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Master Degree Project in International Business and Trade

Commercialize Clean Technologies

A case study regarding commercialization of clean technologies through strategic partnerships in emerging markets

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ABSTRACT

Clean technology has been a growing sector because of emerging environmental issues and stricter regulations derived from these. The cleantech industry has despite its possibilities in this industrial shift experienced high failure rates in the commercialization process. To overcome the high failure rate, several obstacles within the commercialization process have to be recognized, such as the threats from imitators and the institutional void which is especially prevalent in emerging markets. Moreover, complementary assets needed for the often niche clean tech firms has to be accessed in an efficient and cost effective way. A suggested strategy to do this more successfully is to commercialize through a strategic partnership. Through a partnership, firms can receive competitive advantages eventuating in higher profits and more sustainable businesses, especially in these emerging markets where extended safeguard measures may be needed.

The aim with this thesis was to develop a theoretical framework able to derive a partnership strategy for cleantech firms commercializing their technologies in emerging markets. A case study was conducted on the cleantech firm Aquaporin A/S in the potential emerging market of Brazil in order to prove the relevancy of the framework and illustrate its applicability on cleantech firms in general. However, the generalizability of the framework on cleantech firms at large could not be confirmed because of the limitations of a single case study.

Key Words: Clean Technologies, Commercialization, Partnership Strategy, Emerging Markets, Complementary Assets, Case Study

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ABBREVIATIONS

R&D: Research and Development

RBV: Resource-Based View

UPW: Ultra-Pure Water

RO: Reverse Osmosis

FO: Forward Osmosis

PRO: Pressure Retarded Osmosis

1. INTRODUCTION

1.1 Background

1.1.1 Cleantech Industry

In order to understand how to commercialize cleantech firms through partnerships, an industrial background can be helpful. First off, clean technology, referred to as cleantech, is a broad concept that embraces products and services that are environmentally friendly and sustainable such as clean and more efficient energy. Companies within the cleantech sector focus on development of solutions that will make e.g. industries, infrastructures and/or buildings more operational and cost efficient meanwhile reducing pollution, waste and energy consumption. Some of the greater sectors within cleantech are therefore renewable energy, resources and environment, recycling and waste, sustainable transportation and water and wastewater (Swedish Cleantech, 2015). Cleantech firms are because of the industrial nature commonly dependent on defending their intellectual property rights in environments encompassing threats from imitators (Teece, 1986; Nanda & Srivastava, 2009). Poor defending of intellectual property rights does not only have a negative impact on the specific cleantech firms, but it also hampers the global trade with the clean technologies these firms produces (Nanda & Srivastava, 2009).

Investments in the cleantech sectors are of great importance for both industries and the society as a whole, both because of environmental aspects and since estimations points at a 200 to 400 percent higher rate of created jobs when investing in clean energy instead of fossil fuel industries (Pernick, Wilder & Winnie, 2010). The efficiency of these investments could still be questioned, especially from a commercialization perspective of the cleantech firms because of the high fail rates (Johnson & Suskewicz, 2009; Krieger, Faulkner & Haji, 2013).

1.1.2 Commercialize Clean Technologies

Commercialization involves the multiple procedures individuals and firms undertake to transform their ideas to a selling product on the market. There are several strategies to use

when commercializing, and the choice of strategy depends on the innovators vision and philosophy. Two common strategies among innovative firms are to use licensing and strategic alliances. Licensing is typically related to firms with strong focus on innovation and limited sales and marketing activities. If licensing, firms license out their innovations to firms that then manage marketing, sales, manufacturing, engineering and distribution. If an innovative firm seeks to keep control over its innovations they use strategic alliances where they enter an alliance to gain knowledge within marketing, research and development (R&D), manufacturing and possess equity (NIST, 1998). These strategies are also adoptable to cleantech firms who frequently face challenges when trying to commercialize their clean technologies. Smaller firms, such as cleantech firms, often underestimate the need of engineering expertise to develop their products from prototype to mass manufacturing. Consequently, the phase between prototype and manufacturing can be referred to as the "valley of death" because of the high failure ratio of commercialization of clean technologies (Bulkin, 2014; Vella, 2012, Sep). Moreover, cleantech firms are often of smaller scale with limited financial resources, and these are among the most important reasons for their need of assistance from partners in their commercialization (Krieger et al., 2013). This lack of capital is generally seen as one of the greatest obstacles for a successful commercialization, followed by the mentioned lack of engineering capabilities and skills, inappropriate organizational structure or skeptical stakeholders (Bulkin, 2014). An additional factor that is of consideration for cleantech firms, is in what stage of development the particular sector is in, e.g. if the sector is in an experimental phase or have reached maturity. Cleantech firms might finally also face complications when it comes to public awareness and attitudes, government regulations and consumer behavior. To be able to commercialize clean technologies, firms need understand these barriers and strive to change the systematic context in which the technology is embedded. This is a complex process and need to be managed collectively among firms and in cooperation with the stakeholders (Kyrö, 2015).

Cleantech firms may, as described above, find co-occurring issues in their commercialization process because of their often similar specifications and related need for complementary assets (Johnson & Suskewicz, 2009). However, their strategy of

commercialization can be broken down into different segments depending on what theoretical perspective is adopted, but in the end it still comes down to how to maximize profits from the technologies and overcome existing or approaching obstacles (Dyer & Singh, 1998; Mitchell & Singh, 1996; Teece, 1986).

1.1.3 Partnership & Complementary Assets

Cleantech firms do often develop products that are in a direct need of complementary assets, such as the development of critical parts for systems already established in the market. Great investments have been done in these businesses using conventional business models in their cause, but the results are often a misfortune. The integration of the complementary assets is shown to have an important role in the successful commercialization (Johnson & Suskewicz, 2009). Broadly speaking, complementary assets are an important part of the commercialization through partnership according to several theoretical views (Dyer & Singh, 1998; Mitchell & Singh, 1996; Teece, 1986; Brouthers et al., 1995). Thus, the partner strategy becomes of equally important since it is naturally through partners a firm gains its complementary assets if not produced in-house. Different methods of acquiring the assets come with different challenges and opportunities, a collaborative approach can avoid problems correlated with an individual approach and vice versa (Mitchell & Singh, 1996; Teece, 1986; Markman, Siegel & Wright, 2008; Wright, Vohora & Lockett, 2004). A study conducted by Krieger et al. (2013) is one of the authors that argue that partnerships can contribute to cleantech firms' successful commercialization process, even though it is a complex process. Nevertheless, the study further shows that corporate relationships with cleantech firms, or corporate investments in them, both have a higher grade of distressed exits than successful ones. Consequently, even though a firm finds complementary assets of importance in a partner, there are several other factors that must be fulfilled in order to make the relationship, and thus the commercialization, successful in long terms (Krieger et al., 2013).

1.1.4 Cleantech Firms in Emerging Markets

There has been a shift in emerging countries willingness to invest in cleantech. In United Nations Climate Change Conference in 2009 a new acronym was designed and called the BASIC countries, functioning as an alliance based on Brazil, South Africa, India and China, which are the four largest emerging countries (Jolly, 2010). This alliance was constructed to achieve greater influence in world politics, with special focus on climate negotiations (Hallding, Olsson, Atteridge, Vihma, Carson & Román, 2011). These countries have implemented framework legislations, which send out high-level signals to domestic companies to invest in greater energy efficiency and use of renewable energy. Many of the BASIC countries' firms do invest in clean technologies without pressure from state level but rather from a pure business perspective, with focus on cost reductions and energy security. The levels of investments in clean technologies varies between the countries depending on their economic size and growth rates, but is expected to see an increase in the near future (Jolly, 2010; CDP, 2010)

The demand for clean technologies from domestic firms in emerging countries has created major opportunities for international cleantech firms to invest in them (CDP, 2010). But first they have to overcome the countries' institutional trade barriers to be able to invest in them, which are generally harder in emerging countries than in developed countries. Institutional trade barriers to an effective market can take the form of high levels of regulations, and weak legal frameworks and enforcements, e.g. in terms of intellectual property rights (Estrin & Campos, 2007). For a firm to receive a transparent view of the market opportunities, firms might need to embed themselves with local politicians. Firms might also need to do this in order to obtain critical resources from the market. These factors make emerging markets more complex and influence firms' strategic choices of commercialization strategies (Meyer, Estrin, Bhaumik & Peng, 2009).

1.2 Problem Discussion

Traditionally, capital is seen as one of the greatest critical assets, together with the correlating aspect of cleantech firms' smaller scale and other limited resources and

capabilities, constraining them from commercialize their products into new markets. Additional aspects, such as underestimations of the need of engineering skills to manage the development of prototypes to mass manufacturing, and the consideration of the level of maturity the certain industry is in, also influence the success rate negatively (Bulkin, 2014; Krieger et al., 2013; Kyrö, 2015).

Besides, challenges arises for cleantech firms when commercializing in emerging markets, where institutions influence the market with non-market forces, which affect the ease of commercialization and in turn to do business. To overcome these obstacles it is argued to be beneficial in certain situations to commercialize together with a partner that can provide the complementary assets needed (Estrin & Campos, 2007; Krieger et al., 2013; Teece, 1986). Partnerships can be established in several ways through a variety of set ups, which are decided based on several factors. To be able to successfully commercialize and earn revenues from the innovations, a plan of how to commercialize through partnership is therefore necessary. Moreover, earlier research regarding commercialization strategies have been inadequate regarding the application of commercialization theories in the emerging markets (Xu & Meyer, 2013). This thesis will therefore enlighten the purport of strategic partnership and how it is created as part of a commercialization strategy in emerging markets.

1.3 Purpose & Objectives

This thesis intends to develop a theoretical framework for how cleantech companies can commercialize their technologies in emerging markets through strategic partnership. This framework will seek to be developed from research in existing literature, and its applicability in reality will be analyzed in relation to a case study. The case study thus aims at providing sufficient information and understanding for making an appropriate analyze and draw justified and related conclusions, regarding the contributions from and applicability of the developed framework.

The main objective of this thesis is to foster cleantech companies' commercialization of technologies in emerging markets through a theoretical framework guiding firms in how to do this through strategic partnerships in these markets. By exemplifying this theoretically in the emerging market of Brazil, based on a case study of the cleantech firm Aquaporin A/S, the objective is additionally including the guidance of how this can be applied in in a real case. Together, these objectives intend to contribute to top management decision processes in the situations studied through giving them a clear guidance of the decision process.

1.4 Research Question

The purpose and objectives leads this study towards the following research question:
How can cleantech firms commercialize through partnerships in emerging markets?

2. METHODOLOGY

This method has the intended purpose of giving the reader a clear view of how the research is carried out and why the certain methodology is chosen. In this chapter, definitions are therefore given in specific around how the thesis is designed, how the research will proceed, how progress is evaluated and what constitutes a successful research. These are followed by insights regarding the thesis' trustworthiness in terms of creditability, reliability and validity. Explanations will be given regarding of how all these steps are justified in order to conduct the research and what limitations are affecting it. This chapter will also be identifying the research paradigm simultaneously with the procedures mentioned. However, in order to understand the methodology, a holistic view of the research is first provided.

2.1 Holistic View of the Research

First off, Aquaporin A/S is the chosen company for this case study. This choice came naturally because of the authors' interest in environmentally friendly businesses, and the coincident regarding the supervisor's friend at the Danish cleantech firm Aquaporin A/S. The company had not commercialized yet, whereupon it is now the subject for this thesis. Brazil is the chosen market, simply because it is a developing market with water treatment issues. This case study starts with an introduction providing the reader with relevant information regarding the research topic leading to the formulation of the research question, and the definition of its purpose and objectives. The introduction is followed by this method where insights are given in how the thesis is designed in order to answer the research question. A theoretical framework will afterwards create a guiding base for how commercialization can be carried out through a strategic partnership in an emerging market for a cleantech firm. This framework consists of three theories namely resource based view, institutional view and relational view. The framework is grounded in Teece's (1986) resource based theory of profit from innovation because of its emphasis in complementary resources, which is strongly related to the problematic of commercialization of clean technologies. It is also rather related to the western institutional context, which is why an institutional view has to be added when looking into

an emerging market such as Brazil. Its neglecting of the possibility to derive relational rent through joint idiosyncratic contributions in a partnership made this third, relational, view important in this context. This framework will, together with a following chapter containing empirical material gathered from Aquaporin A/S and the market of Brazil, be used in the analysis of a suitable partnership strategy for Aquaporin A/S commercializing its technologies in Brazil. Furthermore, the applicability of the framework in cases of cleantech firms in general will be analyzed in relation to the analyzed case study. Finally, conclusions are drawn, together with suggestions for improvements and further research.

2.2 Design and Implementation

The methods used in this research are assumed appropriate for giving the answers to the research question formulated. This is first projected in that the thesis is designed mainly around logic of deductive reasoning with its starting point in existing theory around commercialization of cleantech firms through partnership in emerging markets. From existing theory originating in the resource-based, institutional and relational view, a hypothetical applicable framework is created and implemented in a case study in order to analyze whether the framework is theoretical applicable on a specific cleantech firm entering an emerging market (Collis & Hussey, 2013; Eriksson & Kovalainen, 2008). A case study is argued by Yin (2013) to be considered as a suitable approach when there is a need of retaining an answer of how and why in a specific circumstance. This research comprises both the elements of how to commercialize and why do it through partnership, and thereby strengthens the choice of conducting a case study. As most cases of social research, there is also an influence of inductive reasoning in addition to the deductive (Eriksson & Kovalainen, 2008). In this thesis it took the form of an extended theoretical framework comprising an institutional and relational view of the matter derived from the understanding that the resourced-based view wasn't enough to cover the case of a cleantech firm entering an emerging market. The theoretical framework works as a guideline for the study to follow and a structure making the findings in the case study illustrative and useful for others. A single case study makes this research illustrative rather than generalizable which would be in accordance with an exploratory purpose suggested

by Polit and Beck (2004). An exploratory approach would also be suitable in work like this where the problems behind the commercialization of cleantech firms in emerging countries has not been clearly explained (Connelly, 2014; Collis & Hussey, 2013). However, a single case study may not be qualified as a ground for generalization according to Eisenhardt (1989), and may instead function as an illustrative case study since it is reasonably descriptive of a certain situation (Mann, 2006). Eisenhardt (1989) further states that at least four cases is necessary in order to generate theory, but more than ten cases does on the other hand contribute with difficulties related to complexity and too vast data volumes.

The research question, and thus the formation of a case study on a specific firm in a specific emerging market, opens up for an empirical study of them both after the theoretical framework is being created. This starts with the acquisition of data from Aquaporin A/S, which is a Danish cleantech company currently working on their global commercialization process of their Aquaporin Inside™ technology. The data collection from Aquaporin A/S is followed by the market analysis of the emerging market of Brazil. The detailed methodology for data acquisition is explained in the section of "Methodology for Data Acquisition". Nevertheless, a case study is a suitable method to generate a greater understanding of the acquired data which is important in order to know how the theoretical framework can be applied to the situation. Woodside (2010) confirms these aspects of case studies, and states that researchers tend to put great importance in the gathering of data, resulting in first the describing, followed by the understanding and/or controlling the individual case. Moreover, this research is through the aim on emerging markets contributing to multinational companies in a greater sense in comparison to the previously high concentration of international business research aiming at industrialized markets such as US, Europe and Japan. Because of the high growth potential in less developed markets such as Brazil, multinational firms is argued to gain more from putting time and effort on business research devoted to these areas (Sreejesh, Mohapatra & Anusree, 2014).

This design also makes the research confirmatory through its application of existing theory in reality and qualitative in the sense of making that application observatory and

descriptive of the reality (Eriksson & Kovalainen, 2008). The complexity of the context, including the aspects of how things work in the social world of business, makes the choice of a qualitative approach suitable in its critical and reflexive view, together with its sensitivity in giving the reader a holistic understanding of the context. The qualitative approach is further acknowledged since data is primarily collected in a unstructured and rather unstandardized mode in this thesis, which is thus in strong contrast to a quantitative research (Eriksson & Kovalainen, 2008; Ghauri & Grønhaug, 2005)

The analyzing of the theoretical framework and its applicability on the case of study starts with the attempt of deriving a partner strategy for Aquaporin A/S in its theoretical commercialization in Brazil. From there the applicability of the framework is further analyzed in the general case of cleantech firms' theoretical commercialization process in emerging markets. The analyzing is wrapped up by looking into the contributions to top management in international businesses. This together with the applicability analyze suggests that the findings is applied for improving the situations of cleantech firms and/or help in solving specific problems for managements, and thus classifies this research as applied research (Collis & Hussey, 2013). From this, it can be said that the analysis includes the connections between the Aquaporin A/S in the case study and cleantech firms in general, in terms of using a partnership strategy when commercializing in an emerging market. The analysis is thus harmonizing with the qualitative spirit of the thesis, and is therefore provided with a hermeneutic approach promoting the contextual and holistic understanding, which is also in strong relation to the approach of connoisseurship and interpretivism (Willis, 2007).

Finally, the conclusions are drawn from the findings in order to answer the research question in a refined manner, and with a clear relation to the research purpose and objectives. This is in accordance with the design suggested by Sreejesh et al. (2014) whose design is further followed in terms of the presentation of the conclusions as first-hand knowledge. The reader is after the conclusion given suggestions for improvements and further research. These final parts relies on a well-structured, consistent, and relevant

methodology in order to make it possible for the reader to follow and assess the research properly (Russell, Gregory, Ploeg, DiCenso, & Guyatt, 2005).

2.3 Data Acquisition

The empirical data in this thesis is primarily collected in an unstructured, and rather unstandardized, mode of interviews in face-to-face, through Skype conversations and through open dialogues in email conversations, combined with pre formulated questions also addressed through emails and companies' contact formularies on their webpages. The interviews are prepared with the formulation of bullet points of interest for the occasion, whereupon the points are sent to the interviewee a day before in order to be able to prepare and be given a heads up of what will be discussed. During the interviews, the bullet points only works as guidelines and is not followed thoroughly. Collected data is thus following a qualitative approach in accordance with the research paradigm, hence it is mutually relying on a qualitative analysis of the data which is dug deeper in later on (Collis & Hussey, 2013). The qualitative data collected is not translated from its original textual form into any sort of symbolic numeric representations in order to maintain its value and avoid any reduction of its content (Berg, 2001).

2.3.1 Acquisition of Preliminary Data

The majority of the preliminary data is derived from in-depth interviews both face-to-face and through Skype with a deputy chairman of the board of Aquaporin A/S who is also a source of information regarding the Brazilian market because of previous experiences as a former external associate professor in strategic management and Brazil expert at Copenhagen business school. The face-to-face meeting is carried out through a field trip to Denmark where the contact lives. Both the interviews are open discussions where bullet points of relevant subjects is prepared and sent to the interviewee a day before in order to have time to prepare for the answers as mentioned above. During the interviews, the discussions will neither follow the bullet points in its specific order, nor solely touch upon the areas included in the bullet points. The trading agency Business Sweden is also a valuable source of preliminary data. Here the data gathering comes from email dialogues,

but they also provide secondary data through a report made in 2014 about the very topic. The email dialogues consist of discussions around the report and gives further insights in the Brazilian water and water management situation that is not possible to gain from the report solely. Even though primary data collection through face-to-face contact has its advantages, such as the availability to explain through physical expressions and the social interactions resulting of meeting in person, there are also several possibilities in online research. First of is the speed of obtaining responses, followed by the lower costs of no need for travel. Moreover, total confidentiality is possible together with that the respondent can respond when it is convenient (Sreejesh et al., 2014).

Regarding local primary data, a state owned water and wastewater management company named Sabesp is contacted through a pre formulated email with a few short and specific questions. In other words, a more structured way is conducted in order to gather the information in comparison to the first unstructured interviews and email dialogues. According to Business Sweden (2015), this company is of great importance since it is operating in São Paulo, one of the most promising business areas within the sector, and is the biggest water and wastewater management company in that state. Copasa is the corresponding company, of almost equal importance, in Minas Gerais who is contacted in the same way. Only Sabesp responded with straight answers, meanwhile Copasa responded with demands of an official document which they in turn did not answer to. The pre formulated email can be seen in Appendix C and was formulated in a greater effort of gathering first source data and gather more information around the Brazilian water treatment market and its most important players.

2.3.2. Acquisition of Secondary Data

A broader view of the players in the Brazilian market is seen as preferable which is why an extended gathering of local data is firstly gathered from secondary sources, but is exchanged to primary data when possible. In order to do this, pre formulated emails is sent to potential partners and buyers able to implement Aquaporin A/S's membranes in their water treatment systems, and to other potential local end customers in term of buyers of

complete water treatment systems. In total, 19 potential partners and buyers, and 17 potential end customers were contacted. In the case of the potential end customers, the same email as the one sent to Sabesp and Copasa is used. The pre formulated emails can be seen in Appendix C, and all the companies contacted can be seen in Appendix D.

Moreover, complementary information is gathered from secondary sources when preliminary ones are not available or simply not necessary. Secondary sources does here take the form of previous research, existing datasets, government records and media, news articles, and relevant companies' web pages. Examples of secondary data is specifications of technologies used in certain water treatment plants in São Paulo which is found on Koch Membrane Systems' web page, since they were the supplier in one of the water treatment plant studied in the area. Another example of importance is the acquiring of information about the dominant design paradigm in Brazil from secondary sources, as a complement to the information gathered from the primary sources. For example, great insights from a recently published article are used where the author already had conducted that specific research. Certainly, secondary data can be inaccurate because of errors in the processing of that information and because of personal bias (Sreejesh et al., 2014). Consequently, primary sources of the data have always been strived for when suitable for the cause of the thesis. Sometimes however, the secondary data give rise to some primary data through the exposure of company names of interest and thus guides the collection of primary data. In fact, secondary data is argued to be able to both complement and substitute primary data in order to avoid unnecessary cost and effort together with overcoming additionally difficulties in gathering primary data within business ethics and thus increase the potential of the research (Cowton, 1998). In this case, it is for example of great value to find companies of interest for primary data gathering, in other secondary data as mentioned before.

2.4 Evaluating the Results

The results are evaluated by analyzing the acquired data from the case study through the lens of the partnership strategy for commercialization of cleantech firms in emerging

markets created in the theoretical framework. Specifically, the applicability of the framework is tested and illustrated by using prerequisites of Aquaporin A/S together with acquired data from the Brazilian market. The result is considered successful if the framework; at first, derives a partnership strategy that seems feasible and relevant in the theoretical commercialization in an emerging market in the case of, and according to, Aquaporin A/S themselves targeting Brazil, and secondly, theoretical applicable on cleantech firms in general resulting in a reasonable solution for commercialization in emerging markets. As the analyze of the results from the research focuses on the understanding of human actions and their intentions, the necessary philosophy of hermeneutic epistemology is adopted as a position in this evaluation (Eriksson & Kovalainen, 2008; Alvesson & Willmott, 2003).

The applicability of the theoretical framework is being analyzed from the case study, thus the analysis becomes the requirement put in place to evaluate if the purpose of the thesis is successfully achieved. Since this thesis aims at contributing to business research it includes the objective of giving a clear guidance to top management in the situation studied. According to Sreejesh et al. (2014), a business research should have the key objective of providing the top management with information that is both accurate and relevant. Additionally it should also be timely in order to contribute to the decision-making process the organization has to follow when faced with a problem or opportunity. The authors mentions four decision-making steps relevant for top managers, namely: problem/opportunity identification, problem/opportunity prioritization and selection, problem/opportunity resolution, and finally implementing the course of action (Sreejesh et al., 2014). Therefore, these steps are part of the evaluation of what constitutes a successful result from this thesis.

2.5 Credibility, Reliability and Validity

From the perspective of the reader, validity or credibility can be assessed with new eyes and with different angles, hence it was important to write a straightforward research question. From there, the reader could follow what is appropriate and what is not in terms

of the choice of research method and the data collection, managing and analyzing (Russell et al., 2005). The writing of limitations of the research design was also a way to provide validity to the thesis, instead of dishonestly ignore its existence (Sreejesh et al., 2014). Regarding the data, it has been compared between different sources to confirm the findings and enhance its quality (Knafl & Breitmayer, 1989). This research used as much primary sources as possible when the case benefited from it. Important were also secondary sources in cases where the primary sources were not necessary or simply not available. A variety of methods were used in both the cases of gathering primary and secondary sources. Through this use of several sources of data acquired through different methods, the data credibility of this case study was increased (Yin, 2013).

A small fragment of the data collected in this thesis is gathered from databases. According to Richards and Richards (1994), this form of data source is problematic in the sense of distancing the researchers from the data, and accordingly making this research less bias. The company of interest in the case study performed here also needed to be kept on distance from the researchers. Not only in order to avoid analyzing and interpreting the data overly optimistic but also in order to not lose a critic view when, e.g. interviewing the board member of the company who of course can have a more personal, and thereby a more optimistic, connection the company. The same goes for the interviews of the expert in the Brazilian market, which similarly is of great interest to him. By only being aware of these aspects, the traps they bring are more likely avoided. Moreover, because of the search for raw data to the empirical part, the questions to primary sources were of the same nature. The risks of that the respondents did not understand the questions or that the answers became open for interpretations were thus minimized, consequently leading to increased reliability (Sreejesh et al., 2014).

The greater purpose of this research is to create a framework possible to derive a partnership strategy for commercializing cleantech firms in emerging markets dependent on the prerequisites of the firm. The validity of testing the applicability of the framework based on one firm's situation may be become vague. The validity is rather strengthened by the sources used for the creation of the framework and the method used for its

development. In comparison to the flowchart from Teece (1992a) the extension with the institutional and relational view intended to increase the content validity through measuring the relevant variables (Sreejesh et al., 2014).

2.6 Limitations of Research Design

Firstly, the theoretical framework is generalized for cleantech companies as such. It is consequently neither takes into account the differences in organization size, nor the characteristic of whether it is a global, multinational, or transnational cleantech firm. These characteristics does have influence in the acting of firms but here it is seen beyond that and the theoretical framework is grounded in complementary assets instead, which sometimes can be the difference derived from the characteristics mentioned.

Neglected are several characteristics of the markets more than their classification as emerging markets. An institutional view is given to point on different aspects of importance in these emerging markets but for the cause of commercializing a cleantech firm in one of these, it will look differently. The institutional view may therefore not directly guide a cleantech firm in its decisions regarding the commercialization process, but rather provide information of what has to be considered. Moreover, the market research is limited by the qualitative research design since this is not giving clear numeric answers of situations that could benefit from it, e.g. the study of the most used products in the market. On the other hand, a more structured research does in turn also result in limitations through inflexibility and lack of understanding in interviews etc., but would as mentioned contribute in certain cases (Eriksson & Kovalainen, 2008; Sreejesh et al., 2014).

The thesis is only covering commercialization alternatives through strategic partnership without looking into other opportunities. Thus it has to be remembered that the commercialization process described here is one of many alternatives, but the partnership strategy is the one alternative described and argued for here. Negative aspects of partnerships will be brought up, but not in comparison to other specific commercialization strategies than those included here.

The case study used for testing the applicability of the theoretical framework is made on a single company and a single market. The case thus become affected by specificities in the specific case and niche in terms of that it is a study of a single segment within the cleantech industry in a single market, namely the water treatment sector in Brazil. Primary sources of data are used for the case study, but have to be complemented with secondary data in, e.g. those situations primary data cannot be gathered. Some of the primary sources is not met in person and undermines the deeper understanding possibly gained from personal interactions (Sreejesh et al., 2014).

3. THEORETICAL FRAMEWORK

This theoretical framework first includes the resource-based view (RBV) brought by Teece (1986) regarding how to profit from innovation. This profiting can be done through immediate commercialization by a firm on its own or through different modes of partnerships. The decision of how to commercialize is not only influenced by the market resources obtained and what is needed to be complemented, especially not in an emerging market where the institutions can play a big role in how firms can operate within their borders (Meyer et al., 2009). This does consequently also affect the position of competitors and imitators who may have advantages in these matters if already established in the market. Thereto, if commercialization through a partnership is required, the modes of partnership are not simply based on who is having what market and non-market resources, but also on who can provide most relational rent through joint idiosyncratic contributions in the partnership (Dyer & Singh, 1998). Market resources or assets are here those that are directly connected to the market and its consumption, such as product designs and marketing activities. Non-market assets are those that are not directly connected to the market, but rather influence the market through indirect means, such as political connections and legal counseling.

From the insights above, the following chapter will include aspects of both the RBV, relational, and institutional view. The choice of using a relational perspective as complement to the RBV is strengthen by Xu and Meyer (2013) who points out the frequent use of this perspective in combination with other theories in business studies. The complementary potential can be demonstrated in that the theories around relational rent does, in conformity with the theories from Teece (1986), include the importance of complementary assets, but from a different perspective (Dyer & Singh, 1998). By including the institutional view, the applicability of the framework is adapted to the critical aspect of emerging markets. This has been a growing trend among theories because of this precise applicability and is here a complementary necessity to both the RBV and the relational view (Meyer & Peng, 2005; Peng, Wang & Jiang., 2008).

Mitchell and Singh (1996) strengthens the applicability of the theories from Teece (1986) on cleantech firms because of its similarities in cases of commercializing complex goods as explained later on. The theories application on commercializing cleantech firms through partnerships is further strengthened by Zahra and Nielsen (2002), who proves that successful technological commercialization is correlated with both internal and external human and technological sources. The most important correlation proved is nevertheless between the successful technological commercialization and the formal integration of both internal and external manufacturing sources, indicating the important contribution from collaboration with other parties besides what is integrated internally.

3.1 Commercialization in Theory

Technology commercialization is defined into four elements by Mitchell and Singh (1996, p. 170), namely: ‘‘the process of acquiring ideas, augmenting them with complementary knowledge, developing and manufacturing saleable goods, and selling the goods in a market.” They further state that businesses face two major difficulties in the commercialization of complex goods, and by complex goods Mitchell and Singh (1996, p. 170) mean “an applied system with components that have multiple interactions and constitute a non-decomposable whole.” In other words, complex goods are often the outcome of cleantech firms (Kachan & Co, 2012). Especially since cleantech firms tend to implement their technologies in already established systems (Johnson & Suskewicz, 2009). The first difficulty origins in that complex technology often consist of many dissimilar components, creating a need of specialized expertise in different areas (Mitchell & Singh, 1996; Teece, 1986). A firm might find it a challenge to hold a market leading position in all specialized areas and develop and maintain the abilities to produce and coordinate the components. The second difficulty origins in that the complexity of the process, managed by the firm, requires a variety cost in organizational structure. These costs can be high for low-complex processes too but typically increases with the complexity. If a firm manufacture their own specialized components or buy them from hands-off suppliers, there tend to be problems with quality, respectively coordination (Mitchell & Singh, 1996). Firms can engage in a collaborative approach to avoid issues connected with an individual

approach to commercialization of complex goods (Mitchell & Singh, 1996; Teece, 1986; Markman et al., 2008; Wright et al., 2004). A collaborative approach aids the commercialization of complex goods with access to specialized expertise from other firms, in which the firm is able to hold a leading-position. Moreover with a collaborative approach, coordination and configuration of components acquired from the supplier will achieve higher quality. On the other hand, issues derives from collaboration as well, e.g. in the form of organizational disruption, adaptation difficulties and lost information (Mitchell & Singh, 1996).

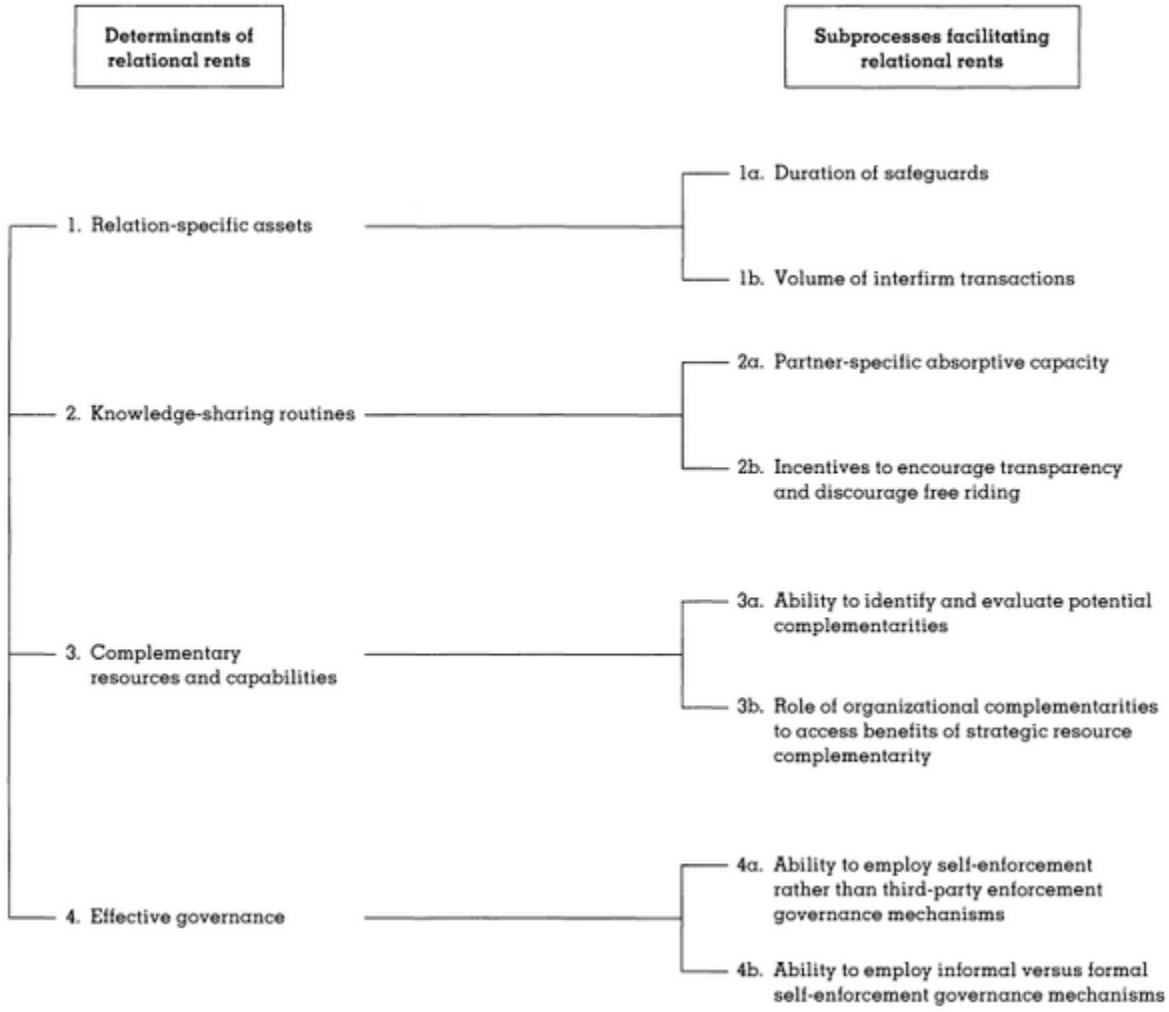
Additionally, according to Gans and Stern (2003) the specific approach of the commercialization strategy also affects the outcome, such as whether it is competitive or collaborative. Their study indicates that technology entrepreneurs gain more innovative rent if pursuing a cooperative commercialization with incumbent firms that harbor important specialized complementary assets when there is a strong protection of intellectual property. Respectively, a competitive commercialization strategy is likely to be of advantage when the protection of intellectual property is weak as long as the entry barriers are low (Gans & Stern, 2003).

3.2 Profiting from Clean Technologies

Strongly related with the commercialization principles brought by Mitchell and Singh (1996), is what referred by Teece (1986), is the goal of profiting from innovation. Teece (1986) frames this RBV into three fundamental building blocks: the appropriability regime, dominant design paradigm, and complementary assets. This perspective has its offset in that innovative firms often generate less profit from their commercialized product or process in the market than their competitors or imitators. The fact that a product meets a certain demand does not grant success for its innovator, but could more certainly do so if the product is better commercialized. Ultimately, it is about maximizing the share of profits in comparison to the shares of the imitators and other competitors, suppliers and customers (Teece, 1986).

In further search for an understanding of why some firms have greater success than others, different theories have been developed about competitive advantages. According to the RBV, performance is based on firm heterogeneity, and that competitive advantage is obtained from firms' resources and capabilities, these resources need to be rare, valuable, non-substitutable and in-imitable. The view can be said to focus on competitive advantages created by the single firm and its environment. The contrasting comprehension of the source of competitive advantage is the relational view (Dyer & Singh, 1998; Jap, 2001; Smith, Carroll & Ashford, 1995; Zajac & Olsen, 1993; Chung, Yam & Chan, 2004). Dyer and Singh (1998) give a relational view on competitive advantages gained from idiosyncratic interfirm linkages, and pointing on the importance of network routines and procedures. This means that a relationship has to be acknowledged within the frames of generating benefits from the relationship itself, and not only from what the partnering firms can contribute to each other in terms of their resources. One example of these interfirm relationships is the arm's-length market relationship which is characterized by non-specific asset investments, minimal information exchange, no common technological and functional systems, minimal transaction costs, and minimal investment in governance mechanisms. This type of relationship makes it easy for companies to engage and break off collaboration, as it is not costly to find new suitable partners. On the other hand, arms-length relationships usually has difficulties to generate relational rent and thus provide lower profits than other relations as they are not difficult to imitate (Dyer & Singh, 1998; Nishiguchi, 1994). To achieve super-normal profits, firms need to engage at a fundamental level by exchange, combine and invest in idiosyncratic assets, resources, capabilities and knowledge, and create effective governance mechanisms that can achieve lower transaction costs (Dyer & Singh, 1998; Duschek, 2004; Chung et al., 2004). These factors are divided in the areas of: interfirm relation-specific assets, interfirm knowledge-sharing routines, complementary resource endowments and effective governance as seen in figure 1 (Dyer & Singh, 1998):

Figure 1 - Determinants of Relational Rent



Description: Shown are the four derived determinants of what creates relational rent.
Source: Dyer and Singh (1998).

These four areas are brought up in relation to the three building blocks of the appropriability regime, dominant design paradigm, and complementary assets from Teece (1986) below. This is done in order to relate the views and put them in better perspective making their differences and complementing strengths more visual.

3.2.1 Appropriability Regime & Effective Governance

Starting with the appropriability regime, Teece (1986) refers to this as the environmental factors that foster the abilities of an innovator to reap the profits from its innovation, excluding the structure of the firm and market. Two areas of importance in the regime are the operations of legal protection from instruments and mechanisms, and the nature of the technology. The first area comprises patents, copyrights and trade secrets where the efficiency of patents could be debated (Teece, 1986). The purpose of patents, copyrights and trade secrets are to protect intellectual property, resulting in the intellectual property to be excluded from competitors and consumers. The exclusion of intellectual property can be difficult to carry out, especially in emerging markets where the non-regulated activities are widespread (Creer, 2004). Trade secrets are in some situations regarded viable substitutes to patents, but only in those cases where a technological secret can be kept even when a product is released to the public (Teece, 1986). Laws are put in place to strengthen the possibility of keeping trade secrets, and is suggested to be both a less expensive and difficult solution than patent protection. However, new technological innovations must not be protected by both patents and trade secret laws, and therefore has only to be protected by either of them. The choice has to be made in consideration of both legal and business aspects in order to derive the advantages and disadvantages following the choice (Beckerman-Rodau, 2002). The nature of the technology includes the degree of tacit or codified knowledge in the technology since this affect the ability of imitation (Teece, 1986). Tacit knowledge is more difficult to transfer than codified knowledge because of its nature, codified knowledge thereby becomes an easier target of espionage (Teece, 1981). Already touched upon is the last including aspects of product and process in the nature of technology, where a process can function as a hub for trade secrets and protect the innovation from imitation. The appropriability regime can thus be classified as weak or tight through these factors contained within the property rights environment, where it is hardly possible to protect technology in a weak environment, but most likely in a tight environment (Teece, 1986).

The factors that fosters the abilities of an innovator to reap the profits from its innovation from a relational view, is partly included in what is called effective governance. Governance

structure is the safeguard for firms investing in an alliance partnership where the construction of the structure determines the outcome of the partnership. There are two forms of governance structure, third-party enforcement and self-enforcing agreements. In third-party enforcement, the risk of opportunism is diminished by contracts that are controlled by a third party in case of disputes. Control of opportunism within self-enforcing safeguards comes from the use of taking economic hostages. Hostages can take the forms of equity or co-specialized asset investments. By invest in co-specialized assets, both partners increase the possibility for higher returns and decrease the risk of partners acting in opportunistic ways. Further definition of what constitutes co-specialized assets will be provided later on. Despite the benefits of strict governance structures, scholars argue that the most effective and least costly governance structure is informal safeguard, such as goodwill (Dyer & Singh, 1998). This is in line with Ill and Gallagher's (2007) arguments about that trust reduce transaction costs and works as a protection mechanism to opportunistic behavior, and therefore indicate a critical element in a partnership formation. If trust is high it can reduce transactions costs, simplify dispute settlements and increase flexibility, consequently resulting in competitive advantages and thus an improved commercialization process. Trust is therefore a critical factor for a sustainable partnership (Ill & Gallagher, 2007; Becerra, Lunnan & Huemer, 2008). Its levels can be difficult to observe and measure but its sources are easier to define, such as social networks, cultural and organizational similarity and reputation. If there is a mutual understanding of how to conduct business, firms will have it easier to trust each other and the risk of opportunistic behavior is reduced in a network as the backlash would be too great. Previous actions based on ability, integrity and openness exercised by the firm also determines its level of trustworthiness of the same reasons. Additionally, firms sharing similar cultures facilitate a greater tacit understanding, and by sharing cultures firms will be able to understand and predict partner's behavior. A firm's reputation is also critical for their trustworthiness, and derives from its legitimacy, which may be created by external sources of recommendation and internal qualifications. The characteristics of the firm's employees also have influence on the reputation, such as experience, education and professional credentials. It can be said that reputation of a firm affects their level of trust in two ways. Firstly, with a positive reputation other actors will know more about the firm, and employees of the firm will be

seen as more stable and perceived transaction costs will be lower. Secondly, trust is easily increased if a firm has a positive reputation of being fair and a considerate partner (Ill & Gallagher, 2007). Based on the arguments of effective governance, Dyer and Singh (1998) states that competitive advantages can be accomplished if governance structures are built upon transaction cost minimizing and value maximizing.

3.2.2 Dominant Design Paradigm

Teece (1986) refers to dominant design paradigm as the stage where a science becomes accepted as standard. The pre-paradigmatic stage is thus the previous stage where no specific science yet has become generally accepted in its field of study. When a standard emerges, only revolutionary science has the ability to succeed it. Threats to an innovator are still prevalent in the possibilities of imitation. If the imitator improves the innovator's design before it becomes the dominant design, the imitator's product has the chance to become standard within the industry which often affects the innovator greatly (Teece, 1986). Sometimes it simply takes time making an innovation the dominant design, accordingly it is important for firms to maintain the vision within the management if the financial and organizational resources prevail (Teece, 2006).

3.2.3 Complementary Assets & Resource Endowment

Commonly, the know how around an innovation has to be applied together with the building block of complementary market assets, developed internally or granted externally, in order to be commercialized successfully. Complementary market assets are almost needed in all cases of innovation commercialization, all the services from marketing to after-sale support (Teece, 1986; Hamel, 1991). These assets can be divided into three segments in regards to the dependence between the innovation and the complementary market asset. A co-specialized market asset represents a bilateral dependence such as the innovation of containerization that required ports and ships to be co-specialized. A specialized market asset on the other hand represents the cases where either the innovation is dependent on the complementary asset or vice versa in a unilateral dependence. The third and last segment of generic market assets represents low

dependence between both the innovation and the asset, e.g. when an asset doesn't necessarily have to be adjusted to a specific innovation. Further on, these assets are also simply called complementary market or non-market assets. Summarized, actors of interest in the commercialization are therefore the innovators themselves, imitators, and the possible partners in possession of the complementary assets. However, a profitable commercialization through strategic partnership requires a careful analysis of challenges and opportunities in order to successfully utilize the know-how in conjunction with other capabilities or assets. Especially small domestic firms with valuable technology and an entrepreneurial mindset, such as many cleantech firms, need this analysis since they often end up with less successful commercialization than larger multinational firms. The reason often relates to that larger firms possess the complementary assets needed at the time of product launch (Krieger et al., 2013; Teece, 1986). What has to be noticed is that Teece (1986) classifies complementary technologies as just another complementary asset because of its low recognition as critical part of the innovation process during the time of study. Its significance as a bottleneck asset is important to keep in mind (Teece, 2006).

Seen from the relational view, it is rather a matter of complementary resource endowment originating in the non-market resources of a potential alliance partner, which together have the possibility to create greater relational rent, than what those resources had generated on their own. These non-market resources need to be specialized and not able to be found in secondary markets, which can be specialized knowledge, capabilities, competencies and intangible assets. Relational rent will be great if synergies could be found between alliance partners, however it is a costly process to find and realize complementary resource endowments. Firms need to have the capabilities to understand what non-market resources will be beneficial and where in their network could those resources be found. Experience in management on how to collaborate with partners will also favor this opportunity of supernormal returns (Teece, 1986; Dyer & Singh, 1998; Hamel, 1991).

The relational view does moreover see complementary assets in the perspective of interfirm relation-specific assets where firms need to invest in interfirm relation-specific assets to gain from the collaboration. According to Williamson (1985) there are three kinds

of asset specificity: site specificity, physical asset specificity and human asset specificity. Site specificity mean that the production sites of the two firms are located away from each other and is not able create competitive advantages, therefore site specific investment should be made to gain advantages, which could be; lower transportation costs, coordination costs and inventory costs. Physical asset specificity implies capital investments such as machinery and tools, these investments can enable higher productivity and product differentiation (Clark & Fujimoto, 1991; Nishiguchi, 1994). Human asset specificity refers to the relationship between the firms' employees, with longstanding relationships knowledge transfer will be efficient and communication errors will be reduced (Asanuma, 1989; Dyer, 1996).

There are two processes that are fundamental for the success of generating relational rent. Firstly, number of years of the governed safeguards agreements that serve as protection against opportunism. These safeguards are of high importance to cleantech firms, which are dependent on their innovations for success and consequently need to create strong barriers against opportunistic behavior (Maguire, 2010). The safeguards can have effect on an alliance partner's will to invest in relation specific assets since alliances are more likely to invest in these when there are rigorous safeguards. Secondly, the total volume and scope of transactions between alliance partners will influence productivity by substituting special purpose assets for general purpose assets, leading to higher possibility to generate relational rents (Dyer & Singh, 1998).

Alliance partners can also achieve relational rents from new ideas created on account of interfirm knowledge sharing routines that allows knowledge to float between firms. To succeed with knowledge sharing it is important to understand the differences of the two sides of knowledge, information and know-how. Information contains facts, symbols and propositions, which can effectively be codified and deciphered, and is consequently easy to transfer as also brought up in the appropriability regime from Teece (1986). Opposite to the ease of transferring information, know-how is knowledge that is complex and tacit, meaning there is a need of deeper knowledge sharing to be able to gain from its partner. Transferring know-how could be of more use for firms and lead to higher potential for

superior relational rents (Dyer & Singh, 1998). Successful knowledge sharing routines is a function of absorptive capacity of the firms, which implies the capability to understand new information and the ability to transform and adapt it to their own benefit. Absorptive capacity can be adapted to a partner focus, which implies then how developed the capability of the individual firm is to distinguish and integrate knowledge from their partner. The ability of absorbing information from an alliance partner depend on how advanced partners knowledge sharing routines and depth of knowledge transfers are, this in turn is an essential part to successfully receive relational rent (Mowery, Oxley & Silverman, 1996; Dyer & Singh, 1998). Shown is that the transfer of complex capabilities is more effective in equity joint ventures than licensing agreements and other contract-based alliances (Mowery et al., 1996; Kogut, 1988).

3.2.4 Influences of Institutional Environments

The RBV and relational view may have affiliation with aspects typical for cleantech firms, but not as much with the aspects of emerging markets where the conditions for commercialization through partnership looks differently. The contributions from the relational view could be assumed to give the insights needed because of its prevalence in studies of MNEs operating in emerging economies. These studies, aiming at the outcome and performance of strategic relationships, do however show vague results on the implications in these environments (Xu & Meyer, 2013). A theory growing popular because of its possibility to bring the analysis of the firm into context, such as the emerging markets, is the institutional theory (Meyer & Peng, 2005; Peng et al., 2008). This theory therefore becomes a complementary necessity to both the RBV and the relational view.

Institutions consist of legal frameworks, including enforcement of laws and property rights, information systems, and regulatory regimes. Additionally, institutions are able to reduce market failures by weakening the probability of information asymmetries through the serving of information about businesses and their behavior (Meyer et al., 2009; Arrow, 1971). In a market economy these institutions need to function in order to enable firms and individuals to engage in market transactions without acquiring extreme transaction costs

or risks. A country's institutions set out the rules that firms need to act after, and this in turn, indicates what possibilities firms have to do business in the country (Meyer et al., 2009). Hence, institutions have a direct effect on foreign firms' choices of entry strategy, such as greenfield, acquisitions and joint venture (Ingram & Silverman, 2002). Institutions vary dependent on country, and it is generally agreed upon that institutions in emerging countries are weaker than in developed countries. Weaker institutes are those that are not able to provide effective markets, which prohibit voluntary exchange. In contrast, strong institutions are those that provide an effective market whereas voluntary exchange is possible. Each entry strategy offer advantages depending on what the firm is seeking and the state of the institutions. By entering a joint venture with a local firm, the firm will gain resources and networks that can counteract weak institutions. With strong institutions other entry strategies might be more favorable since there will not be as many barriers and the ease of doing business will be greater (Delios & Beamish, 1999; Meyer et al., 2009). Weak institutions affect the possibility for foreign firms to do acquisitions because of lacking transparency and smaller, more volatile and less liquid stock markets (Lin, Peng, Yang & Sun, 2008). Greenfields is an especially difficult strategy in a weak institutional state as enforcement of property and legal frameworks are low (Meyer et al., 2009). In addition to engage in partnerships such as joint ventures as a mean to reduce the effects of weak institutions, international firms can invest in relations with political actors, and thereby engage in what is called political embeddedness (Sun, Mellahi & Thun, 2010).

When international firms are entering foreign markets there is a risk of being exposed to liability of foreignness. This liability of foreignness might cause greater transaction costs in emerging countries where institutions differ greatly towards mature markets (Sun et al., 2010; Meyer et al., 2009). To overcome this liability of foreignness and institutional barriers, firms can benefits from connections with political actors and institutions. This is due to the imperfect market efficiency, making non-market assets critical for success. Non-market assets are, as described before, those that are not directly connected to the market, but rather influence the market indirectly. Non-market assets can be divided into regular and special non-market assets. Regular or just called non-market assets are those that many local or even international firms can provide, and is for example legal advice of how

to conduct business in a certain country. These can simply be provided through contractual relations without any deeper commitments. Specialized non-market assets are those that are more difficult to obtain and can be in the form of political embeddedness (Meyer et al., 2009; J. L. Hansen, 4th Mar 2015a). Political embeddedness spotlights a state's need of political and social support and in return creates opportunities for firms to exploit information asymmetries and illegitimately advance their self-interests and firms' capital growth agendas (Luo, 2001; Sun et al., 2010; Prechel & Morris, 2010). The level of relation between a firm and an institution can vary, the relation can be on interpersonal level between managers and political actors or on a firm level. As emerging countries more widely has weaker institutions, international firms need to proceed differently when entering an emerging market (Meyer et al., 2009). However, it might not be enough to invest directly in relations with institutional actors since there can also be a need to engage in networks consisting of suppliers, distributors, and agents with political ties (Peng & Heath, 1996; Sun et al., 2010).

On the other side of the coin, there are substantial risks with political embeddedness. As there can be fast and drastic changes in a country's political situation, there can be uncertainties to have too deep connections with political actors. Because of the many determinant non-market forces in an emerging market, ties with past political actors can consequently lead to resource exclusion and discrimination (Siegel, 2007).

In emerging markets, institutional uncertainty and unpredictable non-market forces do often exist. To confront these issues, foreign firms need to understand the importance of interpersonal networks and social capital, which can be vital for business success. In an emerging context, the dominant institutional linkage is argued to be personal ties between families, social networks and politicians. These networks are built upon trust, social norms and traditions, which foreign firms might need to commit to in order to find cooperation and the resources needed (Marquis & Raynard, 2014; Shirodkar & Mohr, 2015). However, as countries are being developed, these ties have come to be related with corruption. To avoid engaging in non-legal activities such as corruption and to further overcome unpredictable non-market environment, firms might need to establish a political strategy

that maps out how to engage in relations with political decision makers, regulators and/or NGO's (Hillman & Hitt, 1999; Shirodkar & Mohr, 2015). There are various kinds of political strategies taking the form of, e.g. financial incentives where firms support political actors with financial means, or constituency building strategies where firms build up reputation in a certain political question and gain support from special interest groups and then exchange public votes on particular questions. In return firms can gain greater market capitalization, favorable legislative decisions, higher equity returns, higher firm value in the stock market, and reduced risk exposure (Shirodkar & Mohr, 2015).

3.2.5 Modes of Partnership

Relationships can, as mentioned, be created when the innovator searches for complementary assets, and dependent on the type of assets needed, the relationship can look differently. If generic assets are needed, the innovator could simply acquire these through contractual relations such as licenses, component supply contracts, fabrication contracts, service contracts, etc. (Teece, 1986; Teece, 1992a). Licensing is in particular a common method for firms to exploit internal technology when complementary assets are limited (Arora, Fosfuri & Gambardella, 2001; Teece, 2006). If the innovator on the other hand needs specialized or co-specialized assets, contractual relations could damage involved parties in a relationship breakdown, and integration of assets, or at least a deeper form of partnerships such as strategic alliances, would be preferred instead. Integration includes forward, lateral and backward integration and could take the forms of joint ventures, acquisitions, startups, etc. A tight appropriability regime makes it easier for the innovator to commercialize its goods and could grant the innovator time to acquire the complementary assets. Firms in control of co-specialized assets, in opposition to those of generic assets, are often in a preferred position towards the innovator, e.g. when the assets comprise distribution channels or specialized manufacturing capacity (Teece, 1986).

If looking deeper into contractual modes, these involve the innovator to sign contract with the partner of need. This often implies lower risks in some situation because of the common absence of cash expenditures upfront since assets doesn't need to be purchased

nor build (Teece, 1986). Licensing is one of the most well-known contractual method and is argued by Markman et al. (2008) to foster the firm to take advantage of external ideas and talents, keep up the internal development with the science and technology levels of the market, help the firm minimizing the risks of investing in R&D, together with spurring the firm's domination over technology corridors. These advantages from licensing can thus lead to an increase of the firm's speed, scope, odds, and impact of innovation (Markman et al., 2008). Moreover, licensing is one way to conduct the multifaceted contractual relationship called arm's length contracting, also explained by Dyer and Singh (1998). This form helps firms to learn from each other without spending the cost of trial and error or gain market recognition through more established companies. Disadvantages are possible, especially in cases where opportunism is available and costly irreversible commitments are part of the contract. The process itself can therefore be difficult if it involves the innovator to persuade the partner to share risks (Teece, 1986). Many of the contractual modes go hand in hand and overlap each other at certain points, including the deeper form of strategic alliances. Strategic alliances are, as many of the other modes, dependent on trust. Specifically, its exchange of knowledge is dependent on the trust and risk profiles adopted by the firms involved (Becerra et al., 2008; Ill & Gallagher, 2007). There are two general purposes of an alliance, firstly, to gain a more secure access to resources that the firm does not possess, which for example can be technologies, capital and capabilities. Secondly, an alliance can act as an entry strategy to new geographical or product markets (Ill & Gallagher, 2007). The involvement in complex networks of too many arms-length relationships have been shown problematic in some cases, and improvements have been accomplished through strategic changes such as a reduction of these forms of relationships and a stronger focus on long-term partnerships such as strategic alliances instead (Zaheer, Gulati & Nohria, 2000). Moreover, managers does generally not receive all necessary information concerning each partner's resources, synergies and costs of integration, and despite these dilemmas managers do often engage in partnerships due to being overly optimistic about the ease of start it up, its synergies and goals (Ill & Gallagher, 2007).

Teece (1986) distinguish integration from contractual modes, including strategic alliances, through its involvement of ownership. By owning complementary assets needed, the

innovator can secure supply, avoid bottlenecks, and capture beneficial spillover from the innovation in cases where the markets otherwise can be limited. Some of the implications that follow are the lockup of cash in the investments, and the extra effort demanded of keeping the effectiveness of the complementary capabilities at a decent level. According to Teece (1986), wrong partnership strategy can be hazardous such as when a firm integrates instead of contract. But even if a firm is following the optimal partnering strategy, its chances of success is low in the cases of locked up complementary assets and when the intellectual property protection is weak (Teece, 1986). Wright, Vohora and Lockett (2004) argues for the many opportunities in joint venture spin-offs as a commercialization strategy for intellectual property rights, while at the same time emphasize the risks and concerns behind the shared ownership and control it implies.

In addition to these formal partnerships there are also the more informal types, such as personal ties. Personal ties can open up business opportunities that otherwise would be closed. These business opportunities can be with both private and public actors, and is sometime necessary to have in order to receive cooperation and resources (Marquis & Raynard, 2014; Shirodkar & Mohr, 2015).

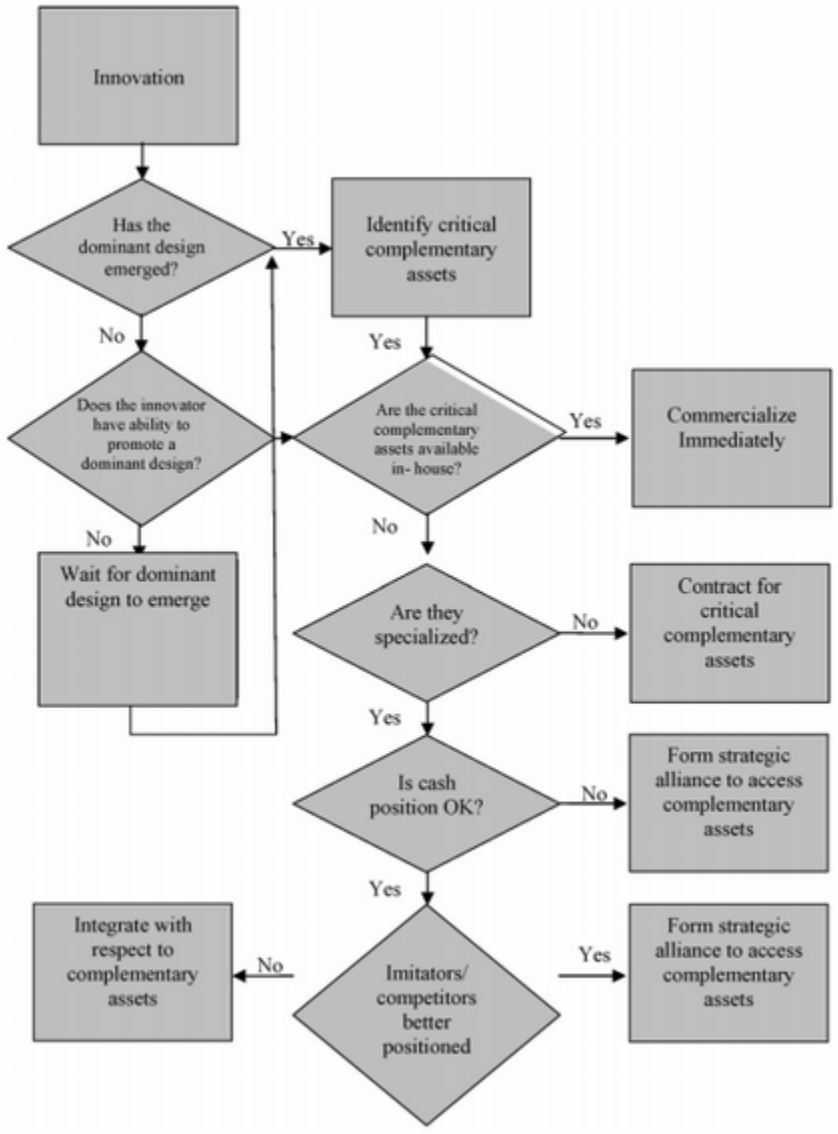
In reality, partnerships seldom comprises either or among contract and integration, but rather a mix of modes because of complex situations requiring tradeoffs and compromises. A mix between partnership modes can take the form of a transition from one mode to the other (Teece, 1986).

3.3 Commercialization Process

Derived from the literature of study, a cleantech firm may enter a relationship when there is a need for complementary assets. Similar with this resourced based view from Teece (1986) are the resourced based view of strategic fit where Brouthers et al. (1995) states that the first critical element of strategic fit comprises complementary skills since a suitable partner need to supply the necessary skills to the firm. They further state that firms shall not engage in, e.g. alliances due to financial reasons alone, a broader

investigation is needed and factors to be analyzed should be skills, technologies and markets. In addition, firms should search for a specific skill or production possibilities and not settle with a partner in a certain category. The searching firm should put strict requirements on potential partners, but it also need to be open and forthcoming to the partner itself as the partner is also searching for complementary skills. Teece (1986) has, with its kick off in the RBV and in accordance with all resource based aspects brought up here, developed a flowchart of the decisions regarding whether to contract, form a strategic alliance, or integrate for access of these assets in situations of weak appropriability regimes, see Appendix B. A more applicable and derivative version was reproduced from this flowchart, also in the case of weak appropriability regime since this is more the rule than the exception, see figure 2 (Teece, 1992a). The flowcharts needs to be considered within the frame of possible over-optimism when used as described by Merrow, Phillips and Myers (1981) and pointed out by Teece (2006). The risks of biased decisions is further noticed by Teece (2006) who suggest the imposition of an "outside view" as described by Kahneman and Lovallo (1993) in order to use the flowcharts in a rational way.

Figure 2 - Decision Flowchart in the Commercialization Process



Description: A flowchart developed in order to guide how to profit from innovation through strategic partnership.
Source: Teece (1992a).

The flowchart from Teece (1992a) is based on the simple business model decisions of whether to make or buy the complementary assets needed. One has to remember that a business model may comprehend more variables, such as those stated by Teece (2006, p. 1143): "(a) the choice of features for the product, including the form functions to be selected; (b) the customers to be targeted; (c) items to be bundled; (d) distribution

channels to be selected and so forth." Moreover, the flowchart may guide a cleantech firm in the partnership strategy of its commercialization process in accordance with the RBV, but a firm may also need to make the decisions in accordance with the complementary institutional and relational view. This, in order to make the strategy applicable in emerging markets and maximize the relational rent derived from the joint idiosyncratic contributions in the possible relationship created (Meyer & Peng, 2005; Peng et al., 2008; Dyer & Singh, 1998; Chung et al., 2004). The effect of the relational view may be integrated in the relationships created from the flowchart and thus not affect the decisions directly as long as no crossroad appears, the institutional view does on the other hand have direct effect on this flowchart since it comprises non-market assets that is considered as complementary assets (Meyer et al., 2009; Siegel, 2007). If adding these aspects to the flowchart, the result would look like in figure 3:

Figure 3 – Modified Decision Flowchart in the Commercialization Process

Description: A modified version by the authors of the flowchart from Teece (1992a), suggestible able to derive a more comprehensive partnership strategy in the commercialization process of cleantech firms in emerging markets.
Source: Authors in combination with Teece (1992a).

The modified version of the decision flowchart still starts in the same way as Teece's (1992a) flowchart, with a firm making an innovation and research whether the dominant design paradigm has been establish in the category of the innovation. If it has, the firm can proceed with identifying what critical complementary assets are comprised in its business, both market and non-market assets, and acknowledge which of these are available in-house. But if the dominant design paradigm has not emerged, the manager need to ask the question if it is possible to promote a new dominant design paradigm or if it should wait for it to emerge before proceeding with identification of the critical complementary assets and acknowledge its availability in-house. If all critical complementary assets, that will say both market and non-market assets, are available in-house, an immediate commercialization could proceed without creating any partnership. An immediate commercialization without partnership would hence lead to an early end in the flowchart. However, if both or at least one of the market respective non-market assets are not available in-house, partnership is needed in the commercialization process of the cleantech firm and its form will first depend on whether the asset or assets not available in-house are specialized. If the assets are not specialized, contractual partnerships could be created since it will not put a supply of any bottleneck assets in risk if the terms would become disadvantageous and a relationship breakdown needs to be done with the contractual partner, nor does it often include the risk of any upfront cash expenditures (Teece, 1986). These steps have to be walked through before continuing to deeper forms of partnerships than contractual ones, since these deeper partnerships depends on additional factors such as cash position and threats from competitors. If a firm need both specialized and generic assets, a combination of contracts and deeper forms of relationships may be needed, which is why the choice of contracting will come back as an option.

If all or some of the critical complementary assets, not available in-house, on the other hand are specialized, integrations, strategic alliances or simply a personal relationships can be advantageous to secure its availability. Specialized non-market assets are in some situations possible to be attained through personal ties and could therefore spare the firm from getting into a relationship of greater measurements. An integration or strategic alliance does however depend on the firm's cash position, since a lack of financial resources might not support the possibility, nor the risk taking, of establishing of something costly such as integrated solutions of JVs, acquisitions, startups, etc. (Teece, 1986). If Imitators or competitors are better positioned in the market of the same design paradigm, strategic alliances would nonetheless be the better choice, even though the firm's good cash position. This in order to secure the availability of the specialized complementary assets without taking the greater risk of heavier investments meanwhile using other advantages of the alliance, such as its possible contributions as an entry strategy, in order to become more competitive than the imitators/ competitors (Teece, 1986; Ill & Gallagher, 2007). If the cash position is good and imitators/ competitors are not better positioned, integrations would instead be a possibility to, e.g. better avoid bottlenecks and increasing the capturing of spillover effects (Teece, 1986). This rationale is indicated through the order of the last two decision-boxes in the flowchart.

An option in the framework is if a specialized market or non-market asset is needed in combination with generic assets, the corresponding relationship for the specialized assets sometimes also grants the firm access to respective generic assets. A separate contracting for the generic assets may therefore not be needed. Clarified, if a firm needs both generic market assets and specialized market assets, it may only need an alliance and not an alliance in combination with a contract. This is up to the firm to decide, and may depend on its ability to coordinate different relationships (Mitchell & Singh, 1996). Moreover, these steps do not deny the possibilities of transitions from certain partnerships to others forms in course of time. The steps rather guide a firm towards a partnership strategy as a start in the commercialization process.

4. AN EMPERICAL OUTLOOK OF AQUAPORIN A/S AND THE BRAZILIAN MARKET

This case study will comprise the operations of Aquaporin A/S and the potential target of the Brazilian market within Aquaporin A/S's segment of water and wastewater treatment. The importance of water and wastewater treatment cannot be neglected since it is, according to UNESCO (2012), possible to prevent about 10 percent of the diseases in the world through improvements in drinking water, sanitation and hygiene together with environmental management and health impact assessments. Besides the health issues, there is also an economic perspective of importance where businesses need to invest in more efficient water input, including water treatment, in order to meet environmental requirements and become more cost efficient (Boccaletti, Grobbel & Stuchtey, 2009, Dec; Frost & Sullivan, 2009). This is related to that some regions are approaching physical water scarcity; for instance in large parts of the middle east, smaller areas in the south Africa, south U.S., Mexico, India, China, and the eastern parts of Brazil (IWMI, 2007). Water demand exceeding water supply is not only a problem for the civilian population but also for the industries conducting water demanding businesses. With an increasing population and already strained water supplies the challenges are about to grow worse and a more efficient use of water is becoming a requirement in order to conduct competitive businesses (Boccaletti et al., 2009, Dec).

4.1 Aquaporin A/S

The firm is a global cleantech firm based in Copenhagen, Denmark, developing the membranes based on Aquaporin Inside™ technology for water purification. In 2014, the first pilot production of membranes was initiated and the intentions for this development are to fill the gap of today's water treatment technology and clean water from all other compounds. This will be done through separation and purification devices used in the water supply of industries and households (Aquaporin A/S, 2015a). As indicated, the firm is in the stage of undertaking a commercialization process.

4.1.1 Business Plan

The mission is defined by Aquaporin A/S "to develop and produce biomimetic membranes with disruptive market potential in water treatment using cutting-edge R&D, and market them through Strategic Commercial Partners, who develop the market, build the necessary systems and sell to end users". Their vision is "to become the leading and dominant company in membranes for water treatment" (Aquaporin A/S, 2015b).

Aquaporin A/S's business plan comprises the successful development of Aquaporin Inside™ technology to remove all other compounds from water and revolutionizing the water purification of today. To achieve this they seek to find and create partnerships with leading system providers in diverse segments through narrow banding co-development and supply agreements in order to get market know-how, product ideas, and IPR inputs. The business plan is further based on cooperation with various strategic partners within academia, government and potential end users with the purpose to aid Aquaporin A/S with research, new applications, market development, customer priming, and IPR input (Aquaporin A/S, 2015a; Aquaporin A/S, 2015b). If a partner can provide all complementary assets needed in the commercialization process of a new market and if the terms are preferable, Aquaporin A/S may be open for discussing the partner's market exclusivity (J. L. Hansen, 4th Mar 2015a). The plan includes aggressive patenting of their technology developments. What Aquaporin A/S doesn't develop in-house they seek to in-license, such as necessary complementary technologies that can contribute to the development of the membrane (Aquaporin A/S, 2015a). In line with the development of the membrane, Aquaporin A/S plans to continue with R&D of the FO system, meanwhile focusing on the commercialization of their RO system, which currently is the dominant design (J. L. Hansen, 4th Mar 2015a). Aquaporin A/S will earn revenue on licensing and contractual agreements in the form of upfront payments, milestone payments, royalty payments and membrane and module revenues (Aquaporin A/S, 2015b).

4.1.2 Technology and Design Paradigm

The cleantech products offered are water filtering and purifying membranes using the aquaporin molecule to selectively transport only water molecules through it. This implies

that any charge species such as salt (ion), protons or hydroxyl ions is rejected to pass the membrane (Aquaporin A/S, 2015a; de Groot & Grubmüller, 2001; Tajkhorshid, Nollert, Jensen, Miercke, O'Connell, Stroud, & Schulten, 2002; Jensen, Tajkhorshid & Schulten, 2003; Zhu, Tajkhorshid & Schulten, 2004; De Groot, Frigato, Helms & Grubmüller, 2003; Burykin & Warshel, 2003; Ilan, Tajkhorshid, Schulten & Voth 2004; Chakrabarti, Tajkhorshid, Roux & Pomès, 2004). Specifications on the membrane produced by Aquaporin A/S is its support of up to 10 bar in pressure and a water flux greater than 100 liters per square meter and hour (Aquaporin A/S, 2015a).

The Aquaporin Inside™ technology finds competitive advantages in both its application of forward osmosis (FO) and reverse osmosis (RO). The FO application reduces costs, even in comparison to the RO. Its FO technology also compete with other applications of FO because of its fertilizer drawn osmosis makes the drawn solution, the concentrated fertilizer, a part of the final product and thus become a possible solution to water scarcity while energy cost is reduced simultaneously. Aquaporin A/S sees its technology as revolutionary in its potential to replace today's costly technologies with its sustainable and affordable water treatment membranes. Its aim for a shift in paradigm when the technology is fully developed is clear, starting with the implementation in industrial water treatment (Aquaporin A/S, 2015a).

4.1.3 Appropriability Regime

Several different aquaporins are known from nature but only Aquaporin A/S has the know-how required to produce it. The process, or the nature of the technology, therefore becomes an important part of the appropriability regime and protects the company from imitators. This makes it easier for Aquaporin A/S to conduct partnership strategies such as licensing since the opportunistic possibilities are reduced as long as they do the critical step in the production themselves, which they will continue with (Aquaporin A/S, 2015a; Teece, 1986; J. L. Hansen, 4th Mar 2015a).

In order to further strengthen the appropriability regime, Aquaporin A/S performs an aggressive patenting of all their newly developed technologies, mainly in core

developments but also within surrounding areas. The patent portfolio reaches several countries worldwide and is constantly extended with new patents in strive for global exclusivity (Aquaporin A/S, 2015a). Currently, they have 50 patents granted worldwide, and aims for more than the double in the future (Aquaporin A/S, 2015d).

4.1.4 Financial Resources

Aquaporin A/S is a subsidiary of the M. Goldschmidt Holding A/S group and is financially built up of investors that currently comprises six shareholders: M. Goldschmidt Capital A/S, Syddansk Teknologisk Innovation A/S, Heilongjiang Interchina Water Treatment, Poten Environment Group Co., Ltd., Morten Østergaard Jensen Holding ApS, and Artefakt Holding ApS (Aquaporin A/S, 2015a). In addition to these shareholders, Aquaporin A/S is interested in further funding besides previous injections from the EU Commission, the Danish National Advanced Technology Foundation, Danish Business Innovation Fund, the Environment and Water industry Development Council in Singapore, Danica Pension and the Innovation Fund Denmark (Aquaporin A/S, 2015b). From these shareholders and funding Aquaporin A/S's equity was estimated to 107.3 million DKK in the end of 2014 (Aquaporin A/S, 2015d).

4.1.5 Complementary Assets Needed

Aquaporin A/S's value network can be divided into four categories where the first is the "supplier of membrane components" which simply includes the component suppliers. Secondly, there is the "provider of membrane technology" solely including Aquaporin Inside™. Thirdly, the "system manufacturers", including manufacturers of ultra-pure water (UPW), RO, FO, and PRO water purification systems that together with Aquaporin A/S implement the Aquaporin Inside™ technology into the systems Aquaporin A/S, 2015c). Hereafter, focus will be on RO and FO since these are the specific applications most used and targeted by the markets and Aquaporin A/S (J. L. Hansen, 4th Mar 2015a; Rubim, 2014, Dec). The fourth and last category is the "end users", comprising both the global industry and population (Aquaporin A/S, 2015c).

Aquaporin A/S Inside™ technology needs a contactor module in order to function. This module is supplied by the German-based Membrana GmbH that is specialized in microporous membranes for medical applications and membrane products to the power, semiconductor, food and beverage, and photographic markets (Aquaporin A/S, 2015a).

When Aquaporin A/S's Inside™ technology is integrated into the contactor module it is ready to be added into the water purification systems. There are various water purification systems the Inside™ technology can adapt to. The complementary systems are divided into UPW/RO/FO/PRO and all have their own complex design and the Inside™ technology is adapted differently for each system. Moreover Aquaporin A/S is searching for companies that can provide these systems and additionally complementary assets such as marketing and sales. In other words, Aquaporin A/S seeks partners complementing the firm with everything except their core activities comprising the development and production of the Aquaporin Inside™ Technology (Aquaporin A/S, 2015c; J. L. Hansen, 4th Mar 2015a).

In addition to the complementary market assets, Aquaporin A/S is in need of non-market assets, both generic and special. Aquaporin A/S has employees that are knowledgeable about the Brazilian market and international intellectual property rights, but it will not be sufficient for an entering in Brazil. Therefore there is a need of legal advice to cover concerns such as taxes, property rights, and import regulations. Furthermore, specialized non-market assets in the appearance of political embeddedness is favorable for doing business with state owned companies and might be required for private actors as well (J. L. Hansen, 22th Apr 2015b).

4.1.6 Network and Earlier Expansion

A part of Aquaporin A/S's advancements in R&D, derives from their network, which is constructed on a global basis with the purpose to test the membranes in different applications, and assist in further developing of the R&D (Aquaporin A/S, 2015b). J. L. Hansen (4th Mar 2015a) describes their time before having an established network as a time of "knocking doors" and broadly reaching out to parties in search of interest.

Cleantech events and global gatherings were forums for building relations and search for this interest. China was the first market to show great interest for Aquaporin A/S and nowadays, people are knocking on Aquaporin A/S's door.

Aquaporin A/S first global expansion was in Singapore through a joint venture with Nanyang Technological University (NTU) Ventures and DHI Singapore. This was initiated in 2011 and created Aquaporin Asia Pte. Ltd which is 80 percent owned by Aquaporin A/S. The purpose of Aquaporin Asia is to utilize nature's separation technologies to decrease water treatment costs, increase treated water quality and enable novel water treatment applications within industries (Aquaporin A/S, 2015a). Aquaporin A/S also created a joint venture with Danish Aerospace Company ApS in 2013 under the name of Aquaporin Space Alliance. The joint venture will commercialize the integration of Aquaporin Inside™ technology in space applications and space programs in collaboration with entities in Europe and the US (Aquaporin A/S, 2015a). In 2015 Aquaporin A/S will engage in another joint ventures with two established Chinese firms within the water treatment industry, Heilongjiang Interchina Water Treatment (Interchina) and Poten Environment (Poten). The joint venture company will be named Aquapoten and will lead the commercialization of Aquaporin Inside™ technology in China. This joint venture is to ensure future revenues to Aquaporin A/S from upfront, milestone, and royalty payments, and profit sharing (Aquaporin A/S, 2015d).

4.1.7 Market Segments

Aquaporin A/S membranes have the possibility to cover several market segments, as their two membranes have different capabilities. With the RO membrane technology, Aquaporin A/S are able to cover market segments of household purifiers, UPW for labs, pharma, semiconductors and power industries, desalination of brackish water and desalination of seawater. With their more advanced FO membrane technology, the following segments can be covered; space applications such as water extraction from body fluids, waste water cleaning within the food and beverage industry, water production, i.e. from the extraction of shale oil and gas since these are huge environmental problems without a sustainable

solution which means the industry is on a burning platform, and finally the segment of hemodialysis (Aquaporin A/S, 2015b).

4.2 Brazilian Market

Even though Brazil is a newly advanced economy with stable economic growth and improving living standards, ranking the seventh wealthiest economy in the world, the country have severe issues within several water areas, such as wastewater treatment (International Trade Administration, 2014; World Bank, 2015a).

4.2.1 Overarching Market Situation

4.2.1.1 Historical Development

Because of a legacy employed in 1980s, the industrial structure of the Brazilian water sector have looked rather the same, with one water company per state accounting for the water and sanitation services. These 27 state companies (27 states) cover 77 percent of the services, by whom, six companies are responsible for half of the country's total services. These six companies are; Sabesp, Sanepar, Copasa, Cedae, Ceasb and Embasa. The proportion of service provisions between municipalities and private companies is for the moment 15 respectively 18 percent. The presence of the private companies is however gaining influence and some of them have formed joint ventures with the state owned companies, especially in more troublesome cities in terms of supply. A not too rare case nowadays is that area concessions are operated by subsidiaries to larger contractors in the place for both state and municipal companies (WaterWorld, 2011).

The Brazilian government have acknowledged the problems within the country and decided to make heavy investments within the sector of wastewater, sanitation, water, waste management and drainage (International Trade Administration, 2014). In order to tackle these problems successfully, the government enacted the Law 11.445/07 in 2007, which was implemented to set the basis for the national policy on water and sanitation. This law will open investment possibilities in the sector, with the aim to provide more sufficient water and sanitation services. The investments in technology will need to be cost

friendly for the users and in line with municipalities' guidelines in order to be implemented. In addition to increase investments the purpose of the law was also to increase transparency and tighten social control over water and sanitation services (Parente & Filho, 2007).

Besides the enacted law, the government initiated a Growth Acceleration Programme with focus on improving the national infrastructure. With these incentives to improve living standards, estimates of the Brazilian environmental technology market is approximately USD 12 billion, where the sub sector; water and wastewater accounts for USD 6.2 billion. The average annual investments in basic sanitation are USD 4.5 billion, but with the goal to deliver basic sanitation services to every citizen, the annual sum is planned to increase to USD 7 billion. The increased funds will be invested by government actors and will be invested in more advanced water supplies, sewage treatment and sewage collection systems. To further increase operational standards, there will be focus on developing management efficiency, technical capacity and quality of service (International Trade Administration, 2014).

4.2.1.2 Key Trends

Water reuse and recycling are key trends within the wastewater treatment sector, which creates opportunities for advanced membrane technologies and more standardized systems (Frost & Sullivan, 2009). Among the specific industries in Brazil that are potential customers for wastewater treatment are: Food and beverage, oil and gas, pulp and paper, automotive, textile, sugar and ethanol, chemical, and mining and mineral processing including the important steel industry (International Trade Administration, 2014; Business Sweden, 2015; Frost & Sullivan, 2009). Out of these industries, the steel industry, food and beverage, and pulp and paper may be of the highest importance, and out of these three, it is the steel industry that dominates the water reuse capacity in Brazil with almost 97 percent reuse of its 4.9 billion m^3 total used freshwater in 2012. If comparing these numbers to the pulp and paper sector the reuse rate is only 34 percent of its consumed 0.7 billion m^3 water in 2010. Even worse is one of the largest companies within food and beverage, namely

Coca-Cola, who only reused 19 percent in their Brazilian operations. The food and beverage sector may discard less water than the pulp and paper sector but does still have great potential in improvements, especially in São Paulo where the pressure of improvements are the greatest in Brazil (Business Sweden, 2015; Economist, 2014, Dec). However, a specific segment of business opportunities for water focusing cleantech companies is desalination since it is needed in order to produce freshwater out of salt water. Desalination thus becomes a necessity both in the creation of drinkable water and for agricultural use (FAO, 2006). The environment ministry of Brazil decided in 2014 to fund desalination projects in 48 cities and towns in the state of Ceará. This is due to that 80 percent of the state is located over crystalline basement (salt concentration in the earth) which is dangerous for people's health. To solve the issue the government is installing 222 desalination systems (Bland, 2014, Jul)

4.2.1.3 States of Interest

Commonly, water treatment is conducted through the use of coagulants such as aluminum sulphate for ionizing suspended solids which then are filtered. The dispersal of this filtered sludge is often problematic since it is commonly dispersed into rivers etc. São Paulo on the other hand, has adopted activated sludge using air and a biological floc created from bacteria and protozoans. This method is also gaining utilization in other cities in Brazil. In parallel, growing opportunities are found in the area of membrane bioreactors (WaterWorld, 2011; Sabesp, 2015a). In spite of these methods, the State of São Paulo has the most critical water situation in the country and suffers from severe shortages of water occasionally leading to taps run dry. The industries accounts for 15 percent of the water consumption in the state, and several companies have acknowledged the economic benefits of increasing their reuse ratio. But the problems of water supply capacity are still prevalent and do specifically land on the desk of Sabesp which is the state owned company responsible for São Paulo. One fifth of Brazil's population lives there and the state produces one third of the country's GDP which indicate its importance of proper water supply (Business Sweden, 2015; Economist, 2014, Dec).

With several of Brazil's water related issues located in São Paulo, this may be an area for Aquaporin A/S to expand its business and find solutions for its commercialization. According to Business Sweden (2015) São Paulo is the state together with Minas Gerais that shows the greatest potential for technology from, at least, Swedish companies active in the wastewater sector. This is due to the extent of the issues of waste water treatment in the areas together with that these areas also invest a large part of their GDP in the business segment. The state-owned companies responsible for these regions, and therefore also affected by the investments, are Sabesp respectively Copasa. Specifically, the markets of São Paulo and Minas Gerais have the strongest presence of companies in three of the most important water treatment sectors of food and beverage, steel industry, and pulp and paper, compared to the rest of Brazil.

4.2.2 Dominant Design Paradigm in Brazil

According to Membrane Technology (2009) the industrial processing of water and wastewater have started one of the fastest market trends in Brazil, namely the trend of water reuse and recycling through membrane bioreactors and stand-alone membranes. There are several membrane technologies applied within Brazil, but the most installed and used is RO. The RO is mainly applied to remove dissolved salts in the production of demineralized water to process within the water and wastewater market (Rubim, 2014, Dec). The technical team of Koch Membrane is in the article from Rubim (2014, Dec) together with what is stated by J. L. Hansen (22th Apr 2015b) both agreeing upon that the most used membrane technology are the RO in the Brazilian market, but different membrane technologies have different advantages and disadvantages dependent on the situation.

Sabesp, the main player in wastewater treatment in the most important state of Brazil (Business Sweden, 2015), has a total of 214 operating water treatment plants in the State of São Paulo, whereof 28 are located in the metropolitan area and 186 in the interior municipalities and those along the coastal areas (Sabesp, 7th Apr 2015a). The company supplied a water volume of 2 billion m^3 in 2014, whereof three quarters were to residential users (Sabesp, 2015b). Their most used configuration of water treatment process in the

plants is as follows: coagulation, flocculation, sedimentation, granular media filtration, chemical disinfection with chlorine, pH correction and fluoridation. Recently though, two of their water treatment plants in the metropolitan area of São Paulo adopted ultrafiltration membrane reactors in order to increase the capacity of the plants' water production. The larger water treatment plant, Rodolfo José da Costa e Silva, increased its production from 14 to 15 cubic meters per second, or 0.319 to 0.342 trillion US gallons per day by installing one of these membrane system from Koch Membrane Systems in parallel to its regular system (Sabesp, 7th Apr 2015a). The provided system is following the dominant design paradigm and is also designed for RO according to the Processing magazine (2012) The smaller plant, Rio Grande, increased its production from 4.5 to 5.0 cubic meters per second, or 0.102 to 0.114 trillion US gallons per day, also by installing a similar system, but from GE Water & Process Technologies, in parallel to its regular system (Sabesp, 7th Apr 2015a). This membrane system was also incorporating RO technology, which GE Water & Process Technologies combined with ultrafiltration in its water treatment solutions in Brazil (GE, 2015a).

4.2.3 Competitors and Potential Partners and Their Complementary Assets

If a company produces both the complementary assets needed by Aquaporin A/S and membranes, it can be considered as both competitor and potential partner dependent on their willingness to cooperate. For example, the Rodolfo José da Costa e Silva water treatment plant owned by Sabesp had its new membrane system supplied by Koch Membrane Systems, and the membrane system at their Rio Grande water treatment plant supplied by GE Water & Process Technologies (Sabesp, 7th Apr 2015a). These two suppliers provide both systems and membranes which makes their position towards Aquaporin A/S unclear.

Koch Membrane Systems is a global company providing membrane technology and customized filtration systems, targeting market segments such as municipal water and wastewater, food and beverage, oil and gas, pulp and paper, and mining water. With focus on membranes, Koch Membrane Systems are among the market leaders in developing new membrane technologies including microfiltration, ultrafiltration, nanofiltration and RO in

spiral, tubular and hollow fiber configurations. In addition to the contract with Sabesp in 2014, the firm has in 2015 received another contract in Brazil, to provide their reinforced hollow fiber ultrafiltration system to an expansion of a drinking water plant in Sao Paulo. The drinking water plant's name is Rodolfo José da Costa e Silva and was the first plant in South America to install ultrafiltration systems in 2014, the plant provide water to around five million people in the metropolitan area of Sao Paulo. With Koch Membrane Systems PURON® HF Membranes the plant successfully increased the water reuse capacity (Koch Membrane Systems, 2015). Aquapolo is another separate project developed by Sabesp in cooperation with Odebrecht Group in order to supply a population of 350,000 inhabitants, and potentially almost the double. The plant will thus have an initial output of 0.65 cubic meters per second, whereof 65 % is contracted to the petrochemical company Quattor (Kullmann, Lawrence & Costa, 2011, Sep).

GE Water & Process Technologies provides water purification systems and spiral wound membranes used in RO, nanofiltration, ultrafiltration and microfiltration to several industries such as food and beverage, municipal, pharmaceuticals and chemical processing. The firm provides its products to markets all around the world (GE, 2015b). GE has been established in Brazil since 1919 and has since developed a presence in several industries, such as power and water, aviation, lighting, energy management, transportation, appliances, healthcare and oil and gas. To be active in most of these industries it requires close connections with the Brazilian government through special partnerships. Brazil is GE's largest market in Latin America and the third largest in the world with around 8,800 employees (GE, 2013).

Another supplier to Sabesp is Enfil, who provides water and wastewater treatment systems, including membranes, to the Brazilian market. Enfil's systems include physical-chemical process, such as RO and biological treatments. Customers to Enfil has been both state owned and private companies, within industries as, steel, mining, pulp and paper, oil and gas and food and beverage (Enfil, 2015a). In its records of customers there are leading companies within their sectors, for example ArcelorMittal in steel, Ambev in food and

beverage, Klabin in pulp and paper, and Petrobras in the oil and gas industry (Enfil, 2015b; Business Sweden, 2015).

4.2.4 Institutional Outlook

Brazil's intellectual property laws are rather young, it wasn't until 1995 Brazil joined the World Trade Organization and accepted the intellectual property rules. Despite the entering of the WTO it has been a slow development of laws covering patents and trademarks. In 2005 the authorities set up a Federal Court of Appeals that would cover intellectual property rights, this development follows the trend of more judges within the country that focus on intellectual property law. To illustrate the slow progress of intellectual property law and clarify the differences between the emerging country of Brazil and a traditional western institutional context, a comparison is made between Brazil and the US. Brazil had around 50,000 patent applications in 2010 compared to the US with almost 500,000 applications. If comparing the case backlog per examiner, US examiners had around 150 cases in 2010, meanwhile Brazil's examiners had around 550. Finally the average time to complete a patent application is in the US 3.5 years and in Brazil 5.5 years (Economist, 2012; Carneiro, 2013, Mar). Despite progress in intellectual property law there are still many issues regarding patents and trademarks. When foreign firms enter the Brazilian market, especially innovative firms, there are important procedures that need to be completed. To transfer technology agreements such as patents and trademarks from abroad, an approval and registration is required by the National Institute of Industrial Property (INPI). The request is analyzed by investigating the necessity of the service to be rendered and/or the availability of the technology in Brazil. These procedures take long time and are often delayed. When the transfers are done there are laws protecting the intangible properties (PWC, 2013; The Economist, 2012). However, these laws are relatively weak according to the Index of Economic Freedom (2015) that defines property rights as the degree to which a country's laws protect private property rights and the degree to which its government enforces those laws. It also reviews the independence of the judiciary, existence of corruption and the ability of individuals and firms to enforce contracts. The scale is up to 100 where private property is guaranteed by the state. Brazil

has a score of 50, which implicates that the court systems is inefficient and delays occur, corruption exist, and there is probability that the judiciary is influenced by other branches of the government (the Heritage Foundation, 2015).

The structure of the public sector in Brazil has diminished in recent years, and privatization of the public sector has increased gradually. However, the authorities still keep strict control through regulatory agencies with the purpose to supervise several former public sectors such as light and power, telecommunications, water supply, railroads, and oil and gas. Foreign firms are normally allowed to fully own local enterprises and enter joint venture. If a foreign firm wish to acquire land it might prove difficult due to restrictions to direct and indirect ownership of rural land. Brazil's investment freedom has a score of 50, which implies that institutional actors have a variety of restrictions of the flow of investment capital between specific activities, both internally and across borders. Furthermore, business activities are regulated and price controls exists, several government agencies control prices in certain areas for instance in the telecom industry, energy industry, water industry and aviation (PWC, 2013). The involvement of the government is in businesses that might affect the Brazilian economy in any larger scale. For instance, if there are job opportunities opening up, or in contrast if Brazilian jobs are jeopardized, the government will interfere (J. L. Hansen, 22th Apr 2015b). Moreover, if a foreign firm wishes to do business with a state owned company, there may be influences of corruption, both on governmental and independent individual level. If a state owned firm needs a partner for a project it can officially announce a selection process, such as in the case of Sabesp when choosing suppliers for their water treatment systems. According to the rules of this selection process, including a structured bidding process etc., the government is not supposed to be able to affect the final choice since the decision is based on technical terms. The opposite have on the other hand been shown in the state-owned company of Petrobras recently, and consequently it cannot be guaranteed what is happening unofficially. The size of the partnering firm is according to the process not affecting the decision as long as it can fulfill the requirements, but in the recent corruption scandals large firms have been able to use their connections to the government to win projects like these. However, if small firms possess superior products or technologies, their

chances to win deals with both governmental and private companies will most likely increase because of the country's interest in absorbing new technologies (A. F. Granjo, 7th May 2015; J. L. Hansen, 22th Apr 2015b).

Partly related to the factors mentioned, the business freedom in Brazil scored at 53.6, which is based on the World Bank's Doing Business study, with focus on the parameters of procedures, cost and time connected to start a business, obtaining a license, and closing a business. The score of 53.6 implies that it is a lengthy and complex process to start a business and receive permits (the Heritage foundation, 2015). To overcome or at least be able to minimize the downturns of these issues, J. L. Hansen (22th Apr 2015b) argues that if entering Brazil it is necessary for firms to get in contact with local or international firms that possess knowledge about the legal framework and the business culture in the country.

Tariffs have historically been high due to protection of domestic industries, but have in recent years been gradually reduced, despite the reduction, tariffs are still relatively high and, the average tariff rate is 7.7 percent. The authorities are supportive of free trade but there are high tariffs on many imports, which discourage imports of goods and services (PWC, 2013; the Heritage foundation, 2015).

5. ANALYSIS OF THE THEORETICAL FRAMEWORK'S APPLICABILITY

The first part of the analyze will take a deeper look into whether the theoretical framework created from the resource-based-, relational, and institutional view is applicable on Aquaporin A/S in the terms of deriving a partner strategy for a commercialization in Brazil. The partnership strategy is based on the decision flowchart from Teece (1992a) and the first part of the analysis will thus follow its structure, but complemented with the relational- and institutional view. The second part of the analysis will analyze the applicability of the framework on cleantech firms in general. In addition to the applicability analysis, the third part will follow with a self-critic perspective where the contributions from the different views in the framework are questioned such as if they comprise the factors needed for the applicability analyze. Finally, it will also include possible contributions derived from this research to top management in cleantech firms.

5.1 Partnership Strategy for Commercializing Aquaporin A/S in Brazil

5.1.1 Appropriability Regime

The partnership strategy derived from the theoretical framework is created for situations of weak appropriability regime and where it is critical for the company in question to acquire complementary assets. It therefore becomes natural to start this first part of the analysis with looking into whether the appropriability regime influencing Aquaporin A/S is weak or tight in the context of the Brazilian market. As brought up in the empirical chapter, Aquaporin A/S is putting great effort in strengthening the appropriability regime through maintaining the know-how inside the company and is conducting an aggressive patenting strategy (Aquaporin A/S, 2015a). However, this patenting strategy may not have the same effect in emerging markets like Brazil compared to developed countries, e.g. in a "western" institutional environment. This is due to the ability to create a tight appropriability regime in emerging markets might be more difficult than in more traditional mature markets. In the case of Brazil, before a foreign firm can enter the Brazilian market with their patents and trademarks protected, there is a need to undergo complex procedures for technology transfers. As Aquaporin A/S has a broad patent portfolio with around 50 patents, this technology transfer could become problematic and as these procedures take long time it

might lead to that Aquaporin A/S need to narrow down their technology transfer to Brazil and choose only the most vital patents. Even if Aquaporin A/S succeeds in transfer their patents into Brazil, the protection of these patents will not meet the standards of developed countries. With a score of 50 on the property rights list from the 2015 Index of Economic Freedom, Brazilian authorities cannot guarantee to provide full protection of Aquaporin A/S's intellectual property rights. Since the success of Aquaporin A/S's business depends on those patents it becomes critical to keep those patents secured. If Aquaporin A/S would come up against a situation where their patents has been compromised, Brazil's institutions weak enforcement of their property right laws and the relatively young established Federal Court of Appeals would probably not aid Aquaporin A/S in any greater extent (PWC, 2013; the Heritage Foundation, 2015).

5.1.2 Dominant Design Paradigm

The dominant design paradigm within water treatment is currently RO, but with the small uprising of MBR (Rubim, 2014, Dec; J. L. Hansen, 22th Apr 2015b). It is not the design paradigm of FO used by Aquaporin A/S who therefore has three choices. First they can promote FO's emergence as a dominant design paradigm, secondly they can wait for it to emerge, and thirdly, follow the current dominant design paradigm of RO which their membrane also can be used for. It would be optimistic with Aquaporin A/S's financial resources and low influence in the Brazilian market to actually promote a new dominant design paradigm. Waiting for it to emerge can be considered an option if nothing else is possible (Teece, 1986; J. L. Hansen, 22th Apr 2015b). However, by following the current dominant design paradigm they can actually reach for the present market potential meanwhile they establish their contacts and influence in the market and thus have it easier to promote FO later on. This last choice is also in accordance with Aquaporin A/S's commercialization plans (J. L. Hansen, 22th Apr 2015b).

5.1.3 Critical Complementary Assets

This analysis will cover and classify the potential complementary market and non-market assets needed to successfully commercialize in Brazil. Aquaporin A/S has outlined in their

business plan that they will produce the membrane technology in-house, and the specialized complementary market assets needed for their membranes to function will be in the form of water purification systems. These systems will be provided from strategic commercial partners that further might be able to provide services such as marketing and sales. Aquaporin A/S will focus on R&D and production of their membrane technologies and strive to find suitable and reliable business partners around the world to provide the complementary systems (Aquaporin A/S, 2015a). If Aquaporin A/S shall be able to commercialize their products in Brazil there need to be reliable suppliers of water purification systems. The most energy efficient system design is the FO, which is the system Aquaporin A/S would like to promote worldwide, due to its cost and energy efficient characteristics. However, since the FO systems are not widely used and have minimal to non-activity within Brazil, producers of these systems may be harder to find. Aquaporin A/S therefore need to find potential partners that can provide RO systems, which is the dominant design and thus also easier to sell (J. L. Hansen, 4th Mar 2015a; Rubim, 2014, Dec). The major actors within membrane technologies in Brazil usually produce the membrane technology and the complementary systems in-house. These actors are often multinational firms with presence in several countries, and these are the firms that Aquaporin A/S needs to contact to receive complementary systems from. These companies do often also provide marketing and sales activities, which is not seen as specialized market assets since the procedures are rather standardized and can take the form of sales and marketing services from an existing sales office. Aquaporin A/S's membrane technology can, as mentioned, be used in several systems, with some modifications, which a majority of system producers can provide. But due to the needed modification of the systems in order to fit the Aquaporin Inside™ technology, the systems are classified as specialized complementary market assets (Rubim, 2014, Dec; Sabesp, 2015a; Koch Membrane Systems, 2015; GE, 2015b; J. L. Hansen, 4th Mar 2015a).

In addition to the complementary market assets, Aquaporin A/S will need complementary non-market assets. As the Brazilian market is complex to enter due to institutional barriers, it is difficult for a foreign firm with limited knowledge to manage an entering by themselves (PWC, 2013; J. L. Hansen, 22 Apr 2015b). Aquaporin A/S therefore needs non-market

complementary assets in the form of legal advice of how to do business in Brazil, such as advices regarding taxes, property rights, and permits. Complementary assets like these are not specialized since this information can be provided by many local and international firms. Consequently, Aquaporin A/S is able to contract for complementary non-market assets. Moreover, the institutions are relatively weak in Brazil compared to more mature markets like the US and Europe (The Heritage Foundation, 2015). This results in a less efficient market where specialized non-market factors become essential to do business (Meyer et al., 2009). For Aquaporin A/S to enter an industry or a business relation with a state owned company, connections with top managements and political actors may be required in order to promote the use of Aquaporin Inside™ technology. Personal ties with political actors can be hard for Aquaporin A/S to establish, because of their non-existent presence in Brazil and their small size, which eventuate in that certain industries may be closed for them. Larger international firms with more resources might on the other hand be able to establish political ties by using a political strategy, either e.g. through a financial or constituency strategy. But this is, as mentioned, not the case for Aquaporin A/S (Shirodkar & Mohr, 2015; J. L. Hansen, 22th Apr 2015b; PWC, 2013). The Brazilian authorities are protective over the domestic labor market and if international firms try to enter the market and risk to affect the labor market the authorities will intervene and shut down the entering of the new firm. Therefore larger international firms that can have a greater impact on the labor market, need to go through the authorities and might then depend on personal ties or a political strategy to successfully enter the market (PWC, 2013; J. L. Hansen, 22th Apr 2015b). In the case of Aquaporin A/S, their presence in the Brazilian market would not affect the labor market in any greater extent, hence they are able to operate under the radar and the authorities would most likely not intervene in their business. However, if Aquaporin A/S would decide to try to form a partnership with a state owned company, it would be more problematic with no personal ties and their lack of political strategies. Despite that, the Brazilian authorities are eager to obtain highly advanced technologies within all industries, e.g. through formal and fair bidding processes, which Aquaporin A/S can provide that in turn opens the possibility for Aquaporin A/S to engage in business relation with state owned companies (Shirodkar & Mohr, 2015; A. F. Granjo, 7th May 2015; J. L. Hansen, 22th Apr 2015b). Moreover, PWC (2013) specifically

mentions the water supply sector to be under institutional influence which theoretically increases the need for political embeddedness in the case of Aquaporin A/S commercializing its technologies in Brazil.

5.1.4 Partnership Modes

If following the strategy of commercializing Aquaporin Inside™ with a focus on the RO, which is the dominant design paradigm in Brazil, the critical complementary assets not available in-house has to be identified in the next step of the flowchart. Complementary assets already acquired for the production of the membranes can be excluded in this analyze, since they are acquired in separate for production in-house in Denmark. As derived from the analyze of critical complementary assets, Aquaporin A/S needs to acquire market assets in terms of services of marketing and sales and specialized market assets in terms of systems for their membranes. Additionally, they also need non-market assets in terms of legal advice and specialized non-market assets in terms of political embeddedness in order to target the state owned enterprises in Brazil, such as Sabesp.

Even though Gans and Stern (2003) suggest a competitive commercialization strategy in weak appropriability regimes, an immediate commercialization is not possible since several critical complementary assets are needed and because of the high entry barriers in Brazil. The question thus becomes, what partnership strategy should Aquaporin A/S adopt to acquire all these assets? First off, they are both in a need of specialized market assets, and would benefit from specialized non-market assets in order to promote their business involving state-owned companies. As Shirodkar and Mohr (2015) discuss the purpose with political embeddedness and political strategies is to gain, e.g. greater market capitalization and favorable legislative decisions. This could take the form of a state owned company, such as Sabesp, at least would discuss with its suppliers, such as GE, to implement the Aquaporin Inside™ technology in their systems. In this scenario Aquaporin A/S would be able to obtain the specialized complementary non-market assets from the personal ties, which makes personal ties a highly valuable partnership, especially in emerging markets (J. L. Hansen, 4th Mar 2015a). Because of this they first have to see if these specialized non-

market assets are possible to be acquired from personal ties. In this case, Aquaporin A/S does not have these connections and could therefore need to form a strategic alliance or integrate. A strategic alliance is beneficial for accessing the specialized non-market assets, regardless of their good cash position, since the better positioned competitors in Brazil, such as Koch, Enfil and GE make an integration disadvantageous (Teece, 1986). These firms could also be seen as potential partners, but even though integration with any of these companies would be established, the competition could still be present from the others and a strategic alliance is still preferable if the competition remains too strong. One can thus choose to target private industries and consequently minimize the need of political embeddedness. Nevertheless, the institutional involvement in Brazil is here assumed to be of value enough to justify the need for political embeddedness in the case of a potential commercialization for Aquaporin A/S in the area.

A strategic alliance strategy also conforms to the specialized market assets, which can be acquired from the same alliance or alliances if possible since it would be favorable in terms of coordination. Because of the coordination aspect, a single partner providing both political embeddedness and the complementary systems would be optimal, where Aquaporin A/S can in return provide their technology. The risks with strategic alliances will then be of opportunistic nature, where Aquaporin A/S's technology might be imitated, if there are no effective governances (J. L. Hansen, 4th Mar 2015a; Dyer & Singh, 1998). As explained in the theoretical framework, trust may be one of the most effective safeguard for opportunism, and is therefore suggested to be acknowledged in the situation of a created strategic alliance (Dyer & Singh, 1998; Ill & Gallagher, 2007).

In addition to the specialized assets of political embeddedness and systems, the complementary market and non-market assets in the forms of marketing and sales, and legal advice can be accessed through contractual relationships including upfront payments, milestone payments and/or royalties etc. in order to avoid high costs for Aquaporin A/S. Some of these assets could of course be found in the strategic alliance or alliances created for the specialized assets. However, it is not always advantageous to acquire these assets from an alliance. First off, the advantage of contractual partnership origins in the

independence between partners. A better price, speed, quality, scope, odds etc. can be strived for through establishing new contracts without making any heavy investments, a strategic alliance may be hazardous in the terms of longer relationships where the terms cannot be changed as easily (Teece, 1986; Markman et al., 2008). Contracting can of course be a greater risk for opportunism, but in this case of legal advice and marketing and sales, Aquaporin A/S is not that exposed since their secrets are more linked to the production (Aquaporin A/S, 2015a; Teece, 1986; J. L. Hansen, 4th Mar 2015a). Benefits from abstaining the contractual modes and gather the assets from strategic alliances instead can originate in the possibility of increased trust, and thus more effective governance as brought up earlier, through the deeper commitments between the partners. As stated by Ill and Gallagher (2007), higher trust can reduce transactions costs, simplify dispute settlements and increase flexibility, consequently resulting in competitive advantages and thus an improved commercialization process. Additional benefits are also available in the possible granting of capital for the procedures and information about the market important for further commercialization (Ill & Gallagher, 2007).

For a company of the size and with the coordination ability of Aquaporin A/S, several partnerships can definitely be problematic to coordinate efficiently, therefore it would be favorable to use the same alliance for accessing legal advice and marketing and sales as for the specialized assets (Zaheer et al., 2000). On top of that, arms-length relations may be easier to optimize through collaboration break-offs, but they do not in the same extent contribute with relational rent or with coordination benefits (Dyer & Singh, 1998; Nishiguchi, 1994; Mitchell & Singh, 1996). The result thus becomes to strive for one suitable partner for a strategic alliance contributing with all complementary assets needed. And if not possible, at least strive for as few, but covering, strategic alliances for the specialized assets as possible and for as much of the complementary assets as possible. Thereafter, create contractual relationships for the complementary assets remaining, suggestible as few as possible.

As GE is discussed to be an actor that might be able to provide all forms of complementary assets, GE could be a potential partner for Aquaporin A/S. Together with GE, Aquaporin

A/S would be able to enter the Brazilian market and be able to do business with state owned companies such as Sabesp. Furthermore, Aquaporin A/S would gain access to the markets all around the world where GE has its presence (GE, 2013). Another firm that could supply political embeddedness is Koch Membrane Systems, because of their presence on the Brazilian market is focused on the partnership with Sabesp. With those political ties there are potential for further market gains (Koch Membrane Systems, 2015). Enfil could be an alternative partner and with their complementary assets and experience with leading companies in several industries, Aquaporin A/S would achieve fast access to the most important industries within the use of water and wastewater treatment. In the collaboration with Enfil, Aquaporin A/S would not need to be politically embedded due to their impact on the labor market is minor and would go under the radar. Moreover Aquaporin A/S would rely on Enfil's contact network to establish customers, which implies that there is no need for personal ties (Enfil, 2015a).

5.2 The Framework's Applicability on Cleantech Firms

5.2.1 Alignment of Analyzed Partnership Strategy with Aquaporin A/S

The result from the framework is aligned with the business plan of Aquaporin A/S in terms of a focused partnership. The suggested partnership mode became the forming of strategic alliances where the partner or partners can contribute with as many needed complementary assets as possible. And only if needed, contractual relationships can be established in order to access the complementary assets that could not be accessed through strategic alliances and that is not specialized. Aquaporin A/S specified this in that they practically want partners that makes everything except the production of the membranes and simply provides revenues in forms of upfront payments, milestone payments, royalty payments and membrane and module revenues. They are even willing to grant market exclusivity to a single partner if the terms are beneficial. Among suggested strategic partnerships from Aquaporin A/S, licensing and contractual agreements are mentioned, which is not recommended as the prioritized partnership here. However, their description of a strategic commercial partners such as these are more similar to the definition of a strategic alliance partner here, or a mixed mode of partnership since they describe it as

narrow banding agreements (Aquaporin A/S, 2015c; J. L. Hansen, 4th Mar 2015a; Aquaporin A/S, 2015b). Therefore, their preferred form of partnership is similar, but not entirely aligned, with our suggested result derived from the framework.

However, Aquaporin A/S has started their expansion with integrations in forms of joint ventures, e.g. in China and Singapore. This is in contradiction with the derived partnership strategy for Brazil, and could be explained by different reasons. Firstly, the demand for Aquaporin A/S's technology in the area may have indicated the absence of better positioned imitators and competitors. Secondly, China and Singapore could be seen as the foothold for Aquaporin A/S's global expansion and may have become valued as target for a more solid and aggressive entering. Its contradiction can however be questioned. Koch, Enfil and GE may be better positioned in Brazil, and thereby make integration look disadvantageous. If one of these companies would be willing to integrate with Aquaporin A/S because of their membrane technology, their presence as competitors would change. This makes the step from the flowchart called *"imitators/competitors better positioned"* misleading as Enfil, Koch and GE are better positioned, leading to a yes in the flowchart resulting in the choice of strategic alliance, which exclude the alternative of integration, which may not be the case in reality. The alternatives therefore have to be analyzed in parallel in order to find out if the imitators/ competitors still are better positioned after choosing the decided partnership.

5.2.2 Applicability of Framework on Cleantech Firms in General

This framework may work in the case of Aquaporin A/S commercializing in Brazil, but the question regarding the framework's applicability on cleantech firms in general remains to be analyzed. The applicability in the case of Aquaporin A/S itself is a factor strengthening the general applicability, but further analyzing has to be made, especially in terms of similarities between Aquaporin A/S and other cleantech firms. With similarities between Aquaporin A/S and other clean tech firms, the likeliness of the framework's general applicability rises. According to Johnson & Suskewicz (2009), cleantech firms tend to implement their technologies in systems already established in the market. The need of

similar complementary assets can thus contribute as similarities between Aquaporin A/S and other cleantech firms. Moreover, according to Mitchell and Singh (1996) the technologies from cleantech firms are often complex, this thus makes their opportunities and difficulties even more alike on a general level. The specific technological difficulties may vary a lot, but because of the similarities in business it is likely that the threats from imitators, hinders in political embeddedness, opportunistic behavior, etc. are more equal, as touched upon by Maguire (2010). An argument of why these similarities are leading to similarities in the commercialization process of cleantech firms is what is stated by Zahra and Nielsen (2002) regarding that partnership is an important part in a successful technological commercialization. These aspects or assumptions, of cleantech firms brought up in the theoretical chapter of this thesis, strongly correlates to the empirical findings of Aquaporin A/S, which further strengthens the applicability of the framework. For example, the firm has complex products to offer, it prefers keeping the core technology in-house because of threats from knowledge leaking, and it needs partnerships in its commercialization process according to both their business plan and previous expansions and according to the developed flowchart.

One aspect important to remember is that Aquaporin A/S has on their later time of operation been granted capital injections of great volumes, which may not be the case for all cleantech firms. On the other side, Aquaporin A/S did not have these injections from the beginning and were then expanding in a more self-enforced manner with them knocking on doors and finally found a partner in Singapore. Aquaporin A/S is still dependent on capital injections but could be seen as being in a good cash position because of all investors. Meanwhile, most cleantech firms may not be in a good cash position, but as long as the flowchart includes the aspect of financial position it could be seen as possible applicable to these cleantech firms too (Bulkin, 2014). Due to the frequent lack of financial resources, integration may become too costly in accordance with the flowchart. A normal strategy is therefore assumed to be the forming of a strategic alliance for cleantech firms in order to access specialized assets without the risk of dedicating too great costs to the commercialization process (Teece, 1986).

5.3 Limitations of the Framework

The framework created is limited to the complementary assets included in the RBV and the institutional view. Contributions from the relational view are included in the overarching guidance when the first two views have already been analyzed. Its influence will therefore affect the decisions as a part of the last saying. This order can definitely be questioned, especially in terms of the actual influential power of including the aspects of the relational view in the end respectively the beginning of the decision makings. The question can be said to reflect the prioritizing of the cleantech firm. Should its decisions be made in contrary to what assets are needed or what can potentially be the most valuable relationship in terms of relational rent? Here it is assumed that no view can be completely excluded and the flowchart therefore comprise all three comprehensive views, but in order to make it as relevant as possible for cleantech firms with their technology oriented sphere, complementary assets is seen as the prioritized guiding in the partnership strategy. This can however be further questioned, e.g. does their smaller size, and often smaller financial resources, lead to a greater need of the specific resources they are lacking or a greater need for relational rent?

Limitations can also be found in the alternatives of partnerships modes derived from the flowchart in the framework. Especially in terms of the lacking variations of mixed modes that is often the case in reality, such as the confirmed case of Aquaporin A/S who search for licensing and contractual agreements at the same time they desire closer relationships. The case of Aquaporin A/S earlier expansions, which do not follow the strategy derived from the framework, may also indicate that the framework has a too narrow approach in terms of what variables should be included in a business model. Teece (2006) commented on this already in his own flowchart, which may not have been fully solved in this thesis either.

Moreover, the framework do not include the aspect of commercialize a cleantech firm on the base of imitation instead of innovation. This may be a typical influence from the western perspective since imitation can be seen as morally wrong.

5.4 Contributions to Top Management

The framework is making it clear for top managers in cleantech firms to start with analyzing the design paradigm and critical complementary assets in order to start the commercialization process. The prioritization of these aspects is likewise clear, since the dominant design paradigm has to exist or emerge from promotion or natural market forces, before the identification of critical complementary assets can proceed. By following the steps in the framework, a resolution to the problems or opportunities appears in the form of whether to immediate commercialize or establish a suitable partner strategy. According to Sreejesh et al. (2014) these are important contributions to the top management in the business decision-making process. However, important is also the implementation of the course of action which may not be equally well approached in this framework. It is not included how derived strategies can be accomplished, such as how to form strategic alliances or establishing contracts. But through the integration of the relational view, the effects of investments in, e.g. interfirm relation-specific assets and knowledge-sharing routines are touched upon in order to make a partnership generate as much relational rent as possible and thus guide the management in the implementation phase. Furthermore, these aspects may be relevant in different forms of established partnerships and therefore not always guide the firm in the specific decision process, but rather how to think when a partnership is chosen. The course of action can therefore be dependent on how these relational aspects can be integrated in the different partnership strategies and its time of integration.

6. CONCLUSIONS

From the framework, it was possible to retrieve a relevant partnership strategy for commercializing Aquaporin A/S in Brazil, which was similar to the firm's business plans. This partnership strategy included the use of a strategic alliance partner in order to access the specialized complementary assets and if possible also the generic assets. Contracting could be performed for the complementary assets not found in the strategic alliance. By not acquire all complementary assets from the same partner, there will be an increased demand for coordination from Aquaporin A/S. Additionally, a single strategic alliance partner may also contribute with more relational rent than having contracts for some assets. The contractual partner can however be optimized in another way since they are kept on arms-length and can be changed more easily. Integration is not relevant as a substitute to the alliance as long as it is not implemented in collaboration with the best positioned competitor.

Aquaporin A/S has many similarities with cleantech firms in general, such as their complex products and difficult business climate including political embeddedness and risks of opportunistic behavior. Aquaporin A/S does also need a strategic partnership for their commercialization, both according to the theoretical framework and their business plan. Because of this, it can be argued that the illustrative applicability of the framework is further demonstrated on cleantech firms in general, especially since it's testing in a case study was successfully illustrated. This is both in terms of alignment between the result and Aquaporin A/S's business plan and capacities, and in terms of the actual possibility to go through the analyzing process in accordance with the created framework.

Moreover, the contributions to top management in the business decision-making process were plenty from this research, and mostly in the form of identification, prioritization and selection, and resolutions of problems and opportunities. A top manager can clearly follow the guiding principles from the flowchart, especially since it illustrates the applicability in the general cases of cleantech firms.

7. IMPROVEMENTS & FURTHER RESEARCH

7.1 Improvements

Increased response rates from potential partners and buyers and from potential end customers could probably be attained through further efforts if the time would allow. More in depth analysis of their suppliers would also increase the strength of this research, especially in the case of Copasa who could not be reached at all. This poor response rates could unfortunately not contribute to an enhanced understanding of the Brazilian water treatment market, but the attempts in reaching out to them could be done more efficient now when it is more known how their culture of responding and supporting works. For example, providing official documents signed by a supervisor was demanded from one of the companies in order to respond to more delicate matters. If this was provided for all companies, the response rate may have increased.

Multiple case studies would test the framework's reproducibility of strategic partnerships in cleantech firms' commercialization process, and by that increase the reliability of the thesis (Sreejesh et al., 2014). Planned in the current case study was a field trip to São Paulo, where in-depth interviews could be held with companies of interest, such as Sabesp and Copasa, in order to gather primary data. Another aim was to attain at forums, gatherings and fairs for cleantech firms, such as the 2015 Cleantech Forum Europe in Florence in order to acquire the bigger picture shared by other cleantech firms and hear out their perspective on the Brazilian market. These projects would however demand a granting of economic support which was not possible this time but would constitute an improvement if conducted.

In contrary to the framework, the flowchart does not separate between different integration and contractual modes, and does not include mixed modes of partnerships. By including these, the contribution to top management in cleantech firms would potentially become greater. Additionally important for the derived partnership strategy from the framework is the analysis of imitators and competitors positions in Brazil. This analyze could constitute a thesis by its own but had to be more efficiently done here. A deeper

analyze of whether the competitors and imitators really is hindering a possible integration in Brazil for Aquaporin A/S would contribute with increased value of this thesis.

7.2 Further Research

Further research of cases where the cleantech firms have made the same decisions as would be suggested by the framework would contribute in terms of whether the partnering strategy is leading to higher rates of successful commercialization processes in emerging countries. In other words, a retroactive approach in testing if the framework provides a successful commercialization strategy would be beneficial.

The framework was suited for weak appropriability regimes, which according to Teece (1986) is most often the case. This may be even more true in emerging markets, but further research could contribute in distinguish the differences and adapt the framework for cases in situations of tight appropriability regimes too.

8. PERSONAL COMMUNICATIONS

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APPENDICES

Appendix A

Improved sources of drinking-water (JMP, 2015)

- Piped water into dwelling
- Piped water to yard/plot
- Public tap or standpipe
- Tubewell or borehole
- Protected dug well
- Protected spring
- Rainwater

Improved sanitation facilities (JPM, 2015)

- Flush toilet
- Piped sewer system
- Septic tank
- Flush/pour flush to pit latrine
- Ventilated improved pit latrine (VIP)
- Pit latrine with slab
- Composting toilet
- Special case

Wastewater (Corcoran, Nellemann, Baker, Bos, Osborn, & Savelli, 2010, p. 15)

"A combination of one or more of: domestic effluent consisting of blackwater (excreta, urine and faecal sludge) and greywater (kitchen and bathing wastewater); water from commercial establishments and institutions, including hospitals; industrial effluent, stormwater and other urban run-off; agricultural, horticultural and aquaculture effluent, either dissolved or as suspended matter."

Economic water scarcity (IWMI, 2007, p. 63)

"Human, institutional, and financial capital limit access to water even though water in nature is available locally to meet human demands."

Water loss (PSC, 2015)
"Water loss is the percentage of drinking water placed into the distribution system that does not find its way to billed customers or unbilled authorized users."

Reverse osmosis (Sourirajan & Agrawal, 1969, p. 62)
"The technique consist in letting the fluid mixture flow, under pressure, through an appropriate porous membrane, and withdrawing the membrane permeated product generally at atmospheric pressure and surrounding temperature; the product is enriched in one or more constituents of the mixture, leaving a concentrated solution on the upstream side of the membrane."

Forward osmosis (Cath, Childress & Elimelech, 2006, pp. 71-72)
"Osmosis is the transport of water across a selectively permeable membrane from a region of higher water chemical potential to a region of lower water chemical potential. It is driven by a difference in solute concentrations across the membrane that allows passage of water, but rejects most solute molecules or ions. Osmotic pressure (π) is the pressure which, if applied to the more concentrated solution, would prevent transport of water across the membrane. FO uses the osmotic pressure differential ($\Delta\pi$) across the membrane, rather than hydraulic pressure differential (as in RO), as the driving force for transport of water through the membrane. The FO process results in concentration of a feed stream and dilution of a highly concentrated stream (referred to as the draw solution)."

Strategic Alliance (Teece, 1992b, p. 19)
A strategic alliance can have different definitions but is here defined "as a constellation of agreements characterized by the commitment of two or more partner firms to reach a common goal, entailing the pooling of their resources and activities. A strategic alliance might include the following: (i) an exclusive purchase agreement; (ii) exclusionary market or manufacturing rights; (iii) technology swaps; (iv) joint R&D or co-development

agreements; (v) co-marketing arrangements. A strategic alliance denotes some degree of strategic as well as operational coordination."

Appendix B

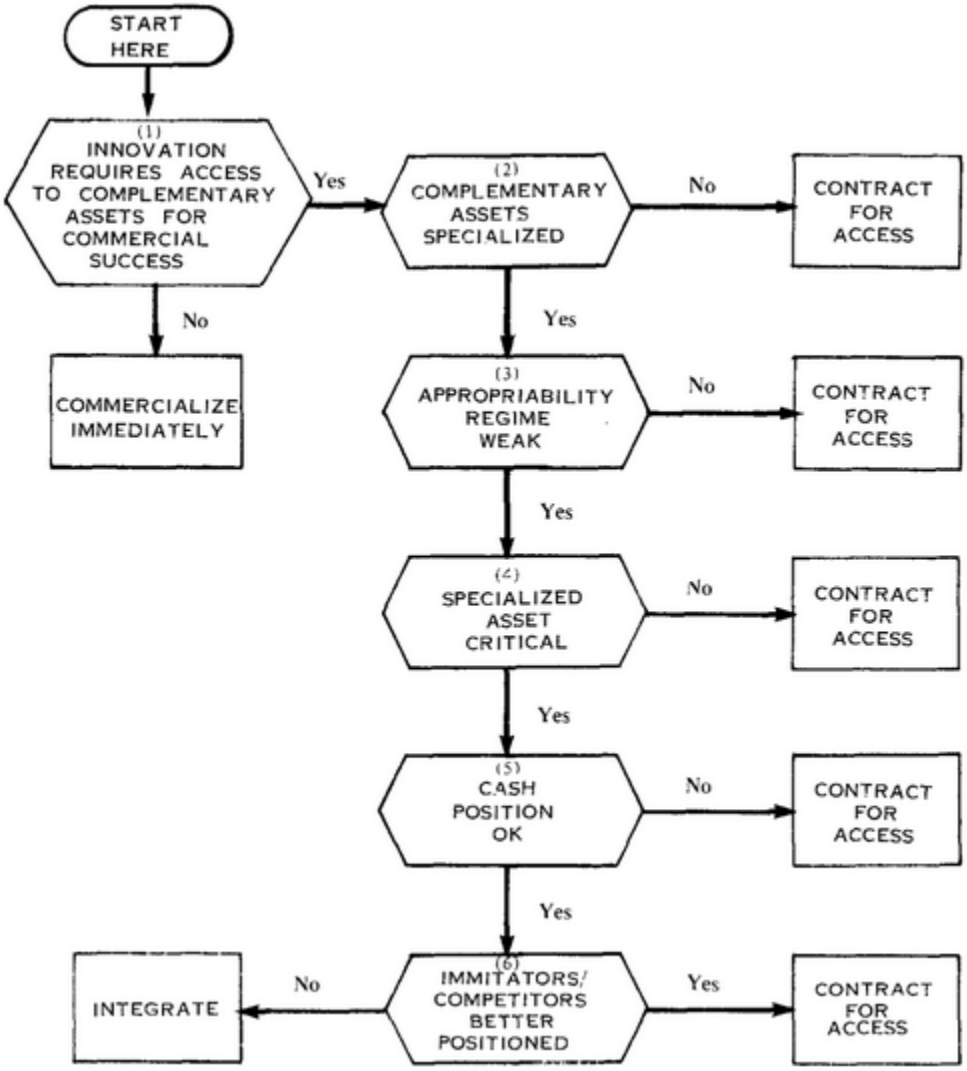

Figure is taken from Teece (1986) and describes how to profit from innovation.

Appendix C

Pre formulated email to potential end customer:

Dear Sir/Madam

We are two master students at the Gothenburg University, Sweden, writing a master thesis about commercialization in water treatment in Brazil. We are conducting our research by analyzing the application of water treatment in the largest industries and companies within Brazil, and seeing if there is any interest in more effective and affordable solutions. Therefore, we would like to know more about how you at "Company name" are managing water treatment, including:

- **Technology specifications, such as what system you are using?** (E.g. whether you are using reverse/forward osmosis, membrane bioreactors, etc.)
- **Who are the supplier(s) of this system?** (E.g. the biggest supplier of the system respectively the membrane/reactor/etc.)
- **Do you have any future goals in relation to your water treatment?** (E.g. in terms of cost efficiency/energy usage, utilization level, environmental effect, etc.)

We would really appreciate your answer!

Best Regards

Karl Stolpe & Jesper Gille

Pre formulated email to potential partners and buyers:

Dear Sir/Madam

We are two master students at Gothenburg University, Sweden, writing a master thesis about commercialization in water treatment in Brazil. We are conducting our research by analyzing the technology and application of water treatment solutions in the largest

industries and companies within Brazil. Therefore, we would like to know more about your systems at “Company name”, including:

- **Technology specifications, such as what system you are supplying in Brazil?** (E.g. whether you are using reverse/forward osmosis, membrane bioreactors, etc. in the systems)

- **Do you have supplier(s) of membranes/reactors/etc to your system?** (E.g. if you are not producing these yourselves, who are the biggest supplier of the membranes/reactor/etc.)

- **Do you have any future goals with your water treatment systems?** (E.g. in terms of cost efficiency/energy usage, utilization level, environmental effect, etc.)

- **Can you provide us with the names of your biggest customers in Brazil?**

We would really appreciate your answer!

Best Regards

Karl Stolpe & Jesper Gille

Appendix D

The potential end customers that were attempted to be contacted were:

AMBEV, Coca-Cola Group and Brasil Kirin in the food and beverage industry, Gerdau, Arcelormittal, CSN and Usiminas in the steel industry, and Fibria, Suzano Papel e Celulose, and Klabin within the pulp and paper sector. Moreover, Sabesp, Sanepar Copasa, Cedae, Ceasb, Embasa, Galvão, Camargo Correa, and Querios Galvão are all companies within water sanitation service included in the potential end customers contacted.

From these, only Sabesp responded with straight answers, meanwhile Copasa responded with demanding an official document which they in turn did not answer to.

The potential partners and buyers attempted to get in contact with are:

Odebrecht Engenharia Ambiental S.A, Estre Ambiental S.A, Enfil, OAS Solucões Ambientais S.A, Degremont, Centroprojekt, VWS BRASIL LTDA, CAB Ambiental, Nova Opersan, COMPESA, Foz do Brasil (the engineering division of Odebrecht Group), Lidermarc, GE Water & Process Technologies, Koch Membrane Systems, Dow, Kubota, Mann+Hummel Fluid Brasil, Pentair, and Toray.

Not a single one of these companies responded to the emails.