniques 2014-05-08

Schnapp, K. (BSEE Oil Spill Response Division). *Considerations for Successfully Incorporating the Subsea Well Control Support Functions into a Response Organization during an Offshore Oil Spill from an Uncontrolled Well; Three Options from Four Viewpoints.*

Owens, E. (Owens Coastal Consultants). *Tidal Inlet Protection Strategies (Tips) Field Guide for Shoreline Protection.*