FRAMEWORK FOR FINDING AND EVALUATING OPPORTUNITIES FOR PEXa

Master of Science Thesis in the Master's Degree Programme, Product Development

RAVI SUBRAMANIAN VENKATESWARAN

Department of Product and Production Development
Division of Product Development
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2013

FRAMEWORK FOR FINDING AND EVALUATING OPPORTUNITIES FOR PEXa

RAVI SUBRAMANIAN VENKATESWARAN

Department of Product and Production Development
Division of Product Development
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden

Printed by Reproservice

Göteborg, Sweden 2013

Abstract

This thesis was about developing a framework for finding and evaluating the future business opportunities for PEXa for the company “Uponor”. The objective of this research was divided into three parts; the first part was to develop a framework for identifying and selecting the business opportunities for PEXa and to actually identify and select the new application segments for PEXa using the developed framework; the second part was to develop a questionnaire and to find the list of companies in the selected application segments; the third part was to develop a qualification criteria for evaluating the selected application segments.

First, this study was started through a literature review of market research methods and product development methods. After that, a framework was developed for identifying and evaluating the business opportunities. This developed framework was used to gather the empirical details and to identify the new application segments for PEXa. Empirical details include

- The history of PEXa, an Introduction to PEXa and the properties or features of PEXa
- Uponor’s current way for identifying and evaluating new application segments
- Uponor’s current application segments of PEXa and insights about new application segments

After the identification of new application segments, analysis was done to select the application segments that overlap with the selection criteria’s. Finally new application segments were selected after the analysis for the further evaluation process. This developed framework proved to be efficient because it helped to find more than 10 application segments and also it serves as a structured format for identifying and selecting business opportunities or application segments for any organization or user.

Second, a list of questionnaires was prepared focusing on the questions to be asked during the interviews with different companies during evaluation stage. The list of companies were found out in these selected application segments using online and through the contacts received in trade fair.

Third, personal brainstorming and futuristic thinking regarding the further recommendations of the thesis were used to develop the various requirements for the evaluation process. These requirements were initially classified into different basic requirements and detailed requirements. Different basic requirements were needed to evaluate an industrial application segment from an outside perspective before carrying out an interview with the concerned companies in those application segments. However, after an initial evaluation of potential application segments using different basic requirements, potential application segments were evaluated in greater detail against different detailed requirements. The following detailed requirements should be evaluated after carrying out the interview with the company(s) in those application segments and the above developed questionnaires can be used for carrying out this interview. These requirements were weighted to know the importance for each of them. Finally, a qualification process description was developed using Kesselring evaluation matrix for evaluating different selected application segments against the different requirements and their weights. This developed qualification process description was tested using a case study for a food industry application. The test results proved to be very good because this qualification process evaluated an application segment with respect to all requirements and gave a concrete result to select the application segment with the best potential for the company. The test results also provided additional details required for performing the further recommended steps of this thesis.

Acknowledgements

I would like to start by thanking Mr. Suleyman Dag and Mrs. Charlotte Ericsson for giving me an opportunity to do this thesis at Uponor AB and for their continuous support and constructive comments which have contributed significantly to this thesis.

I would also like to thank all my interviewees, Mr. Toni Sigmundsson, Mr. Rafael Diaz and other people at Uponor AB for spending their personal time for my study.

A special thanks goes to my examiner and supervisor Dr. Erik Hulthén for helping me with the academic writing and for helping to make this thesis what it is today.

I would also like to thank Mr. Gauti Asbjörnsson and other professors at Chalmers university of Technology for their direct and indirect support throughout my study.

Finally I would like to thank God, My family and my friends for their immense support and good wishes, without you I would not have finished this thesis in a good way.

Contents

Table of Figures

Index of Tables

1. Introduction

The introduction provides the background information for this thesis followed by the purpose, objective, scope and deliverables.

1.1 Background

The background information is presented in two parts. The first part, called the “Overall background summary”, reviews the background content in a concise manner to provide a quick overview for the reader. The second part, titled “Detailed background”, explains the background content in a more comprehensive way for those who wish to thoroughly understand the details. The detailed background summary will be used as a reference in various areas of this thesis. The overall background summary and detailed background are written using primary market research and secondary market research techniques. The detailed methods used for collecting this information are explained in Section 6.1, “Approach for identifying and selecting different industrial segments” in Chapter 6, “Results and Discussion”.

1.1.1 Overall background summary

Uponor AB is a leading international provider of plumbing and indoor climate systems for residential and commercial buildings. Uponor is a principal supplier of piping systems for infrastructure in the Nordic countries. Uponor's key products are under- floor heating systems, water supply systems and customized solutions for different plumbing applications. Uponor has approximately 3200 employees in 32 countries and they work closely with construction industry, consultants, house owners and land contractors. In general, Uponor uses PEXa pipes for many applications.

PEXa pipe is manufactured out of high-density polyethylene using the Engel process. In this process, peroxide is added to the base resin of the high-density polyethylene with required additives and stabilisers and blended using a plunger action in a maintained extrusion chamber under high temperature and high pressure. Next, the amorphous crystalline areas of the high-density polyethylene chain molecules are linked together via molecular bridges to form cross-linking structures. Cross-linking is defined as a process that changes the chemical structure of high-density polyethylene in such a way that the polymer chains connect to each other to create a three-dimensional network through chemical bonds. This new structure makes it impossible to melt or dissolve the polymer without first destroying its structure. The PEXa (cross-linked polyethylene) pipe material has many positive properties, such as

- High temperature and pressure resistance
- Low friction number
- Purity and non-toxicity
- High elasticity and impact strength
- Good electrical insulation
- High abrasion resistance
- Thermal memory

1.1.2 Detailed background

This section presents a more complete version of the history of PEXa, an introduction to PEXa and the properties or features of PEXa.

History

PEXa is produced by chemically joining the individual polyethylene molecules to enhance the properties of the original base resin at higher temperatures. The main reason for cross-linking polyethylene (PE) is to increase the thermal stability of the material under load and to significantly improve environmental stress crack resistance and resistance to slow crack growth.

In the late 1950s, scientists investigated different methods for strengthening the connections between the polymer chain links through covalent or chemical bonding of the polyethylene structure. The result of these efforts was a polyethylene structure (PE structure) that did not "flow" or transition to a softened state as quickly when the temperature was increased (Plastic Pipe and Fittings Association).

Introduction to the manufacturing method

In general, PEX can be manufactured via the Engel method, the Silane method and the Electron beam method. The X in the acronym PEX refers to the cross-linking or, in other words, the chemical linking of Polyethylene (PE) molecules into a three-dimensional network. When PEX is manufactured by the Engel method, it is known as PEXa. Likewise, if it is manufactured using the Silane method, it is called PEXb, and if it is manufactured by the Electron beam method, it is designated PEXc (Plastic Pipe and Fittings Association).

PEXa is manufactured using a process developed by the German inventor Thomas Engel. The manufacturing process for PEXa is explained in the following steps:

1. Before the actual manufacturing begins, the raw materials, additives, stabilisers and peroxide are subjected to laboratory testing to verify the correct melting index, density and homogeneity.
2. Next, the mixture of raw materials, additives, stabilisers and peroxide is fed into the extruder with constant application of heat and pressure.
3. Finally, the cross-linking process takes place while the tubing is formed in the extruder, and the PEXa tube exits through a ring-shaped opening at the other end of the extruder (Lenman, Skarelius, Svenson, & Westberg, 1995).

Features/ properties

The PEXa (cross-linked polyethylene) pipe material has many positive properties, which are listed in Table 1 below. Several of the properties are explained with an application context to provide a practical outlook on the features of this material.

Table 1 – Properties of PEXa

S.No.	Name of the property	Explanation
1	HEAT RESISTANCE	PEXa pipes can withstand high temperature. These pipes can be used at a working temperature of 95°C but can also withstand up to 120°C.
2	PRESSURE RESISTANCE (STRESS RUPTURE RESISTANCE)	Cross-linking of PEXa improves the pressure resistance property at room temperature by reducing the creep tendency. Because cross-linked high-density polyethylene produces a closer packing of the chains for an intrinsically higher pressure resistance, this material is easily adaptable for higher pressure applications.
3	SCRATCH RESISTANCE AND ENVIRONMENTAL STRESS CRACK RESISTANCE	PEXa pipe withstands scratching without weakening because it has a good resistance to crack growth. Cross-linking of polyethylene significantly improves this crack resistance property at room and elevated temperatures. This characteristic makes it possible to use PEXa pipes directly in stony-ground environments without the need for expensive ground works.
4	RESISTANCE TO UV LIGHT	Cross-linking improves performance under UV light exposure because more bonds must be broken before embrittlement occurs. However, PEXa tubing cannot be used in applications where it is exposed to sunlight for a long period of time because it degrades fairly rapidly. Prior to installation, PEXa should be stored in darkness and shielded from daylight after installation. Exposure to direct sunlight for as little as 20 days may result in premature failure of the tubing due to embrittlement. Hence, PEXa pipes have notably low resistance to UV Light.
5	CHEMICAL RESISTANCE AND DURABILITY WITH FLUIDS	The basic cross-linked structure of PEXa physically hinders the diffusion of aggressive chemicals, and thus PEXa material has more resistance to penetration and softening from these chemicals. Therefore, chemicals that can cause cracks in ordinary plastic pipes do not affect PEXa pipes, and PEXa is resistant to the majority of common chemicals, even at high temperatures. PEXa is not suitable for oil related application as it is made of similar material to oil.
6	LOW FRICTION NUMBER	PEXa has extremely low coefficient of friction, which reduces the pressure drop in the pipe and also minimises the risk of deposits. This low friction coefficient property makes it effective in applications involving transfer of particles over a longer distance.
7	ROOM TEMPERATURE AND LOW TEMPERATURE PROPERTIES	PEXa pipes have stable impact strength at room temperature and even at temperatures below -100°C. This characteristic allows PEXa to be used in refrigeration systems (e.g., for ice rinks).
8	LONG LIFE	PEXa material has undergone extensive long-term testing at Uponor and has shown notably good long-term stability. Specifically, 10 years of continuous pressure testing at 95 °C and an ongoing long-term test since 1972 proves its long life capability. This advantageous property of PEXa also makes it a suitable for progressive replacement of metal and

		thermoplastic pipes, especially in long-life applications, and the longest average warranty offered by any PEXa producer is 25 years.
9	EASE OF USE	PEXa is a flexible plastic that is able to bend around corners and does not require the use of expensive expansion bellows, as with metallic piping. In fact, PEXa does not require most of the tools that are required for use of metallic tubing. Although saws can be used on PEXa, the maximum requirement is a PVC cutting tool. PEXa does not require the use of solder, blowtorches and special fittings and can be attached with compression fittings to different household plumbing applications with simple crimps to seal off its open ends. Because fewer fittings are required, PEXa pipe reduces the number of leakage points and optimises the flow. Less required fittings for PEXa also prevents the risk of bacterial growth, which often occurs with other pipe materials.
10	COST	PEXa is relatively inexpensive to produce, buy and install compared to metallic pipes. Generally, PEXa can be bought at about a third the cost of traditional copper piping. In addition, if there is a bend required in the routing of a pipe layout, copper pipes require fittings, whereas PEXa piping does not, which reduces the additional costs for PEXa with respect to bend fittings.
11	SOUND-ABSORBING	PEXa pipes have the ability to reduce the amplitude of sound, which makes this material favourable for the transport of solid materials. For example, wood chips and other solid materials can be transferred through PEXa without the risk of high noise levels.
12	CLEAN	PEXa pipes do not release any harmful substances, and Uponor's PEXa pipes have gained approval for transport of drinking water. The exceptional cleanliness of PEXa pipe makes it highly suitable for various applications in the medical field, as well.
13	ELECTRICALLY INSULATING	PEXa pipes have good electrical insulating characteristics that are on par with the best insulating materials. PEXa material is also non-polar and completely free of impurities.
14	THERMAL MEMORY	When pipes are heated to the PEXa softening temperature, the material reverts to its original shape. This feature is used to produce a reliable method for shrink-mounting of sealing devices if needed. This property also makes it easy to develop various pre-shaped pipe structures for a variety of applications.
15	LOW WEIGHT	PEXa pipes weigh just a fraction of an equivalent metal pipe of an identical dimension, which offers a unique advantage in many applications and often provides a crucial role in lightweight applications.
16	ABRASION RESISTANCE	PEXa pipes have notably good resistance to abrasion and erosion. Corrosion does not occur in PEXA pipes, even at high water velocities.
17	VIBRATION ABSORBING	A PEXa pipe withstands vibration. There is no need to combine PEXa pipes with vibration-absorbing hoses or

		connectors. This property yields higher reliability and lower costs for the installation.
18	LOW ENVIRONMENTAL LOAD	PEXa is a material with low environmental impact, both during manufacturing and energy recovery.

1.2 Purpose

The current section is more of an introduction of this thesis work. Uponor's current industrial applications for PEXa pipe are focused mainly on the plumbing and electrical power areas and less focused on other businesses. Thus, Uponor wanted to explore the new market potential for PEXa material properties within other industrial segments to expand the company's growth and profit and broaden their industrial customer application areas. It was also necessary to evaluate the various industrial application segments for PEXa to assess the potential business opportunities.

1.3 Objectives

Based on the PEXa material properties, a study was performed to identify new potential application segments within industrial markets other than Uponor's building solutions and currently active industrial solutions. The main objective for this thesis work is to *develop a framework for finding and evaluating opportunities for PEXa applications*.

1.4 Scope and deliverables

The scope of this work entails extensive empirical study and communication regarding Uponor's current industrial segments. Next, broad market research and market analysis were performed to identify other industrial markets suited to PEXa's material properties. Last, a detailed qualification process description was developed for selection and evaluation of new potential market segments and applications.

The deliverables for the thesis work are represented in the three steps explained below:

a. **Different industrial segments:** Initially, a broad market research effort is carried out to identify a list of different industrial segments in which PEXa can be used. Next, various industrial application segments are listed in a separate heading and a description of how this list was assembled is described in a process description.
   Deliverables: Market research method and process description.
b. **Mapping of the continuous process:** The various industrial application segments described above are mapped within the continuous process of Uponor with the assistance of a tabular approach. After mapping, the continuous process application segments are determined from the identified industrial segments. Then the continuous process application segments are analyzed and filtered by selection criteria's corresponding to Uponor's strengths and material capability. After filtering, the selected application segments will be considered for further evaluation process. Next, a separate list of questionnaires and companies are developed for those application segments.
   Deliverables: Market segments and applications, developed questionnaires and a list of potential customers/ companies.
c. **Description of qualification process for new segments and applications:** Further evaluating of the exact application segments for this study is accomplished by considering factors or requirements, such as size of market, new types of applications and others. Next, an evaluation process for new applications and segments is described in detail. The evaluation process for new areas and a method for qualifying segments are described and evaluated using a process chart supported by a table and checklist. The process for qualification and procedures for evaluating new business ideas is bundled with a table and checklist.
   Deliverables: Process description, table and checklist

2. Thesis method

In this chapter, the author's approach is explained along with a summary of the limitations of this thesis work.

An overview of this thesis is shown in Figure 1 below.

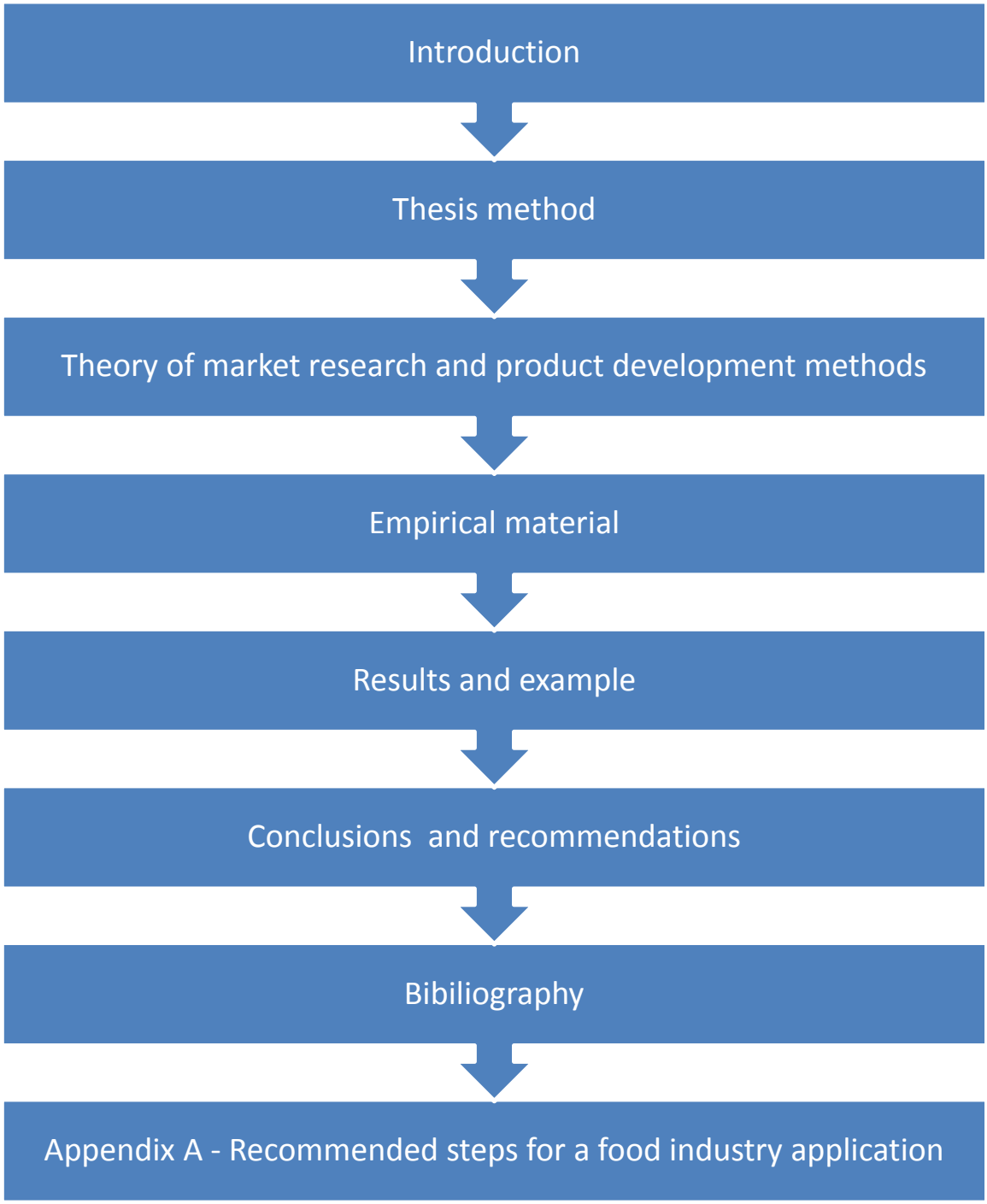

Figure 1 – An overview of this thesis

Detailed steps done in theory of market research and product development methods, empirical material, and results and example are shown in Figure 2 below.

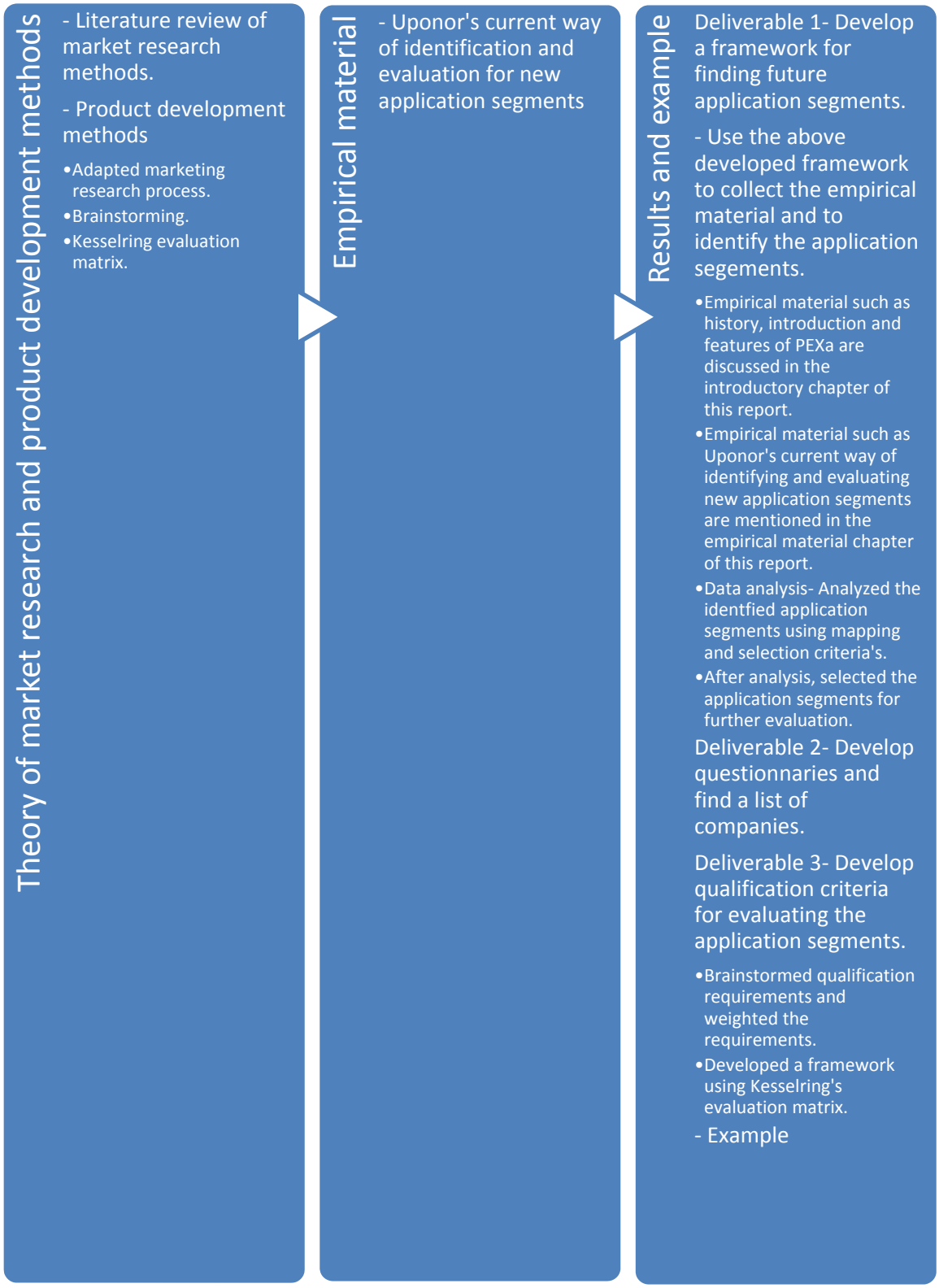

Figure 2 – Detailed thesis process

The detailed thesis process is explained below.

Theory of market research and product development methods

Initially, literature reviews were conducted that pertain to this thesis. After that, different product development methods were discussed.

Empirical material

In this chapter, Uponor's current way of identification and evaluation for new application segments were discussed.

Results and example

First stage of the deliverables: Develop a framework for finding different application segments. Identify different industrial segments and select the segments for evaluation.

Actual market research methods and analysis technique were selected from the possible study methods gathered in the literature review and adapted to suit this thesis. The adapted market research methods and analysis technique were used as a framework plan for identifying different application segments and also for finding the empirical details such as history, introduction, features of PEXa, Uponor's current way of identification and evaluation for application segments, Uponor's current application segments and insights about future application segments.

Empirical findings were documented using the selected market research method from the framework plan. In this thesis, empirical findings were discussed in three different chapters.

1. Empirical findings such as history, introduction and features of PEXa were discussed in the introductory chapter of this report for providing a vital background to understand this thesis.
2. Uponor's current way of identification and evaluation for new application segments were discussed in the empirical material chapter of this report because this subject does not come under the results objective. But this subject matter was collected, as it was needed to analyze Uponor's current way for identification and evaluation of new application segments with researcher's proposed way for identification and evaluation of new application segments in this thesis.
3. Then, specific industrial application segments were selected from the overall list of different industrial application segments using the following steps:
   The first step consists of the continuous process mapping, and the second step contains the evaluation of the different industrial application segments that overlap with the company's strengths and the PEXa material capabilities. The above mapping of continuous process and the evaluation of different industrial segments using selection criteria's were changed from deliverables 2 to deliverables 1 because these embraces the actual analysis of this thesis. Also, in marketing research process, analysis should be done before the actual selection of the application segments.

After this analysis, different industrial application segments were selected as a result of the overall approach to the marketing research process.

Second stage of the deliverables: Questionnaires and a list of companies

Personal brainstorming and online web resources were used to develop a set of questionnaires and the list of relevant companies for the selected application segments. Questionnaires were developed for using in the evaluation stage.

Third stage of the deliverables: Qualification process description for new segments and applications

In this penultimate stage, personal brainstorming and futuristic thinking regarding the further recommendations of the thesis were used to develop the various requirements for the evaluation process. Then requirements are weighted to know the importance for each of them. Finally, a qualification process description was developed for evaluating different identified application segments against the different requirements and their weights.

The limitations of this thesis work are as follows.

- Actual interviews with the companies in the selected application segments were not carried out because of the limited time period for the thesis. But a case analysis for food industry application was evaluated using the qualification process description to provide an overview of how this qualification process description works.

Example

An example was done to show the evaluation of an application segment with our different requirements and their corresponding weights. The example will also show how the questionnaires are helpful for the evaluation part of this thesis.

3. Theory of market research and product development methods

In the first section of this chapter, different market research methods are discussed followed by a description of data collection methods. In the second section, different product development methods such as a marketing research process, brainstorming and Kesselring matrix are discussed.

3.1 Market research methodology

The purpose of a particular market research study can be categorised as exploratory or confirmatory. These classifications are developed according to the objectives of the research. If the goal of the market research is discovery, then it is designated as exploratory market research. The purpose of conducting exploratory market research is to broaden the scope of available options. The purpose of conducting confirmatory research is to narrow the available options and to concentrate efforts along an optimal path. (McQuarrie & Edward, 2005)

The decision cycle can be referred to a set of decisions made over the course of a project, which could include decisions regarding a new product or a new business opportunity or decisions as to whether a market should be segmented into sub-segments, among others. The business decision cycle is shown in Figure 3 below. Exploratory techniques are used early in the decision cycle, whereas confirmatory techniques are often used later in the decision cycle. It would be a mistake to use confirmatory techniques when the goal is discovery, and therefore it is important to use the right techniques at the right time to avoid unnecessary costs. (McQuarrie & Edward, 2005)

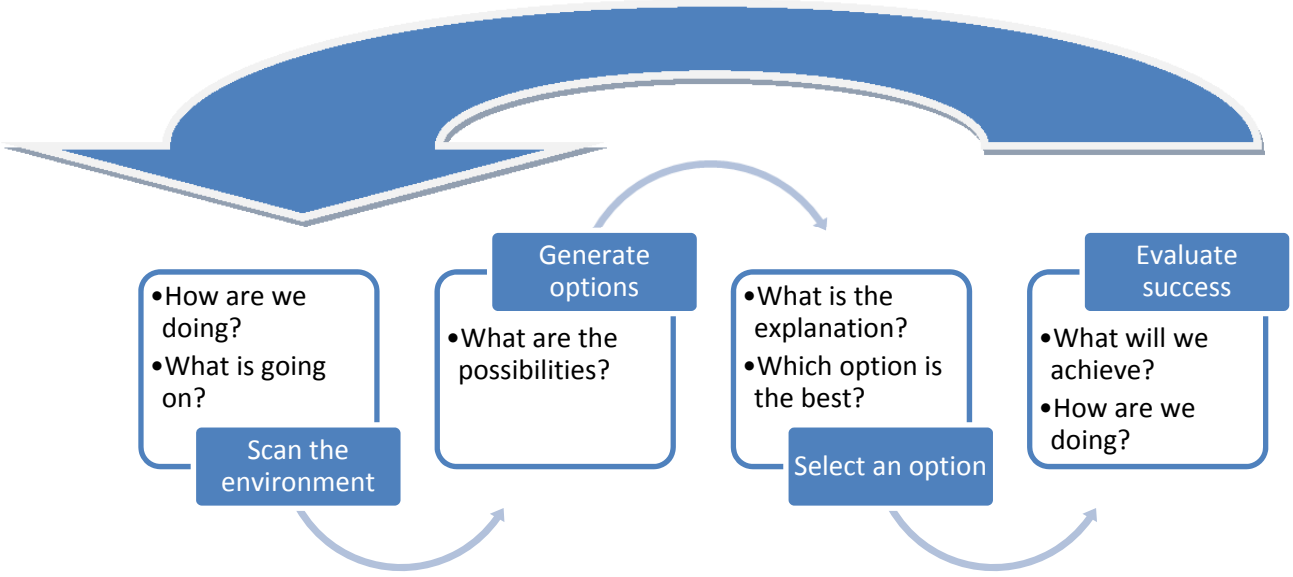

Figure 3 – Business decision cycle. Original illustration from (McQuarrie & Edward, 2005)

Marketing research is defined as the systematic process of identifying, analysing and presenting the information or data collected, which aids in the decision-making processes. (Aaker, Kumar, & Day, 2001)

Marketing research is often classified into two types with respect to the target market:

1. Consumer marketing research,
2. Business-to-business (B2B) marketing research (Brown, Lilien, & Ulvila, 1993)

Alternatively, it can be classified by methodological approach:

3. Primary market research
    a. Qualitative marketing research, and
    b. Quantitative marketing research (Holme & Solvang, 1991)
4. Secondary market research

Traditionally, the data used in marketing research are classified into two types, namely, primary data and secondary data. Primary data are collected by a particular organisation itself or by an entity hired to collect it for the purpose of dealing with a particular problem. This primary data are collected using primary market research methods. Secondary data are collected by another organisation for another purpose via secondary market research methods (Gates & Jarboe, 1987). Primary market research methods and secondary market research methods are explained in detail in the section below.

3.1.1 Consumer marketing research

Consumer marketing research is mainly targeted to consumer markets in which the number of potential buyers of a product is notably large as a proportion of a total population of millions. Techniques that are often used to research these markets are quantitative methods and qualitative methods. Quantitative methods are used for precise sampling, and qualitative methods are used for investigating complex consumer perceptions and stimuli. (Worcester, 1972)

3.1.2 Business-to-business marketing research

Market research in which the respondents are businesses or organisations and not consumers is known as business-to-business marketing research. Because the respondents are normally businesses or industries, these business-to-business markets are characterised by a smaller population, which is many times smaller as measured in terms of tens or hundreds or a maximum of thousands. Even if the population is small, consumption will consist of more volume per year. This approach is almost same in industrial research in which the respondents are industries. Hence, industrial research is much the same as business-to-business marketing research. (Bradley, 2007)

Business-to-business marketing research differs from consumer marketing research in the following aspects:

1. More reliance on secondary data, exploratory research and expert opinion in industrial research.
2. Understanding of technical factors is more important for business-to-business marketing research or industrial marketing research.
3. More emphasis is given to descriptive methods in business-to-business marketing research or industrial marketing research compared to experimental and observational methods used for primary data collection. (Morich, 1988)

3.1.3 Primary market research

Primary research involves collecting new information to meet specific needs (FastTrac TechVenture, 2008). Primary research can be carried out using qualitative marketing and quantitative marketing research methods.

3.1.3.1 Qualitative marketing research

Qualitative market research provides an understanding of and motivation for how or why a situation exists in its present form. This research is usually conducted with a small sample of the population because there is no attempt to extrapolate to the total population (Malhotra, 1996). No fixed set of questions is asked in this research; instead, a discussion guide related to the topic is used to explore the various issues in detail. The discussion between the moderator (or interviewer) and the respondent is largely determined by the respondent's own thoughts and perceptions. The respondents should be carefully selected such that they are experts in that field and have extensive experience related to the topic of discussion. This type of research is used for gathering descriptive information, usually represented by verbal or narrative data, through personal interviews during a customer visit or during focus groups. (McQuarrie & Edward, 2005)

A. Personal interviews during customer visit

Personal interviews during a customer visit may be the only option for collecting high quality data. It is advised to use personal interviews when the required data must be collected in a detailed manner. In this approach, one or more customers are interviewed at their place of business. The interview is mainly conducted with high-profile executives who cannot be reached through other means and who are technical experts on the topic. This method has primary importance in the environmental scanning stage of the business decision cycle (McQuarrie & Edward, 2005). Listening to customers describe problems can aid in identifying new product opportunities, and regular contact with customers helps to monitor emerging market trends and changes in the business environment. This method also plays a significant role in the generation of new options and helps the interviewer or moderator to directly visualise products and understand their features and capabilities. (Kvale, 1996) This method should almost never be used to test, evaluate or select options.

B. Focus groups

Focus groups are another qualitative method used for conceptualising issues. This method is also used for scanning the environment and for generating options. In a focus group, 8 to 12 qualified respondents meet in a special facility to discuss a specific topic. This approach is less useful when extensive descriptive data are needed. However, the focus group allows for interaction among respondents and enables development of fresh and creative insights. Generally speaking, as with customer visits, focus groups should never be used to select among options (McQuarrie & Edward, 2005)

3.1.3.2 Quantitative market research

This market research approach is used for gathering numerical information that can be analysed statistically. (Malhotra, 1996) This method is generally comprehensive, relying on measurements of the market, such as overall market size, size of market segments, purchase frequencies and distribution levels. Therefore, the method used for collecting quantitative data must be capable of achieving a certain level of accuracy (though not a very high level in all cases). Quantitative research provides valid data across different respondent groups with the intention of leading to specific

recommendations and measures that can be used as controls to determine the effectiveness of future actions taken (Parasuraman A. , 1991). Quantitative market research can be performed using the following methods.

A. Survey research

Survey research is performed by asking a fixed set of questions to a sample of customers. The sample of customers is usually large and in many cases is carefully selected to represent the total population of customers. The survey can be administered by telephone or by mail and executed with a reasonably large and carefully selected sample using questions that are largely descriptive (Marsden & Wright, 2010).

Surveys can play a supporting role in the environmental scanning stage of the decision cycle (McQuarrie & Edward, 2005). If a fairly exact factual description of the behaviours and simple perceptions of certain customer groups are needed and if such data cannot be gleaned from existing secondary research, then it makes sense to execute a survey. If, however, good secondary data already exists, it is rarely cost-effective to do another survey, unless this survey takes the form of a small, quick and tailored survey directed at filling in a few gaps in the available secondary data. (Alreck & Settle, 1994)

B. Conjoint analysis

The primary function of conjoint analysis is to assist in the selection of the best options in the specific sense of optimal product configuration. In a conjoint analysis, consumers are presented with various product configurations or choices, consisting of a set of features delivered at a specified level (Raghavarao, Wiley, & Chitturi, 2010). Thus, a computer monitor might be described in terms of resolution (1024*768 pixels or 1280*1024 pixels), price ($300, $400 or $500) or screen size (15-inch, 17-inch, 19-inch). A subset of all possible permutations is rated, and the mathematical analysis of these ratings gives insight into how consumers make tradeoffs among different features and price points. Although there are many different ways to implement conjoint studies, regardless of format, the goal is always to build a model of how a customer makes a choice among the various product offerings available and thus to identify and quantify choice drivers (e.g., how many dollars more, if any, will a consumer pay for a monitor with a resolution of 1280*1024) (McQuarrie & Edward, 2005).

C. Experiments

Experiments can be carried out by administering two different treatments to two equivalent groups of customers and measuring the response of each group to the treatment (McDaniel & Gates, 1998). The purpose of an experiment is to test which one of a small number of treatments stimulates the greatest response (McQuarrie & Edward, 2005). As was the case with conjoint analysis, experiments are primarily intended for use in option selection.

3.1.4 Secondary market research

This research technique encompasses any data collected by someone else for some other purpose that happens to be useful to everyone. Secondary research has apparent significance to the environmental scanning stage of the decision cycle. This research technique is often quicker and cheaper to conduct than another primary market research effort. Secondary research can also be used to identify market opportunities, describe market structures and monitor competitive activity (McQuarrie & Edward, 2005).

Secondary research can consist of internal or external data. Several examples of external secondary research include data compiled by the Census Bureau and other government agencies, reports written by consulting firms and sold to interested parties and publicly available information, such as articles in the trade press. Some examples of internal secondary research include sales records, customer databases and past market research reports (Aaker, Kumar, & Day, 2001).

3.2 Product development methods

In this section, some methods of product development and decision support methods that were used in this thesis are described.

3.2.1 Marketing research process

The overall approach to the marketing research process is described below in a detailed manner using the stepwise approach and shown below in Figure 4.

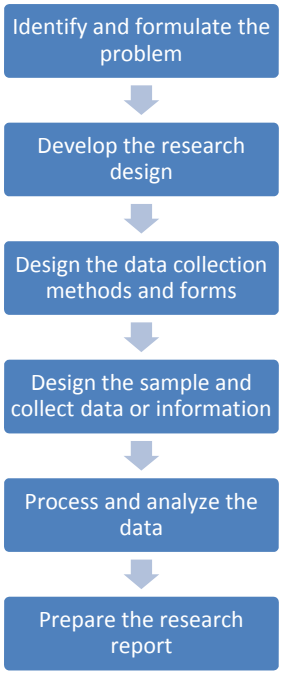

Figure 4 – Overall approach to the marketing research process. Original illustration from (Churchill & Iacobucci, 2009)

3.2.1.1 Identify and formulate the problem

The first step in the marketing research process consists of identifying the purpose of study: whether is it to solve a problem or identify an opportunity and formulating the problem.

3.2.1.2 Develop the research design

The research design is the procedure or method used for carrying out the research specific to the type of information, such as target market research and research methods.

Information type

This list of information required should be prepared with respect to the research objective (Parasuraman, Grewal, & Krishnan, 2006).

Target market research

Target market research defines the type of target market in which the research activity is focused. The general types of target market research are consumer marketing research and business-to-business marketing research (Morich, 1988).

Research methods

Research methods determine whether the particular market research objective is exploratory or confirmatory.

3.2.1.3 Design the data collection methods and forms

The sources of the data are identified in this step. The sources of data clarify the way in which data are collected, and these data are generally classified as primary and secondary data. The data classification is performed with respect to primary market research or secondary market research. The detailed description of this primary and secondary market research and different methods of making contacts for the data collection can be found in the previous section covering the market research methodology.

3.2.1.4 Design the sample and collect the data or information

The sample is the target population from whom the data is collected. The samples are carefully selected to represent the overall population.

This phase is also referred to as field work in which data collection from the source of data with method of contacts (as selected in the previous step) is carried out to gather the list of information required (Burns & Bush, 2005).

3.2.1.5 Process and analyze the data

After collecting the data, an analyst analyses the information. This processing and analysing of data in an orderly way aids in understanding the overall information gathered about the problem and illuminates the research objectives in a clear manner. After gathering the different information pertaining to the research objective, the data should be edited and classified in a systematic manner according to the research objectives.

There are two methods of analysis for the data, descriptive data analysis and inferential data analysis. The method used to analyse the data depends on the two methodological approaches, which are primary market research and secondary market research. For primary market research, the method of analysis also depends on the type of data collection tool used to collect the data or information (Christ, 2009).

Descriptive data analysis

Descriptive analysis is generally used to describe the results obtained after collection of data or information. The way in which the descriptive data analysis is performed depends whether a qualitative market research data collection method or a quantitative market research data collection method was used. For the qualitative data collection method, the analysis may include a summary of researcher's knowledge, and the information should be summarised in grouped categories or organised by a specific method. For the quantitative data collection method, the analysis outputs are visually represented as charts or (and) tables and as measures of central tendency (i.e., mean value) (Berk & Carey, 2009) (Christ, 2009)

Inferential data analysis

If a researcher wants to make judgments using the information obtained from a sample of customers (i.e., a small group), wants to compare different groups to evaluate how they respond to a common issue or wants to forecast the future based on the collected information, then inferential data analysis methods can be used. Most inferential data analysis techniques are used in the case of quantitative data collection, and advanced statistical techniques are commonly employed to make judgments regarding the issues of interest (Christ, 2009).

For example, if a researcher or organization wishes to know how different customers from different countries rate certain issues in buying a product, then the analysis offers much more insights than simply showing simply what percentages of customers have responded to each issue.

3.2.1.6 Prepare the research report

Research report should consist of research findings and it should be related to the marketing research objective. The research findings should be presented in a way that is easy for the reader to understand.

3.2.2 Brainstorming

Brainstorming is a popular creativity tool that helps researchers to identify different requirements to evaluate a business opportunity or to generate creative solutions to a problem (Ulrich & Eppinger, 2003). It is predominantly useful when the researchers want to develop new ways of looking at things. Individual brainstorming can sometimes be more effective than group brainstorming, as it often results in ideas of better quality (Mindtools Brainstorming).

3.2.3 Kesselring matrix

Kesselring matrix is the decision matrix where different application segments can be evaluated against the different requirements and their weighting factor. The requirements and their weighting factor (w) are shown in the left-hand column, and to the right of each requirement in the column is a row containing the corresponding weight value (v) of different application segments.

t is the product of w and v; t = w * v. T represents the overall summation score of all the t's in the same column for each application segment. These values are shown in Table 2 below using the Decision Evaluation Table for evaluating the application segments. This tool is generally used to evaluate and select the application segments with the best potential that have a very good overall summation score with respect to all requirements (Rebernik & Bradač, 2009).

Table 2 – Decision Evaluation Table for evaluating application segments

Different requirements	**Weighting factor**	**Application segment 1**		**Application segment 2**	
	w	v	t	v	t
Requirement 1					
Requirement 2					
Requirement 3					
Requirement 4					
Technical sum, T					

4. Empirical material

In this chapter, Uponor's current way for identification and evaluation of the application segments are discussed.

4.1 Uponor's current approach for identifying and evaluating new application segments

Currently Uponor is not putting concentrated efforts to find new application segments. As Uponor is a leading company in PEXa applications, different companies directly approach the sales department of Uponor with a problem and they discuss about it with them. Then experts from Uponor work on the problem to find a solution. If the experts feel that the problem is solvable by them, then they think whether they can offer their value added benefits or not because Uponor usually differentiates themselves with their competitors through their property/ price ratio and value added benefits.

Property/ price ratio

There are pipe materials in the market sold at 1/10 of the PEXa pipe price. Other pipe materials are sold at 10 times the PEXa pipe price. PEXa is technically on the upper half of the table meaning that the technical properties are high (not the highest) in relation to the price.

Added value

Uponor add additional values to their offer by offering a product that matches the market needs. For instance, quick and easy jointing technology, coil lengths, straight pipes, pre-shaped pipes, flanged pipes, pipes with integrated connectors, fittings, etc.

If Uponor finds that property/ price ratio and added values are satisfied for a particular application segment, then they evaluate the application segment through other factors mentioned below.

Potential applications

These should be applications fulfilling Uponor's requirements regarding volumes and profitability. There is a room for lower volumes, high profit contents and specialisation.

Uponor looks for other aspects like

- Material used presently, price estimate, advantages and disadvantages
- Consolidated or fragmented market
- Match between Uponor's offer (technical) and market requirements (estimate)
- Match between Uponor's offer (price) and market requirements (estimate)
- Comments regarding expected profitability out of general or factual assumptions
- Estimate of annual total market size
- Estimate of annual potential market size
- Estimate of annual sales/customer

5. Study

In this chapter, adapted marketing research process for this thesis is described and reasons for using different methods are explained.

5.1 Adaptation of marketing research process and reasons for using different methods

The marketing research process is used in this thesis because it helps to find an opportunity in a structured way. The adapted marketing research process is described below in a brief manner using the stepwise approach and shown below in Figure 5. Only the modified and newly added steps are explained below to avoid the repetition of contents.

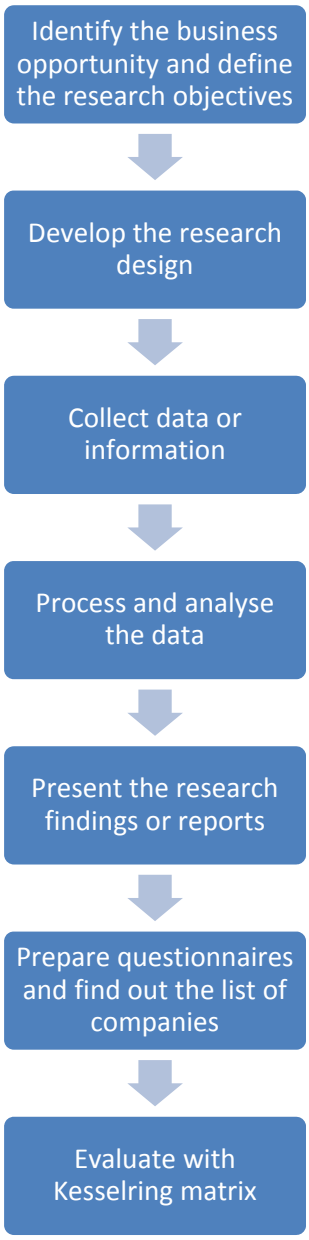

Figure 5 – Adapted marketing research process, compare with original approach in figure 4

5.1.1 Develop the research design

The research design is the only step that is modified in the marketing research process. The research design in this thesis is tailored to include information type, target market research, research methods and source of data with method of contacts under one heading to simplify the process. The reasons for selecting specific information type, target market research, research methods and source of data with method of contacts are explained clearly in a detailed manner. The diagram in Figure 6 below shows the stepwise approach in development of this research design. This diagram is also tailored for this thesis.

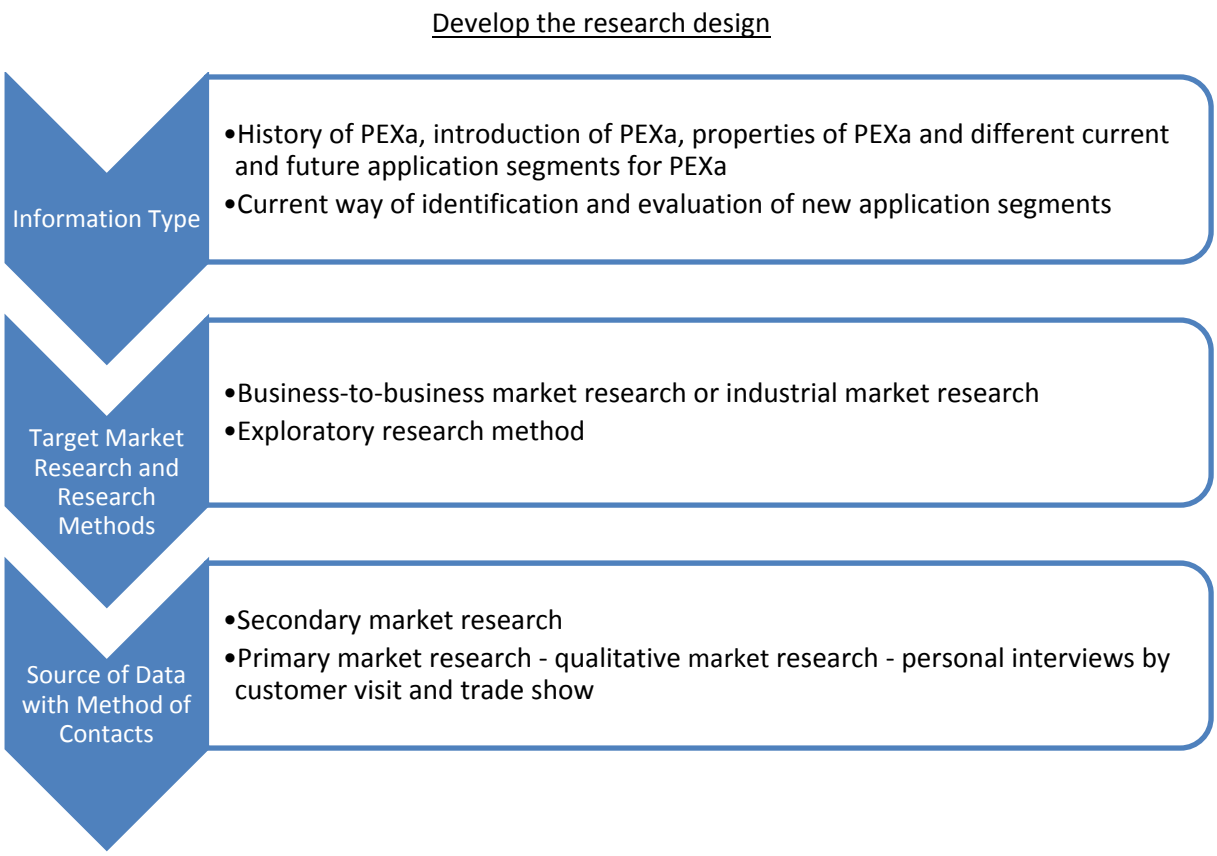

Figure 6 – Stepwise approach to the development of research design, Adapted from (Churchill & Iacobucci, 2009)

Information type

The research objective here is to identify and select the different new application segments in which PEXa can be used. The list of information should include history and introduction of PEXa, properties or features of PEXa, current way of identification and evaluation of new application segments, and current application segments and new application segments (Parasuraman, Grewal, & Krishnan, 2006).

Target market research and Research methods

Because the target market consists of industries and not direct consumers and because the main objective is to identify new industrial application segments for PEXa, the business-to-business marketing research or industrial marketing research approach is used in this work (Morich, 1988).

Because the purpose of this work is to identify different industrial application segments for PEXa, the research methods can be termed as exploratory research methods.

Sources of data with method of contacts

Initially, secondary market research is recommended to gain an overview of the various research details required, and therefore primary market research methods are used to gather the missing details and in-depth information such that the combination of both approaches is warranted. In this study, secondary market research was performed initially with different online web resources to build an overall list of required information such as the history of PEXa, the manufacturing method for PEXa, properties and features of PEXa and applications of PEXa. Following that approach, a reference book issued by Uponor known as "Water and Pipes" was also used to understand the manufacturing of PEX tubing. Subsequently, during the primary market research, the decision was made to proceed with qualitative market research because it was necessary to gather the descriptive information. Furthermore, in the qualitative market research, it was preferable to carry out personal interviews during customer visits because the descriptive information about PEXa was needed (such as the history, introduction, features and applications), as well as an understanding of the views of technical experts who can describe the possible future industrial application sector for PEXa (Morich, 1988) (Derveer, 1994). First, a personal interview was planned with the Material department of Uponor to gather knowledge regarding the characteristics of PEXa and how these characteristics make PEXa adaptable for different applications. Second, a personal interview was planned with the production department of Uponor to gain familiarity with the production process of PEXa and also to gather views regarding future industrial applications of PEXa. Third, an interview was proposed with the Sales and Marketing department of Uponor to understand the required marketing factors that should be considered when searching for new industrial applications of PEXa. Next, attendance at a trade show called "Plastic Technology Sweden/Denmark 2011" was planned to discuss the future opportunities or industrial segments for PEXa and also to locate the companies in those different fields of applications. (ASB Central, 2011) (Brown, Lilien, & Ulvila, 1993)

5.1.2 Collect data or information

The selected methods of contact described above were used to gather the different types of information required.

5.1.3 Prepare questionnaires and find out the list of companies

A set of questionnaires was prepared focusing on the questions to be asked during the interviews with different companies. The questions are helpful in the evaluation step of selected application segments. The company list can be used as a reference for Uponor to identify the relevant personnel to target for the interviews.

5.1.4 Evaluate with Kesselring matrix

Initially, 29 different idea evaluation methods were studied, though only one method was deemed appropriate for the case in which there is more than one business opportunity available and when one needs to choose the business opportunity with the most potential for the company. The chosen method for evaluating business opportunity is Kesselring's matrix. (Rebernik & Bradač, 2009)

6. Results and example

In this chapter, the results and example are explained according to the scope of this thesis work by following the order of the deliverables described in the chapter of "Thesis method".

6.1 Approach for identifying and selecting different industrial segments

The difference between "approach" and "method" used in this thesis are explained here for clear understanding. Approach shows the general guideline on ways of performing a work. In comparison, method refers to a step by step description of task to be done for performing a work. For example, a teacher may give a detailed step by step method for solving a problem in mathematics, or just indicate the general approach indicating the theoretical concepts and formulas which need to be applied for solving the problem. In short, approach is what you are going to do and method is how you are doing to do.

This approach shows the way used to carry out the marketing research for identification, selection and evaluation of different industrial segments. The overall approach for identifying, selecting and evaluating different new industrial application segments is shown in Figure 7 below to explain the larger picture in a clear manner. The two steps "Develop the research design" and "Collect data or information" are described in the chapter 5; therefore these steps are not mentioned in this chapter to avoid the repetition of contents. The final two steps of the figure 7 are explained separately in the next headings following the order of this thesis method.

Figure 7 – Overall approach for identifying, selecting and evaluating new industrial application segments, the approach presented in Figure 5 is followed

6.1.1 Identify the opportunity and define the research objectives

The opportunity and the research objective for identifying and selecting different industrial segments for PEXa are explained, as follows.

Opportunity

The current Industrial application business segment for PEXa pipe is focused mostly on electrical power applications and less on the other business areas. Therefore, in this thesis it was needed to

explore the new market potential for PEXa material properties within other industrial segments to expand the company's growth and profit and broaden their industrial customer application areas.

There are a lot of current application segments in which Uponor works with, but only 2 current application segments are described below because of the confidentiality issues. The current application segments are presented in this part of the thesis for ease of researcher to easily distinguish the new application segments from the identified application segments.

Current application segments

1 Residential water plumbing application

PEXa is a major candidate for use in residential water plumbing applications because of its excellent flexibility. It can easily replace piping material such as polyvinyl chloride (PVC) and copper because it can be bent into wide-radius turns without use of elbow joints. PEXa pipes can be connected from a distribution point to an outlet fixture without cutting or splicing the pipes, which reduces the additional need for costly joints and reduces the pressure drop due to the turbulence induced at the transitions. The cost of PEXa is approximately 25% of that for copper pipes, and overall installation is also less labour-intensive.

2 Hydronic radiant heating systems

PEXa tubing has also become a major contender in transportation of water in hydronic radiant heating systems. In these systems, PEXa tubing is used to carry hot water from the heat source to the radiators. Generally, when ferrous components are present in a radiant heating system, PEXa tubing with an oxygen barrier is used to prevent rust formation. However, if the above system does not contain ferrous components, ordinary PEXa tubing can be used. Generally PEXa tubing is widely used to replace copper in plumbing applications. Typically, red-coloured PEXa tubing is used to symbolically represent the transportation of hot water, and blue-coloured PEXa tubing is used for the transportation of cold water.

Research objective

The research objective is to *Identify and select the different new industrial application segments in which PEXa can be used.*

6.1.2 Process and analyze the data

Descriptive data analysis is used in this work, and the analyzed information is shown in a summarized form with descriptive headings for different application segments. This format was chosen because qualitative market research was used for collecting the primary data. Because the researcher must avoid judging the views or opinions of the sample of customers from which the data was collected, inferential data analysis was not used in this work. (Christ, 2009)

According to Miles and Huberman(1994), the data analysis consists of three parts, data reduction, data display, and results or findings and conclusion drawing. This part starts to evaluate the intelligible data collected through the interview with selection factors. The drawn conclusion will be presented in the next chapter.

Data reduction

According to Miles and Huberman(1994), “Data reduction is a process of selecting, focusing, simplifying, abstracting and transforming the data that appear in a written report”. The data should not be condensed just for the sake of condensing; they also have to be transformed to logical and lucid. The data reduction should primarily address on the research objective. In qualitative analysis, analyst should decide which data are to be presented according to the research objective. (Miles & Huberman, 1994)

In this part of the thesis the data reduction is done around two research questions, the first question focus with the approach to identify the new application segments and the second question concentrates with the method to select from the identified application segments for further evaluation.

New application segments

1 Dental applications

Medical-grade cross-linked polyethylene (PEXa) resin has been proven to be highly biocompatible in numerous tests for use in composite filling applications. This composite filling application ensures that the filling material is a harder and more durable product than the other polyethylene. The crystalline structure of PEXa gives it properties similar to that of the natural tooth, such as macro-toughness and micro-elasticity. The wear rate of PEXa is similar to that of natural tooth, as well.

PEXa tubing can also be used for air pressure lines that run from an air compressor to dental equipment. Currently, copper tubing is mostly used in air pressure lines, but PEXa tubing can be another good option in this application sector.

2 Foam extrusion applications

Cross-linked polyethylene (PEXa) foam is an environmentally and aesthetically pleasing material that provides a wide range of performance applications. PEXa foam has many similar characteristics to that of conventional polyethylene foam with the exception of the exclusive capability of PEXa foam to protect class “A” surfaces. PEXa foam can also be used in the packaging of medical products.

Foam extrusion is also used for the manufacture of cast films, blown films, sheets, profiles and piping. The wide variety of performance applications for the extruded category of foam products ranges from decorative ribbons to thermo-formed food trays or cups to profiles for picture frames and foam-core pipes. The applications also include claddings, picture frames, sealants, decorative ribbons, sealing profiles and food trays.

PEXa-series foaming agents are of a fine-celled foam structure that enables thermoforming without surface defects.

3 Biomedical applications

Cross-linked polyethylene directly addresses such problems as wear and delamination that lead to the failure of medical implants. PEXa properties have the potential to extend the durability of an implant by providing a durable solution for the joined replacements.

Generally, cross-linked polyethylene products are designed and tested to meet the three important standards for performance benchmarks in joint replacement applications:

- Resistance to wear achieved through a strong network of cross-links
- Resistance to aging achieved by the removal of residual free radicals
- Mechanical properties suitable for the knee, which are evaluated and validated by rigorous device-specific testing techniques

The foremost problem in hip and knee replacement is wearing of the implant surface over a continuous period of time. Continuous motion between the plastic polyethylene components and a metal surface can cause small particles to be removed very easily from the surface of the polyethylene, and this plastic polyethylene may degrade over time. Cross-linked polyethylene (PEXa) was developed mainly to address these problems of wear, as well as aging issues.

4 Roto-moulded storage tanks

PEXa has a good resistance to crack propagation, a property that linear polyethylene does not have. This advantage clearly demonstrates higher resistance of PEXa to rupture and catastrophic failure in high-impact and over-pressurisation conditions. These higher resistances are tested by drop and pressurisation-to-failure tests in which PEXa shows better performance and added factors of safety. Hence, PEXa tanks can provide the best justification for rotational moulded storage tanks applications. It was also found that many rotational moulders are currently using PEXa tanks in different high performance applications, and field performance evaluation have given higher ratings to the PEXa tanks in this application.

5 Canoes and kayaks

PEXa can also be used for canoes and kayaks because the properties of cross-linked polyethylene give it good impact strength and environmental stress crack resistance. These properties of PEXa prevent repair of any damage to the hull, but there are some adhesives on the market such as 3M's DP-8005, which have the ability to bond to PEXa for small repairs. Larger repairs require the melting and mixing of more polyethylene into the damaged area of a canoe or kayak to form a solid bond.

6 Mining industry and chemical industry

PEXa pipes can replace the current copper pipes used for slurry transportation in large-diameter mine tubing in such places as copper, gold, and silver mines because of very favourable PEXa properties such as low coefficient of friction, high abrasion resistance, high elasticity and impact strength. These properties make it suitable for transport of highly abrasive sand slurry, as well.

PEXa pipes can be used in cleaning operations for transportation of different solvents, raw materials and chemicals in such industries as the chemical industry and transportation of pulp in the paper industry among others. PEXa becomes desirable in these industrial cleaning applications because its basic cross-linked structure physically hinders the diffusion of aggressive chemicals, and it also has more resistance to penetration and softening from contact with chemicals. The abovementioned properties of PEXa also make it possible to be used in conveying of aggressive fluids (e.g., acids and solvents), sea outfall large-diameter lines, large diameter industrial waste pipelines, process lines in the process industry, pneumatic conveying and pumping of corrosives and salt water.

7 Borehole industries

PEXa pipes can be used in the borehole industry because the properties of PEXa, including high temperature and pressure resistance and a low coefficient of friction, are better than those of steel in this application. It was found that PEXa pipes can be used for pumping water from boreholes at a depth of over 200 m by means of a continuous PEXa pipe combined with a submersible pump and motor. Additional properties of PEXa, such as scratch resistance and environmental cracking resistance, make direct use of PEXa pipes feasible in the borehole industry.

8 Automotive industries

PEXa pipes can be also be applied in the automotive industry for transport of fluids in heating, cooling and ventilation systems due to the PEXa properties of low weight, chemical resistance, durability with respect to fluids and long life. One additional important consideration is that the automotive industries are keen to reduce the weight of onboard systems to improve overall fuel efficiency.

Several researchers have suggesting using PEXa instead of stainless steel inside the low temperature heaters and in hydraulic hoses to protect the hoses and tubes from mechanical damage. The reasons for suggesting PEXa are mainly because of properties such as temperature resistance, low weight, vibration absorption and optimal cost.

9 Ship-building and offshore industry

PEXa can find new applications in ship-building and transportation for the offshore or sub-sea oil industries. PEXa pipes are attractive for oil transportation in offshore segments and are already used for transporting a large number of chemicals and solvents. PEXa can be used for general piping in ship-building operations, as well as applications in mobile homes and luxury boats.

10 Food and agricultural industry

Because PEXa is already used for supplying clean water, it should be easy to gain additional approvals for transporting food items. This possibility makes PEXa an effective challenger in the food transportation aspects of several industries. The main properties that make PEXa suitable for this application are low friction, cleanliness and corrosion resistance.

PEXa pipes can be used for transporting water in agricultural areas for irrigation purposes, and some of these pipes are present underground. PEXa pipes are attractive in this industry because of current applications in transportation of water in residential water supply applications.

Data display

Data display is a comprehensive piece of text or a diagram, table, or matrix that provides a way for analyst to think and evaluate the identified data that overlap with selection factors. (Miles & Huberman, 1994)

In this thesis, specific industrial application segments are selected from the overall list of new application segments using the following selection criteria's that are shown below in Table 3.

Table 3 – Selection criteria's for analyzing the new application segments

Selection criteria's	Continuous process mapping	Uponor's strength- Pipe diameter less than 75 mm	PEXa material characteristic- Chemical resistance and durability with fluids	Ideas and views of sales and marketing head of Uponor
Application segment 1				
Application segment 2				
Application segment 3				

The first step consists of the continuous process mapping, and the second step contains the selection of the different industrial application segments that overlap with the company's strengths and the PEXa material capabilities, and the third step contains the evaluation of application segments with the ideas and views of sales and marketing head of Uponor. These abovementioned steps are done in a stepwise manner. If an application segment does not pass the first step, then it cannot go to the second step and likewise for all the aforementioned steps. Hence if an application segment does not pass anyone of the selection criteria's, then that application segment cannot be considered for evaluation with qualification criteria.

Mapping of the continuous process

The continuous process in place at Uponor is one that has similar applications in matchmaking with tubing and unique joining technology. For this reason, we will identify other industrial applications that use similar shapes of tubing structure with a circular diameter to ensure that we can replace the existing materials with our PEXa and our unique Quick and Easy (Q&E) joining technology.

If the concerned application segment contains some kind of tubing structure with circular diameter in it, a "Yes" was entered in the field for Continuous Process of Uponor. If the concerned application segment did not contain tubing structure of circular diameter, a "No" was entered in the field for Continuous Process of Uponor.

The entries for S.No. that are represented by numbers refer to Different Industrial Segments and entries for S.No. that are represented by letters refer to Different Application Segments. The application segments that have "Yes" in the field for Continuous Process of Uponor will be carried forward in the process for further selection. This information is shown below in Table 4.

Table 4 – Mapping of different new industrial application segments with the continuous process of Uponor.

S.No.	Different industrial segments	Continuous process of Uponor
1	**Medical application segments**	
a	Composite filling applications	No
b	Air pressure lines in dental equipment and other pharmaceutical equipment	Yes
c	Drug transportation applications	Yes
2	**Foam extrusion segments**	

a	Packaging extrusion applications	No
3	**Biomedical application segments**	
a	Hip and knee replacement application	No
4	Roto-moulded storage application	Yes
5	Canoe and kayak application	No
6	**Mining industry and chemical industry**	
	Industrial cleaning operation	Yes
a b	Slurry transportation	Yes
7	Borehole industry	Yes
8	**Automotive industry**	
a	Heating, cooling and ventilation systems in buses, trucks and cars	Yes
b	Hydraulic hoses in Trains	Yes
9	**Ship-building and offshore industry**	
	Oil transportation for offshore segments	Yes
a b	General pipes used in ship-building industry. Mobile homes and luxury boats.	Yes
10	**Food and agricultural industry**	
a	Food transportation applications in industries	Yes
b	Food transportation applications in agricultural areas such as irrigation piping	Yes

Evaluation discussion with material capability and Uponor's strengths

After completing the tabular columns, we picked the application segments that match the continuous process of Uponor, and we excluded the applications that do not match with the Uponor material capability and strength.

Uponor's strengths are proprietary regarding the material properties of PEXa, Quick &Easy (Q&E) fitting and expertise because of good Original Equipment Manufacturer (OEM) knowledge and skilled personnel.

1. Material properties or features of PEXa and important Uponor technical information can be found in the Features/Material properties of the PEXa section in the initial stage of the project report.
2. The Q&E fitting is a unique patented joining technology owned by Uponor that allows connections with other PEXa pipes in a short matter of time.
3. Good experience and good OEM knowledge can be validated because Uponor is the world's largest manufacturer of plastic pipes with sales of more than 1 billion Euros and approximately 4100 employees. Uponor also has significant product development resources that can assist other business needs by reducing the weight and cost of PEXa pipes. Uponor also invests a large amount of resources in research and development, which is often carried out in close cooperation with partners and customers. The company also takes great responsibility for environmental safety and operational reliability, which is one of Uponor's highlights.

In the matched application segments, we exclude the roto-moulded storage application because these storage tanks are of very large diameters that are not possible to manufacture in the existing production facilities at Uponor.

Additionally, oil transportation for offshore segments is omitted because PEXa becomes somewhat softened in this application because it is made of similar materials to oil. Therefore, PEXa pipes will not be suitable for offshore segments.

Next, further convergence of the exact application segments is performed using the qualification process description. However, the selection process for new industrial application segments also includes gathering the ideas and views of the Sales and Marketing heads of Uponor.

In addition to omitting roto-moulded storage tanks and oil transportation for offshore segments, applications which are highly suited for Uponor to proceed further are marked as “Yes - Interesting”, “Yes” for applications that are interesting and may be investigated further and “Not - Interesting” for the applications which are not suitable for Uponor to proceed further.

The industrial segments that are marked as “Yes - Interesting” and “Yes” will be carried forward for further analysis, but the “Not - Interesting” application segments will be omitted in further proceedings. The names of the industrial segments and application segments have been taken out of Table 5 below for reasons of confidentiality.

Table 5 – Mapped industrial segments that will proceed further after selecting the continuous process of Uponor.

S.No.	Different industrial segments	Proceed further
1	Industrial segments 1	
a	Application Segments 1	Yes- Interesting
2	Industrial segments 2	
a	Application Segments 2	Yes
3	Industrial segments 3	
a	Application Segments 3	Not - Interesting

6.1.3 Present the research findings

Research findings should be related to the marketing research objective. In this study, the findings are a list of new industrial application segments that are mentioned in Table 5 after the data analysis. The findings are not included in this report because of confidentiality issues.

6.2 Questionnaires and companies

Prepare questionnaires and find out the list of companies

The questionnaires cover areas such as the details of the current material used in that particular segment (including price, advantages and disadvantages), market requirements with respect to technical properties and price and annual sales in that particular application segment.

The questionnaires were given to the company representatives. The questionnaires were separated into Marketing and Engineering sets of questions because it will be more efficient to separately gather the answers from the relevant marketing or engineering departments of various companies.

Questions were grouped into engineering questions and marketing questions because if the interview is with a person from an engineering team, then engineering questions can be asked; similarly, marketing questions can be asked with a person from marketing team. If the interview will be with a product manager, then we can ask both types of questions. In the future, if Uponor carries out interviews with different companies, then these questions should be adapted according to the particular companies. The questionnaires are not included in this report because of confidentiality issues.

The list of customers and companies in these industrial application segments are presented in Table 6 below. The list of companies in these selected application segments are found out using online and through the contacts received in trade fair. The list of companies in these application segments is taken out of this report because of confidentiality issues. The questionnaires can be modified according to the type of available personnel for the interview.

Table 6 – Different industrial segments with selected companies in those industrial segments.

S.No.	Different industrial segments	Companies
1	Industrial segments 1	
a	Application segments 1	Xxxx, yyyy
2	Industrial segments 2	
a	Application segments 2	Aaaa, bbbb
3	Industrial segments 3	
a	Application segments 3	Cccc, dddd

6.3 Qualification criteria for evaluating different application segments

Evaluate with Kesselring matrix

The qualification criteria are a list of criteria or requirements that are the important factors in evaluation of the selected application segments. A decision evaluation table with the stated requirements and their weights are used for evaluating different industrial application segments. These requirements are notably important when evaluating a new business opportunity that contains many unknowns. Therefore, to identify the requirements for the evaluation, brainstorming sessions were performed from different perspectives.

The requirements below are initially classified into different basic requirements and detailed requirements. Different basic requirements are needed to evaluate an industrial application segment from an outside perspective before carrying out an interview with the concerned companies in those application segments; these requirements represent the basic set of requirements that are evaluated initially for the potential application segments.

However, after an initial evaluation of potential application segments, there are other requirements against which we need to evaluate the application segments in greater detail. The following detailed requirements can be evaluated after carrying out the interview with the company(s) in those application segments.

Though the different basic requirements do not contain inner categories, the different detailed requirements are classified into three categories: engineering- and market-allied requirements,

innovation- and business-allied requirements and quality- and people-allied requirements. This classification process groups similar types of requirements into separate headings and also aids the user or organisation in clearly understanding the requirements.

After finding the different requirements for the system, it is essential to know the importance for each of them, to ease the solution search. In this case, all requirements are assigned a weighting factor by discussing with sales and marketing head of Uponor. Weighting factor (w) is stated in a scale from 1 – 4. An interpretation of the weighting factor is explained as follows:

1 is assigned to a requirement that is least important,

2 is assigned to a requirement that is important,

3 is assigned to a requirement that is very important, and

4 is assigned to a requirement that is mandatory. If an application segment does not satisfy the mandatory requirements, then that particular application segment cannot be considered for further proceedings.

Tables of the various basic requirements and different detailed requirements along with their weighting factor can be found below.

Table 7 shows the different basic requirements and their weighting factor that can be evaluated with different industrial application segments.

Table 7 – Evaluation of application segments with respect to different basic requirements and their weighting factor.

Different requirements	**Weighting factor**	**Application segment 1**		**Application segment 2**	
	w	v	t	v	t
Market growth	2				
Customer base	2				
Innovative leadership using prior experience	2				
Feasibility of application	3				
Management team effectiveness	2				
Compatible with contextual experience	3				
Suitable pipe size and pipe shape	4				
Suitable transportation fluid	4				
Low-weight requirements	3				
Competitive	3				

pricing					
Requires unique joining technology	3				
Requires low friction	3				
Clean transportation need	3				
Suitable temperature and pressure	4				
Overall score (T)					

The evaluation or verification criterions of different basic requirements in Table 7 are explained in detail below:

Market growth – Check for growing market

Customer base – Check for known, identifiable customers or limited and non-specific customers

Innovation leadership using prior experience – Check if able to lead the market using prior experience or a need to equip more gradually

Feasibility of application – Feasibility checked by the Marketing head of Uponor using his experience in this field

Management team effectiveness – Check with Uponor as to whether the management team has the required skill and motivation to pursue this application segment

Compatible with contextual experience – Check for prior experience and knowledge for this kind of application

Suitable pipe size and pipe shape – Check whether the applications are suitable to the continuous process of Uponor

Suitable transportation fluid – Check whether the transportation fluid is compatible with the technical properties of PEXa

Low-weight requirements - Check whether the particular application segment is looking for a low-weight alternative material

Competitive pricing – Does that particular application segment appear ready to opt for the price of PEXa?

Requires unique joining technology – Does the particular application require a good type of joining, such as Uponor's recently patented unique joining technology for PEXa?

Requires low friction – Check whether the application requires less friction.

Clean transportation need – Check whether the application requires clean transportation without introduction of any harmful substances.

Suitable temperature and pressure – Does the particular application satisfy the PEXa capabilities for temperature and pressure?

Tables 8, 9 and 10 show the different detailed requirements and their weighting factor that can be evaluated with different industrial application segments. The evaluation or verification criterions of different detailed requirements are explained in detail below after each table.

Table 8 – Evaluation of application segments with respect to Engineering- and Market-allied requirements and their weighting factor.

Engineering- and market-allied requirements

Different requirements	**Weighting factor**	**Application segment 1**		**Application segment 2**	
	w	v	t	v	t
Suitable material properties	4				
Suitable price range	3				
Customer reliance and convergence	2				
Customer communication	2				
Competition differentiation	2				
Long-term partnerships and supplier networks	2				
Market establishment	2				

Suitable material properties – Does the material in the application segment match exactly with PEXa, and does it have a better fit with the material characteristics of PEXa?

Suitable price range – Does the price range of this application segment match or fit with Uponor's price range for PEXa?

Customer reliance and convergence – Assess whether the customer will be reliable, and if there is a possibility of good business in the future

Customer communication – Assess whether the customer can be trusted, and if they have a good relationship with clients overall. Check for any compatible practices with the customer.

Competition differentiation – Assess whether their application segment has unique strengths and advantages compared to the competitors or are they forced to compete only on the price of the product.

Long-term partnerships and supplier networks – Assess whether they maintain long-term partnerships with strong supplier networks, or if they have short relationships within weak networks.

Market establishment – Assess whether this application segment is first-to-market or in an already-established market; if it is first-to-market, then we can be easily be a market leader with our competitiveness in this field, or if it is an already established one, then we will need to compete with others.

Table 9 – Evaluation of application segments with respect to Innovation- and Business-allied requirements and their weighting factor.

Innovation- and business-allied requirements

Different requirements	**Weighting factor**	**Application segment 1**		**Application segment 2**	
	w	v	t	v	t
Technological differentiation	3				
Innovation based on customer needs and requirements	2				
Feasibility of realisation	3				
Intellectual Property Rights issues (IPR issues)	4				
Growth in the business	3				
Value creation	3				
Risk	3				

Technological differentiation – Does our product have very good optimal performance and cost benefits compared to the current material, or do we offer less performance and marginal benefits compared to the current material?

Innovation based on customer needs and requirements – Does our PEXa with unique joining technology meet the informed customer's needs and requirements, or it does not suit the customer's real needs?

Feasibility of realisation – Is the implementation of this application segment is feasible, and can the challenges can be overcome by our strengths, or is it very difficult to implement this application segment because of additional obstacles?

Intellectual Property Rights issues (IPR issues) – Does the application segment have strong IPR protection with clear ownership and control, or does the application segment have weak or nonexistent IPR protection with unclear ownership and poor control?

Growth in the business – Is there possibility for business growth in this application segment, or is there only a limited scope for business growth?

Value creation – Does this application segment have high value creation with a high profit margin, or does this application segment have only low value creation with low profit margin?

Risk – Does this application segment have associated risks that are acceptable in the worst-case scenario, or does the segment have unacceptably high risk associated with it? It is necessary to perform risk assessment with the relevant application segment before filling out this row.

Table 10 – Evaluation of application segments with respect to Quality- and People-allied requirements and their weighting factor.

Quality- and people-allied requirements

Different requirements	**Weighting factor**	**Application segment 1**		**Application segment 2**	
	w	v	t	v	t
Suitable to our current quality standards	3				
Feasibility of required quality certifications or standards	4				
Staff capability	1				

Suitable to our current quality standards – Are the standards required for this application segment satisfied by our current quality standards, or do we need to develop additional standards for this application segment?

Feasibility of required quality certifications or standards – Are the required additional quality certifications or standards achievable with optimal cost and within a short period time, or is it very difficult to acquire those quality certifications or standards because of high cost and longer lead-time?

Staff capability – Can this application segment be pursued by our experienced staff, or do we need to recruit or consult special personnel within the industry to carry out this opportunity?

Next, the different application segments are evaluated against the various basic requirements and different detailed requirements and their weights, depending on how well they respond to the requirement. How well they respond is stated in a scale from 0-3. The corresponding weight value (V) should be an integer value between 0 and 3, inclusive.

3 is assigned to an application segment that has high value opportunity or which is highly suitable,

2 is assigned to an application segment that has medium value opportunity,

1 is assigned to an application segment that has low value opportunity, and

0 is assigned to an application segment for which the requirement concerned is not applicable or not suitable.

If an application segment does not satisfy the mandatory requirements, then that particular application segment cannot be considered for further proceedings. For example, if an application segment get “0” as an assigned value for “Suitable temperature and pressure” requirement in the table of different basic requirements, then that particular application segment will not be taken for further proceedings, as that particular requirement is a mandatory requirement.

Last, the final summation score is calculated for the different industrial application segments. An interpretation of the final summation score for the basic requirements is explained as follows in terms of the final summation score:

0-31 – Low value business opportunity; do not proceed further with the respective application segment

32-61 – Reasonable business opportunity, assess the possibility of good growth potential in that particular application segment.

62-91 – A likely valuable opportunity to proceed further; list measures to overcome risks and to improve the weak areas by examining in detail.

92-123 – A highly valuable and best business opportunity to proceed further; re-check and examine again in detail after the interview process with the relevant company(s) in that particular application segment.

An interpretation of the final summation score for the detailed requirements is explained as follows in terms of the final summation score:

0-35 – Low value business opportunity; do not proceed further with the respective application segment

36-70 – Reasonable business opportunity, assess the possibility of good growth potential in that particular application segment.

71-105 – A likely valuable opportunity to proceed further; list measures to overcome risks and to improve the weak areas by examining in detail.

106-138 – A highly valuable and best business opportunity to proceed further;

If a particular application segment is a reasonable business opportunity or good business opportunity or highly valuable business opportunity, then user or organization can carry out the recommended steps mentioned in the chapter of “conclusions and recommendations”.

6.4 Example of evaluating an application segment

For example, we show how the food industry application is evaluated with our different requirements and their corresponding weights. The example also shows how the questionnaires are helpful for the evaluation part of this thesis.

The recommended steps for this food industry application are added in the appendix of this thesis. Even the recommended steps were also done for this application to show how the further steps were done after evaluating a new application.

Case study for a food industry application

The food industry has been targeted as an interesting segment to penetrate for Uponor. Contact was made with an engineering consultant appointed to design a new plant for food company A. This company will produce and handle compounds and fluids in its plant.

Engineering questions:

1. What is the current material used in the application and what are its main properties?

Stainless steel pipes and welded fittings

2. What are the properties of your product?

The material is resistant to acids and aggressive cleaning chemicals. Stainless steel is resistant to temperature and pressure.

3. What are the advantages and disadvantages of the current material used? The main advantages/disadvantages are the following.

Advantages

Stainless steel is a robust material suited for the purpose

Disadvantages

Expansion and contraction result in material stress and rupture.

High cost regarding the material itself, as well as qualified welding work.

4. What is the price estimate for the current material used, and what are your views about price for the new material?

The estimated cost is 2 million euros for stainless steel. Material 800000 euros and labour 1, 2 million euros. A PEX installation is estimated to cost 1, 4 million euros. Material 280000 euros and labour 1, 12 million euros.

5. What are your thoughts on replacing the existing material?

The consultant states the following areas:

Is the material certified for the food industry?

Connection techniques and fittings

Maintenance

UV resistance

Opacity

6. What technical requirements should the new material satisfy?

The materials must comply with the following requirements:

Standards (according to 7)

Temperature of 70°C during operation and 85°C during cleaning cycles; 1 hour every 24 hours.

Pressure of 3 bar

Smooth internal surface, low friction, seamless joints and no pockets for bacterial growth

7. What quality standards should the PEXa material satisfy in that application segment?

Standards

FDA XXXX

NSF XXXX

CE XXXX

8. What accreditations or certifications does Uponor need to supply that product to you?

Existing approvals and certifications are related to the construction industry within the areas of plumbing (fresh drinking water) and heating.

9. What type of flexibility is required to manufacture that product?

Easy maintenance and cleaning

10. What type of service is essential for that product?

Availability of spare parts within 6 hours from order.

11. What kind of support is needed for that product?

Training and support during installation, stock of spare parts.

12. How do you expect the delivery precision of that product?

The delivery time as agreed but not longer than 4-6 weeks.

13. What type of experience do you expect to require for manufacturing this product, and what are the resources that you feel are mandatory for manufacturing this product?

Question to be amended or removed

14. Briefly state your thoughts about environmental effects and sustainability in regard to this product.

Environmentally friendly because plastics require less energy to be produced.

15. Can you think of a specific component where a high-tech plastic can replace metal or do you see any area of expensive components where you can appreciate a price reduction for more competitiveness?

Dosage manifolds in filling stations could be replaced by PPSU manifolds

Marketing questions:

1. What would be your purchasing criteria for new material?

See points 1 and 2 above.

2. Briefly describe your thoughts about the supply chain and logistics for this product?

Tailor-made products delivered from the factory to our site or warehouse.

3. How many products are sold per year? Or what is the sales volume of the current product per year?

Tailor-made products for every project. Total contract sum is the interesting feature.

4. How often do you buy this product?

This consultant company is involved in two new plants in the Nordic countries every year and an additional plant in continental Europe.

5. What is the increase or decrease in product volumes over the past 5 years?

This will increase volume because it is a new application.

Table 11 – Evaluation of food industry application with basic requirements

Basic requirements:

Different requirements	**Weighting factor**	**Application segment 1**		**Reasons**
	w	v	t	
Market growth	2	3	6	It is a new application, and total contract sum is an interesting value.
Customer base	2	2	4	Two plants in the Nordic countries and an additional plant in continental Europe
Innovative Leadership using prior experience	2	3	6	We have required approvals and certifications and are already an expert in fulfilling similar kinds of engineering needs
Feasibility of application	3	3	9	PEXa already satisfies many of

				their engineering requirements characteristics
Management team effectiveness	2	3	6	We can train and support during installation and are able to deliver the product within their delivery time
Compatible with Contextual experience	3	3	9	We are an extensive supplier of pipes for drinking water applications and can do the same in this application. Additionally, approvals and certifications are the same as those of the construction industry.
Suitable pipe size and pipe shape	4	3	12	Matches with the continuous process of Uponor
Suitable transportation fluid	4	3	12	PEXa has high resistance to aggressive chemicals and acids. Cross-linking of PEXa also prevents in rupture. Most technical properties of current application matches with the technical properties of PEXa.
Low-weight requirements	3	0	0	Not needed for this application
Competitive pricing	3	3	9	PEXa price is much less than stainless steel, and this application also requires less price
Require unique jointing technology	3	3	9	Requires seamless joints and no pockets for bacterial growth, so our unique joining technology will be of great aid
Need low friction	3	3	9	This application also requires low friction
Clean transporting	3	3	9	As required for fluids

need				in related food application
Suitable temperature and pressure	4	3	12	PEXa has suitable temperature and pressure required for this application
Overall score (T)			112	

Because the overall score is 112, this is a best business opportunity to proceed further.

Detailed requirements:

Table 12 – Evaluation of food industry application with Engineering- and Market-allied requirements

Engineering- and market-allied requirements

Different requirements	**Weighting factor**	**Application segment 1**		**Reasons**
	w	v	t	
Suitable material with properties	4	3	12	PEXa material properties match with the technical properties of this application
Suitable price range	3	3	9	PEXa replacement will drastically reduce the overall price for this application.
Customer reliance and convergence	2	3	6	Reliable customer and possibility of good business in the future because of increase in volumes with new application
Customer communication	2	3	6	Answered the questions well and have good relationships with their suppliers
Competition differentiation	2	3	6	Completely new application
Long term partnerships and supplier networks	2	2	4	They maintain long term relationships with suppliers
Market establishment	2	3	6	First to market, so there are many possibilities for us to be a market leader in this

				application in the future

Table 13 – Evaluation of food industry application with Innovation- and Business-allied requirements

Innovation- and business-allied requirements

Different requirements	Weighting factor	Application segment 1		Reasons
	w	v	t	
Technological differentiation	3	3	9	We are technically sound; very good technical properties and good cost benefits compared to their present material
Innovation based on customer needs and requirements	2	3	6	Our unique joining technology solves the customer needs
Feasibility of realisation	3	2	6	It is feasible
Intellectual Property Rights issues (IPR issues)	4	3	12	Sold mostly in Nordic countries and continental Europe, where IPR is valid
Growth in the business	3	3	9	Due to increase in volume
Value creation	3	3	9	High perceived value creation with a high profit margin
Risk	3	2	6	Risks are possibility of new entry into this business by a competitor, risks of failing if the new application industry fails and low cost Asian competitors

Table 14 – Evaluation of food industry application with Quality- and People-allied requirements

Quality and people allied requirements

Different requirements	Weighting factor	Application segment 1		Reasons
	w	v	t	
Suitable to our current quality	3	3	9	Existing approvals related to

standards				construction industry are sufficient for this application; PEXa already has required approvals
Feasibility of required quality certifications or standards	4	3	12	No need for new quality certifications
Staff capability	1	3	3	Can be performed by our staff members
Overall score			130	

Because this food industry application has an optical score, it is selected as a best opportunity for Uponor to proceed further.

7 Conclusions and recommendations

Finally, this chapter provides the quick analysis of the developed framework and qualification criteria and presents overall conclusions from the results discussed. At the end of this chapter, recommendations have been suggested. (Miles & Huberman, 1994)

Quick analysis:

The above developed framework for identifying and selecting different application segments proved to be successful because the developed framework helped to identify and select more than 10 new application segments. As Uponor does not have any approach for identifying application segments, the developed framework is recommended to Uponor because it is very systematic in its approach.

The above developed qualification process description was tested using a case study for a food industry application. The test results proved to be good because the developed method evaluated that application segment in all the possible factors and gave a concrete result to find whether that particular application segment is a good business opportunity or not for the company. The test results also provided additional details required for performing the further recommended steps of this thesis. Furthermore, the developed qualification process consists of all possible requirements and their weights with which an application segment can be evaluated and it is more structured than Uponor's current way for evaluating an application segment. Therefore, the developed qualification process is considered to be a best replacement of Uponor's current way for evaluating an application segment.

Conclusions:

The conclusions summarize the researcher's personal opinion regarding this thesis and are mainly focused toward industrial personnel from Uponor.

The first deliverable of this thesis is to identify and select the different industrial segments in which PEXa can be used. Uponor wanted to find new industrial segments to broaden their industrial application customer areas. A structured methodological approach is used here to locate current and new industrial application segments for PEXa. The current industrial application segments aided the author in understanding Uponor's current industrial applications, and the new industrial application segments will aid Uponor with a list of future application segments that can be explored to expand their business areas.

The abovementioned new industrial application segments also laid the foundation in this thesis for the first part of the second deliverable, which is to map the continuous process of Uponor. Initially, mapping was performed to match the new industrial application segments that use tubing structures with circular diameter because Uponor wanted to target those industrial applications that required some type of tubing structure. The mapping of the continuous process filtered out the industrial application segments that were not suitable for Uponor. After mapping, the satisfactory application segments were evaluated against Uponor's strengths and material capability; this step assisted in locating the most appropriate industrial application segments for further advancement.

As a second part of the second deliverable, a questionnaire was developed to equip Uponor with the essential questions to be asked during interviews with the relevant company personnel in the selected industrial application segments. The classification of questions as Engineering and

Marketing also simplifies the process for Uponor to gain answers from the relevant Engineering or Marketing representative. As a component of the second deliverable, companies were identified in the selected industrial segment, which reduces the additional time Uponor would need to locate the companies in those application segments and to interview a relevant person from those listed companies.

The third deliverable is the qualification process description; this step helps Uponor to score the selected application segments with respect to the different requirements and their weights, and to find the high-value business opportunities among those different application segments. The different requirements are grouped in two categories, different basic requirements and detailed requirements. Different basic requirements can be used by Uponor to evaluate an application segment even before the interview process. The different detailed requirements assist Uponor in evaluation of an application segment after an interview with a relevant person from that company.

Recommendations:

Several recommendations that Uponor could consider in the future are presented below. The recommendations mostly pertain to this thesis and act as further steps that could be taken as an extension.

- It is recommended that Uponor carry out interviews with the company(s) in the selected industrial application segments to evaluate the application segments with respect to the qualification process description. Next, it is recommended that Uponor identify the highly valuable and best business opportunity application segments that have very good overall final summation scores with respect to the different requirements.
- Different quantitative market research methods that are explained in this thesis are suggested for further reading for the researcher or an organisation when evaluating market size and size of market segments; these sources provide good theoretical references before the actual evaluation of different quantitative factors.
- In addition, new activities such as regular discussion with Uponor's key people and participation in trade fair are suggested to Uponor for getting insights about new application segments and developing new contacts of different companies in new application segments.
- Next, it is suggested that Uponor define the barriers, challenges and costs for entering those highly valuable industrial application segments. This process will help Uponor to follow through with respect to certifications, quality standards and environmental and sustainability efforts.
- Next, SWOT analysis is recommended for the highly valuable industrial application segments because this technique will help Uponor to categorise their strengths and weaknesses with respect to the particular business opportunity. This analysis also uncovers opportunities for proceeding with those application segments and aids in understanding potential threats such that Uponor can work to eliminate those threats and compete successfully in the market.
- Finally, it is also recommended that Uponor evaluate the market potential, sales forecast and market share with respect to those highly valuable application segments to compare with other different industrial application segments.

- An example of the last 3 recommended activities has been carried out and is shown in Appendix A for future reference to both Uponor and to any user.

Other general recommendations for Uponor are given below:

- Study of the market opportunities for PEXa in developing countries, such as India, Bangladesh and Sri Lanka, is also recommended because these countries have a high gross domestic growth in the region of South Asian. These countries are investing heavily in their infrastructure to develop their countries, and there is less risk in these countries for copying our patented technologies.

Bibliography

Aaker, D. A., Kumar, V., & Day, G. (2001). *Marketing Research.* John Wiley & Sons, Inc.

Alreck, P. L., & Settle, R. B. (1994). *The Survey Research Handbook.* Irwin.

ASB Central. (2011). *ASB Central.* Retrieved November 16, 2011, from ASB Central Website: http://www.asbcentral.com/marketing%20pdf/potential.pdf

Berk, K. N., & Carey, P. (2009). *Data Analysis with Microsoft Excel: Updated for Office 2007.* Cengage Learning.

Blankenship, A. B., Breen, G. E., & Dutka, A. F. (1998). *State of the art marketing research.* McGraw-Hill Professional.

Bradley, N. (2007). *Marketing research: tools & techniques.* Oxford University Press.

Brassington, F., & Pettitt, S. (2006). *Principles of marketing.* Pearson Education.

Brown, R., Lilien, G., & Ulvila, J. (1993). New Methods for Estimating Business Markets. *Journal of Business-to-Business Marketing , Vol.1(2)*, 33-57.

Burns, A. C., & Bush, R. F. (2005). *Marketing Research* (5th Edition ed.). Pearson International Edition.

Christ, P. (2009). *KnowThis: Marketing Basics.* KnowThis Media.

Churchill, G. A., & Iacobucci, D. (2009). *Marketing Research: Methodological Foundations.* Cengage Learning.

Derveer, C. V. (1994). Quirk's Marketing Research Review. *Tips for selecting the best methodology for industrial marketing research* .

FastTrac TechVenture. (2008). *Take Charge of Your Business, A program of the Kauffman Foundation.* Ewing Marion Kauffman Foundation.

Fine, L. G. (2009). *The SWOT Analysis: Using Your Strength to Overcome Weaknesses, Using Opportunities to Overcome Threats.* CreateSpace.

Gates, R., & Jarboe, G. (1987). Changing trends in data acquisition for marketing research. *Journal of data collection , 27* (1), 25.

Holme, I., & Solvang, B. (1991). *Research. The qualitative and quantitative methods.* New York: University Press.

Kvale, S. (1996). *Interviews: An Introduction to Qualitative Research Interviewing.* Sage Publications.

Lenman, T., Skarelius, J., Svenson, P. A., & Westberg, M. (1995). *Water and Pipes.* Wirsbo Bruks AB.

Malhotra, N. (1996). *Marketing research, an applied orientation* (2nd ed.). Prentice Hall international edition.

Marsden, P. V., & Wright, J. D. (2010). *Handbook of survey research* (2nd ed.). Emerald Group Publishing.

McDaniel, C. D., & Gates, R. H. (1998). *Marketing research essentials.* Taylor & Francis.

McQuarrie, & Edward, F. (2005). *Market research toolbox; A concise guide for beginners* (2nd ed.). Sage Publications.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook* (2nd ed.). SAGE Publications.

Mindtools Brainstorming. (n.d.). Retrieved September 10, 2011, from Mindtools: http://www.mindtools.com/brainstm.html

Morich, M. F. (1988). Quirk's Marketing Research Review. *10 steps to improve business/industrial research* .

Pahl, N., & Richter, A. (2009). *SWOT Analysis - Idea, methodology and a practical approach.* GRIN Verlag.

Parasuraman, A. (1991). *Marketing research* (2nd ed.). Addison-Wesley.

Parasuraman, A., Grewal, D., & Krishnan, R. (2006). *Marketing Research.* Cengage Learning.

Plastic Pipe and Fittings Association. (n.d.). Retrieved May 10, 2011, from Plastic Pipe and Fittings Association Website: http://www.ppfahome.org/pex/historypex.html

Raghavarao, D., Wiley, J. B., & Chitturi, P. (2010). *Choice-Based Conjoint Analysis Models and Designs.* CRC Press, Taylor & Francis Group, A Chapman & Hall Book.

Rebernik, D. M., & Bradač, B. (2009). *Idea Evaluation.* Maribor: Univerza v Mariboru.

Ulrich, K., & Eppinger, S. (2003). *Product Design and Development* (3rd ed.). McGraw-Hill/Irwin.

Worcester, R. M. (1972). *Consumer market research handbook.* Madison, Wisconsin, United States: McGraw-Hill.

Appendix A- Recommended steps for a food industry application

1. Barriers, challenges and cost

The barriers, challenges and cost for entering the application segments can be assessed by identifying the quality standards that the PEXa should satisfy for entering those application segments, accreditations or certification that Uponor must have to supply that product, environmental and sustainability effects in regard to the product and price estimation for the current material and for the new material. The barriers, challenges and costs for Uponor to enter those application segments are represented in a table shown below for reference.

Table 15 – Barriers, challenges and costs for food industry application

S.No.	Application segments	Barriers, challenges and cost
1.	Food industry	Barriers: 1. Availability of spare parts within 6 hours from order. Challenges: 1. Need to show the certifications for fittings, maintenance, UV resistance and opacity. Cost: 1. The cost for showing all the certifications may cost x SEK.

2. SWOT analysis

The SWOT analysis will be developed by considering the internal strengths and weaknesses of Uponor in light of those application segment requirements, as well as the outside opportunities and outside threats of those application segments (Fine, 2009).

The model template of SWOT analysis shown below can be used for evaluating different applications. Factors are listed out under the headings of strengths, weaknesses, opportunities and threats, and these factors were identified by personal brainstorming. The listed factors can be considered when evaluating a business opportunity.

Table 16 – SWOT analysis template, Adapted from (Pahl & Richter, 2009).

Evaluating a new business opportunity for PEXa	
Strengths	**Weaknesses**
Advantages of proposition?	Disadvantages of proposition?
Capabilities?	Gaps in capabilities?
Competitive advantages?	Lack of competitive strength?
USPs (unique selling points)?	Reputation, presence and reach?
Resources?	Financials?
Experience, knowledge, data?	Own known vulnerabilities?
Financial reserves, likely returns?	Time scales, deadlines and pressures?
Price, value, quality?	Effects on core activities, distraction?

Accreditations, qualifications, certifications?	Accreditations?
Opportunities Market developments? Competitor vulnerabilities? Global influences? Technology development and innovation? Geographical, export, import? New USPs? New markets, vertical, horizontal? Niche target markets? Business and product development? Volumes, production, economies? Seasonal, weather influences?	**Threats** Political effects? Legislative effects? Environmental effects? Competitor intentions - various? Market demand? Vital contracts and partners? New technologies, services, ideas? Sustaining internal capabilities? Sustainable financial backing? Economy - home, abroad? Seasonality, weather effects?

A SWOT analysis directed to the food industry application is shown below.

Table 17 – SWOT analysis for the food industry application

Evaluating a food industry application for Uponor	
Strengths • Have very good technical properties w.r.t the application • Satisfy all important quality standards • OEM knowledge and skilled personnel	**Weaknesses** • Difficult to send spare parts within 6 hours from order because of distant locations • Stocking of spare parts increases inventory space
Opportunities • Unique material properties of PEXa compared to the existing material used in the application • Increase in volumes because it is a new application and Increase in overall sales for our products • Possibilities of high profits because of new application, and we might be a cost setter in this new industry • Good opportunity for us to enter similar types of application segments in future if we develop experience in this application	**Threats** • Increase in tool costs in future because it is a tailor-made product for every project • Low-cost Asian competitors • Risk of failing if the new application fails • Possibility of new entry by a competitor with optimal cost benefits

3. Market potential, sales forecast and market share

Market potential

Market potential determines the overall amount of possible sales in a market. A company should calculate the market potential before entering an application segment or before proceeding with a business opportunity (Brassington & Pettitt, 2006).

The market potential for the food application industry is shown below and explained on a step-by-step basis for clear understanding. (ASB Central, 2011):

1. Number of companies which might buy our product: 3
2. Assumed possible volume of purchase per company in a year: 50000 units
3. Assumed average cost of a single product: 2500 SEK
4. Market potential for our product with first project: SEK 375000000 per year

Sales forecast

The sales forecast gives an estimated value of sales that a single company expects to generate within a single market. A basic method of calculating a sales forecast is to divide the total market potential for a market by the number of available companies in that particular market. There are additional variables that may exist if there is more than one company in that particular market. A well-managed company with very good strengths will capture more sales than a poorly managed company with many weaknesses (ASB Central, 2011).

1. It is assumed that there are three competitors in this new application market. The formula for calculating the sales forecast is as follows: Sales Forecast = Market Potential/Number of Companies = SEK 375000000/3 = SEK 125000000. This figure indicates our company's expected sales per year. There are also other factors that will affect sales, such as advertising and prices.

Market share

Market share gives the total percentage of sales that a company can expect to gain from a single market. The market potential is calculated by dividing the sales forecast by the total market potential (ASB Central, 2011).

The estimated market share for our company in this market is calculated by the following formula: Market Share = Sales Forecast / Market Potential = SEK 125000000 / SEK 375000000 = 33, 33%

Please remember that the above market share is only estimation, and actual market share should be calculated after one year of sales data is collected and analysed.