Defining Invention X's Market Potential

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Abstract

September 13th 2016

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Degree programme	
International Business Management	

Thesis title Defining Invention X's Market Potential	**Number of pages and attachment pages** 86 + 11

Tampere University of Technology has created a new technology for measuring ultrafine particles from air. In order to commercialize the invention, a TEKES-funded project was started on January 1st 2016. The project has four phases: (1) discovering the market potential, (2) building a prototype, (3) calibrating and testing, (4) formulating an overall strategy and creating a business plan. The main research question, and at the same time, the ultimate objective, is to investigate phase 1 in order to understand what is the market potential of Invention X. The research design and the plan for this study are aimed at facilitating phase 4, i.e. overall strategy formulation and business planning.

This study has five interlinked objectives: the first is to identify and segment potential customers, the second is to discover which product-related features are of value to the customers, the third is to carry out an analysis of the competition, the fourth is to acquire knowledge of the market environment, and the fifth and the final objective is to estimate the market potential. This study has been framed carefully in order to meet the research objectives. Therefore, the most obvious potential customer segments, research & academia and the filtration industry, were first selected for further analysis.

The theoretical part of this study has been designed in a way that supports the empirical research part of this study. It scrutinizes different layers of the business environment and presents the main frameworks for understanding the external market environment and, concepts for better understanding the competitive landscape, the customers' needs, and the innovation's capabilities. The two main theoretical frameworks for understanding the external environment, Porter's Five Forces framework and Kim et al.'s Blue Ocean strategy represent opposite views on how to assess the external market environment, as well as the competitive landscape. In addition, Osterwalder's framework is used to assess the customers' needs, and the study also presents the main theories on how to segment, position, and target the customers. Finally, the theoretical part of the study defines which tools can be used for assessing the invention's capabilities.

The selected research strategy is action research which relies on co-operation between the researcher and the project's sponsor. The research in this study is based on a mixed-method sequential exploratory research design where qualitative methods are followed by quantitative ones. In the qualitative part of this study, 16 semi-structured interviews were analyzed. The quantitative part consists of desktop research where the market-related data was used to estimate the market potential of Invention X. As a result, the main findings based on the interviews and the market potential's monetary value were presented to the project's steering committee on August 15th 2016. Invention X's market potential in pre-selected segments, i.e. research & academia and the filtration industry, was found to be unfeasible from an economic perspective but the final outcome of phase 1 of the project is to continue investigating the new technology's potential for the clean rooms' market.

Keywords
Market Potential, Market Analysis, Customer Value Proposition

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1   Introduction

The Technical University of Tampere (TUT) is an international scientific community with 10,500 undergraduate and post graduate students, and with over 2,000 staff. The university is a foundation, whose model offers all the required prerequisites for top notch scientific research.

Against this background, in 2015, a team of scientists in the aerosol physics research department came up with a new air filtering measurement technology. This breakthrough can be used to obtain accurate measurements of any particles in the air, regardless of their size, mass and density.

The discovery has great commercial potential, so a TUTLI project was started on January 1st, 2016 which will continue until February, 2017. This project, co-funded by TEKES and TUT is aimed at creating new knowledge and, where possible, new business from research ideas. The project is headed up by Sampo Saari (TUT) and its steering committee consists of experts from TUT, the business partners and the funding organization.

The project is divided into four interconnected phases. First, the market potential of Invention X will be discovered. Second, the project will proceed to a proof-of-concept phase, where a prototype will be built and the performance of the technology will be optimized according to the customers' expectations. Third, the technology will be adjusted with test customers and by calibrating the invention. Finally, as a part of overall strategy formulation a preliminary business plan will be created. This final phase is an ongoing process lasting throughout the project time line. Hence, the research design and plan for this study are formed in a way they would contribute to overall strategy building and business planning.

The main objective of this phase of the project is to assess whether Invention X is commercially viable. For that purpose, the following interconnected research objectives were defined:

1. Potential customers will be identified and segmented
2. Product related features which are of value to the customers will be discovered
3. Competitor analysis will be done
4. Knowledge of the market environment (incl. development of the standards) will be acquired
5. Market potential will be estimated

The main research question and the ultimate objective at this point is to understand what is Invention X's market potential. In order to answer the main research question, the research project was framed carefully to address research & academia and the filtration industry since those are the most obvious customer segments based on preliminary investigation.

There are various possible ways how to commercialize this invention and countless end-user segments. Therefore, two interconnected sub-questions were created: 'Who are the customers?' and 'What is the value proposition for the customer?'. The first sub-question is aimed at making sense of ambiguous customer segments, and by doing so pave the way to commercialize the invention. The second one, is aimed at ensuring that there is a fit between the product offering and the customers' needs.

In this project, assessing how the external environment affects Invention X is crucial since it has direct implications for its market potential. In other words, this means paying attention to what competitors are doing and creating a holistic picture of those actions, i.e. conducting a competitor analysis. Furthermore, acquiring knowledge of the environment, especially regulation, is at the core of this study. In addition, this study will also investigate future prospects since the project is in its beginning phase which is projected to last around one year before Invention X can be commercialized.

The empirical part of this study divides into two phases: the first phase consists of 11 qualitative interviews carried out at the World Filtration Congress in Taiwan and five further interviews conducted in Finland, and the second phase consists of desktop research conducted in order to find quantitative-market related information from various sources. The purpose of the first phase was to get answers to all the aforementioned research questions, and the aim of the second phase was to estimate the market potential in terms of its monetary value. The research strategy, i.e. action research, facilitates the process since it relies on co-operation between the researcher and the project's sponsor.

The structure of this study is as follows. The next chapter presents a literature review of the most relevant concepts and frameworks needed to meet the research objectives. Chapter 3 explains the conceptual framework, and how those concepts are applied in the empirical part of the study. The following chapter on research methodology and methods describes the philosophy and approach to this research, i.e. how this study was designed and what strategies and procedures were used to carry out this research project. It also gives a detailed description of the data collection methods and procedures, and scruti-

nizes the quality of the results is scrutinized from several angles. The next chapter presents the findings of the study in two parts; the first being a description of the findings resulting from the interviews, while the second is a quantitatively-based estimate of the market potential for the new technology. The study ends with a summary of the main conclusions, a proposal for further research, an implementation plan, and a reflective analysis of the learning process.

2   Literature review

The selected topic is relevant for TUTLI project since the goal of the first phase is to understand what the market potential of Invention X is. Therefore, the literature review facilitates the research process when answering the main research question, the sub-questions, and the objectives. Before commercializing Invention X, detailed information on all of the layers presented below in Figure 1 should be obtained. In this way, the literature review provides a solid foundation for the rest of the study.
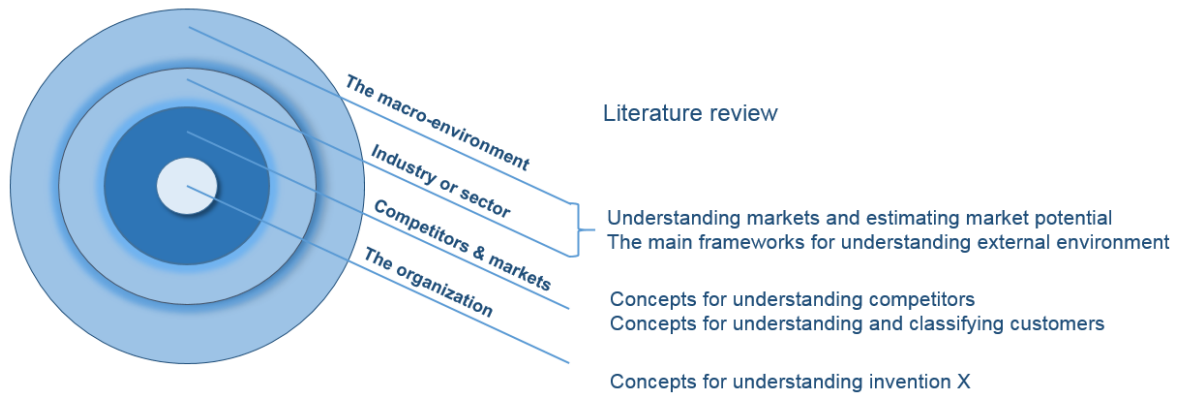

Figure 1. Layers of the business environment (modified from Johnson et al. 2005, 64).

In the following sections, the external market environment is scrutinized starting from the outermost layer, i.e. the macro-environment, and finishing with to the inner circle, the business organization itself. The emphasis is on identified tools and frameworks which are needed to evaluate Invention X's market potential.

The outermost layer, the macro-environment, consists of factors that impact on all organizations to greater or lesser extent. Therefore, it is important to understand how the changes in the macro-environment might impact on Invention X when estimating its potential part of an overall strategy. The PESTEL (or PESTLE, or PESTL depending on author) framework helps to identify how political, economic, social, technological, environmental and legal factors affect organization. It also provides broad data from which key drivers for change can be identified. However, these vary from sector to sector and from country to country, and therefore they will have different impact depending on organization. If the future environment is likely to change, scenario building could be used as a tool to construct possible future scenarios in order to see what the business environment might look like in the future.

The layer encircling the organization, competitors and markets, consists of organizations competing on a different basis having different characteristics. Regarding competition, the

concept of strategic groups, which help to identify both direct and indirect competition, is scrutinized. Additionally, Porter's Five Forces framework will be investigated thoroughly. In practice, this means assessing individual company's competitive positioning and understanding how the competitive dynamics within and around an industry are changing. Thereafter, customers are scrutinized in more detail, and since the customers' expectations differ, understanding customers' needs is significant. Hence, concepts such as customer value proposition, market segments, targeting, and positioning are explained. This study focuses on the most recent framework by Osterwalder et al. (2010) when delving deep into the customers' expectations and making customer value propositions.

The innermost layer, i.e. the organization, could be assessed in various ways, so the most applicable tools will be presented which will enable an internal assessment of Invention X's strengths, weaknesses, opportunities, and threats. Conducting an internal assessment might be valuable in order to create mutual understanding and share knowledge across the development team. Furthermore, this iteration might lead to further insights paving the way towards how to develop Invention X further. Therefore, the product-related core competitive advantages should be understood by evaluating.

2.1 Understanding markets and estimating market potential

Invention X could be developed for both consumer or business markets. However, in this study it is initially assumed that Invention X would be sold to research & academia and the filtration industry. Thus, the first part of this chapter explains how business markets differ from consumer markets. Furthermore, in the core of this study is to comprehend how markets can be investigated, and further, how the market potential should be estimated. Hence, both are explained and scrutinized next. As it might take around one year before Invention X can be commercialized, the final part of this chapter will explain why forecasting is increasingly important. Finally, scenario building will be presented as one viable option for predicting the future market potential.

Business markets vs. consumer markets
Business markets comprehend all the organizations that are involved in acquiring goods and services used in the production of other products and services that are sold, rented, or supplied to others. Hence, any company supplying components for products is in business-to-business markets. The monetary value of business markets is larger than consumer market since the production process of goods usually consists of numerous steps. The main obstacle in business-to-business markets is the same as for consumer markets, i.e. understanding customers and what they value. In addition, building interfaces between

the marketing and the sales, creating stronger innovation marketing interfaces, and extracting and leveraging more detailed customer and market knowledge, pose challenges towards marketers in business-to-business markets. (Kotler et al. 2016, 211-214.)

Business markets differ from consumer markets in following manner as they have: (1) fewer and larger buyers; (2) close supplier-customer relationships and professional purchasing; (3) multiple buying influences, i.e. a buying centre consisting of multiple stakeholders; (4) multiple sales calls, e.g. the sales process is slow taking even years; (5) derived demand, i.e. demand is ultimately derived from the end-customers' needs, and therefore understanding the buying patterns of the end-customers is needed; (6) inelastic demand, for many business goods' demand is inelastic since, e.g. the producers are not able to change their production methods fast enough, and therefore the demand can be more volatile than in consumer markets; (7) fluctuating demand, e.g. a percentage increase in consumer demand will lead to a much greater increase in the demand for plant and equipment; (8) geographically concentrated buyers; (9) direct purchasing, e.g. if items are technically complex or expensive, business buyers tend to purchase directly from manufacturers rather than through intermediaries. (Kotler et al. 2016, 211-214.)

High-technology products have several unique features. How the buyers perceive the differences of those features affect buying behaviour, e.g. when buyers believe technologies to be similar, they are more likely to search longer for a solution compared to technologies where significant differences exist. If the rate of the technological change is fast, buyers will search for alternatives carefully, however, the time frame being relatively short. Organizational buyers might have close relationship with their suppliers increasing the switching cost. If the switching costs are high, the solution is searched with lower effort. However, if the compatibility related switching costs are high, the more considerable search is usually conducted. (Tidd et al. 2009, 417.)

Researching markets

Conducting an external environment analysis could be described as investigating the potential market environment. It consists of scanning, monitoring, forecasting, assessing the environment ending up to identification of opportunities and threats. Through scanning, firms identify early signals of potential changes. Usually, scanning process is about dealing with ambiguous, incomplete, and unconnected data. Monitoring means a process where analysts observe environmental changes in order to see if important trends are emerging. Whereas scanning and monitoring are based on scrutinizing the present, forecasting aims to develop feasible projections what might happen as a result of scanning

and monitoring activities. Finally, without assessment it is difficult to see what are the implications for the organization in question. Therefore, assessing the timing and significance of effects of environmental changes and trends is needed. (Hitt el al. 1999, 49-50.)

A profound analysis minimizes the risk of failure when launching new products or when starting new business. Therefore, an environment analysis is an important part of overall strategy building. A good analysis contains information related to competitors and their strategies, industry trends, distribution channels, and potential customers. (Lowe 2006.)

When creating the analysis, knowledge should be gathered from different sources. The first-hand knowledge, primary data, is the brand new knowledge gathered for instance, directly at the market place. The secondary data, could, for example, consist of scrutinizing different market analyses, market reports, and information gathered from the internet. (Lowe 2006.) In order to minimize the risk of not understanding the potential return on investments and the customers' needs, detailed marketing research should be conducted. Typical steps for marketing research are as follows: (1) formulating the research problem, (2) determining on research hypothesis, (3) designing a sample, (4) collecting data by using various methods, (5) analysing and interpreting data. (Viardot 2004, 93-94.)

When conducting market research in business-to-business markets: derived demand, concentration ratios, and accelerator effect, i.e. fluctuating demand, are decisive factors. Because of derived demand, primary research might be too costly and time-consuming, thus secondary sources can be used to keep up to date with trends in the market. Fluctuating demand means the market can grow at significant rate compared to consumer businesses. For example, if the markets are increasing at significant rate, e.g. 60% or 80% annually, the competitive positioning will change with a tremendous speed making the prediction of the market demand problematic. Therefore, it is advisable to use tools to predict the future events. Finally, the concentration ratios affect directly to the marketing research since the few and large buyers make up a large proposition of the total buying power of an industry, and hence those should be a part of the market research. (Brennan et al. (2007, 122.)

Brennan et al. (2007, 118-119) summarize researching business-to-business markets in following core problems to be answered: (1) the buying criteria and buying processes of customers' and potential customers', (2) the importance of inter-firm relationships in customers' and potential customers' target markets, (3) strategic plans, the positioning strategies and the target markets of those customers with whom partnering relationships are to be created, and (4) the potential and existing customers' definition of value.

Defining market potential

According to Kotler et al. (2016, 108) Figure 2 below, there are 90 different types of demand estimations depending on the purpose, consisting of six different product levels, five space levels, and three time periods.
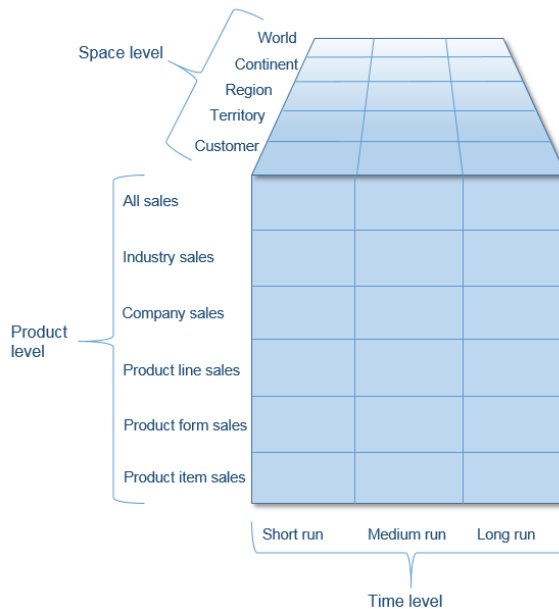

Figure 2. Ninety types of demand measurement (6*5*3) (Kotler et al. 2016, 108).

When estimating the market potential many ways to break down the market could be used, and hence the following definitions should be understood:

- – The potential market is a set of consumers (companies) with a sufficient level of interest in the product offer.
- – The available market is a set of consumers (companies) who have interest, income, and access to particular product offering.
- – Target market, is the part of the qualified available market that the company decides to go after.
- – Penetrated market, a set of consumers (companies) who are already purchasing the company's product. (Kotler et al. 2016, 108-109.)

The definitions related to the market potential and the market demand differ depending on author. For example, Kotler et al.'s (2016, 109) definition "Market potential is the limit approached by market demand as industry marketing expenditures approach infinity for a given marketing environment." differ from Anderson et. al (2009, 53) definition: "Market potential identifies the maximum units of an identified product or service capable of being purchased within a designated geographic area, during a designated time period, when supported by a realistic level of marketing activity." Since the definitions regarding the market potential and the market demand differ, in this study Kotler et al.'s definitions will be used.

When scrutinizing Kotler et al.'s (2016, 110) definition of the market potential "the limit approached by market demand as industry marketing expenditures approach infinity for a given marketing environment" more closely, the phrase "for a given market environment" should be understood properly since during prosperity the market potential will be higher than during recession, as Figure 3 illustrates.
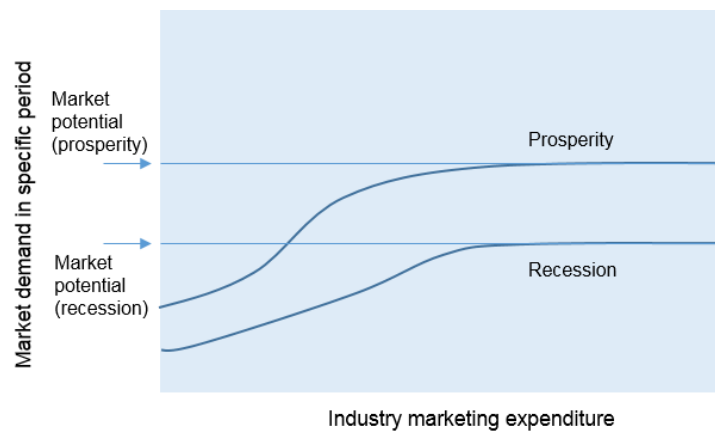

Figure 3. Marketing demand as a function of industry marketing expenditure (Kotler et al. 2016, 109).

According to Kotler et al. (2016, 109) the first step is to estimate the total market demand. "Market demand for a product is the total volume that would be bought by a defined customer group by a defined geographical area in a defined time period in a defined marketing environment under a defined marketing program." Figure 4 illustrates the different conditions underlying; the horizontal axis demonstrated the different possible levels of marketing expenditure in a given time frame, the vertical axis illustrates the demand level. Hence, the market demand could be seen as a function, rather than a fixed figure. The minimum level of sales (market minimum, Q1) would exist without any expenditures to trigger demand. Higher marketing expenditures would mean first increasing rate and then decreasing rate in demand. Marketing expenditures are not going to stimulate any further demand when they reach the upper limit (market potential, Q2). The space between market minimum (Q1) and market potential (Q2) illustrate the marketing sensitivity of demand. If the market is non-expansible the expenditures to marketing would not increase the sales significantly, and hence the distance between Q1 and Q2 would remain relatively small. On contrary, the expansible markets are highly affected by the marketing expenditures; the higher levels, the higher sales. (Kotler et al. 2016, 110.)
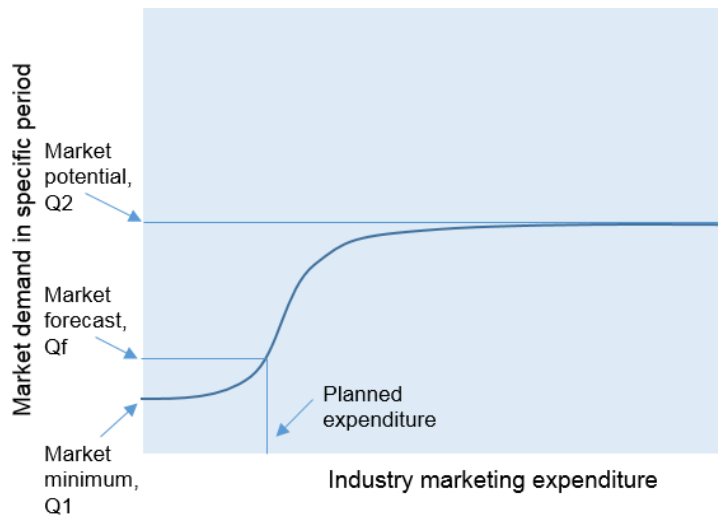
Figure 4. Marketing demand as a function of industry marketing expenditure (assumes a particular marketing environment) (Kotler et al. 2016, 109).

After there is an understanding of the market demand, the total market potential "the maximum sales available to all firms in an industry during a given period, under a given level of industry marketing effort and environmental conditions." could be estimated. It could be calculated by multiplying the potential number of buyers by the average quantity each purchases and then by the price. The most difficult task usually is to estimate the number of buyers. One way to do it is to estimate the total population in the nation, and eliminate the groups of people who would not purchase the product. However, this method applies better to consumer markets than business markets. When estimating the market potential within a specific area two approaches could be used: (1) build-up method, identification of each potential customer and estimating what each will purchase; or (2) multiple-factor index aimed to estimate the potential for consumer markets. (Kotler et al. 2016, 111.)

Anderson et al. (2009, 54) suggest estimating the total market demand in a following manner:

1. Define the market
2. Divide total industry demand into its main components.
3. Forecast the drivers of demand in each segment and project how they are likely to change.
4. Conduct sensitivity analyzes to understand the most critical assumptions and gauge risks to the baseline forecast.

The first step of defining the market potential should be conducted broadly as possible by scrutinizing what kind of customers company wants to gain. The second step is related to segmentation using e.g. customers' capabilities, product application, and usage situation as criteria. The third step consists of macroeconomic factors, and forecasting the industry

related developments. Finally, several scenarios should be built in order to estimate the future demand. (Anderson et al. 2009, 54.)

Blank et al.'s (2012, 72) framework is especially applicable for start-up companies. The framework, Figure 5, describes the market size dividing into three numbers: the total addressable market (TAM) consisting of all the potential customers, the served available market (SAM), i.e. those customers who are reachable within the product's sales channels, and finally, the target market comprising of the most likely buyers.

Figure 5. TAM, SAM and Target Market (Blank et al. 2012, 72).

The market size could be estimated top-down by first calculating the total addressable market (TAM) and then, the served available market (SAM). In other words, the top-down approach could be used, which begins by gathering market research reports and industry analyses, competitors' press releases, and discussions with investors in order to estimate the size of the total addressable market. However, for start-up companies the more realistic estimation is usually gained by using the bottom-up approach (Blank et al. 2012, 73), which is the same as the build-up method, i.e. identification of each potential customer and estimating what each will purchase (Kotler et al. 2016, 111). Finally, when estimating the market size, switching costs should be also taken into consideration as a part of evaluating how attractive the new product is compared to the existing products (Blank et al. 2012, 73).

Another view for start-up companies is proposed by Mars (2009) where the understanding of the market potential is dependent on strategic decisions related to the product development, partnering and distribution, organizational design, and employee skills. Here, the first step is to assess whose customers' needs to fulfil first, i.e. target customer selection as described in chapter 2.4. The second step is to estimate the number of target custom-

ers. The third step consist of determination of penetration rate. The final step, is about calculating the potential market size in terms of volume (number of target customers*penetration rate) and value (market volume * average value).

Forecasting the market potential

Forecasting is a demanding task for new technological products since the technology trends are driving the product life cycles shorter, i.e. the speed at which technologies become and are used has substantially risen over the past 15 to 20 years. This so called technology diffusion explains how, why and what rate innovations spread leading to situation where competitors have pressure to introduce new technologies at increased rate. Furthermore, it generates indistinguishable products where the competitive advantage is based on how fast one enters the market. In addition, in the global economy, company's competitive advantage may be imitated in few days posing a great challenge for new inventions. (Hitt et. al 2015, 11.)

Technology development is a discontinuous process consisting of stages. The future can be anticipated if one can pinpoint the stage where the technological development is. The stages are as follows: scientific findings, laboratory feasibility, operating prototype, commercial introduction or operational use, widespread adoption, diffusion to other areas, and social and economic impact. (Cornish 2005, 46-47.)

The four elements: the innovation itself, communication channels, time and social system affect the spread of technology. The technological diffusion usually follows an S-curve where initially the rate of adoption is low, and innovators are the first ones to adopt. The next ones are early adopters, followed by early majority and late majority, and finally laggars adopt the innovation. The innovation must be widely adopted before it is self-sustainable. Hence, at some point, the innovation will reach a certain point of adoption, i.e. critical mass. In practice, however, the most of the innovations fail to be adopted widely. (Tidd 2010, 5-13.)

Looking globally, there are substantial variations across technologies and countries how fast technologies are diffused (Comin et al. 2008, 1). Technology diffusion is one of the models which can be used to estimate how fast and how widely Invention X might be adopted. However, the model should be used together with other forecasting methods (Cunningham et al. 2016, 101; Tidd 2010 13-14). So far the researchers have failed to identify robust generic models of adoption, and the main drawback of diffusion model is that it assumes all the potential adopters have similar needs, which is unrealistic (Tidd 2010, 14).

Scenario planning

Scenario planning is one of the tools for forecasting future events. It emerged over sixty years ago, so it is not a new phenomenon. Scenario planning is about creating future models of the world. It can be used for several purposes. For example, it assists companies to grasp the dynamics of the business environment, it helps to realize new opportunities, weigh the different strategic options, and make long-term decisions. Furthermore, by confronting assumptions companies can act more effectively by widening the perspectives and addressing the blind spots. Additionally, scenario building will recognize the degrees of uncertainty. Finally, it addresses dilemmas and conflicts. (Assen et al. 2009, 46-48.)

Typically, several scenarios are being developed so that the decision makers are aware that the future events may invalidate whatever scenario which is used for the planning purposes. Developing scenarios is an important task since the accelerating changes in today's world make it likely that any given trend might not proceed as anticipated. The well-thought scenarios make us aware of the costs and the benefits of an action and the various consequences that may arise. Usually, it is recommended to create at least three scenarios: optimistic, pessimistic and the most likely. In addition, alternative possibilities can be build, e.g. a disaster scenario or a miracle scenario. For each scenario, it should be identified the reasons why the scenario might or might not come to pass. After this step, the likelihood of each scenario should be assessed based on how the current situation is trending. (Cornish 2005, 98-100.)

2.2 The main frameworks for understanding external environment

This chapter describes the main frameworks for understanding the external environment: PESTLE model, Porter's Five Forces framework, and Blue Ocean strategy. PESTLE model identifies and takes into consideration the main factors affecting the environment. Porter's Five Forces framework and Blue Ocean strategy, represents opposite views on the external environment. The former, reckon industry structures more or less fixed having more static perspective. The latter, on contrary, assumes the industry structures can be shaped, and thus a company could create its own market space.

PESTLE model takes into consideration political, economic, social, technological, legal, and environmental aspects. Understanding how these factors change the market environment and drive the change is a starting point. Hence, the model could be used as a tool to understand what are the key drivers of change. Furthermore, the model considers the impact of external influences on particular industries and individual organizations. Thus, the model could be used as a tool to predict the future. (Johnson et al. 2015, 65-69.)

According to Morrison (2006) PESTLE is a helpful tool when building a strategy. Even though it does not take all the relevant aspects of international business environment into consideration, it focuses on the key elements of strategic planning, especially when used together with SWOT tool. By doing so, both external and internal aspects of strategic planning are covered. Fleisher et al. (2007, 88) refer to social, technological economic, ecological, and political/legal factors, i.e. STEEP, which represents same approach as PESTLE having time-bound perspectives, i.e. past, present, and future; covering a large geographic area, e.g. global, international, multinational, regional, national, provincial/state, and local. Further et al. (1996, 28) see macro-environment as a general environment consisting of numerous factors where areas of concern are demographic, political, social/cultural, technological, and global environment.

When scrutinizing the external environment, Kotler et al. (2016, 95) emphasize the major forces' interconnected relationships. For instance, explosive population growth (demographic, social) will lead to more resource depletion and pollution (environmental), which leads to call for more laws (political, legal), which may stimulate new technological solutions and products (technological), and if those products are affordable, attitudes and behaviour will change as an outcome (social).

Political factors mean the role of a state and other political forces. In general, a state can be seen as a direct economic actor since it has multiple roles as a potential customer, a supplier, and an owner of businesses. Political movements, campaign groups or concerned media affect directly towards different industries. Figure 6 illustrates the level of direct state involvement and the political exposure in certain industries. Furthermore, industries can rapidly move positions, e.g. after financial crisis banks were moved towards stricter state control. (Johnson et al. 2014, 34.) Fleisher et al. (2007, 89) emphasize the governments' legislative role since it can foster greater or lesser competition, and therefore its role should be closely scrutinized when analyzing the market environment. Experienced international businesses conduct political risk assessment which consists of scrutinizing: (1) ownership risk, e.g. the property of a firm might be threatened through confiscation or expropriation, (2) operating risk, e.g. operations of the firm and/or safety of its employees are in danger because of changes in laws, environmental standards, tax codes, terrorism, armed insurrection, etc. and (3) transfer risk, i.e. the government interferes when a firm is transferring money into and out of the country (Griffin et al. 2007, 76).
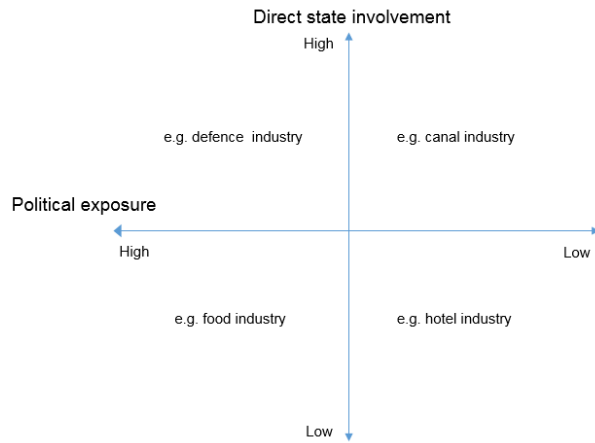
Direct state involvement

High

e.g. defence industry   e.g. canal industry

Political exposure

High   Low

e.g. food industry   e.g. hotel industry

Low

Figure 6. The political environment (Johnson et al. 2014, 36).

Economics are macro-economic factors such as exchange rates, business cycles, and differential economic growth rates around the world. According to Johnson et al. (2014, 36) markets are affected by the prosperity of the economy as a whole. Thus, it should be acknowledged that in global environment changes might occur rapidly outside of one's market or country, affecting the firms' capabilities to remain competitive in the local market. (Fleisher et al. 2007, 89.) Therefore, the market environment should be closely monitored, scanned, forecasted, and assessed as Hitt el al. (1999, 49-50) suggests.

Social factors include changing cultures and demographics, i.e. cultural attitudes, literacy rates, education levels, customs, beliefs, values, lifestyles, age distribution, and population mobility. The effects in this sector could be described as rather profound and inescapable, however, the pace of change is slow. (Fleisher et al. 2007, 90.) Understanding cultural differences is critical to success of firms when engaging in international business. For example, language is one important cultural element since it allows members of society to communicate with each other. Common language is especially needed when doing business cross-border. (Griffin et al. 2007, 111) In order to have more profound understanding of cultural aspects, both Hofstede's framework and Hall et al.'s classification scheme of importance of context within a culture could be used when assessing the social factors.

Technological factors refer to influences emerging from the existing technologies, e.g. the internet and the new technologies such as nanotechnology, or IOT (internet of things). The rise of the new technologies opens up opportunities for some companies challenging others. (Johnson et al. 2014, 36.) Technological impact is compounded with the product and process innovation creating new opportunities for producing goods and services. Therefore, it is important to identify and monitor how the effects of technological change affects the firm's competitive strategy. (Fleisher et al. 2007, 90.) According to Griffin et al.

(2007, 68) a country can alter its technological infrastructure by enticing direct investments or transfer the technology from one country to another.

Legal aspects include legislative and regulatory constraints and changes. On the one hand, legal aspect can provide opportunities, e.g. the liberalization of FDI (foreign direct investment) in India. On the other, restrictions might mean losses or limitations when doing business cross-border, e.g. there might be a tax treatment of profits earned overseas. (Johnson et al. 2014, 36.) Therefore, differences in countries legal systems, i.e. whether the system is based on common, civil, religious, or bureaucratic law, should be understood well before entering the market. Furthermore, laws directly affecting the international business transactions should be scrutinized since on occasions countries might pass laws that are explicitly directed against the foreign firms, e.g. many governments limit foreign ownership in order to avoid having their economies or key industries controlled by the foreign firms. (Griffin et al. 2007, 59-65.) Furthermore, the standards could be considered as a one form of constraint regulating how to develop products. The standards can either be voluntary, or mandatory if adopted by a government. (Wikipedia 2016.)

Ecological stands for environmental issues such as pollution, waste, and climate change encompassing both the physical and biological environments. Sustainability programmes and 'greening' related to companies' strategies are examples how ecological issues affect. Thus, the effect might in some cases be powerful. (Fleisher et al. 2007, 90.) In addition, environmental regulation might lead to additional costs, e.g. pollution controls, however, such regulation might be an opportunity (Johnson et al. 2014, 36) for instance, for new businesses emerging around ultrafine particle industry.

Porter's Five Forces framework

Figure 7 demonstrate how the state of competition in an industry is depended on five forces: threat of new entrants, bargaining power of suppliers, bargaining power of buyers, threat of substitute products or services, and rivalry among the existing firms. The goal of the competitive strategy is to find a position in the industry where the company can best defend itself against these forces or influence them in its favour. (Porter 2004, 3-5.)

By using Porter's Five Forces framework, the company will better understand its strengths and weaknesses, the positioning in the industry, and the areas where the greatest opportunities and threats might exist. Jointly the forces will rule the intensity of industry competition and profitability, and the strongest force/s will become essential when formulating a

strategy. If the five forces are high, the industry is not attractive to compete in since excessive competitive rivalry, powerful buyers, powers of suppliers, and threat of new entrants will reduce profitability. (Porter 2004, 3-5.)
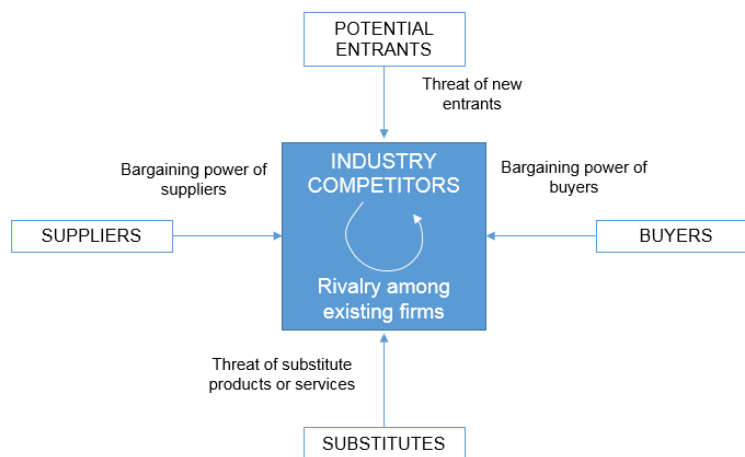

Figure 7. Forces driving industry competition (Porter 2004, 4).

Rivalry among the existing firms prevail because one or more competitors identifies an opportunity to improve or is in pressure to move position. Competitive move by one firm might have significant effects on its competitors. Hence, the firms could be seen as mutually dependent. Moves and countermoves by the firms might lead to a situation where the whole industry might suffer and be worse off than before, e.g. price competition leading to decreased profitability. (Porter 2004, 17.)

Threat of substitute products or services exists in every industry since all the companies are competing with industries who are producing substitute products. The substitute is a product or service performing the same function as the product of the industry. Thus, substitute products limit the potential earning of an industry. Hence, the more attractive the price offered by the substitutes, the weaker industry profits are to be excepted. (Porter 2004, 23.)

When the buyers compete in the industry, they force prices down, demand higher quality or more services, and are competitors against each other. Bargaining power of a buyer group is powerful if the following circumstances prevail: (1) if the buyer group is concentrated or purchases large volumes in relation to seller's sales, (2) if the product cost is significant compared to buyers' costs or purchases, (3) products are standard or undifferentiated, (4) or there are few switching costs, (5) if the buyer group is partially integrated or represent a threat of backward integration, e.g. controls some of the inputs used in the

production, (6) if the buyer group has full information regarding the demand, the market prices, and the supplier costs. (Porter 2004, 24-26.)

Powerful suppliers can use their bargaining power by threatening to raise the prices or by reducing the quality of purchased goods or services. A supplier group is powerful if: (1) it is more concentrated than the industry it sells to, (2) is dominated only a few companies, (3) competes well compared to the substitutes, (4) the industry is not an important customer of a supplier group, i.e. a supplier group sells to a number of industries, (5) supplier's product is an important input to the buyer's business, (6) supplier's products are differentiated, (7) supplier's products contain switching costs, or (8) supplier group poses a threat of forward integration, e.g. by controlling distribution centres and retailers where the products are sold. (Porter 2004, 27-28.)

Following barriers to entry exists: economies of scale, product differentiation, capital requirements, switching costs, access to distribution channels, cost disadvantages dependent of scale, and the government policy (Porter 2004, 7-14). Next, the entry barriers towards potential entrants are scrutinized more closely since those should be understood before Invention X enters the market.

Economies of scale refer to downward change in unit cost of a product (or operation or function) as the volume per unit increases. Thus, it can exist in every function of business, e.g. in manufacturing, purchasing, R&D, marketing, service network, sales for utilization, and distribution. The economies of scale discourage entry, by forcing the entrant to become large at scale or enter small at scale, and accept a cost disadvantage. Product differentiation conceives into barrier of entry by forcing new companies entering the market to spend money in order to overcome customer loyalties which product differentiation creates. If the company is required to invest significantly in resources in order to be competitive, capital requirements can constitute as an entry barrier. Furthermore, the cost the buyer faces when switching from one supplier's product to another's might create a barrier. Product manufacturers might have control over the distribution channels, and therefore the new entrant needs to persuade existing channels of distribution to take the product into supply and by doing so, go through price breaks and cooperative advertisement allowances, which in turn reduce profits.

In some cases, entry barrier is so high that a new company must create a totally new distribution channel. Despite the new entrant's size and economies of scale possessed, the established firms may have cost advantages which cannot be copied, e.g. propriety product technology, favorable access to raw material, a favorable location, the government

subsidies, and a learning curve. For instance, a firm gains experience when producing products decreasing the cost of production. As a final barrier, the government can restrict or prevent new companies to enter the market by placing controls, e.g. licensing requirements and preventing access to raw materials. (Porter 2004, 7-14.)

Porter's Five Forces framework teach how to think systematically about imperfect markets. This is important since in real life very few markets are perfect, i.e. when supply rises, the prices drop down to equilibrium. When conducting Five Forces analysis, the most attention should be on the following: (1) the government regulation, since it has effect on one or more of the five forces; (2) technology, as it can change the industry structure, e.g. the internet increasing the power of buyers; (3) high-growth industries since they are often mistakenly assumed as attractive. For example, high growth alone tells nothing about the power of customers. (4) complements, i.e. products and services used together with an industry's products, e.g. hardware and software, affecting the demand, and consequently industry's profitability. (Magretta 201, 52-55.)

Strategy consultant Magretta (2012, 41) suggests applying Porter's framework in a following manner; first, by clarifying the industry structures, and then mapping out the companies' and the rivals' relative positions within the industry. During this process, the main point should be grasped: "there are a limited number of structural forces at work in every industry that systematically impact profitability in a predictable direction" (Magretta 2012, 52).

Assen et al. (2009, 18) acknowledge Porter's framework as one of the most widely used model for strategic analysis. Even though, it has one major drawback; its tendency to emphasize the external forces. Hence, the organizations internal capabilities and the abilities to develop those capabilities are not included in the framework, and therefore some additional tool which includes an inside-out approach, e.g. a VRIO model, could be used.

Blue Ocean strategy
Whereas Porter's Five Forces framework and SWOT see the industry as a given structure, Blue Ocean strategy claims it can be shaped, and by doing so firms are not fixed to build their strategy on a given structure. In other words, Blue Ocean strategy is about creating a new market space where little or no competition exists. Hence, the competition should not drive companies' strategies since companies' time and attention is then focused on benchmarking the rivals and responding to their strategy, and not on understanding how to create value to the buyers. (Kim et al. 2015.)

The aim of Blue Ocean strategy is to take a significant leap in value creation making the competition irrelevant. Thus, the focus is not on outperforming the rivals or positioning the company against them, it is about innovating value by unlocking strategic creativity. There exists common strategic patterns behind successful creation of Blue Oceans. The tools such as, Strategy Canvas and Four Actions framework bring structure for building Blue Oceans systematically. In Blue Ocean strategy, the formulation and the execution go hand-in-hand by building the execution right from the beginning. (Kim et al. 2015.)

In order to explore the roots of high performance, the right unit of analysis is the set of managerial actions and decisions. Thus, innovative strategic moves might deliver products and services capturing the new market space leading to a significant increase in demand. Small and large companies, young and old managers, companies in attractive and unattractive industries, new entrants and incumbents, companies in consumer markets and in business markets, and multinational companies can all create Blue Oceans. (Kim et al. 2015, 10-12.)

Figure 8 describes the cornerstone of Blue Ocean strategy, value innovation. It has emphasis on both value and innovation since without innovation the focus is on value creation improving value, but not giving sufficient advantage to stand out in the markets. Further, innovation without value tends to be technology-driven pioneering without understanding truly what the customers' value, and therefore the asking price might be way beyond what the customers are ready to accept. Hence, the value innovation is a new way to think about and execute strategy resulting breaking of from the competition, i.e. red ocean. Conventionally, it is believed that companies can either create value to the customers at a higher price or create a reasonable value at a lower cost. Thus, a strategy is conventionally seen as making the choice between differentiation and low cost. In contrast, in Blue Ocean strategy, differentiation and low cost can be created simultaneously. (Kim et al. 2015, 12-13.)
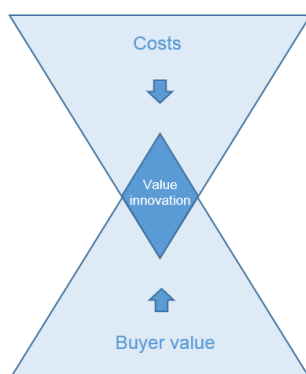

Figure 8. Value innovation: The cornerstone of Blue Ocean strategy (Kim et al. 2015, 17).

Creation of Blue Oceans is based on driving the costs down while simultaneously lifting up the value for buyers leading into leap in a value for both the company and its buyers. Thus, the cost savings are made by eliminating the factors an industry competes on, and a buyer value is increased by creating elements the industry has never before offered. (Kim et al. 2015, 12-18.)

The value innovation has strategic, rather than an operational or a functional approach. It is achieved only when the system of the company's utility, the price, and its cost structure are all aligned. This is due to the fact that the buyer value is based on the utility and the price the company offers to buyers, and further, since the value of the company is created from a price and a cost structure. In order to sustain value innovation, the employees and other stakeholders working for the company need to support it. In other words, the whole system of a company's activities is in pursuit of both differentiation and low cost. On contrary, product innovations rarely create Blue Oceans since they are achieved on a subsystem level, and thus they have limited impact on a company's overall strategy. However, they might lower the company's cost structure securing or lifting the company's position in the existing market space. (Kim et al. 2015, 12-18.)

Successful Blue Ocean strategy formulation is based on reconstructing the market boundaries, focusing on the big picture instead of numbers, reaching beyond the existing demand, and getting the strategic sequence right. When executing, organizational hurdles should be defeated, value, profit, and people propositions should be aligned, and the execution should be built into strategy. Finally, after discovering Blue Oceans, those should be renewed. (Kim et al. 2015, 23.)

Assen et al. (2009, 13) recognize that Blue Ocean strategy might be a good strategic approach for many companies. The most valuable insight is that the companies can pursue both differentiation and low costs. However, depending on a company, a fast moving strategy, costs leadership, differentiation or focus strategy, i.e. Porter's approaches, may be more successful.

2.3 Concepts for understanding competitors

When answering the main research question 'What is invention X' market potential?', competitive landscape should be understood. Therefore, the main competitors should be identified and analyzed. For this purpose, the main concepts for conducting a competitor analysis are presented next.

Competitor analysis

Competition is not a zero-sum battle where only the best will prevail. Thus, the key to success is to create unique value, not beating the rivals. Therefore, companies should compete to be unique for the chosen customers. (Magretta 2012, 19-30.) According to Porter (2014) the aim of a competitor analysis is to develop a competitive positioning by maximizing the value of capabilities that in turn, will distinguish the company from its competitors. Hence, each competitor should be profiled in order to understand what are the strategic changes they might initiate, their response to the range of feasible strategic moves the other firms could set up, and their probable reaction towards industry changes and environmental shifts.

Competitor analysis clarifies against whom, and with what sequence or moves the company should compete. Furthermore, it explains what is the meaning of competitors' strategic moves and what areas should be avoided. In practice, conducting a competitor analysis requires a considerable amount of data which much of might not be easily accessible without hard work. (Porter 2004, 47.)

Figure 9 below illustrates the four components of the competitor analysis: future goals, current strategy, assumptions and capabilities. Together these components form a prediction of competitor's response profile. The driving factors, i.e. future goals and assumptions, are much harder to observe than actual competitor behaviour which is visible through current strategy and capabilities. Forecasting the competitive situation requires identifying the competitors from the following: (1) the companies who could overcome entry barriers particularly cheaply but are not yet in the industry, (2) the companies who see synergy from being in the industry, (3) the companies whose corporate strategy extends on competing in the industry, and (4) the customers or the suppliers who have capabilities to integrate backward or forward. (Porter 2004, 49-50.)

What Drives the Competitor

Future goals

At all levels of management
and in multiple dimensions

What the Competitor Is Doing and Can do

Current strategy

How the business is
currently competing

Competitor's response profile
Is the competitor satisfied with current
position?
What likely moves or strategy shifts will
the competitor make?
Where is the competitor vulnerable?
What will provoke the greatest and most
effective retaliation by the competitor?

Assumptions

Held about itself and the
industry

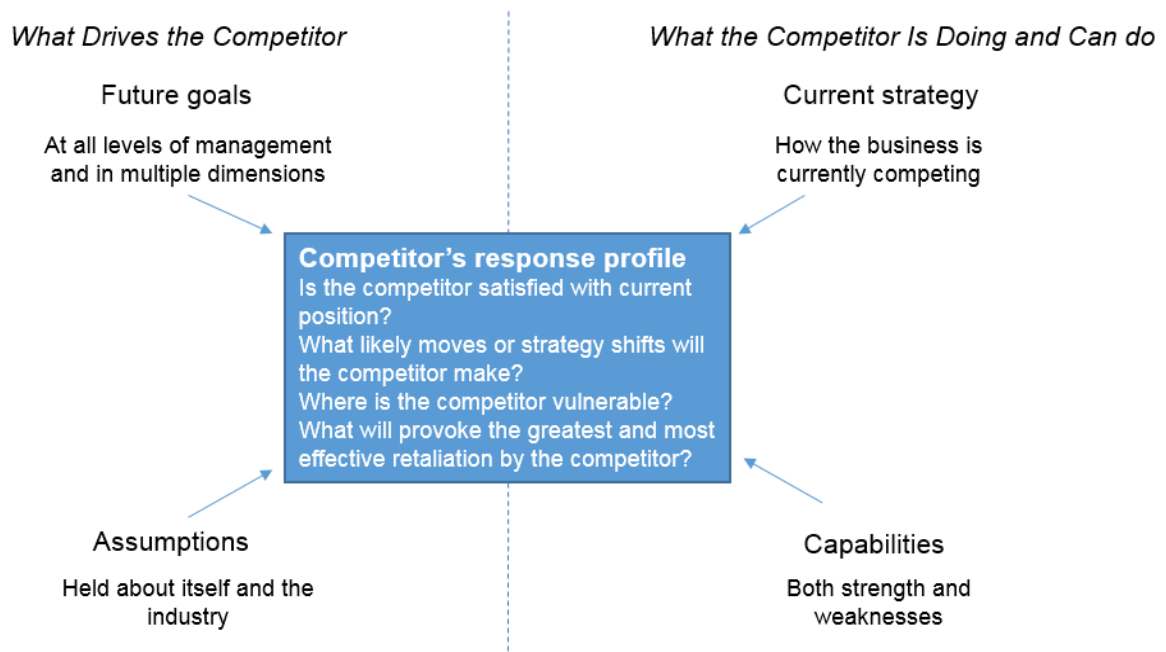**Capabilities**

Both strength and
weaknesses

Figure 9. The components of a competitor analysis (Porter 2004, 49).

Knowing competitors' future goals will help predicting whether the competitors are satis-fied with the current positions and the financial results, or not. In addition, competitors' re-actions towards strategic changes could be forecasted more easily. Furthermore, an anal-ysis of competitors' goals aids to understand how serious the competitors' initiatives are. Analysis of competitors' goals is not just analyzing the financial performance; it includes qualitative factors such as leadership, technological position, social performance, etc. (Porter 2004, 50-58.)

The assumptions are either competitor's assumptions about itself, or about the industry and the other companies in it. These assumptions about the company itself will guide the company's behaviour and the reactions. In addition, companies can, for example, greatly over or underestimate the competitors in terms of resources, skills, or resilience. Hence, both of these assumptions may or may not be correct. Scrutinizing the assumptions may reveal blind spots, i.e. the areas where a competitor will see the significance of actions ei-ther slowly, incorrectly, or not at all. A company can greatly benefit from identifying these blind spots. For example, by moving strategically in accordance with the blind spot analy-sis a company can ensure that the competitors' reactions towards moves are too slow, or the competitors will not react at all. (Porter 2004, 58-62.)

How the competitors currently operate is analyzed by creating statements of each com-petitor's current strategy. Hence, a competitor's strategy could be thought as its key oper-ating policies in each functional area of the business, and how the competitor seeks to in-terrelate those policies. A strategy can be developed through a careful planning or emerge

organically, thus it is either explicit or implicit. In short, developing a competitive strategy consists of creating a formula for how the company is going to compete, what the goals should be, and what policies are needed in order to execute those goals. (Porter 2004, 63.)

The final step is to create a realistic view on each competitor's capabilities. The competitor's goals, assumptions and current strategy all together will affect the likelihood, timing, the nature and the intensity of a competitor's reactions. Strengths and weaknesses will determine competitor's capability to initiate strategic moves or react towards them. Furthermore, strengths and weaknesses will discover how well the competitor is able to deal with environmental or industry events occurring. (Porter 2004, 63-67.)

Asking critical questions about competitor's future goals, assumptions, currents strategies, and capabilities will lead to competitor response profile. In order to predict the strategic changes, e.g. following questions could be asked: 'Is the competitor satisfied with the current position?', 'What are the most likely moves?', and 'What is the strength and the seriousness of those moves?' The second step is to build a response profile by understanding the competitor's defensive capability by posing the following questions: 'To which strategic moves or governmental, macro-economic or industry events the competitor is the most vulnerable?', 'What moves will provoke the competitor?', 'What are the moves threatening the competitor's goals or the position?', 'To what moves the competitor is able to react quickly and/or effectively?' and finally, 'What is the course of action to be taken in order to make the competitor less effective when the competitor tries to match or emulate the moves?' (Porter 2004, 67-70.)

Hussey (2000, 61-63) merge Porter's framework of competitor analysis together with practical approach on how to find information for competitor analysis. The outermost layer describes the analytical steps starting with industry mapping analysis, describing the competitive situation and the positions of key competitors, moving to profiling and definition of competitor's businesses, ending up to building competitive advantage. The steps illustrated in Figure 10 work as individual tools, however, when merged together, they develop an understanding of the industry and the competitive arena.
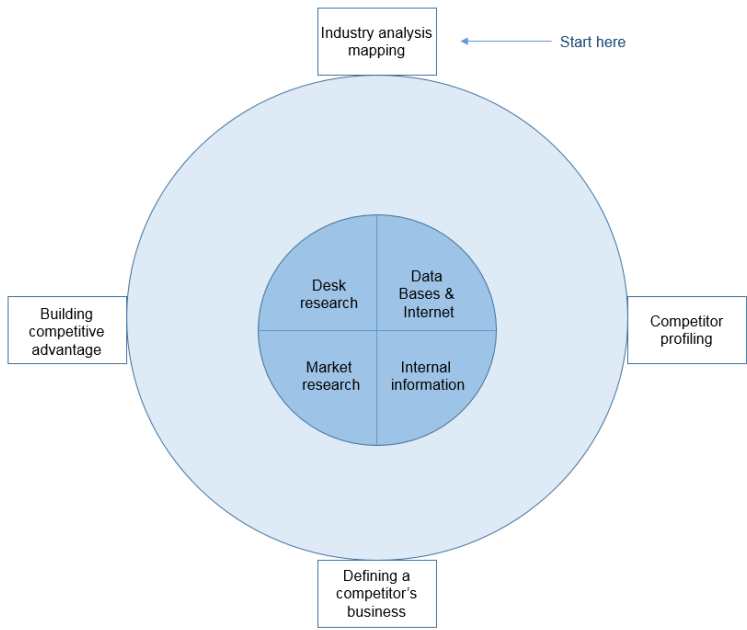
Figure 10. Approach to competitor analysis (Hussey 2000, 62).

The Strategy Canvas as a tool for understanding competition

Kim et al.'s (2015) view is an alternative view towards the external environment, and hence for creating a competitor analysis. Strategy Canvas answers questions such as: 'How to break out from bloody competition, i.e. red ocean in order to make competition irrelevant?', and 'How to open up and capture in order to create a new market space, i.e. Blue Ocean?'

Figure 11. Strategy Canvas related to wine industry (modified from Kim et al. 2015, 28).

Figure 11 is an example how the wine industry might look like. The canvas illustrates the current state of play in the known market space. Hence, it creates understanding where

the competition is currently investing, how the industry competes in terms of products, service and delivery, and what the customers are receiving from competitive offerings. The vertical axis captures the offering level that the buyers receive, e.g. a high score means that a company invests and thereby offers the buyers more. As for the price; the higher the score, the higher the price is. In other words, a strategic profile is the value curve demonstrating the company's relative performance across its industry factors. In order to shift the Strategy Canvas from competitors to alternatives and customers to noncustomers, a reorientation of strategic focus should take place. Hence, the old logic of benchmarking existing competitors, and selecting between differentiation and cost leadership should be avoided since both value and low cost, can be achieved by using Strategy Canvas as a tool. (Kim et al. 2015, 27-30.)

Instead of focusing on competing head-to-head against rivalries within industry, Blue Oceans are looking across alternative industries. In other words, competitive positioning is not scrutinized merely within a strategic group, instead all the strategic groups within an industry are looked across. Thus, the conventional boundaries of competition are altered by reconstructing the existing market boundaries. When conducting the competitor analysis, Strategy Canvas could be used as a framework since it shows the strategic profile of an industry by drawing a clear picture on the factors affecting the competition, e.g. by highlighting the factors companies are likely to invest in the future. In addition, it compares competitors' key success factors and highlights the differences in customer preferences leading to differentiation. (Johnson et al. 2014, 58; Kim et al. 2015, 81-85.) Figure 12 is an example related to electrical components companies illustrating how company C's value curve outperforms company A and B in terms of testing services and design advice (Johnson et al. 2014, 58).
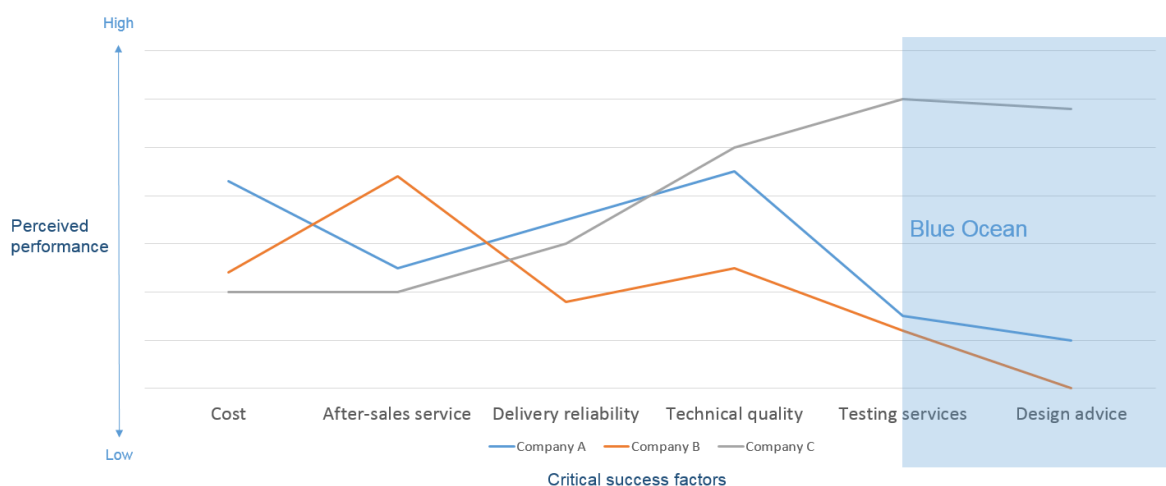

Figure 12. Strategy Canvas for electrical components companies (Johnson et al. 2014, 58).

The Four Actions framework for creating value

In order to reconstruct buyer value elements and to create a new value curve, the trade-off between differentiation and low cost must be broken. The core questions are represented in Figure 13 towards industry's strategic logic. The question related to elimination of industry's factors, forces to consider whether the factors are valid since they are often taken for granted, even though they would not have value anymore. With respect to reduction of factors, companies might often overserve the customers by producing overdesigned products in order to match the competition. Thus, it should be considered whether some of the factors could be reduced. In contrast, some of the factors could be raised well above the industry standards and by doing so, compromises could be eliminated. Finally, by creating something entirely new, value for buyers and new demand will be created, and hence a shift in the strategic pricing of an industry will occur. Four Actions framework should be applied together with Strategy Canvas since by doing so, new insights instead of old truths might emerge. (Kim et al. 2015, 31-32.)
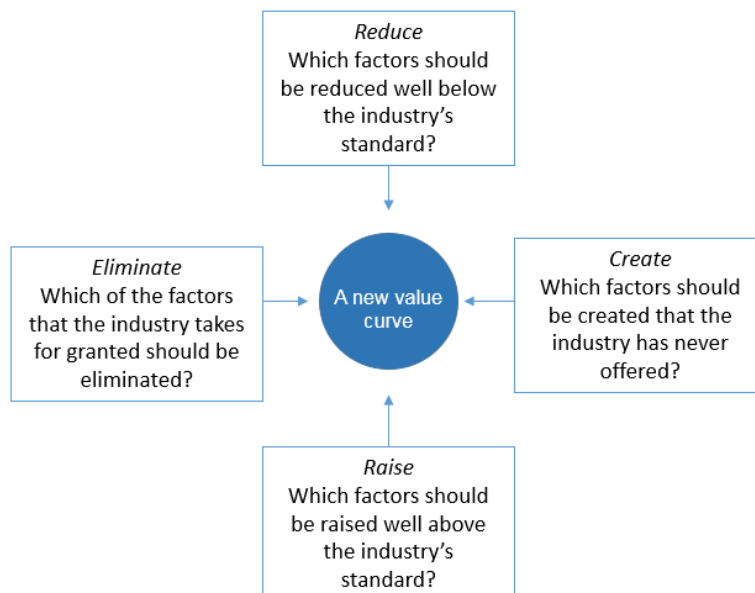
Figure 13. Four Actions framework (Kim et al. 2015, 31).

Strategic groups

Viardot (2004, 117-121) propose forming strategic groups of companies which are all alike since they often tend to compete against each other. Furthermore, the concept works well for the high-tech industry where the technology might have a significant impact on the formation of the strategic group. Johnson et al. (2014, 54-56) refer to the strategic groups as companies within an industry or sector with similar strategic characteristic, or companies who follow similar strategies, or if competition occurs on similar bases. The two main characteristics separate the strategic groups from each other. (1) The scope of an organizations activities, e.g. product range, geographical coverage and the range of distribution

channels used, and (2) the resource commitment, e.g. branding, marketing effort, extent of vertical integration, quality, leader or follower in terms of technological leadership, and the size of an organization.

Strategic groups are an important concept since it helps to understand competition better. According to Kim et al. (2015) looking across strategic groups is one of the steps when formulating Blue Ocean strategy and when reconstructing market boundaries. Even though, most of the companies are trying to improve their competitive positioning within a strategic group. However, the key is to break out from this thinking by creating Blue Ocean across the existing strategic groups and try to understand what are the customers' decisions to switch from one group to another. Strategic grouping could be used as a tool by drawing the groups onto a two-dimensional chart. Furthermore, when analyzing strategic groups, the most appealing strategic spaces might emerge, e.g. where little or no competition exists. When trying to discover these spaces, strategic groups could be ranked in a hierarchical order based on price and performance. (Kim et al. 2015, 58.)

In addition, Porter's Five Forces approach could be used when analyzing strategic groups since moving across the map (chart) from one strategic group to another means overcoming obstacles, i.e. entry barriers (Johnson et al. 2014, 54-55). Even though building strategic groups is generally perceived as valuable, following criticism towards strategic groups exists: first, there is no convincing evidence that a company's performance is dependent on belonging in a particular strategic group, and second, it is hard to capture the nature of a company's outputs by studying merely a few strategic dimensions. Thus, forming a strategic group is problematic. (Hitt et al. 1999, 71-72.)

2.4   Concepts for understanding and classifying customers

In this study, two sub-questions are to be answered: (1) who are the potential customers, and (2) what is the value proposition for those customers. When answering these questions, value proposition, segmentation, positioning, and targeting should be investigated thoroughly. Furthermore, in the core of understanding the market potential is actually understanding the customers' needs since in the end, customers are the ones making the purchase decision. Therefore, the becoming chapter will represent the main concepts for understanding and classifying customers.

Customer value proposition

The value proposition is the element of strategy looking outward at the customers trying to answer questions such as: 'Which customers to serve?', 'Which needs to fulfil?', 'What relative price is accepted by the customer in terms of value?', Or by the company in terms of

profitability?' (Magretta 2012, 96). Hence, the value proposition reflects the buyer's, not the seller's perspective, and in the center are the benefits the customers value highly in relation to the price. If the product is applicable for multiple markets and it has been decided to reach several customer segments, it is advisable to formulate a value proposition covering the entire market. However, value propositions must be tailored to fit each customer segment perfectly. (Valentin 2015, 8.)

Osterwalder et al. (2014) has created a framework for the value proposition creation. The framework could be used as a tool for building a customer value proposition since it helps to discover what the customers want by directly targeting at customers' jobs, gains, and pains. The framework fits well for new ventures when setting up a new business model from the very beginning. The building of value proposition design starts with the customer, existing value proposition, business model, environment, or business models/value propositions from other industries and sectors, always ending to addressing jobs, pains, gains that customer care about. The key idea is to create a fit between the product offering and the customer profile, otherwise customers will not be attracted. (Osterwalder et al. 2014, 94-95.)

Great value propositions are embedded into a business model focusing on the jobs, pains, and gains that matter the most to the customers. Hence, they have emphasis on unsatisfied jobs, unresolved pains and unrealized gains targeting only few jobs, pains, and gains creating the value proposition as compelling. When building the value proposition two common approaches exists: technology push and market pull. Technology push begins designing the value proposition from the invention ending up to customers' jobs, gains and pains. In other words, in technology push, the technology is in search for a problem. Market pull starts by investigating customers' jobs, pains and gains, and ends with developing a solution to address those problems. (Osterwalder et al. 2014, 94-95.) Next, components for understanding a customer profile are scrutinized more detailed.

Customer profile describes a specific customer segment in a more specific and structured way breaking down into jobs, pains and gains. Customer jobs are described by customers' own words explaining what they wish to do in their work and in their lives. While, pains are the bad outcomes, risks, and obstacles; gains are the outcomes customers want to achieve, or concrete benefits they are seeking. (Osterwalder et al. 2014, 9.)

Value proposition describe the business model in a structured way consisting of products and services, pain relievers and gain creators. To put it simple, products and services

form a list of all the products and services the value proposition is/will be built around. Further, pain relievers describe how products and services alleviate customer pains. Finally, gain creators illustrate how products and services create customer gains. (Osterwalder et al. 2014, 8.)

Customer jobs can be divided into three main types: functional, social, and personal/emotional jobs, and supporting jobs. First, functional jobs are the tasks what customers are performing to solve a specific problem, e.g. write a report. Second, social jobs describe how customers want to be perceived by others in order to gain status or power. Third, customers can seek a specific emotional state, e.g. job security. Fourth, supporting jobs have two roles: (1) deciding which products to buy, e.g. participating in the design of product or service, and (2) transferring value, e.g. when reselling or transferring the product to others. (Osterwalder et al. 2014, 13.)

It is crucial to understand that not all the jobs have the same importance for the customers, e.g. failing to perform some of the jobs might lead to significant ramifications. Therefore, it is necessary to investigate the level of importance when creating an overview of customer jobs. Finally, when investigating the customer jobs, the customer's perspective should be adopted since it is needed for understanding what the customers are trying to get done. (Osterwalder et al. 2014, 13.)

Customer pains consist of undesired outcomes, problems, problem related characteristics, obstacles, and risks. Pains can be functional (e.g. solution does not work as the customer expects), social (e.g. customer is afraid how using the solution affects social status), emotional (e.g. customer does not feel good to use the solution), or ancillary (e.g. customer does not like to purchase the solution via traditional store since it takes more time than buying online). Whereas, obstacles describe what prevents customers from getting started with the job or getting it done in a given time frame; risks are the undesired potential outcomes describing all the things which could go wrong having negative consequences. (Osterwalder et al. 2014, 14.)

Customer pains have similar severity level as customer jobs, i.e. pains vary from extreme to moderate. Therefore, the level of severity should be investigated. In addition, by understanding how the customers measure pain severity, the better pain relievers can be created. (Osterwalder et al. 2014, 14.)

Customer gains describe everything what customers expect from the solution. Gains can be divided into following: (1) required gains are so called must have gains, without these

the solution does not work, (2) expected, i.e. basic gains the customer expects from the solution, (3) desired gains are the wanted features the customers are able to tell and describe, and (4) unexpected gains, i.e. features which go beyond customers' expectations and needs. As described regarding customer jobs and pains, the relevance level varies, i.e. some of the features are more essential than others, as others merely are nice to have. (Osterwalder et al. 2014, 16.)

Even though, Osterwalder et al.'s (2014) framework is generally accepted and academically perceived as well-formulated, Bocken et al. (2013, 5) criticize it having a limited view regarding the value proposition since it focuses merely on the customer. Hence, it fails to create a wider view across the full stakeholder network, incl. suppliers, local communities, society, and environment.

The researched methods for defining a compelling customer value proposition are as follows (Kotler et al. 2016, 224):

- internal engineering assessment (where the company's engineers will use laboratory tests to estimate the product's performance characteristics)
- field value-in-use-assessment (which is conducted by interviewing customers about how costs of using a new product compare in relation to the competitors' products)
- focus-group value assessment (by asking from the customers what is the value of the product offering)
- direct survey questions (by asking customers to put monetary value on one or more features in product offering)
- conjoint analysis (by asking customers to rank their preferences for alternative product offerings or concepts. Here statistical analysis should be used in order to estimate the exact value related to each attribute.)
- benchmarking (by showing the benchmark offering to the customers followed by company's new offering.)
- compositional approach (where the customers' will give a monetary value on three different levels of a given attribute. After the repetition of other attributes, all the formed values are added together for further analysis.)
- Importance rating (by asking customers to estimate the importance of different attributes and their suppliers' performance respectively.)

After the company has defined a powerful customer value proposition, it should be stated clearly emphasizing the difference between the company's value proposition and the competitor's offering with respect to the dimensions that matter the most to the customers. Furthermore, the value that the customers' capture by using the new offering should be documented. Finally, the means how the company creates value to the customers should be implemented within a company. The implementation process includes training and rewarding the personnel accordingly. (Kotler et al. 2016, 224.)

Segmentation

Market could be seen as a set of different customer requirements. Segmentation is about dividing the whole market into distinct customer groups who have similar characteristics. The value of the segmentation will be realized when the company decides where to target, and when establishing a competitive positioning. According to Fill et al. (2005, 50) the overall process is referred as segmentation, targeting and positioning.

The process steps are as described in Figure 14: firstly, the market and the segments within the market are identified by using variety of criteria. Secondly, organization selects the most appealing segments, i.e. those segments which have the strongest business potential, e.g. in terms of volume and profit. Thirdly, accessibility of the segment is scrutinized from the strategic point of view, e.g. by assessing how the company's internal resources are organized in order to meet the target segment's needs. Fourthly, entry barriers and competitors' positioning are mirrored against company's overall strategy. (Viador 2004, 142-143.) During the latter step, the products are being positioned in a way the distinction between the competitors' products is explicit (Fill et al. 2005, 50). If the process is successful, each member within the segment will share characteristics with respect to their market needs.

Market

Segment

Target segment → Target

Position → Position
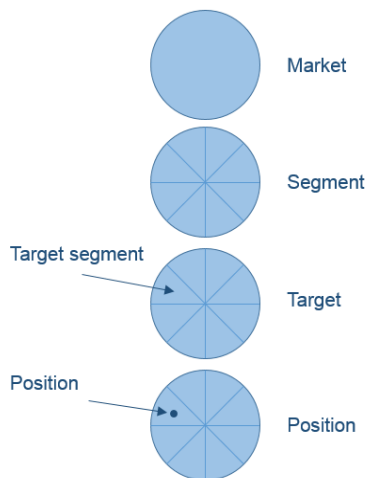
Figure 14. The STP process of target marketing (Fill et al. 2005, 51).

The two main approaches towards segmenting business-to-business markets are breakdown method and build-up method. According to the first view, market is considered to consist of businesses who are essentially the same, and the segmentation procedure is to find groups that differ from each other. The second view, comprehends market consisting of businesses that are all different, and hence the task is to find similarities among those businesses. (Fill et al. 2005, 51.)

The business customers differ greatly from each other in terms of their needs and behaviours. When segmenting, the firm-specific characteristics should be taken into consideration. The three main factors for classifying business customers are industry, company size and location. These rather easily observed characteristics create a rough picture on customers. However, when selling to business customers one should understand how the companies behave and what are their buying habits and purchasing criteria. Therefore, even more detailed view should be created. Hence, (1) company's technology, (2) product and brand-use status, (3) customers' capabilities, and (4) customers' strategic types should be taken into consideration. (Brennan et al. 2007, 156-157.) Next, a short description what those characteristics mean in practice.

(1) Company's technology assesses customers' technological readiness, and the buying needs in terms of technical capabilities. (2) Product and brand-use status is about separating light, heavy, and medium users from each other, and deciding the strategy for those customer groups, e.g. retain heavy users, or invest in the growth of light users. (3) Customers' capabilities tell what the customers' could do with the product. (4) Analyzing customers' strategies might be a difficult task but extremely worthwhile e.g. for small customer groups. When assessing customers' strategic type, customers could be monitored based on their purchasing behaviour, i.e. by observing how companies have organized themselves in terms of procurement, what kind of power structures and buyer-seller relationships there are. Furthermore, the company might have general purchasing policies and other specific criteria for buying. (Brennan et al. 2007, 156-161.)

In addition to above characteristics, customers could be segmented by application since the companies who are using the product or service for the same purpose tend to perceive value similarly. Furthermore, customers' business priorities strongly indicate the capabilities the customers would like to possess in terms of competitive advantage. Hence, business priorities could be used for segmentation purposes. (Anderson et al. 2009, 49.)

According to Kim et al. (2015, 103-115) companies should try to reach beyond existing demand by challenging the existing strategy practices that usually focus on existing customers. The other false practice is to aim for the finer customer segments in order to accommodate the buyers' differences since by doing so companies typically strive to retain and expand the existing customer base. Furthermore, when companies try to embrace the customers' needs and preferences, too small target markets might be a result. Hence, reverse tactic could be used, i.e. instead of focusing on the customers, the search for non-customers should begin allowing the companies to reach beyond existing demand. In addition, instead of focusing on customer differences, powerful commonalities should be

built in order to meet buyers' needs and expectations. Thus, discovering the customers' needs is crucial as Osterwalder et al. (2014) suggests.

Kim et al. (2015, 105) asks how the company focuses the attention: 'Does the company try to capture the existing customers, or do they convert noncustomers into a new demand?', 'Or do they strive to understand customer differences, and hence end up in finer customization and segmentation?', 'Or is their ambition to search customer commonalities in what buyers' value?' In order to create new demand, noncustomers, commonalities and de-segmentation over finer segmentation, should be preferred.
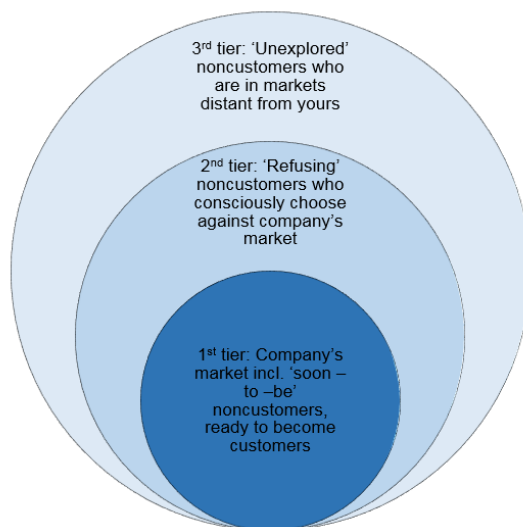

Figure 15. The three tiers of noncustomers (modified from Kim et al. 2015, 106).

As Figure 15 above illustrates, the first tier consists of company's existing customer base, and those customers who are ready to be customers. The latter, however, are searching for something better to appear. They are ready to purchase a better alternative, and in this respect they are sitting in the edge of 1st tear. (Kim et al. 2015, 105-114.)

The second tier consists of noncustomers who consciously do not want to, or do not have afford to purchase the current market offering. Hence, their needs are being fulfilled with other means or ignored. The second tier contains business potential since the demand waits to be released. In order to understand why the second tier customers do not want to purchase company's products or services, the commonalities across their responses should be investigated further, instead of focusing on differences. (Kim et al. 2015, 105-114.)

The third tier customers are not usually thought as potential customers by any player in the industry. Hence, they are unexplored since their needs are assumed to belong to

other markets. The company should focus on the tier that represents the greatest potential that the company has capability to act on. However, all the three tears should be investigated in order to see whether there are overlapping commonalities. If that is the case, company should not focus only one tier, instead look across tiers. As a thumb rule, the company should try to seize the greatest potential reachable within the capabilities and competence the company possesses. (Kim et al. 2015, 105-114.)

Kim et al. (2015) wish to challenge the existing, taken-for-granted strategic orientations related to segmentation. Even though, they admit it is not wrong to focus on existing customers, they suggest that every company should first try to reach beyond existing demand when formulating future strategies.

Targeting is making the best informed choice about deciding which particular markets to serve. Hence, the company needs to consider its possible competitive position in relation to each segment. This could be done by using three alternative views: (1) undifferentiated targeting, (2) differentiated targeting, or (3) niche targeting. (Brennan et al. 2007, 165-166.)

When a company decides to serve segments with undifferentiated approach, it has the same standard offering for all customers. The advantage of this approach, for example, is producing economies of scale. However, the company is vulnerable to competition since the competitors might serve the same segments with differentiated products more efficiently. (Brennan et al. 2007, 165-166.)

Differentiated target market selection is focused on meeting the needs of the selected segments more carefully. Here the aim is to fit the products together with the needs of the customers'. (Brennan et al. 2007, 165-166.)

In competitive environment, however, some form of customization approach should be taken. Nonetheless, whether to provide a differentiated product offering to each customer segment is a troublesome decision. Thus, the costs should be calculated against the potential benefits in order to make sure the long-term benefits outweigh the costs. Niche market approach is applied when a company has a particular capability in some specific area, or if the company is small and therefore does not have resources to fulfil customers' needs. (Brennan et al. 2007, 165-166.)

According to Fill et al. (2005, 63-64) market selection should be based on systematic analysis of the market; first scrutinizing the market characteristics, e.g. from the secondary

sources, and then moving to the buyers' characteristics by investigating the primary source, i.e. customers. The following criteria will help to identify valid segments: 'Is the segment easy to identify and measure?', 'Are all segments accessible?', 'Are segments substantial offering sufficient return on investment?', 'Does the company have capabilities to reach the segment?', and finally, 'Are all segments compatible with current business strategy and market conditions?' However, these criteria are merely guidelines, and hence in the end the managerial decisions will be the decisive factors when selecting the appropriate segments. (Fill et al. 2005, 63-65.)

According to Anderson et al. (2009, 53) determining the most interesting market segments is calculated in a following manner: first, market segment's size and growth rates are estimated; and second, the segment's sales and profit potential are calculated. Viardot (2004, 143) shares the view that the prospects by segment in terms of volume and profit should be estimated. In addition, he proposes estimating the segment's accessibility in accordance with the company's resources. Furthermore, segment's strategic significance against the company's mission, the position of competitors, and the level of entry barriers focusing on administrative and the governmental factors should be assessed when deciding which segments to target. Finally, Viardot (2004, 143-145) does not acknowledge the niche marketing approach since he proposes targeting the most important customers within the selected segment by using either concentrated or differentiated marketing approach.

Positioning

After segmenting and targeting, the final task is to position the organization, the brand or the product/service. When positioning the product or service, actually, the positioning takes a place in the minds of the buyers'. Hence, it should be considered what to do with the minds of the buyers' rather than the product itself. (Fill et al. 2005, 69; Viardot 2004; Brennan et al. 2007, 166.) The goal of the positioning is to get the potential buyers to see suppliers differing from other suppliers, and add value to the buyers with distinctive offering (Fill et al. 2005, 69). Thus, it might be sensible to position against a particular competitor. When creating this relative positioning, a company has to be sure of its strengths and weaknesses. After the positioning process, the position should be converted into a message. (Brennan et al. 2007, 166.)

2.5   Concepts for understanding Invention X

Invention X is in a prototype phase, and therefore assessing the external environment, as proposed in earlier chapters, is crucial. Nonetheless, conducting an internal assessment might be valuable in order to create mutual understanding and for sharing knowledge across the development team. Furthermore, the assessment might lead to further insights

paving the way towards how to develop Invention X further. Therefore, the product related core competitive advantages should be understood by evaluating them. Next, the two commonly used tools to assess innovation's value are presented.

SWOT is one of the most commonly used tools when assessing firm's **S**trengths, **W**eaknesses, **O**pportunities, and **T**hreats focusing on both external and internal environments. It highlights company's distinctive competencies and addresses the shortcomings. (Morrison 2006, 31-33.) The tool can be used on a product level making it as an applicable tool for assessing Invention X's strengths and weaknesses in relation to opportunities and threats.

The tool has limitations because there are no coherent economic principles underlying a SWOT, and as a result, one might end with a random list depending on who is participating and what are the issues in mind. Therefore, a SWOT might be heavily biased, e.g. based on executive's agenda. In contrast, Porter's Five Forces framework, is built on analysis, not just bullet points, and therefore more objective tool for understanding the dynamics of competition (Magretta 2012, 39).

Valentin (2015, 117-118) refers to a SWOT as a common centrepiece of situation analysis for half a century, although it could be seen as rather a primitive tool. Therefore, he suggests creating a prospective situation in two and five years taking the competitive positioning into consideration. Thus, the creation should start by constructing competitive profiles proceeding to evaluation of the future competitive positioning. Furthermore, when creating opportunities and threats, tools such as PESTLE should be simultaneously used since it takes the external environment into consideration. (Valentin 2015, 117-118.)

VRIO framework is an abbreviation of the words **V**aluable, **R**are, costly to **I**mitate, and supported by **O**rganization. The academically approved tool can be applied on organization and on product level making it as a feasible framework when scrutinizing Invention X. It assesses which capabilities could be seen as core competencies leading to sustainable competitive advantage. For example, a company may have core competencies which are valuable and rare but not unique, making the company vulnerable in the eyes of competitors since they can imitate those competencies - some easily than others. Therefore, a company should understand its core competencies by assessing those, e.g. according to Table 1 below. (Hitt el al. 2015, 86-89.)

Valuable capabilities allow firm to effectively use those capabilities by exploiting opportunities and neutralizing threats and in the process of doing so, create value for the end-customers. Rare capabilities are possessed only by very few, if any, making them extremely

valuable. Here the key question to be answered is: 'how many rival companies possess the unique capabilities?' (Hitt el al. 2015, 86-89.)

Valuable, but common capabilities will lead to competitive parity, not competitive advantage. Hence, the valuable capabilities should be developed in way they differ from the competitors' capabilities. Costly to imitate capabilities are difficult for the other companies to develop. They emerge or are created as an outcome of historical reasons, unique organizational culture, social complexity, or ambiguous reasons. Nonsubstitutable capabilities are the ones that have no equivalents. (Hitt el al. 2015, 86-89.)

Finally, in addition to aforementioned factors, Johson et al. (2015, 80) acknowledges organizational support as one of the issues which is needed in order to scrutinize whether a capability can be a source of sustainable competitive advantage. For example, if the organization is not suitably organized to support the capabilities, including appropriate organizational processes and systems, it is difficult to take full advantage of the capabilities.

Table 1. VRIO framework (modified from Hitt et al. 2015, 89; Johnson et al. 2015, 80).

Is the Capability Valuable?	Is the Capability Rare?	Is the Capability Costly to Imitate?	Is the Capability Nonsubstitutable?	Supported by organization?	Competitive Consequences	Performance Implications
No	No	No	No	No	Competitive disadvantage	Below average returns
Yes	No	No	Yes/no	Yes/no	Competitive parity	Average returns
Yes	Yes	No	Yes/no	Yes/no	Temporary competitive advantage	Average returns to above-average returns
Yes	Yes	Yes	Yes/no	Yes	Sustainable competitive advantage	Above-average returns

3   Conceptual framework

This chapter illustrates how the identified concepts guided the empirical research part, and highlights their interconnected relationships. Thus, the aim of this chapter is to reveal how the conceptual framework answers the research project's questions and the objectives.
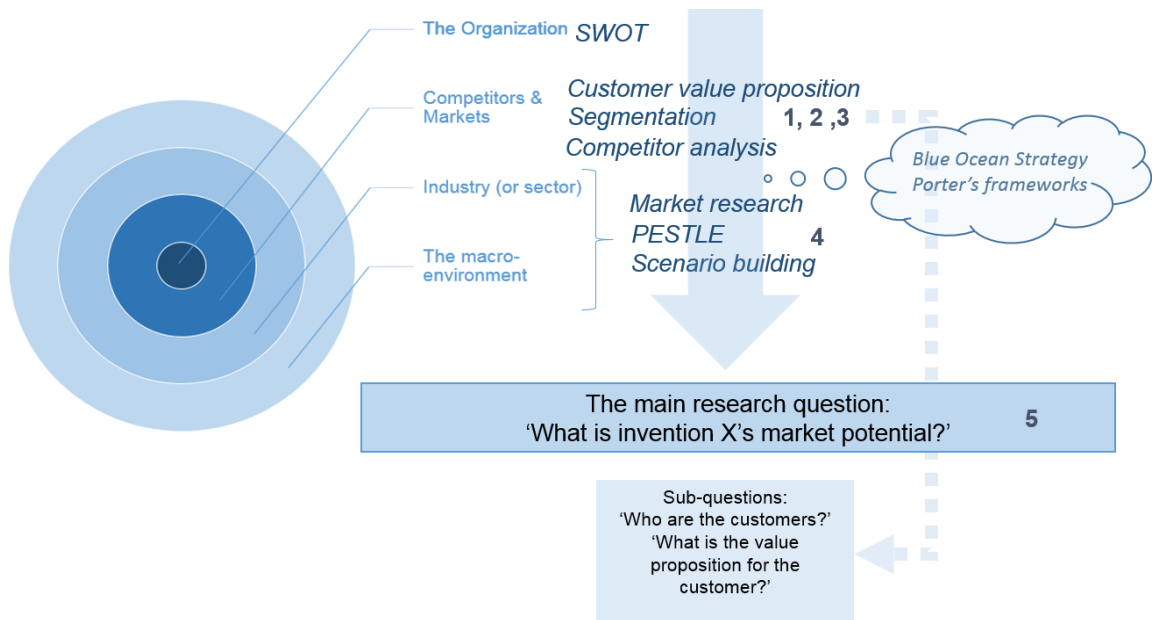

Figure 16. Conceptual framework

Figure 16 illustrates the relevant concepts and their interconnected relationships. The circle on the left hand side describes the market environment dividing into the macro-environment, the industry, competitors and markets, and the organization itself. The conceptual framework for this study consists of understanding the different layers of the market environment by using the most applicable tools when answering the research questions. Figure 16 illustrates how the five research objectives marked with numbers 1 to 5 interlink with the theoretical frameworks and concepts. The objectives of this study are as follows:

1. Potential customers will be identified and segmented
2. Product related features which are of value to the customers will be discovered
3. Competitor analysis will be done
4. Knowledge of the market environment (incl. the development of standards) will be acquired
5. Market potential will be estimated

The study began by evaluating the innermost layer with the assessment of strengths, weaknesses, opportunities, and threats on a product level focusing on Invention X, i.e.

during this phase an Invention-related SWOT was created (see attachment 1). The purpose of this step was to create and share knowledge among the project team facilitating the actual research project.

The layer encircling the innermost layer consist of competitors and markets, incl. customers. When researching this layer, Osterwalder et al.'s (2014) framework related to customer value proposition was used as a main concept to guide the formulation of the interview questions. For example, questions regarding customers' expectations, needs, benefits, challenges and risks were derived by using his framework. As a result of transcribing and analyzing the interviews, segmentation of the potential customers emerged organically. In addition, the different theoretical frameworks, especially Blue Ocean strategy and Porter's Five Forces model, guided the thinking when analyzing the interviews and segmenting the customers. Finally, when creating an overview of competitive landscape, Porter's Four Components of competitor analysis were not applied as such because of the tight time schedule, however, they facilitated the process.

The two outermost layers, industry and the macro-environment, should be closely scrutinized when conducting a market research. Therefore, in this study a PESTLE framework was used as a main tool when reading the market related reports and analyzing the interviews. In addition, the other tools such as Porter's Five Forces framework and Blue Ocean strategy aided since they were used to make sense of the ambiguous external market environment. Finally, when estimating the market potential in terms of monetary value, scenario building was used for forecasting the future prospects.

4   Research methodology and methods

This chapter will explain what methodological choices the researcher made when designing this study. For understanding the nature of this study better, the chapter begins by representing the applied research philosophy and the research approach. Thereafter, the selected research method, the strategy, the research process and the steps will be thoroughly described. Finally, this chapter will end in outlining how data was collected and implemented.

4.1   Research philosophy and approach

Research philosophy explains how knowledge develops and what is the nature of the knowledge. Pragmatism is one of the research philosophies based on approach where the nature of reality is perceived as external from researcher's reality acknowledging that multiple realities can exist. Thus, in pragmatism the taken view enables answering the research question the best possible way. Furthermore, the focus is on practical applied research and the research can be, but is not necessarily, based on multiple research methods. However, the main point in pragmatism is to use research method(s) which enable the gathering of well-founded, reliable, credible, and relevant data that aims for advancing the research. (Saunders et al. 2012, 130.) Next, explanation why pragmatism is the prevailing research philosophy throughout this study.

First, during this study, multiple methods, and different philosophical positions were taken. Second, the decision which position to take was based on the main research question: 'What is invention X's market potential?', and hence the main research question acted as a driver. Third, after conducting the primary research part, it was obvious that there was a need to investigate the phenomenon more since the researcher was unable to answer the main research question. In other words, the researcher adopted different research philosophies instead of unambiguously taking one approach. Thus, it was acknowledged that there are many ways to undertake the research, and that no single point of view can ever give the entire picture since there can be multiple realities. Fourth, the values played a significant role when interpreting primary data, however, value-free position when interpreting the results related to secondary research were taken. (Saunders et al. 2012, 130-140.)

The research approach in this study is abduction. Saunders et al. (2012, 144-150) calls the process where both research methods induction and deduction, are used as abduction moving back and forth combining both research approaches. In abduction, data are used

to identify themes and explain patterns in order to generate a new or modify existing theory often through additional data collection. The study started by induction by moving from data gathering to theory formulation proceeding to secondary research, in which the gathered data from secondary sources was used to enrich primary data and formulate the final conclusions. In addition, data was gathered in order to form generalizations, and the discovered premises where used to generate untested conclusions. This is typical in inductive approach. The purpose of inductive approach is to understand the nature of problem better by making sense of data. The second part of the study could be called as deductive since the data collection was used to evaluate the propositions, and it started by investigating different market reports, and hence generalizing from the general to specific occurred when estimating the market potential. (Saunders et al. 2012, 143-150.)

4.2   Research method and strategy

The research method in this study is based on mixed method sequential exploratory research design, where both ways to analyze knowledge are used in a sequential order; qualitative methods followed by quantitative methods (Saunders et al. 2012, 165). The research project started with initial exploratory discussions together with the project sponsor. The gathered data was analyzed qualitatively in order to agree the scope of the project and gain contextual data. The project kicked-off officially by designing qualitative semi-structured interview, and continued by gaining in-depth information through face-to-face qualitative interviews. However, as an outcome of the first part of the study, not enough valid data related to the market potential was obtained, and hence it was decided to continue investigating the relevant market reports in order to estimate the market potential's monetary value.

The research strategy is action research, where the explicit focus is on action related multiple stages. The aim was to resolve a real project-related issue in order to produce practical outcomes through identifying issues, planning action, taking action and evaluating action. (Saunders et al. 2012, 183-185.) The understanding of the phenomenon was co-created together with the project's sponsor since he possesses substance knowledge related to particle industry which was needed when answering the main research question: 'What is invention X's market potential?'. Furthermore, in each step the emerged findings were iterated and further developed by taking into account the previous evaluations.

The researcher worked tightly allocating the whole time to this particular project, and as explained, the project sponsor was committed enabling action research as a strategy since the researcher itself did not possess substance knowledge related to fine particle in-

dustry. Hence, information flowed seamlessly between the project sponsor and the researcher, and knowledge emerged through action and by working in the project. This is very typical in action research where the researcher is embedded in the organization or project, enabling knowledge to deepen (Saunders et al. 2012, 183-185). Additionally, the researcher acted as a facilitator within the project by iterating together with the project's sponsor regularly, and by using the aerosol physics research department as a reference group in order to receive feedback related to project's findings. Finally, informal discussions were held around the topic within the organization.

Research process

In practice, the research project progressed through steps illustrated in Figure 17 below. During the first step, the research objectives and the problems were identified by discussing internally, e.g. SWOT tool (see attachment 1) was used to gain better understanding of Invention X's strengths, weaknesses, opportunities, and threats. As a result, a research plan and also clues on how to develop the theoretical framework emerged. During the second step, the interview questions were developed in co-creation with the project's sponsors and the external partners. During the third step, the primary data was collected by interviewing researchers and companies at the World Filtration Congress in Taipei. During the fourth step, the interviews were transcribed and analyzed. Finally, the insights were presented for the project's sponsors and for the Tampere University of Technology's aerosol physics research department. All of the taken research steps can be found from the attachment 7.

After the presentation of the results, it was obvious that further research was required in order to answer the main research question, and therefore another action research cycle began. Further information related to the development of standards, competitors, and potential customer segments was acquired by interviewing five more companies in Finland. In addition, since it was discovered that information related to the market potential in terms of numbers was hard to get by interviewing, a desktop research started June 1st 2016 by searching relevant information from the internet and different databases. Furthermore, the TUTLI project had ordered market related reports from Haaga-Helia's bachelor level students which were used when creating estimates of the market potential. Finally, the research project's phase one formally ended when the final results and the main findings were presented to the TUTLI project's steering committee on August 15th 2016.
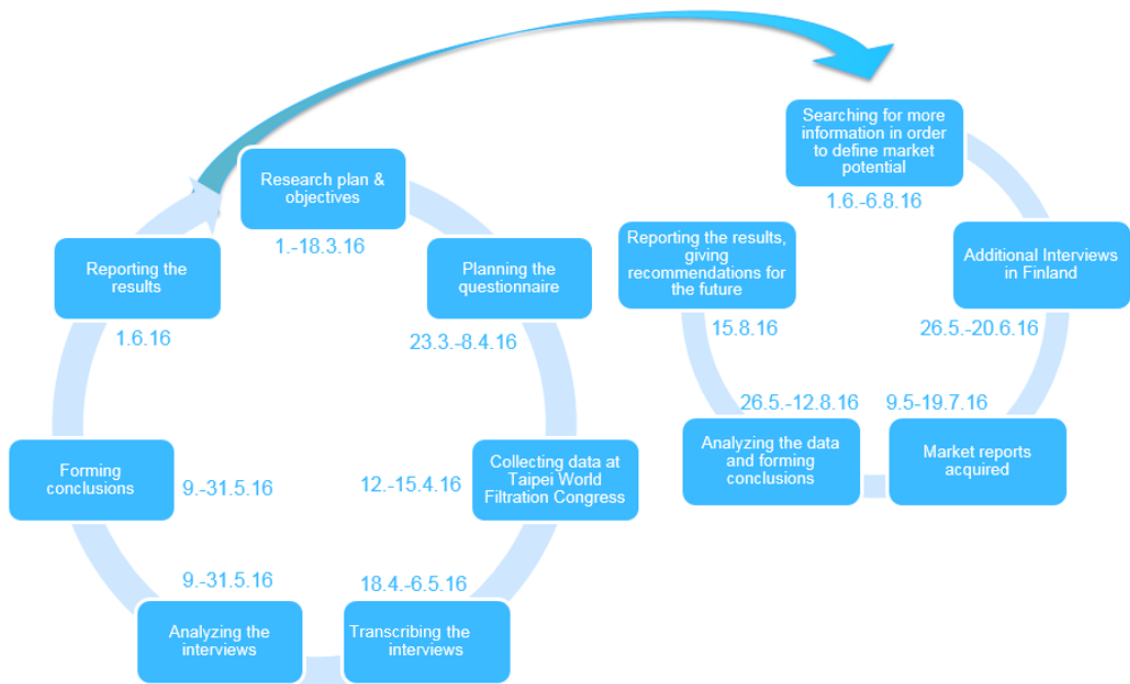
Figure 17. Research time line and steps

4.3   Data collection and implementation

When conducting this study, data was acquired multiple ways. Firstly, at the beginning of this research project, the aim was to share substance knowledge with the researcher, so she would be able to conduct this study successfully. Thus, this study started with exploratory research by iterating within the project team. Secondly, regarding the actual research objectives and the research questions, data was gathered by interviewing companies' representatives. Thirdly, as the study progressed and the researcher was unable to answer the main research question regarding Invention X's market potential, further data was acquired. Hence, a desktop research was conducted by acquiring knowledge from various databases. Fourthly, regarding the theoretical framework, the research objectives and the questions determined what theories and frameworks to apply. When building the theoretical framework, searching information related to the external environment, strategy formulation, customers' needs, segmentation, targeting, positioning, competitor analysis, and market research played a crucial role when building the theoretical and conceptual framework for this study.

Interviews as primary data collection method

The interview structure was formulated by discussing internally and externally. The researcher and the project's sponsor formulated the preliminary questions together. After the preliminary version was created, the questions were scrutinized in a meeting together

with one internal and with one external researcher. The purpose was to pilot test the interview questions face-to-face, but within the given time frame, it was not possible. Therefore, the interview questions were distributed to an external product specialist for review. Finally, Haaga-Helia's tutor, the researcher, and the project's sponsor verified and approved the interview questions together. When formulating the questions, the researcher tried to get answers to the main research questions by using Osterwalder et al.'s (2014) Patton's (2002), and Fisher's (2010) frameworks.

When using Osterwalder et al.'s (2012) framework, the researcher formulated the interview questions regarding customers' jobs, gains, and pains together with the project's sponsor. As a result, a long list of questions was created, which in the end was structured and grouped various ways by, e.g. merging and rewording questions. After several iteration rounds, in total 33 questions were created. The questions derived from Osterwalder et al.'s (2014) framework are as follows:

Gains:
  – What kind of expectations do you have related to measuring ultrafine particles?
  – What kind of needs do you have with respect to measuring ultrafine particles?
  – What kind of benefits could there potentially be with respect to measuring ultrafine particles?

Pains:
  – What kind of challenges does ultrafine particle measurement involve?
  – What kinds of risks are associated with ultrafine particle measurement?

Jobs:
  – What are you currently testing?
  – How do you conduct your tests at the moment?
  – How do you test ultrafine particles when conducting air filtering tests?
  – How do you prove to your customers that your products work?

During the formulation process the researcher followed closely Fisher's (2010, 183-184) steps: the ideas were sorted and areas of questioning were listed, the questions were edited and prioritized, the decision which questions should be open and which closed was taken, questions were organized into a sequence (core, additional questions for the respondent who is familiar with measuring, and background related questions), and finally, the questions were checked in order to make sure they were answering the research questions and goals.

Patton's (2002, 352) matrix of question options was used during the iteration process (see attachment 3). The matrix divides the questions into behaviors/experiences, opinions/values, feelings/emotions, knowledge, sensory, and background. Furthermore, it takes the time horizon into account, in other words questions are divided into past, present, or future. The framework helped to understand what is the focus of the question and to decide whether alter the questions somehow, e.g. ask behaviors instead of opinions. Additionally, by using the framework the researcher made sure the questions are not focusing merely on the present.

Patton (2002, 378) suggests creating a one-shot question which is the one question to be asked if the interviewee has only a few minutes time to discuss. The one-shot question was related to importance: "In your view, how important is it to measure ultrafine particles (less than 100 nm)?" Finally, in formal interviews it is important to give the interviewee the final say, and therefore the researcher used Patton's (2002, 379) closing technique by asking after the official interview is there something else the interviewee would have wanted to add or clarify.

The semi-structured interview consisted of 33 questions in total. The amount of questions varied depending on the job profile; 24 questions were posed to everyone, and if the interviewee was familiar with measuring, nine more questions were asked. Finally, all the participants were asked four background related questions. The focus was on open-ended 'Why?' and 'How?' questions since the goal was to gain in-depth understanding regarding the phenomenon despite the researcher's limited substance knowledge related to the particle industry. Open questions are advantageous since the respondents can use their own terms when answering, unusual responses might emerge allowing exploring and testing new ideas, and respondents level of knowledge and understanding can be tapped since the question does not suggest certain type of answer (Bryman et al. 2007, 248-249). If the question was close-ended, e.g. 'In your view, how important is it to measure ultrafine particles (less than 100 nm)?', the researcher asked 'Why?' in order to get an explanation.

The interviews possessed features from structured interview, i.e. a formal questionnaire was created and the interview followed a rather careful script protocol (Yin 2011, 133-135). Nevertheless, the interview could be considered as semi-structured since the aim was to interact with the respondent, e.g. the researcher might have asked out-of-the box questions and the focus was on open-ended questions. The final list of questions which were posed at the World Filtration Congress can be found from attachments (attachment 2).

When organizing the interviews, Fisher's (2010, 183-184) approaches were applied when possible. The approaches are as follows: check the language is simple and unambiguous, prepare an interview schedule, decide upon recording method, pilot an interview with someone friendly, make changes if required, select the interviewees, negotiate access, and arrange time and place. First of all, the aim was to interview people with a different country of origin in order to get comprehensive views, and therefore interviewees were interviewed in English. In order to minimize the false interpretations, language was checked in-cooperation together with the project's sponsor and the translator from Tampere University of Technology. It was impossible to prepare the interview schedule in beforehand since the interviews were booked at the World Filtration Congress by meeting the company representative's spontaneously at the venue. However, before the congress, altogether six companies, and four researchers were identified as interesting respondents from the long list of participants which was provided by the World Filtration Congress.

Even though, the researcher failed to pilot test the interview questions before the congress, the researcher felt confident to pose the questions since the interview questions were beforehand iterated multiple times. In addition, before each interview session, the researcher tried to search for a quiet, comfortable place where to interview. Furthermore, the researcher had bought a small recording device for professional recording purposes which was used in all interviews. For back-up purposes and for writing down key ideas, the researcher had a pen and paper. Finally, in order to gain trust, the interviews started with introductory presentation (see attachment 4), and by promising confidentiality and anonymity.

The interviews were conducted between April 12th and 15th 2016 at the World Filtration Congress in Taipei, Taiwan (see Table 2). In total, 11 interviewees were interviewed: a researcher, one test laboratory, one certification company, four filter media producers, and four air filter equipment producers. The interviews took between 30.50 to 54.05 minutes.

Table 2. Interviewees and company profiles

Interviewee's title	Company profile	Interviewee's company's location
Researcher	University	USA
Founder	Performance testing company	USA
CEO and Founder	Certification laboratory	UK
Product Manager	Producer and supplier of filter media	USA
CEO	Manufacturer of duct cleaning equipment	China (Hong Kong)
Director of Marketing for HEPA and ULPA filtration	Filter media manufacturer	China
General Manager	Manufacturer of Air Filtration systems	Abu Dhabi
Technical Service Engineer	Filter media manufacturer	Taiwan
Mechanical Engineer	Manufacturer of oil-mist filter systems	Taiwan
General Manager	Filter Media Manufacturer	Taiwan

Processing the interviews

Since only few of the interviewees' spoke English as a primary language and the researcher did not possess substance knowledge related to particle industry, the interviews needed to be carefully transcribed. When transcribing the interviews, Transana Standard 3.01 transcription programme was used as a main tool. It facilitated the process by having features such as a possibility to create transcript collections, clips, self-memos, research notebooks, and reflective journals. As Saunders et al. (2012, 553) describes those features will help to recall the context and reflect ideas. However, despite the effort of transcribing unclear words, in few cases, some of the words remained ambiguous.

After the transcription process, the interviews were analyzed. When conducting a qualitative data analysis, the researcher usually needs to go back and elaborate the previous decisions in order to gain more understanding regarding the phenomenon. In other words, the process is a reiterative process of data collection, theory development and refinement of the research questions indicating what areas to research more. The process continues as long as sufficient amount of data is gathered to support the developed theory leading to drawing conclusions and finalizing the research project. (Walliman 2011, 128-132.) As, Sauders et al. (2012, 556) explains there is no standardised approach how to analyze data, some are more structured approaches than others. However, the approach should be aligned with the research philosophy and strategy, and nature of data collection methods in order to justify the research approach. The key determinant here is to understand whether the approach is inductive or deductive. Whereas, the inductive is less structured

relying on interpretation, the deductive relies on rules and is based on more structured approach.

In practice, the researcher needed to take multiple iteration rounds when analysing the interviews since the researcher did not possess substance knowledge and the inductive research approach relied heavily on interpretation. Furthermore, the researcher needed to co-operate with the project's sponsor in order to create and share knowledge by discussing and highlighting the ambiguous terminology, concepts, phrases, etc.

Even though there are many ways to analyze qualitative data, Saunders et al. (2012, 557) outline five general ways to conduct analysis: (1) identifying categories or codes; (2) attaching data from different sources to appropriate categories or codes to integrate these data; (3) developing analytical categories in order to identify relationships and patterns; (4) developing testable propositions; (5) and finally draw and verify conclusions. Walliman (2011, 128-132) acknowledges more simplistic approach to analyze qualitative data: first, simplification by reducing the amount of data. This can be achieved through coding, clustering, or summarizing. Second, the simplified data should be displayed by arranging it, for example, producing tables or diagrams. Finally, conclusions can be drawn from the arranged data and data can be verified.

In practice, data was analyzed mainly by using categorising, i.e. creating headlines in order to create a structure. The created structure was based mainly on the theoretical frameworks by Osterwalder et al.'s (2014) and a PESTLE, dividing data into main categories and sub-categories, i.e.: gains (benefits, expectations, needs), jobs (job profile, previous experience, testing), pains (challenges and risks), environment (number of global testing labs, market change, relevant particle size, standardization), product related information (features, price, what products are in use), and background related questions.

It was a time-consuming task to categorize the information since the interviewees did not necessarily answer in a chronological order, i.e. the answer to the question came at the later stage. Furthermore, some of the answers were more or less hidden requiring reading between the lines. Hence, further ways to analyze the data was required. The analysis continued by searching relationships and key themes among rearranged data. As an outcome, the rearranged data was arranged again in a different way enabling main themes to emerge. In practice, however, the process was not straightforward since analyzing went back and forth reading the transcriptions over and over again, and by trying different analyzing techniques. This step was particularly challenging since as said, the researcher did not possess substance knowledge related to air particles.

As Walliman (2011) suggests after the categorization and the identification of relationships and key themes, the knowledge was summarized into an interim summary, in this case as a PowerPoint presentation. This presentation was iterated several times together with the project's sponsor, and then together with the aerosol physics research department. All the sessions were interactive allowing questions to emerge, which in turn guided the research project further and highlighted the research gaps. At this point, it was obvious that the standards and the market potential in terms of monetary value were the research areas which should be investigated more thoroughly.

Therefore, five more interviews were conducted in Finland between May 26th and June 20th 2016 in co-operation with the project's sponsor (see Table 3). Since the project's sponsor possess substance knowledge, the interview question template was not followed as such, and the additional, modified questions were asked allowing more alternative views to emerge. When analyzing those complementary interviews, merely rough summaries were created, as Saunders et al. (2012) suggests as one of the options if the schedule for conducting the research project is tight.

Table 3. Complementary interviews conducted in Finland

Interviewee's title	Company profile
CEO	Instrumentation for measuring ultrafine
CEO	Manufacturer of air filtration systems
CEO	Supplier of air purifier systems
Product manager	Research institute
Researcher	Research institute

Secondary data

According to Walliman (2011, 78-79) the benefit of using secondary data is that is has been produced by a teams of experts very often with large budgets and extensive resources. Thus, experts access information easily compared to a single research student. In other words, by using the secondary data the research student can conduct the research efficiently compared to doing merely fieldwork. Furthermore, if the secondary data has been produced and collected over a long time period, the student has the possibility to trace developments over time having longitudinal perspective which would be otherwise impossible to reach over a short-time period. Additionally, the secondary data can be used to compare it with the primary data and by doing so, triangulate the findings, i.e. put the primary data into a larger context. The downside of this is that the secondary data might not fit easily with the research problems and the objectives, and even though the data

might be free of charge, it might be difficult to access. Finally, when collecting data from various sources, the terminology can vary depending on the source, and therefore assessing the credibility of the research might be difficult. In other words, understanding how representative the findings are, authenticating the sources, and selecting methods to interpret data might be challenging.

In this study, written communication via email, and numerous market research reports were scrutinized, of which four market research reports were analyzed meticulously when comparing and triangulating the findings. In addition, Haaga-Helia's bachelor level students' course reports generated information which was used when assessing the findings. Finally, conducting the competitor analysis and estimating the total market potential, required gathering secondary data via companies' web pages. During the secondary data gathering process, the main challenge was to assess the credibility of the sources since the estimates on markets' sizes and growth rates varied depending on the report. Finally, without the secondary data it would have been difficult to answer the main research question and formulate the future estimates of the market potential.

4.4   Assessment of the quality of the results

Saunders et al. (2012, 192) acknowledges the research design as a main driver for assessing quality of the results since the criteria for evaluating depends on researchers' position. Hence, a major split between positivist and interpretivist researchers exists. If the research project's quality is evaluated through positivist lenses, it evaluates reliability, and internal and external validity. In this case the research philosophy is based on pragmatism where multiple realities exist instead of one truth, and research design is constructed in a way that interpretative position is taken in the first phase of the study, so evaluating research validity is problematic. For example, Patton (2002), Silverman (2011), and Yin (2011) acknowledges the problem of evaluating qualitative research's quality merely from positivist position. Hence, the credibility of the research project could be evaluated from several stances, for example: what is the credibility of the researcher, are methods rigorous, and what is the philosophical belief in the value of qualitative inquiry. (Patton 2002, 542-552). This chapter highlights all the facts affecting the research project's quality either positively or negatively.

One of the main principles affecting the credibility of the researcher is whether the researcher reports any personal and professional information that may have affected data collection, analysis, and interpretation (Patton 2002, 566). The researcher did not possess any prior knowledge regarding the investigated phenomenon. Furthermore, there was no previous connection to people working within the project, so these relationships needed to

be established when starting the research project. The experience the researcher brought to this topic was from business side after working nine years in banking industry and studying master's degree level studies regarding international business management. Thus, when building the theoretical framework, the researcher's background facilitated the process.

The most cumbersome task was to analyze the interviews without any a prior substance knowledge related to particles and filtration industry. This posed a great challenge for the research project. Though, the researched strategy; action research, aided since it is based on co-creation. Without co-operation between the researcher and the project's sponsor it would have been difficult to carry out the research project with selected research design successfully. Additionally, even though the phenomenon was new and the researcher did not have any strong feelings or strong views, biases might have existed and obtained when the project proceeded as a result of investigating and cooperating with the research sponsor. In other words, since the project sponsor has been discovering Invention X's core technology, he could be considered bias. Therefore, triangulation, reflection, and critical attitude when conducting research project were used to recognize and avoid biases.

There are several ways to ensure the selected methods are rigorous. One way to do it, is to look for data that supports alternative explanations. If the researcher fails in this process, it is easier to trust in the original explanation. However, when investigating the researcher should not be satisfied with one truth, instead the search for so called 'best fit' should be pursued. Here assessing the weight of evidence and searching for patterns, and conclusions fitting the dominant data will increase the credibility. (Patton 2002, 553-554; Yin 2011, 19-21; Silverman 2011, 369-370.)

In the previous chapter it was explained how the qualitative data analysis was performed. The researcher tried to search for alternative explanations when conducting more interviews in Finland and when conducting the desktop research. By gathering the data from multiple sources triangulation was used to check the consistency by comparing already gathered findings against new data, and secondly by putting the primary data into a larger context. Hence, it could be said that the data used in this study is likely more credible and more valid than in a study conducted using only one single method.

When evaluating the research project's reliability through positivist position, participant error and bias, and research error and bias should be evaluated. The participant error means any factor altering the way a participant performs, e.g. if the respondent was tired,

or otherwise the timing of the interview was not good. Some of the interviews were conducted in a hurry since the respondents had more important things to deal with, and therefore the participant error most likely exists. Furthermore, the participant bias might have existed since some of the interviews were conducted in an open space where the respondents might have been overheard leading, e.g. to falsely positive answers.

The research error exists since the researcher did not possess substance knowledge related to fine particles leading to not understanding what the respondents were at times explaining. Furthermore, as Saunders et al. (2012, 562) suggest, the researcher should allocate enough space between the interviews in order to word process a transcript or a set of notes, and analyze those before the next interview. However, this was not possible within the given time frame, and therefore the researcher felt overloaded since the time period was short for conducting 11 interviews.

Looking back, more time should have been allocated to record the direct observations and for analyzing the main findings before proceeding to the next interview. Additionally, the study would be of better quality, if the researcher would have created a step-by-step overview regarding the research process already when analyzing the interviews, not afterwards. Thus, there is a room for improvement with respect to keeping track of various data analysis methods which were used during the research process. Finally, as discussed, research bias might have emerged as a result of cooperating together with the project's sponsor. (Saunders et al. 2012, 192).

When conducting the desktop research in order to find estimates regarding the market value, different views exists. Hence, it was difficult to estimate in which market report to trust. Therefore, the four different reports were used as main sources and three alternative quantitative scenarios of the future were constructed when creating the final estimates of the market potential. Thus, if the study were to be replicated by another researcher, the results might be different. Yin (2011, 19-21) proposes transparency as one of the main factors when evaluating study's quality. As this study is partially confidential and some parts of this study are hidden, other people cannot replicate this study as such. This affects this study's reliability and credibility.

5   Findings

Next, the main findings are summarized in a following manner. First, the key points from the interviews are presented. Thereafter, the relevant market related information is summarized highlighting the main insights, since those were used to estimate the market potential. Finally, this chapter ends in illustrating the market potential of Invention X.

5.1   Findings based on the interviews

Ultrafine particle measurement is in its beginning. At the moment, ultrafine market share is app. 10% of the total market since the most of the manufacturers supply instruments between 10 to 100 micron size range (interviewee 11). Even though there are already instruments in the market which measure ultrafine, general publics might see the company launching such an instrument still as a pioneer: "If you would launch this kind of device, you would be the pioneer. Pioneers make good money out from their products since they are the first ones to enter the market" (interviewee 5). At the moment, in many market areas, the air filter products are pushed to the end-customer by educating them. 20 years ago nobody knew about health risks associated with ultrafine particles, and nowadays companies sell air filter equipment by telling about health risks, i.e. pushing the products to the end-customer. (interviewee 2, 4 and 9 and 14.) According to interviewee 3, "big players do not want to develop a product unless they will sell hundreds of them, not four." So, in other words, there needs to be enough market demand.

There are numerous studies regarding health risks associated with ultrafine particles, and it has been already shown that many cancers are caused by ultrafine particles. Nano industry could be described as similar as asbestos in 1960's: "we get really enamoured with the nanotechnology and then realize it is dangerous technology later" (interviewee 3). At the moment, there is scientific interest to measure ultrafine particles and the government institutions are investing heavily on the instrument development and new technologies. According to interviewee 10, this is a good time to develop a new product to meet those needs, and furthermore this is the beginning to have more and more projects on ultrafine. In addition, the international suppliers of particle size instruments are increasingly interested in developing instrumentation. "If the ISO committee decides there will be a new standard, manufacturers will be forced to develop instrumentation" (Interviewee 11). To summarize, this is the beginning for ultrafine measurement, and at the moment, the customer demand exists only in few segments. However, health risks and the governments' financial support related to ultrafine particle research will lead to more instrumentation being developed which in turn, will pave the way towards the standards being developed for ultrafine particle size area.

Standards as the driving force

The development of the standards is driving the business forward but when the standards come into force is another, uncertain issue since development of the standards depends on the market segment where one is going to compete. On the one hand, some customer segments are measuring ultrafine particles already and on the other, it might take decades for the other industries to start measuring. Furthermore, it is not in every companies' interest to have the standards and therefore those companies act as blocks slowing down the process (interviewee 13). However, the high-efficiency filtration companies see the whole industry moving towards more regulated market, i.e. the standards will be developed for ultrafine particle size; though some move slower than others but the direction is the same (interviewee 8). Hence, the companies competing with products aimed for the customers who have a need for ultrafine solutions, might act as the key drivers. Thus, as they are sitting in the standard committees, they might pursue their own agenda. (interviewee 12, 14.) Therefore, when developing Invention X, being a part of a standardization body is recommended since otherwise the instrument might not be standardizable (interviewee 14).

Figure 18 illustrates the three main drivers having direct impact on development of the standards: (1) health problems, (2) research on ultrafine particles, and (3) the new technologies enabling development of the standards. Health problems occur since ultrafine particles go straight from the human lungs into the blood circulation. Hence, there is a growing attention towards researching ultrafine particles because they cause serious health effects (interviewee 8). However, even more research on ultrafine particles should be conducted in order to understand what the ultrafine particles are and what is their interaction with the human body (interviewee 3, 9,10). The new, more stable reliable technologies for ultrafine particle measurement should emerge enabling development of the standards (interviewee 1). Since without the enabling technology, it is impossible to create the standards. Furthermore, the development requires enough lobbying from the filtration industry. (interviewee 14.) After the standard are developed, the generally acknowledged market demand exists.
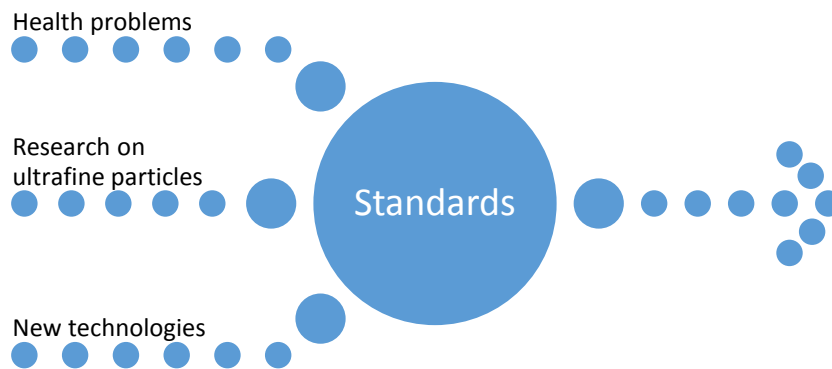
Figure 18. The forces driving the development of standards

Potential customer segments

The fact that fine particles are everywhere, makes the segmentation process as rather cumbersome. Figure 19 describes all the possible end-user segments which were discovered during this study. However, Figure 19 is incomplete as such since it is based on limited amount of interviews and research data. The bolded words inside the circle describe the segments where the demand is the most obvious according to the respondents. Medical and pharma segments emerged from the interviews since the interviewees' companies are selling products, i.e. air filters, to customers in those segments. For example, HEPA and ULPA filters are used in healthcare facilities and in other cleanrooms, and therefore those are potential customer segments. Furthermore, there might be new potential customer groups emerging for ultrafine particle measurement, e.g. internet of things (IOT) applications for industrial processes creating new business possibilities for Invention X (Interviewee 16).
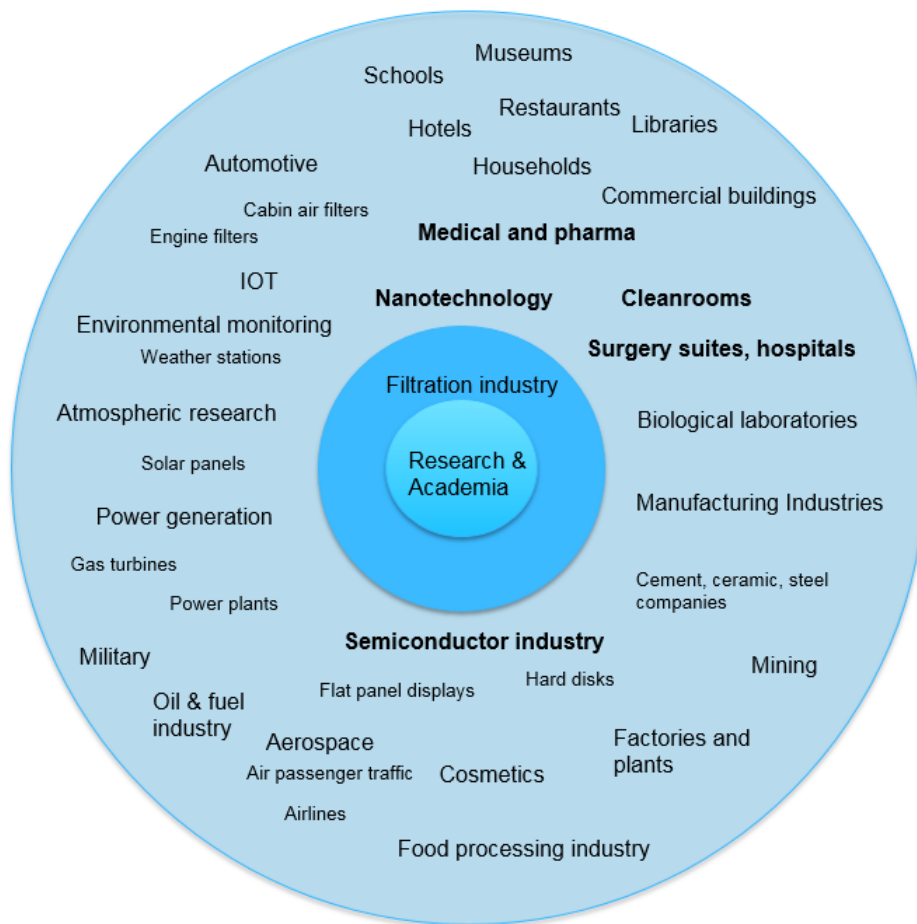
Figure 19. Possible end-user segments

Table 4, presents the customer segments which were the most commonly mentioned. As Table 4 illustrates, usually, the largest manufacturers enter the market through testing laboratories and universities. If these segments think the instrument has potential, it will most likely be a new product in a few years. Therefore, the large manufacturers use academia and universities to test their products. (interviewee 1, 3.) Clean rooms, especially in healthcare and pharmaceutical industries, might be subjects to strong competition (interviewee 3). Furthermore, there is demand in the semiconductor industry, however, it might take around five years before the semiconductor industry drives their technology processes down to ultrafine level (Interviewee 6).

Table 4. Potential customer segments (demand exists)

Customer Segment	Amount/Sub-segment	Demand
Research & Academia (Universities)	**App. 100**	**Demand exists *(Market entry)***
Testing laboratories (company related)	**Hundreds**	**Demand exists *(Market entry)***
Nanotechnology	Should be investigated further	There is demand
Clean rooms	Semiconductor industry, **hospitals, laboratories, surgery suites, medical industry and pharmaceutical industry**	There is demand, **competition**

Table 5 below describes the customer segments which were mentioned but the customer demand does not exist yet, or exists only partly since the products are more or less pushed to the end-customers. All the customer segments in Table 5 should be investigated further in order to understand the market potential of those segments.

Table 5. Potential customer segments (there might be demand)

Customer Segment	Sub-segment	Demand
Indoor	households, schools, hotels, restaurants, and commercial buildings	Technology push. Some customers are health conscious (heterogeneous segment)
Factories and plants	where a heavy machinery is produced, power companies, cement, ceramic, steel	Technology push, educate the customer. (Usually customers do not care since there is no regulation at the moment for ultrafine).
Oil and Fuel Industry		Technology push, educate the customer.
Airlines		Technology push, educate the customer.
Automotive Industry	Various customer segments, car brand owners, paint booth manufacturers	There is / will be interest
Food processing industry		There might be interest?
Cosmetics		There might be interest?

Investment appetite

3 out of 11 interviewees told that their companies are measuring ultrafine particles 1-100 nm already, and 6 out of 10 companies would like to measure ultrafine particles in the future. When asking about the investment appetite, 4 out of 11 companies would like to invest in ultrafine particle measurement. Nothing significant can be concluded from these answers without investigating underlying reasons further. When comparing answers towards companies, it was rather obvious that the investment appetite is totally dependent on the company's profile. For example, if the company has end-customers from the segments which are interested to filter ultrafine, e.g. cleanrooms, then the company is keen as well. In addition, as interviewee 2 and 3 said, the investment appetite correlates with the market requirement, in other words demand among companies' customers. If there are standards to measure less than 100 nanometers, then it becomes as a general customer requirement. Therefore, understanding the standardization is an important factor in this equation. Additionally, it was said that the investment depends on the potential of the

instrument and how much return on investment (ROI) the instrument can generate (interviewee 3, 11). When the tests are being performed in a short time frame, the more ROI instrument generates. Therefore, the speed is a major criterion, especially if the company needs to issue qualitative reports on production (interviewee 8). Interviewee 11 wanted to understand whether Invention X is just a modification rather than a complete new innovation. In other words, the investment appetite is dependent on how innovative Invention X is and how much value it generates to the end-users.

The importance of measuring ultrafine particles

When asking about the importance of measuring ultrafine particles the interviewees thought it was either perceived as very important or getting more important. Only interviewee 7 did not see any point in measuring ultrafine particles since there are no requirements coming from the standards. The most obvious reason why the interviewees saw importance in measuring ultrafine particles was the fact that it has a negative effect on people's health and environment. According to interviewee 9: "Of course, this is very important. Because you know in China, people are working on PM 2.5 which is much bigger than what you are doing which is 0.1 but we know the finer, the dangerous for the human health. That is why it would be beneficial if air quality would be monitored down to this level." Interviewee 10 continued by explaining: "It is very important, as you know around freeway, there are a lot of ultrafine particles and people related that causing asthma and other health effect problems." At the moment, considerable amount of research regarding ultrafine particles is conducted, and as interviewee 3 explained, many cancers are caused by ultrafine. People spent around 90% of their time indoors, and therefore it is important to measure and filter ultrafine particles (interviewee 5). Interviewee 2 explained: "PM 2.5 is too high and no good for human being lungs. Therefore, number one is for the environmental issue, number two are the cost savings, number three of course health." The researcher would have liked to discover how ultrafine measurement generates cost savings but, however, it remained unclear. Thus, one possible interpretation is that the interviewee 2 was referring to the filtration process instead of the measurement process.

Currently the standards for HEPA and ULPA filtration involves MPPS measurement. According to interviewee 8 new technologies that are being developed go down to 70 to 80 nanometers. In the future, it is increasingly important to have capabilities to measure below 100 nanometers which is ultrafine particle size (Interviewee 8). Furthermore, there is demand also in semiconductor industries (interviewee 6). To conclude, it depends on company's business area weather measuring ultrafine is seen as important or not. For example, high efficiency filtration is a business area where the testing standards are already requiring measuring ultrafine particle size.

Product related expectations and needs

When summarizing the answers related to product related expectations and needs, the following questions: 'What are your expectations for the measuring device?', 'What do you think about the measuring devices currently available on the market?', 'What kind of features are missing from the currently available devices?', and 'What kind of features should the measurement device have in the future?' were merged and analyzed. Following Table 6 represents the most commonly mentioned features.

Table 6. Product related expectations and needs

Requirements	Detailed description
Reliability & high accuracy	There is uncertainty about the quality of the results (German and American manufacturers have a very good reputation, there is no trust in the Chinese products)
Price	Different views on pricing: On the one hand, the price the customer is willing to pay depends on the revenue which the device can generate (ROI). On the other, products with a good quality are perceived as expensive.
Speed	The direct cost is time, the faster the device the better.
Other general responses	– Easy to calibrate and maintain – User-friendly, easy to operate – Real-time data – Automated test report – Smaller size, portable, easily moved from one testing to another, on-site measurements
Single responses	– Connection with data (e.g. mobile application) – Measures multiple sizes at ones – Should be designed for different ranges, and it should cover all the ranges – The support from the supplier for spare parts and for technical data – Devices which measure bio aerosol (how contaminant in terms of virus or bacteria) are missing from the market – Different kind of financing solutions, e.g. leasing

Table 6 above summarizes all the product related expectations and the needs which were mentioned during the interviews. The most common answers were related to reliability and accuracy. The interviewee 1 described the instrument they have as 'not stable', and therefore the data cannot be trusted. "It is very difficult to see those very fine particles in a

reliable way, so reliability and accuracy is important" (interviewee 4). Interviewee 5 continued: "There are plenty of types and a lot of ranges but reliable ones, I would say 50 % maybe." Interviewee 11 referred to reliability and accuracy as traceability: "'Meaning the results, you produce, are the right results. Because if there are too many approximations to get the results, then measurements become uncertain." Interviewee 2 explained they need to use third party testing since the current, Chinese manufacturers cannot be trusted.

The direct cost for the company is time, so speed is a big deal. Running the test reports e.g. in two hours instead of two days, and measuring multiple sizes at ones is a big expectation for the measurement device since CPC (condensation nuclear counter) can count only one size at a time (interviewee 3). Additionally, the instrument should be economically viable, fast in response time, easy to calibrate and operate (interviewee 8). On the one hand, the interviewees expected cheap cost, and on the other, good quality. "If you are very good, but you are very expensive, I am sorry, no one will be interested. And then your knowledge, the know-how, the benefit, will not be extend to the public" (interviewee 9). If Invention X ends up being expensive piece of equipment different kind of innovative financing solutions should be considered since not all companies have enough operating cash flow, i.e. funds available to purchase the machine (interviewee 3). Finally, the invention should be easy to operate since the instruments in the market are too complicated (interviewee 8).

Benefits of measuring ultrafine particles

The benefits of measuring ultrafine particles could be summarized into following key words:

– RELIABILITY
– TRUST
– SAFETY and PROTECTION
– UNDERSTANDING ultrafine particles
– NEW BUSINESS POSIBILITIES
– MORE SALES
– CREATE new products and IMPROVE existing products
– PIONEER

Filter media producers want to have more reliable products which help to understand the filter performance (interviewee 1). The benefit of measuring ultrafine particles is that the end-customer can trust the filter as it has been tested and certified. Hence, this increases the sales since the end-customer is more confident to make the purchase decision, and

therefore will purchase the product more likely (interviewee 2). According to interviewee 3, measuring ultrafine particles would create new business possibilities since they could participate to research projects in which they were not able to participate before. Furthermore, one could create new better working products and improve existing products by measuring ultrafine particles (interviewee 4). From instrument manufacturer perspective, the market would see the company launching the instrumentation for measuring ultrafine particles still as a pioneer since there are not that many instruments for that purpose (interviewee 5). Looking from health perspective, the main benefit is to understand what ultrafine particles are and then remove them (interviewee 11). Finally, safety and protection would become as a result from the standards developed for ultrafine particles. They are needed to protect vulnerable groups, e.g. old, sick, kids and infants. (interviewee 9.)

Challenges and risks

The most of the interviewees acknowledged accuracy, stability and calibration as the main challenges. "The finer particles, the more difficult to measure. This means, there is less accuracy from measurement perspective" (interviewee 4). Looking from the filter media manufacturer point of view, a considerable amount of cost is added before the end-product is tested. Therefore, the instrument needs to be stable since the product will be tested many times during the manufacturing process (interviewee 8). Furthermore, the ambient conditions affect the test results since creating a controlling environment to measure ultrafine particles is challenging (interviewee 3). Additionally, the equipment must be safe to operate, i.e. no leeks of nanoparticles coming out (interviewee 8). Even though there are instruments to measure ultrafine particles, they have not reached the public awareness. The main challenge is that the market lacks good measurement instruments for ultrafine particle size (interviewee 2). Interviewee 5 described the launching of new innovations as challenging, since the standards for measuring ultrafine exists in few particular market segments, e.g. in high efficiency filtration, and therefore there might not be enough demand for the technology.

Competitor analysis

It was rather difficult to get the competitor related information since the interviewees did not want to mention anything negative about the other market players. Therefore, after the interviews, a competitor analysis was created by searching for more information from the internet and by discussing internally. Based on the internal iterations and the interviews, there seems to be only a limited amount of companies supplying to fine particle industry. For assessing the current state of play, a review of 18 companies was conducted where the emphasis was on investigating the companies' profiles and financials, e.g. a country of

origin, the company size in terms of revenue and the number of employees, the market areas, the market shares, etc. After scrutinizing, a following overview emerged.

First of all, the end-users do not trust in Chinese manufacturers, however, European, especially German and US manufacturers have a good reputation. According to interviewee 2, products from China cannot be trusted since nobody can tell exactly what the companies involved at the market place are doing and how the Chinese instruments calculate ultrafine particles. Second, all the companies act more or less globally. There are large conglomerates such as Teledyne; large international manufacturers, e.g. TSI and MET one; good-quality German producers, e.g. TOPAS and PALAS (revenue less than MEUR 10); and three small Finnish players. Third, it seems that all the companies are selling their products to multiple customer segments, as even the smallest companies have several end-user segments. Fourth, the companies have a wide range of product versions. Fifth, the companies are selling additional services, e.g. calibration and testing. Sixth, at the moment, all the companies seem to have a rather similar approach towards the end-customers and as the interviewee 11 put it: "I think there are quite a few companies trying to get involved in the market place. At the moment it is hard to distinguish between them." To conclude, it might be hard to compete against the large international manufacturers since their budget for product development is substantial compared to the smaller players. Finally, a company needs to have the capabilities to compete internationally since the local market demand might be insufficient.

5.2   Short market overview based on the market reports

According to Top Technologies in Clean and Green Environment (2015, 117) the market potential can be seen in countries where the highest growth opportunities will emerge in the future. Looking from this perspective the Middle East and Africa seem both attractive market areas since technology adoption levels are still low as below Figure 20 illustrates. China and India are expected to have even worsening air pollution levels, and therefore those both market areas are expected to increase. The global air filter market is at the moment dominated by APAC countries accounting 52%. They will continue to grow in the future as well since countries such as India and Indonesia together with huge Chinese market are experiencing rapid economic growth. Furthermore, Americas and EMEA will also see high demand for air filters. The market shares for global air filter market are as follows in 2015: 52% APAC, 26% EMEA, and 22% Americas. In the near future, in 2020 the market shares are estimated to be: 52% APAC, 25% EMEA, and 23% Americas. (Technavio 2015, 29.)
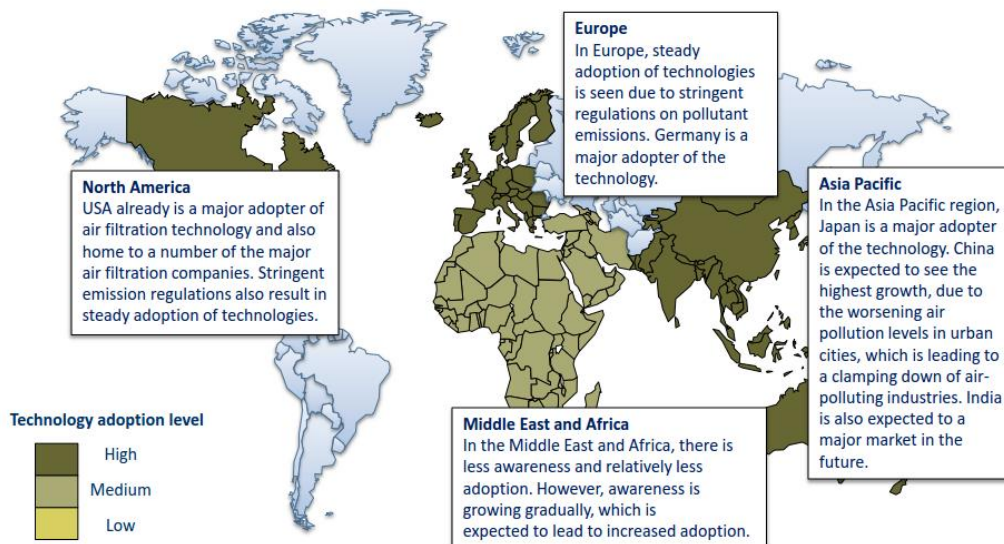
Figure 20. Region-wise adoption (Top technologies in Clean and Green Environment 2015, 117).

The global HEPA filter market is expected to grow at significant rate from $ 2502.74 in 2015 to $4984,14 Million by the end of 2021 with CAGR 12,5% (Email 28 Jul, 2016). In China, high-efficiency filters are estimated to register CAGR of 10.2% between years 2012 and 2022 reaching $692,8 Million by 2020. The drivers for growth are the growing manufacturing sector, especially electronics and pharmaceutical clean rooms. (Chinese HVAC Air Filters Market 2016, 63.) In North America, HEPA air filters market segment is expected to grow steadily reaching $ 159 Million by 2020, and the compound annual growth rate for 2014-2022 is estimated as 5.8% (The North American HVAC Air Filters Market, 2015). The regional splits for the HEPA filter market presented in Table 7 below.

Table 7. Global HEPA filter market: regional splits (email 28 Jul 2016).

Region	2015	2021 E
APAC	38 %	39 %
Europe	23 %	24 %
The Middle East & Africa	6 %	7 %
North America	27 %	26 %
South America	5 %	5 %

As Table 7 represents, APAC is the dominant market area followed by North America and Europe. According to interviewee 13, Africa, South America, and the Middle East are expected to grow within the next ten years. In fact, Table 7 and Figure 20 supports this argument as the market shares and the technology adoption levels in those countries are still low. The global HEPA filter market shares are as Figure 21 illustrates:
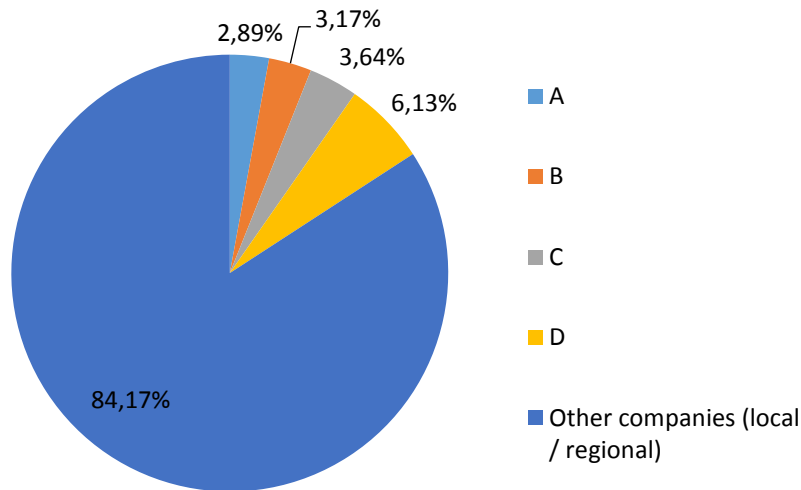

Figure 21. Global HEPA Filter Market Share by Companies in 2015 (Email 28 Jul 2016).

There are four larger companies in the HEPA filter market obtaining almost 16 % market share. Hence, the global HEPA filter market is dominated by the regional and the local companies.

In air purifier industry, the foreign brands dominated the Chinese market with a total of more than 200 manufacturers and with more than 80 % market share. The air purification market has been booming in the recent years, and the market peaked in 2013 with a tremendous growth rate of 80%. Furthermore, the Chinese market is expected to grow a CAGR of 28.9% between 2014 and 2022. The driving factors for this growth are high levels of air pollution and the increasing end-user health awareness. Hence, the potential for air purification instruments exists in China since the market penetration is 1% of Chinese households compared to 17% in the US and 28% in Japan. (Chinese HVAC Air Filters Market 2016, 26.) The usage of indoor air purifier in countries like China and India is indispensable since their indoor air quality is very low due to the rapid industrial development and increasing vehicular pollution (Technologies Enabling Indoor Air Purification 2016, 31). When estimating the market potential for air purification technologies, it should be taken into account that the HEPA technology is the most commonly used technology for

the air purifiers, and it is also anticipated to be the leading technology in the future. (Chinese HVAC Air Filters Market 2016, 25.) There are 50+ companies competing in air purification industry in China and the value of the market is expected to be $ 7,096.5 Million by the end of 2022.

5.3   Market potential estimations

As described in chapter 2, as a part of literature overview, there are various ways how to estimate the market potential depending on the information available. The main challenges for defining the market potential are as follows: there is not enough information on the markets, and the investigated market reports contained different kind of estimations regarding the market size, the future prospects, and the companies involved at the market place. Furthermore, the air filtration companies act globally, regionally and locally creating the estimation increasingly harder. In addition, the air filtration companies might use external third party labs or have their own test facilities affecting the number of test laboratories, i.e. decreasing the market potential. In order to successfully estimate the potential, the researcher framed this study carefully to address research & academia and the filtration industry. Thus, the market potential is defined for the universities, the high efficiency filtration companies, the indoor air purifier companies, and the future potential emerging from HVAC industry.

This chapter illustrates the market potential in terms of numbers. The figures are based on calculating the total market potential as Kotler et al. (2016) proposes by multiplying the potential number of buyers by the average quantity each purchases and then by the price. The future figures were estimated by creating three alternative scenarios; pessimistic, neutral, and optimistic, excluding the high efficiency companies where the three alternative scenarios are based on more specific data. There is uncertainty with respect to the future estimations since those are dependent on the development of standards. Therefore, the future estimations are presented with grey colour.

Interviewee 12, presented the market potential as described in Figure 22 below. The axis Y presents the price for the measurement instrument and the axis X illustrates the quantity of products sold. The costly high-precision instruments are sold mainly to research and academia, and companies' research facilities. The instrument could be developed for more affordable price but then the markets for such a product would be different, e.g. it could be used for monitoring indoor and outdoor air quality, or as a PEMS (portable emission measurement system). When estimating the market potential two different price points were used; for universities, a high-tech product version estimated of EUR 100,000,

and for companies' research laboratories a product version presumably costing EUR 50,000.
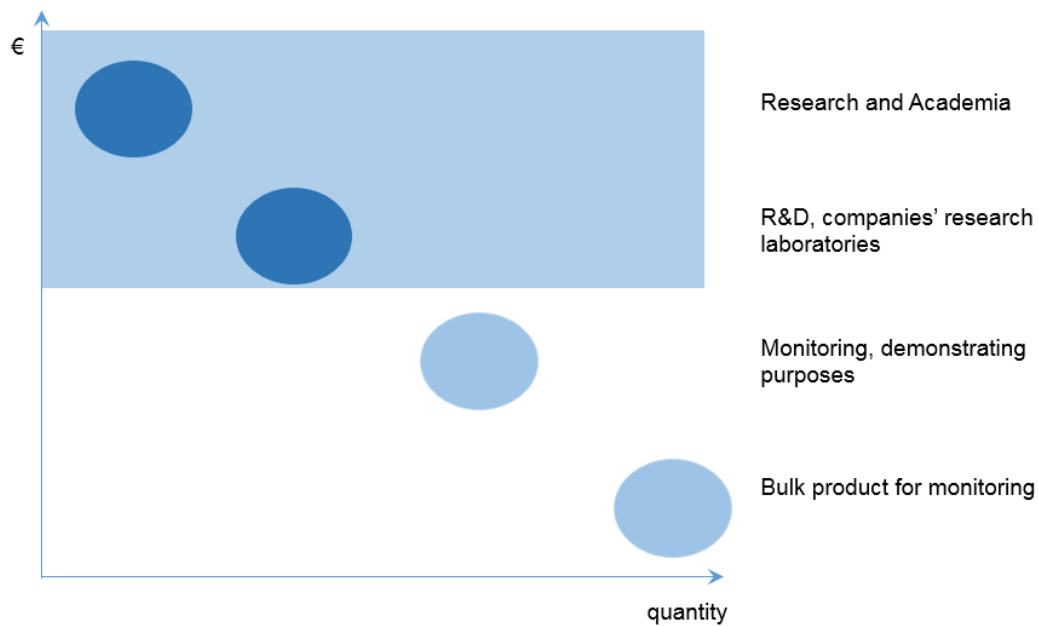

Figure 22. The definition of the market potential (interviewee 12).

For estimating the number of testing facilities globally, there should be understanding on how many independent, 3rd party laboratories and company related laboratories there are. The question number 7: "Do you know how many test facilities there are globally?" was created in order to calculate what is the demand for Invention X, i.e. how many places there are where the instrument could be sold. According to the interviewees there are hundreds of research laboratories on global level of which less than a dozen 3rd party laboratories. The single responses can be found from the attachment 6. This information was afterwards enriched with the desktop research when creating the overview related to number of testing laboratories on global level. In total 27 companies were investigated of which the researcher was able to find 12 companies whom had information regarding the test laboratories on their web pages. This information was used when the market potential was estimated. The more detailed information related to the number of test facilities on global level can be found from the attachment 5.

The market potential among the universities was calculated based on the internal iteration and the figures received from the Tampere University of Technology (see Table 8). However, the numbers were not exact, and therefore three alternative scenarios were created. According to the neutral view the market potential for Invention X among universities is around MEUR 10.

Table 8. The market potential among universities

Measurement name	Pessimistic	Neutral	Optimistic
Number of universities	85	100	150
Number of test laboratories	85	100	150
Market potential	MEUR 9	MEUR 10	MEUR 15
Market potential 2025	MEUR 9	MEUR 12	MEUR 20
CAGR	1%	2%	3%

Table 9 presents the market potential among the high efficiency companies. It was calculated by creating three alternative scenarios. The scenario number one was estimated based on the market reports; the total HVAC market size was calculated, and the share of estimated HEPA market (23%) was used when estimating the market potential. The scenario number two is based on the guestimate received from one of the largest companies competing in the air filtration industry. Finally, the information with respect to the market reports was a bit ambiguous since it was not clear whether the number of the filter media companies was included. Therefore, the scenario number three was created adding the filter media companies into the equation.

Measurement name	Pessimistic	Neutral	Optimistic

Table 9. The market potential among the high efficiency companies

Measurement name	Scenario 1 (23% of total HVAC is HEPA)	Scenario 2 (Based the guestimate received from one of the largest companies)	Scenario 3 (Filter Media companies added)
Number of companies (HEPA)	80	75 - 100	130 - 180
Number of test facilities (HEPA)	115	80 - 130	180 - 250
Market potential	MEUR 6	MEUR 4 - 7	MEUR 9 - 13
Market potential 2025	MEUR 7	MEUR 5 - 8	MEUR 10 - 14
CAGR	2%	2%	2%

Regarding the air purifier companies, the lack of information related to the other market areas than China led to a situation that estimation was done very roughly the margin of error being high (see Table 10). The number of companies in China 50+ (Chinese HVAC Air Filters Market, 20) and the number foreign brands' manufacturers 200 (Chinese HVAC Air Filters Market, 23) were used when estimating the potential. Otherwise, the figures are rough guestimates.

Table 10. The market potential among air purifier companies

Measurement name	Pessimistic	Neutral	Optimistic
Number of companies	150	200	250
Number of manufacturers	250	300	370
Market potential	MEUR 13	MEUR 15	MEUR 18
Market potential 2025	MEUR 14	MEUR 20	MEUR 36
CAGR% 7.3%* until 2020, 28.9% in China (between 2014-2022)	1%	3%	7.3%

Depending on the development of the standards, future potential among HVAC industry might emerge. The figures presented in Table 11 are forecasts based on the market reports. As these figures try to predict the future, a lot of uncertainties exists, and therefore the figures below should not be trusted solely.

Table 11. The future market potential from HVAC industry (2025)

Measurement name	Pessimistic	Neutral	Optimistic
Number of companies (HVAC)	100	150	200
Number of test facilities (HVAC)	200	320	380
Market potential 2025	MEUR 11	MEUR 16	MEUR 28
CAGR 5.6% (technavio 2016, 6).	1%	2%	4%

Table 12 presents the total market potential. The estimates regarding the current market potential were calculated by summing up the figures from tables 8, 9, and 10. The future estimates, i.e. Market potential 2025, was calculated by adding the figures from tables 8, 9, 10 and 11 together. The estimated total market potential according to the neutral view is MEUR 34.

Table 12. The total market potential

Market potential	Pessimistic	Neutral	Optimistic
Market potential	MEUR 26	MEUR 34	MEUR 46
Market potential 2025	MEUR 41	MEUR 59	MEUR 98

5.4 Future development

The people are more and more concerned about their health. Thus, air quality is generally perceived as a major factor impacting people's lives. "In the next ten years, air quality will be the big issue, no matter where you are; inside of factory, home, airplane, or car, everybody will really care about ultrafine particles." (interviewee 2). At the moment, the ultrafine market is at the beginning, and the first-movers have started to commercially introduce similar technologies. The market regarding ultrafine particles could be scrutinized through the diffusion model, i.e. those who are early adopting the new technology, and those who will obtain it when it is necessary (interviewee 4). If Invention X is evaluated by using the diffusion model and enriched with the data gathered from the interviews, it would mean the standards for ultrafine particle measurement would most likely be created before the next stage, widespread adoption, takes place. However, the forecasting methods should be used to estimate the rate of the adoption. The overall estimation based on interviews is that the standards for ultrafine particle measurement will be developed during the next 10 years.

The potentially becoming regulation for ultrafine particles will be a turning point since the market will gradually move from technology push to market pull. This means increasing demand since the products based on the old standards become obsolete creating the market potential. "Some of the players who fail to deliver the higher standards, they will be out from the market, because they are not providing the right solutions to protect the general publics." (interviewee 9). At the moment, there is already demand for ultrafine particle measurement as described in Table 4 above, and there will be demand in the market at increasing rate as the short market review suggests.

Looking geographically, the largest customer base for Invention X is at the moment in APAC area, and it will continue to grow in the future as well creating viable business opportunities for Invention X. In addition, business possibilities are emerging from the countries such as the Middle East and Africa since the technology adoption levels are still low. Furthermore, India will be an attractive market area because of the worsening air pollution levels.

Finally, companies will create new creative business models around the ultrafine particle industry attracting new customers, since the governments are supporting the development of new technologies. As a result, Blue Oceans might be discovered around ultrafine parti-

cle industry. For example, Internet of Things (IOT) is one of the emerging new technologies which represents new business opportunities for measuring ultrafine particles (Interviewee 16).

6 Conclusions and recommendations for further research

This chapter evaluates the research objectives and the research questions in the light of the work carried out, highlights the main findings, and finally ends proposing further research.

This study had five interconnected objectives:
1. Potential customers will be identified and segmented
2. Product related features which are of value to the customers will be discovered
3. Competitor analysis will be done
4. Knowledge of the market environment (incl. development of the standards) will be acquired
5. Market potential will be estimated

The following conclusions were reached as a result of conducting this study. First, the most obvious customer segments were identified. Second, the product related features which are of value to the selected customer segments were discovered. Third, a competitor analysis was conducted. Fourth, knowledge regarding the development of standards related to the air filtration industry was acquired, otherwise only a limited view regarding forces affecting the market environment exists. Finally, the market potential was estimated for the selected segments.

The researcher presented the main findings on August 15th 2016, and the first phase of the project (WP1) discovering the market potential came to a partial conclusion at that meeting. Invention X has a great commercial potential since the core technology can be applied multiple ways and there are numerous end-user segments. However, the estimated market potential for research & academia and the filtration industry was insufficient from a funding perspective. Therefore, it was decided to continue investigating the market potential for clean rooms. Furthermore, the steering committee suggested that for filtering purposes, Invention X could be sold as a part of a testing rig as the customer usually purchases a full package, incl. test aerosol, test system, maintenance, calibration, and other services. Nevertheless, this was not taken into consideration when the market potential was calculated, and therefore the calculations here could usefully be reviewed once more and adjusted as needed.

The conducted study is beneficial for TUTLI project since it facilitates the process of building a business plan for Invention X and is of use when formulating an overall strategy. Even though the market potential calculations are rough estimates, they have already influenced the business planning as the prototype will be built in a way that is also suitable for monitoring purposes.

This study was conducted with mixed methods. The qualitative part of this study, i.e. insights gained from interviews, are not generalizable as they are subjective views on the phenomenon. The same applies to the quantitative part of this study, as there are different estimates of the market potential. Thus, if the study were to be replicated by another researcher, the results might be different. Furthermore, this study is partially confidential, and therefore other people cannot replicate the study as such, since some parts affecting the reliability and the credibility of this study have to be kept secret. However, the researcher used to triangulate the findings by checking them for consistency and by comparing already-gathered findings against the new data. Therefore, this study is arguably more credible and more valid than a study conducted using one single method.

Even though the steering committee decided to investigate one of the most obvious customer segment's; the market potential of clean rooms', it is however, also recommended to get more information on other potential customer segments at this point. By further investigating the customer segments, the project will have data against which the future findings can be compared and evaluated. For example, one option is to investigate business opportunities emerging from nanotechnology since customers in that segment are already demanding solutions for measuring ultrafine particles as shown in Table 4 above. Hence, there might already be competition in that segment so finding an alternative view is needed, as Kim et al.'s (2015) Blue Ocean strategy suggests. A further viable option would be to investigate the possibilities emerging from IOT (Internet of Things).

Conducting the desktop research in order to calculate the market potential for the most appealing customer segments is highly recommended. The desktop research will support decision-making when formulating an overall strategy for Invention X. For example, some customer segments might seem appealing at first, but after investigating the segment in terms of numbers, the outcome might be that the market potential is limited - as it turned out to be in this particular study regarding research & academia and the air filtration industry. However, even though the market potential was insufficient from a funding perspective in these segments, it might be possible to compete profitably with a competitive strategy.

At the beginning of this study, the project team shared its knowledge by using a SWOT framework as a tool, which resulted in the identification of the strengths, weaknesses, opportunities, and threats of Invention X. However, as described in the literature review, the downside of SWOT is that only a list of bullet points might emerge depending on who is participating and what are the issues in mind, i.e. it might be biased. This is in fact what happened in this project and therefore it is recommended to continue working with an inside-out approach combined with an environmental analysis. An inside-out approach, i.e.

internal assessment is needed for a better understanding of Invention X's capabilities since as Kim et al. (2015) point out, a company should try to seize the greatest customer potential reachable within the capabilities and competences the company possesses. Assessing Invention X's related critical capabilities might lead to competitive sustainable advantages. Thus, the evaluation of the invention's potential should continue, e.g. by using a VRIO framework as a tool.

It will take around one year before Invention X can be commercialized, and therefore forecasting tools such as scenario building could be used to assess where the market potential might exist in the future. This assessment could be done as a part of overall strategy building. Furthermore, Blue Ocean strategy and Porter's Five Forces framework will help to understand industry logic and competitive forces. Additionally, the project should continue investigating customers' needs when discussing potential customer segments since only a limited understanding of the customer jobs, pains, and gains were obtained since the research design and philosophy only supported the investigation of a limited number of respondents. In addition, the interviewees have diversified backgrounds (e.g. performance company, filter media company, filter manufacturer, researcher), and therefore it is not always possible to make generalizations.

If Invention X is sold to research & academia and the filtration industry, Kotler et al.'s (2016) approaches to building customer value proposition could be used. As the prototype is still in its development phase, it might be possible to develop an invention which will take customers' needs into consideration by investigating potential customers' further. This way, the project will ensure there is a fit between the solution and the customers' needs. The next step could be focus-group value assessments where customers are asked what is the value of the product offering, importance rating by asking customers' the importance of different attributes, or benchmarking the offering against competitor's offerings. Conversely, if the TUTLI project decides to develop the product for segments other than research & academia and the filtration industry, the customers' needs should be investigated from point zero, since the customers' demands usually differ segment to segment. Thus, the findings presented in this study apply merely to the investigated segments.

Competitor analysis was conducted over a short time-frame. Nevertheless, the produced competitor analysis is an applicable framework for understanding and analyzing competitors further. In contrast, if the TUTLI project decides to target other segments than research & academia and the filtration industry, the competitive landscape should be re-as-

sessed by finding the main competitors and by creating strategic profiles of them as Porter's (2014) framework suggests. Furthermore, Kim et al.'s (2015) Strategy Canvas could be used together with Four Actions framework in order to create a new value curve for Invention X. Finally, concepts such as strategic groups will help to understand the competitive landscape better.

In this study, obtaining knowledge regarding market environment concentrated mainly on investigating development of the standards. The standards were identified as a driving force having clear implications for Invention X since the market demand is based at least partly on the standards. Therefore, it is important to monitor development of the standards in the future as well, since by doing so, the project will ensure Invention X is applicable when it will be launched.

As the project proceeds, and the most appealing target segments are clarified, an environmental analysis should be carried out simultaneously as a part of overall strategy building. This could be done by investigating political, economic, social, technological, legal, and environmental factors as PESTLE framework suggests well before entry into the market. In addition, the process will be facilitated by adding Kim et al.'s (2015) Blue Ocean strategy and Porter's (2004) Five Forces frameworks into equation. By using Porter's (2004) framework, the project will gain further understanding of Invention X's strengths and weaknesses, and its positioning in the industry by highlighting the areas where the greatest opportunities and threats might exist. The Blue Ocean strategy will provide an alternative view proposing industry structures can be shaped, and by doing so Invention X might be able to create a new market space where little or no competition exists. Thus, by applying both frameworks, at least two-fold view regarding environment analysis is assured.

7   Implementation of the recommendations

The researcher will present the main findings and suggest for future research on October 25th 2016 for the aerosol physics research department. In this meeting, the most significant tools and frameworks will be introduced. In addition, the TUTLI project will have access to all the materials which were created during the research project excl. confidential information, e.g. the interviews. Hence, the project can continue working seamlessly and utilize all the tools and frameworks provided in this study when creating a business plan and an overall strategy for Invention X. The implementation plan below, Figure 23, suggests how to move forward.

It is recommended to get a better understanding of critical success factors, and therefore the work which was started by using a SWOT, should continue by using a VRIO framework as a tool allowing more ideas to emerge. The benefit from this is that the project will gain a better understanding of the competitive advantages.

As the steering committee suggested, the next step is to evaluate the market potential of clean rooms'. This analysis will be done investigating the monetary value of the market potential, and by scrutinizing the different levels of the business environment. In other words, the customers' needs, the environment incl. the standards and the competitive landscape will be investigated. When investigating the customers, the project should stay open-minded as Blue Ocean strategy suggests. Hence, knowledge regarding the most attractive customer segments should be simultaneously acquired when investigating clean rooms.

As the competitive landscape differ segment to segment, a competitor analysis should be drafted for each customer segment individually. However, the best practices and the suggested frameworks should be utilized. As a result, more profound insights of the customers' needs and the competitive landscape will be discovered, which in turn facilitates an overall strategy formulation or even allows a new strategy to emerge.

At the same time, when an understanding of Invention X's capabilities, the customers and the competitors is gradually formed, assessing the timing and the significance of environmental changes and trends are needed. For this purpose, Porter's Five Forces framework and Kim et al.'s Strategy Canvas could be used as tools to understand the external environment better. Additionally, as Kim et al. (2015) suggests, Four Actions framework could be combined with Strategy Canvas tool. As it takes around one year before Invention X

can be commercialized, and the market demand is partly depending on the development of the standards, scenario building could be applied to estimate the future potential.

When the TUTLI project creates a business plan in phase four, Osterwalder et al.'s (2010) Business Model Canvas could be used. Thus, findings from this study and from becoming investigations can be implemented in the building blocks called 'Value Proposition', and 'Customer Segments'. Consequently, this study benefits the TUTLI project's phase four, when a preliminary business plan and an overall strategy will be formulated. After this study is finalized, a detailed time schedule for implementing the activities described in be-low Figure 23, will be drafted in co-operation with the project's sponsor.
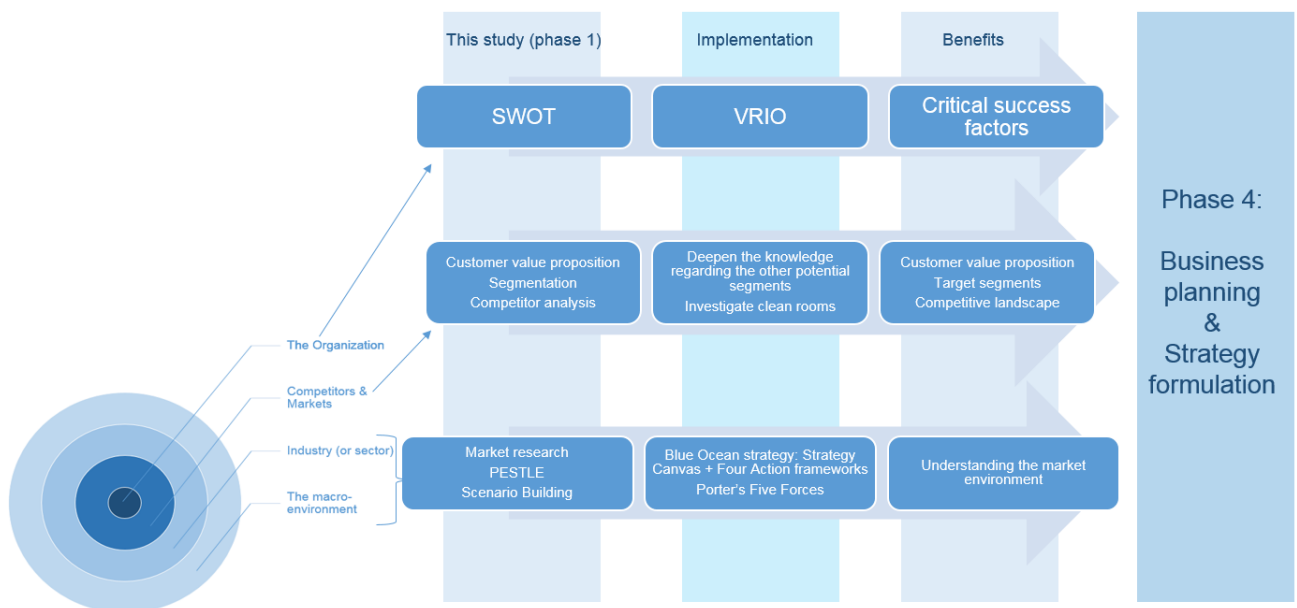

Figure 23. The implementation plan

8 Reflections on learning

This study has been the most substantial academic work so far for the researcher. It took around seven months to complete. When the project kicked off, the researcher did not have any substance knowledge related to the filtration industry or fine particles. Furthermore, the past experiences from conducting the bachelor level studies helped only little since the study was conducted by using quantitative method, and hence carrying out a qualitative research project was something new. However, as the researcher had worked as a project manager in a banking industry, the methodological skills from this experience facilitated the research process since the tasks such as planning, scheduling, framing, and adjusting the plan as the study progressed felt relatively easy. However, despite this experience, the planned time schedule for conducting this study was adjusted once giving the researcher more time, around three weeks, to conduct the desktop research successfully.

The most difficult and at the same time, the most demanding task was to get acquainted with the phenomenon, i.e. air particles and the air filtration industry. A considerable amount of background data needed to be acquired when analyzing the interviews since, for example, without understanding the industry-related terminology, it was difficult to analyze and draft conclusions from the transcribed interviews. During this step, however, the project sponsor's assistance helped. Furthermore, the selected research method, action research, facilitated the process since it enabled relying on the sponsor whenever support was needed.

When formulating a plan for this study, a careful framing needed to be done since as described in the earlier chapters, fine particles are everywhere and thus countless end-user segments exists. Hence, the research project was framed to address research & academia and the filtration industry. Retrospectively, this decision was sensible since the research plan was ambiguous enough for the researcher as such. The drafted objectives and questions remained unchanged throughout the study, however, the emphasis shifted from exploring customers' needs to answering the main research question regarding the market potential as the study progressed.

After analyzing the interviews conducted at the World Filtration Congress, it was obvious that more research data should be gathered in order to evaluate the monetary value of the market potential. The task to collect the secondary data took longer than expected since relevant knowledge was rather hard to find. Therefore, more time was allocated for carrying out the desktop research successfully. The investigation paid off and the researcher

felt confident enough to pose the monetary estimates even though, as discussed in chapter 4, this study could not be replicated as such, which in turn affects the reliability of this study.

During this study, the researcher obtained considerable amount of substance knowledge related to fine particles and the air filtration industry. The research project would have been more successful if the researcher had more time to read relevant literature at the beginning of this study. In practice, however, this was not possible since the World Filtration Congress was held on fixed dates in mid-April, after 1,5 months after this study kicked-off. Therefore, the beginning of this study, i.e. from March 1st until mid-April, was reserved for creating the research plan, preparing for the interviews and acquiring substance knowledge related to fine particles. Finally, even though the literature review was finalized lastly, the researcher feels it is robust enough since it facilitates the project's phase 4 when a preliminary business plan and an overall strategy will be formulated.

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Attachments

Attachment 1. Invention X's SWOT

Strengths

Vast particle size area
Measures ultrafine particles (size under 50 nm)
Small particle content
Good cost quality ratio
Cost efficiency
Many application possibilities
Small size
Easy to use
Unique technique
Strong scientific foundation

Weaknesses

There is no patent
Requires maintenance
Physical size
Too costly for consumers
Concept missing
Design
Boundaries are missing
Measures particles only (not chemistry)
There are no scientific publications
No regulation based demand
Financing the business?

Opportunities

Regulation shifts towards smaller particle
size
Significant investor
Huge possibilities for productize the technology
Air pollution problems
Partnership possibilities
Many possible customer segments
The instrument measures better than other
instruments
The need to know particle size distribution
increases
Global markets

Threats

There is no financing
Performance is not sufficient
Pricing fails
Branding fails
Design fails
Marketing fails
The selection of customer segments fails
There is not enough demand
Protection fails
Competitors
Regulation does not change
Resources

Attachment 2. The interview questions

Core questions

1. What is your job profile?
2. What kind of previous experience do you have in terms of measuring ultrafine particles?
3. In your view, how important is it to measure ultrafine particles (less than 100 nm)?
4. What is the particle size that is relevant to your business? How about the customers of your company?
5. In your view, how will the market change with respect to ultrafine particles? Within the next 10 years, for example?
6. What kind of market players are essential for your business?
7. Do you know how many test facilities there are globally?
8. What kind of expectations do you have related to measuring ultrafine particles?
9. What kind of needs do you have with respect to measuring ultrafine particles?
10. What kind of benefits could there potentially be with respect to measuring ultrafine particles?
11. What kinds of different applications can you think of for ultrafine particle measurement?
12. What kind of changes do you expect in standardization?
13. What are you currently testing?
14. How do you conduct your tests at the moment?
15. How do you test ultrafine particles when conducting air filtering tests?
16. How do you prove to your customers that your products work?
17. Do you buy research services related to particle measurement? If yes, where do you buy them?
18. How much do you invest in testing (annually or in the past three years, for example)? How do you invest?
19. How would the filtering of ultrafine particles impact your company's image? What about the customers?
20. Is there something that could surprise you positively with respect to fine particle measurement?

If the interviewee is familiar with measuring:

1. What are your expectations for the measuring device?
2. What do you think about the measuring devices currently available on the market?
3. What kind of features are missing from the currently available devices?
4. What kind of features should the measurement device have in the future?
5. What is the smallest particle size you would like to measure? Why?
6. How interested are your customers in measuring or monitoring ultrafine particles?
7. What kind of challenges does ultrafine particle measurement involve?
8. What kinds of risks are associated with ultrafine particle measurement?
9. How much would you be willing to invest in ultrafine particle measurement?

Background related questions:

1. How long have you worked in the field?
2. What kind of customers does your company have?
3. Where do you sell your filters? What are your main market areas?
4. What is the turnover of your company?

Attachment 3. Questions in a matrix (Patton 2002, 352).

Question focus	Past	Present	Future
Behaviors/experiences	What kind of previous experience do you have in terms of measuring ultrafine particles?	What are you currently testing? How do you conduct your tests at the moment? How do you test ultrafine particles when conducting air filtering tests? How do you prove to your customers that your products work? Do you buy research services related to particle measurement? If yes, where do you buy them? How much do you invest in testing (annually or in the past three years, for example)? How do you invest?	
Opinions/values		In your view, how important is it to measure ultrafine particles (less than 100 nm)? What is the particle size that is relevant to your business? How about the customers of your company? What kind of market players are essential for your business? What kind of expectations do you have related to measuring ultrafine particles? What kind of needs do you have with respect to measuring ultrafine particles? What kind of benefits could there potentially be with respect to measuring ultrafine particles? What kinds of different applications can you think of for ultrafine particle measurement? How would the filtering of ultrafine particles impact your company's image? What about the customers? Is there something that could surprise you positively with respect to fine particle measurement?	In your view, how will the market change with respect to ultrafine particles? Within the next 10 years, for example? What kind of changes do you expect in standardization? What kind of features should the measurement device have in the future?

		What are your expectations for the measuring device?	
		What do you think about the measuring devices currently available on the market?	
		What kind of features are missing from the currently available devices?	
		What is the smallest particle size you would like to measure? Why?	
		How interested are your customers in measuring or monitoring ultrafine particles?	
		What kind of challenges does ultrafine particle measurement involve?	
		What kinds of risks are associated with ultrafine particle measurement?	
		How much would you be willing to invest in ultrafine particle measurement?	
Feelings/emotions			
Knowlegde		Do you know how many test facilities there are globally?	
Sensory			
Background		What is your job profile?	
		How long have you worked in the field?	
		What kind of customers does your company have? Where do you sell your filters? What are your main market areas?	
		What is the turnover of your company?	

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Research on Ultrafine Particles

World Filtration Conference, Taipei
11-15 April 2016

TAMPERE UNIVERSITY OF TECHNOLOGY

- Established in 1965
- Started operating in the form of a foundation in 2010
- 9,200 students (2014)
- Collaborates with 230 universities around the world
- Quality assurance system audited by The Finnish Higher Education Evaluation Council in 2014

Aerosol Physics Laboratory

Our mission:
- Conduct applied research in aerosol science and technology
- Support and initiate industrial activity in aerosol technology
- Combine academic and industrial research to reach high scientific and societal impact

We study
- Innovative measurement techniques
- Emission studies linked with atmospheric relevance, real-world emissions
- Nano-coating & functional materials

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The Project
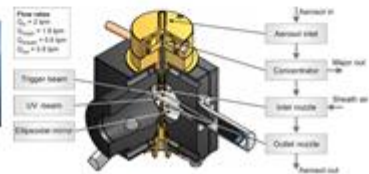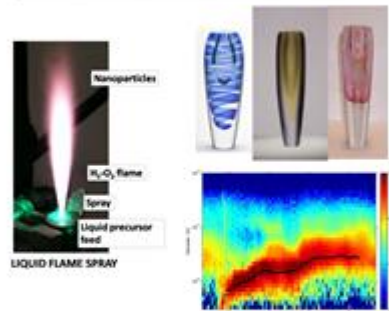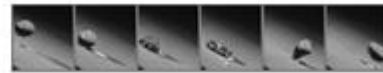
Project Researcher

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Working at Tampere University of Technology
9 years working experience from banking industry
International Business Management, Master's Degree, October 2016
BBA, International Business Management, 2006

- The research team for aerosol physics at Tampere University of Technology has innovated a new technology for ultrafine particle measurement.
- The purpose of the project is to commercialize the invention.
- The project started on 1st of January 2016 and will last until end of February 2017.
- My role is to survey the market potential of the invention as regards filtration applications.

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2.6.2016   4

Particle number size distribution in the urban atmosphere of Beijing, China
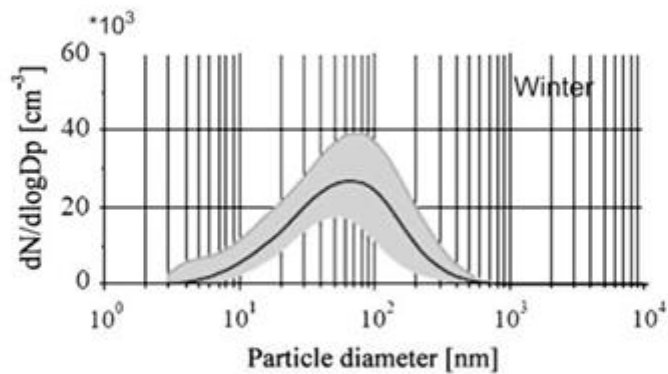
Wu, Z., Hu, M., Lin, P., Liu, S., Wehner, B., & Wiedensohler, A. (2008). *Atmospheric Environment*, 42(34), 7967-7980.

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Definitions

- Particle size:
  - 'Ultrafine' = less than 100 nm (0.1 μm)
- 'Measurement' = particle concentration
- 'Testing'= particle filtration efficiency

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2.6.2016　　　6

The Interview

- Involves 24 or 33 questions, depending on your job profile
- Will be recorded
- Remains confidential
- Takes approx. 30 to 45 minutes, varies slightly depending on your job profile
- The findings will be reported to all respondents in October 2016
- The results will be reported anonymously

Let's begin...

- By responding, you will get a free market analysis in October 2016.
- Thank you for your participation!

Attachment 5. The number of the production facilities

Company	Daikin	Donaldson	Clarcor	Camfil	Flanders Corporation	Delta Filtration	Filtration Group	AAF (American Air Filter)	HEPA corporation	Glassfloss Industries	Freudenberg	Hollingsworth& Vose	Average
Locations	North America 1, Europe 1, China 9, India 1, Japan 4, Malaysia 1, Singapore 1, Thailand 3, Australia 1	distribution and manufacturing in 44 countries, estimation manufacturing in 20	china 2, europe 5, north america 22, india 1, Africa 2, APAC 2	25	7	1 manufacturing facility in Limerick, Ireland, operates in 38 countries	India 1, Poland 1, Germany 2, Sweden 1, Mexico 1, Canada 1, Australia 1, New Zealand 1, Malaysia 1, China 1, Africa 1, North America 1	operations in 22 countries	1 production facility in California	2 plants at Ohio and Dallas	26 locations Freudenberg filtration technologies	America 8, Europe 4, China 1, India 1	
Total	22	20	40	25	7	1	13	22	1	2	26	14	16
HEPA (40%)	8,8	8	16	10	2,8	0,4	5,2	8,8	0,4	0,8	10,4	5,6	6,4

Attachment 6. Guestimates related to the number of test facilities (Interviews conducted in Taipei, Taiwan)

Interviewee	China	Japan	Korea	Taiwan	Global
1	10	10	5 to 10		
2					100
3					200-300 (3rd party labs less than 12)
4					100 to 500
5					
6				10 to 20	
7					(3rd party labs at least 2)
8					(3rd party laboratories: 10)
9					N/A
10	20				
11					52-100 (3rd party labs half a dozen)

Attachment 7. The steps of the research project

Date	Subject
18.3.2016	Kick-off meeting with the Haaga-Helia's tutor and the sponsor
21.3.2016	Meeting at Haaga-Helia regarding the Haaga-Helia's course assignments (geographical market reports)
23.3.2016	Planning the questionnaire together with the sponsor
23.3.2016	Product related SWOT created
30.3.2016	Internal presentation related to Invention X
4.4.2016	Planning the questionnaire together with a member from the steering group
5.4.2016	Planning the questionnaire together with the core project team and the specialist from a research institute
6.4.2016	Checking the questionnaire together with HH's thesis tutor and the sponsor
12.4.2016-15.4.2016	Interviews conducted in World Filtration Congress, Taiwan
18.4.2016-6.5.2016	Transcribing the interviews
9.5.2016-31.5.2016	Analyzing the results
26.5.2016	Meeting with a potential customer
26.5.2016	Meeting with a research institute
26.5.2016	Final reports related to HH's course assignments received
1.6.2016	Preliminary analysis presented for the TUT's personnel
9.6.2016	Meeting with an external consultant
9.6.2016	Meeting with a research Institute
13.6.2016	Internal meeting related to development of the standards with a research institute
20.6.2016	Internal meeting related to development of the standards with a potential customer
20.6.2016	Meeting with a potential partner/competitor
30.6.2016	Internal meeting with the sponsor
8.8.2016	Internal meeting with the sponsor
15.8.2016	Presentation of the final results, Steering group meeting