NTNU – Trondheim
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Board Composition, Board Roles and Behavioral Integration in High-tech Start-ups

A Case Study of the Norwegian Renewable Energy Sector

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Oppgavetekst/Problembeskrivelse The thesis will look at the composition of members of the management team and board of high-tech start-ups to evaluate its effect on firm performance. Specifically the factors considered will relate to the skills and experience of team and board members, as well as the divergence of opinions and interests within the teams and the degree to which boards actively contribute to the management of the firm. The measures of firm performance considered include different measures for profitability, growth and international expansion. Data will be gathered from selected case companies in Norway.	
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Abstract

This study has examined how the board operates in order to facilitate for the development and success of the clean-tech start-up. Specifically the study has examined several aspects and characteristics of boards to determine which factors contribute towards creating an efficient board that best facilitates for the growth of its company.

Through an in-depth analysis of five case firms, several key insights regarding boards in clean-tech ventures have been uncovered. The main constructs examined were the composition of the board, the engagement of the board into different board roles as well as the behavioral integration of the board. The case study has revealed that these constructs were all important determinants of the contribution of the board towards the growth and success of the clean-tech firm.

Boards in clean-tech start-ups favor engagement in the service role, and this is also the role that has the strongest influence on the firm's strategic action capabilities. As the firm develops, the control role takes on a larger part of the focus of the board, due both to reduced effect of performing the service role and to pressure from shareholders. The behavioral integration of the board acts as a moderator of the contribution a firm can expect from its board. That means the more the board is integrated behaviorally the more it will be able to influence the firm. While boards can have an immense effect on the development of a young firm, clean-tech start-ups also need to be cautious about not becoming dependent on their boards. Firms that to an excessive degree rely on their boards' network to reach out to potential partners and investors develop lower strategic capabilities and growth.

Sammendrag

Dette studiet har evaluert hvordan styret opererer for å fasilitere for utvikling og suksess i oppstartsbedrifter innenfor området fornybar energi. Mer konkret har studiet utforsket flere aspekter og karakteristikker ved styrer for å avgjøre hvilke faktorer som bidrar til å skape et effektivt styre som best mulig fasiliterer for vekst i bedriften.

Gjennom en dybdeanalyse av fem case-bedrifter har viktig kunnskap angående styrer i fornybar energi-bedrifter blitt avdekket. Hovedaspektene som har blitt evaluert i dette studiet har vært komposisjonen av styret, styrets engasjement i forskjellige styreroller og styrets atferdsintegrasjon. Case-studiet har avslørt at alle disse aspektene er viktige determinanter for styrets bidrag til vekst og suksess i fornybar energi-bedrifter.

Styrer i oppstartsbedrifter innenfor fornybar energi engasjerer seg mer i service-rollen, og dette er også den rollen som har den største påvirkningen på bedriftens strategiske handlingsevne. Når bedriften utvikler seg tar kontroll-rollen over en større andel av styrets fokus, både grunnet redusert effekt av utføring av service-rollen og press fra bedriftens aksjonærer. Styrets atferdsintegrasjon fungerer som en moderator for bidraget en bedrift kan forvente fra styret. Styret kan ha en betydelig påvirkning på en ung bedrifts utvikling, men oppstartsbedrifter innenfor fornybar energi må allikevel være forsiktige med å ikke bli for avhengig av deres styrer. Bedrifter som i en overdreven grad avhenger av deres styrers nettverk for å nå ut til potensielle partnere og investorer oppnår lavere strategiske handlingsevne og vekst.

Preface

This paper has been written as a master thesis within Industrial Economics and Technology Management at the Norwegian University of Science and Technology (NTNU). The degree is being taken at the Department of Industrial Economics and Technology Management.

I would like to express my very great appreciation to Postdoc Ekaterina Bjørnåli, my supervisor, for valuable input, critique and suggestions during the process of planning and performing this research, as well as during the development of this report. Additionally, I would like to express my gratitude towards the case firms that have contributed with their experiences and knowledge towards this study. I would also like to thank good colleagues for contributing with feedback and as discussion partners in the development of this report. Ultimately, I would like to thank some of the professors at NTNU within the field of strategic management for providing me with the theoretical background that this paper has been based on, specifically Professor Arild Aspelund, Professor Elsebeth Holmen, Professor II Tage Koed Madsen and Professor Roger Sørheim, as well as Professor Mario Calderini from the Politecnico di Torino.

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1 Introduction

Entrepreneurial ventures are a significant source of economic growth and innovation (Bygrave and Timmons 1991, Kortum and Lerner 2000). Entrepreneurial ventures are here representing smaller, privately held entrepreneurial firms that are within their first years since establishment. There is a continuous turnaround among the largest companies in the world, exemplified by firms such as Google, Facebook and GroupOn. The Fortunes 500 list, which lists the 500 largest companies in the United States based on revenues, also shows the effect new ventures have on the total business landscape. Of the 500 companies on the original Fortune 500 list in 1955, nearly 90% of them are not there today (Collins and Porras 2002), and from the list of 1995, half of the companies were substituted within the next 12 years (Arbesman 2012). All of this serves to underscore the tremendous potential new ventures of today have to become the major companies of tomorrow. In supporting for this development, extensive research has been done investigating the characteristics of entrepreneurs (Brockhaus 1980, Shook, Priem et al. 2003) and the venture's top management team (Eisenhardt and Schoonhoven 1990, Beckman 2006). However, the area of board of directors in these ventures has not been covered to the same extent.

In these times of increasing debate around firm governance and maximization of internal resources, theory and literature concerning boards have been growing in magnitude lately (Kim, Burns et al. 2009, Bjørnåli and Aspelund 2012, Garg 2013). While most mainstream research on boards and governance focuses on large companies (Zahra and Pearce 1989, Forbes and Milliken 1999), there is a gap in the literature regarding boards in smaller ventures. Studies on large companies might give valuable insights into some board characteristics. However, due to the huge differences between a Fortune 500 and a relatively newly started firm, in terms of resources, governance needs and firm activities, the results of these studies can be applied to smaller and younger firms to a very limited degree. These large companies, with a large set of shareholders and resources, differ greatly from younger, entrepreneurial companies in the way they are managed and developed. In entrepreneurial companies active boards do not, to the same extent, operate separately from top management and the nature of the boards' contributions therefore differs (Zhang, Baden-Fuller et al. 2011). As entrepreneurial firms are young and yet to be fully formed the impact an active board could have on such a company is vast, which serves to emphasize the importance of examining the role of the board in these firms.

Studying the formation and operation of boards across entrepreneurial ventures can provide important knowledge to put into effect for future ventures. However, for several industries and types of companies, studies considering all types of new ventures become too broad, as these companies operate in ways that differ significantly from that of the average new venture (Huse 2007, Ellingsen 2013). As Huse (2007) points out, in the board literature "*recommendations in one contextual setting should not be applied in other settings without being given due consideration*." High-tech ventures are examples of such companies that have several important characteristics in common which differentiate them from other ventures. High-tech ventures might also be among the ventures that have the most to gain from exploiting the resources, experiences and knowledge of their boards, due to the importance of quickly overcoming liabilities and building a critical mass for most high-tech businesses (Knockaert and Ucbasaran 2013). Despite this, issues regarding boards of directors in high-tech entrepreneurial ventures have been covered only to a limited degree, thus the potential is there to add to the field by examining these aspects further.

Research into entrepreneurial ventures suggests that the composition of entrepreneurial teams are important determinants of the growth and success of a new venture (Colombo and Grilli 2005, Vanaelst,

Clarysse et al. 2006, Wright, Hmieleski et al. 2007). As the divide between the board of directors and the top management team (TMT) is so short in new ventures (Bjørnåli and Gulbrandsen 2010), some researchers extend the entrepreneurial team term to include also board of directors (Vanaelst, Clarysse et al. 2006), which depicts how boards of directors in entrepreneurial firms to a larger extent are involved in certain roles than in other firms (Hambrick and Abrahamson 1995, Forbes and Milliken 1999). The area of research into boards' influence on the strategic decision making of firms have been gathering more attention recently (Pugliese, Bezemer et al. 2009) and this paper aims to add to that research by examining the effect an effective board can have on the growth and performance of a young firm.

Several researchers have studied the diversity of boards and entrepreneurial teams, albeit without arriving at a definite conclusion to when board diversity is desired (Simsek, Veiga et al. 2005, Bjørnåli and Aspelund 2012). While the desired degree of heterogeneity is still uncertain, researchers strongly encourage the inclusion of external directors into the board (Gabrielsson and Huse 2005, Knockaert and Ucbasaran 2013). External directors refer to those board members that are not employed by the firm. This area has received some attention in research lately, mainly from a theoretical perspective (Gabrielsson and Huse 2005, Garg 2013). Despite the previous research that has been performed there are still a series of questions regarding these areas that have not yet been sufficiently covered, such as for example the relationship between the composition of a board and the roles it performs, which will be examined in this study.

Adding to the issue of board effectiveness, the roles that the board fulfill have also gathered some attention from researchers (Gabrielsson and Huse 2005, Garg 2013, Knockaert and Ucbasaran 2013). The roles are generally split between the service role and the control role. The service role covers those tasks that aim at exploiting the experiences and knowledge of the board members to give advice, participate in strategic evaluations or contribute with their network. On the other hand, the control role covers the tasks of controlling and monitoring the internal and external activities of the firm. This role aims at ensuring that everyone in the firm are incentivized to pursue goals that are in the best interest of the firm and its shareholders. Researchers are split in their view on which of these roles contributes the most to the development of the firm. There is therefore a potential for contributing to the field through further evaluating the effect of the board's engagement in the two roles.

The contribution that a board can bring to a firm can be manifested in several characteristics of firm performance. However, firm performance is difficult to measure directly for young firms. The most used and developed measures of firm performance regard some degree of financial performance, such as revenue or result growth. Financial measures might be less viable for young firms, due to them often not being expected to be financially viable for several years. Other measures are therefore needed to adequately cover the contributions that can come from the board's influence in these firms. One of the measures that have been used frequently for this are strategic action capabilities of the firm's TMT (Miller and Chen 1996, Baum and Wally 2003, Kim, Burns et al. 2009). Strategic action capabilities are generally measured in terms of strategic action speed and breadth, and the board's involvement in certain tasks can affect these characteristics of a firm (Kim, Burns et al. 2009). Strategic action speed refers to the amount of time spent to form and implement strategic actions, while the strategic breadth depicts the range of strategic behaviors that a company can enforce relative to competitors (Kim, Burns et al. 2009). Both of these characteristics have been found to positively influence firm performance (Miller and Chen 1996, Baum and Wally 2003), but the degree to which boards of directors can shape these strategic action capabilities have been evaluated only theoretically (Kim, Burns et al. 2009). This area will be further examined in this study.

Researchers have long acknowledged the effect of having certain characteristics present in a TMT (Hambrick and Mason 1984). However, knowledge regarding the nature of processes within these groups is scarce (Simsek, Veiga et al. 2005). Lately, *behavioral integration* has been proposed as a concept that depicts these processes, specifically by capturing the following elements of the processes: (1) The level of collaborative behavior, (2) the quantity and quality of information exchanged, and (3) emphasis on joint decision making (Hambrick 1994, Simsek, Veiga et al. 2005). In sum, Hambrick (1994) argues this captures the "degree to which the group engages in mutual and collective interaction". Focus in existing literature on behavioral integration has been to study this solely for TMTs (Simsek, Veiga et al. 2005). This study adds to the research on behavioral integration in TMTs by studying the behavioral integration of the board, and its effect on the board's contribution on a young venture's development. Additionally, the study builds on existing behavioral integration research in suggesting several potential determinants of the degree of behavioral integration of the board.

To examine boards in high-tech ventures this study focuses on case firms within the renewable energy technology industry. This industry will hereby be referred to as the *clean-tech* industry. Previous literature has established that this industry has several important specifics, which limit the value these companies get from a broad, cross-industry study (Ellingsen 2013). To facilitate for a generation of emerging clean-tech companies it could therefore be very valuable to look at the relationships between boards of directors and management teams specifically in companies from that industry. It seems inevitable that these clean-tech firms will gradually consist a larger and larger part of the whole business landscape, as the human race struggles with battling emerging climate challenges (IEA 2011, Eyraud, Clements et al. 2013), and studies related specifically to their challenges should therefore grow in numbers. While macro-level factors regarding clean-tech firms have been covered well in the literature, micro-level factors, such as the ones considering managements and boards, in these firms have virtually not been studied to any extent (Ellingsen 2013). Thus, by focusing on the board and TMT in clean-tech ventures, this study adds to the stream of research on the clean-tech industry.

There exists many different terms for the clean tech industry, as well as many different definitions for each term. In this paper I will use the term "clean tech" as defined by Pernick and Wilder (2007):

> *Clean tech refers to any product, service, or process that delivers value using limited or zero nonrenewable resources and/or creates significantly less waste than conventional offerings.*

Generally these are companies which serve to protect the environment, through facilitating for the increased use of clean energy and environmentally friendly solutions (Menon 2011). A wide variety of technologies and sub-industries fall within the boundaries of this definition, ranging from solar, wind and hydropower, to biofuels, green transportation and green buildings.

Boards of directors in clean-tech companies have a couple of features distinguishing them from boards in many other companies, which all supports the claim that a specific study concerning these companies is needed. Firstly, clean-tech companies often have a long list of investors, both public and private, which all expect to be able to push the firm in the direction they want. The emergence of this mix of private and public investors stems from the fact that many clean-tech companies aim to satisfy two needs at the same time; one is to achieve economic returns for the owners, the other to help society fight climate challenges. This combination of possible goals of shareholders also might contribute to an increased tension within management and board of directors, as different measures are sure to be needed depending on which goal is deemed most important. Furthermore clean tech companies operate in a business environment

differing largely from many other businesses, mostly concerning differing market mechanisms. While most companies depend on having either a cost or a quality advantage over their competitors, many clean technologies are subsidized by the government because of the industry's current inability to compete with conventional energy in terms of costs (Tsoutsos and Staltiboulis 2005). This adds a complex political layer to the strategizing in clean tech companies and thus complicates the operations and composition of the boards of directors. Similarly, unlike in most industries, the demand for clean tech products depends not mainly on the technical aspects of the product, but more on the motivation of the public for appreciating more environmentally friendly alternatives (Tsoutsos and Staltiboulis 2005). All these factors emphasize the importance of performing research constricted to the industry of clean technologies (Ellingsen 2013).

1.1 Research questions

Responding to the calls discussed in this section, the purpose of this study is to explore how the board of directors in young, clean-tech ventures operate in order to facilitate for the development and success of the venture. As presented, we know relatively little of what makes boards in high-tech entrepreneurial firms effective, and what board characteristics best facilitate for the growth of the firm. Based on this, the over-arching research question of this study has been the following:

> *RQ: How does the board operate in order to facilitate for the development and success of the clean-tech venture? What are the distinctive features of effective boards?*

To evaluate this question it has been important to uncover in what ways the board provides value to a young venture. As presented in this section this question can be divided into three areas. These are the composition of the directors on the board, the roles that the board performs and the board's behavioral integration. The effectiveness of the board thus depends on who sits on the board, what they do and how they do it. Figure 1.1 shows this relationship. Through evaluating how these aspects work in high-tech ventures one can evaluate how effective boards function and how they contribute to the firm's development and success.

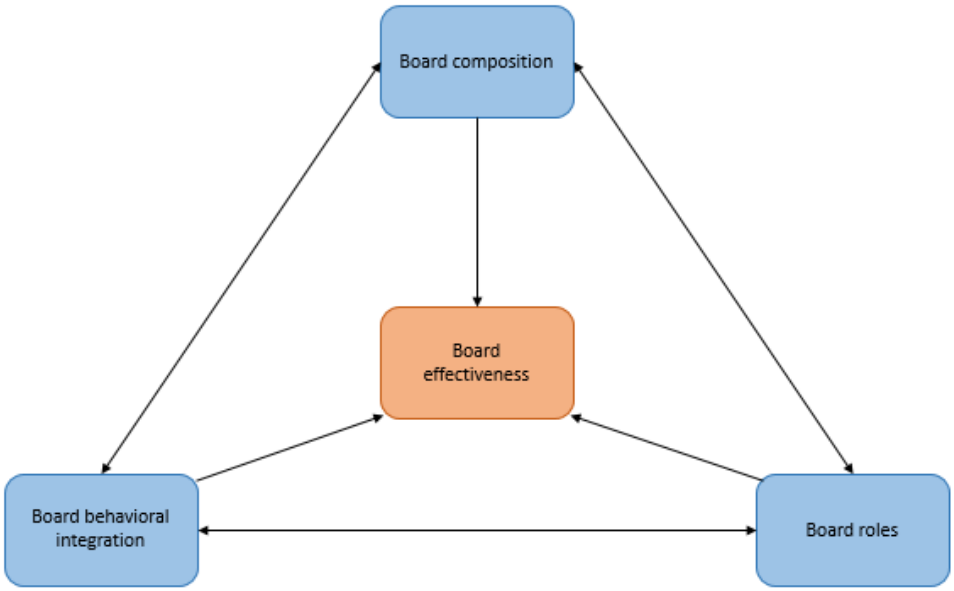

Figure 1.1 - Board effectiveness

While board composition and board role engagement have received some attention in existing board literature, we know little of the consequences and determinants of board behavioral integration. This study will therefore attempt to further develop the streams of literature on board composition and board roles, as well as introduce the concept of behavioral integration to the board setting. Together these three aspects will help us answer the over-arching research question. The set of underlying research questions of this study were formulated in the following way:

RQ1: Who are the board members of effective boards?

RQ2: What roles do effective boards perform?

RQ3: How do effective boards fulfill their roles? That is, what are the determinants and consequences of board behavioral integration?

In the next section of this report, I will present the theoretical foundations around which this study has been built and lay down the frameworks that have been used to explain different phenomena in the study. Subsequently I will explain the methodology that has been used in the study to gather and analyze data. I will then present the findings of the study, based on the gathered data, before analyzing the data to arrive at certain key propositions. Furthermore, I will discuss the contributions these findings can bring, both to future research, to strategizing in clean-tech entrepreneurial ventures and to those responsible for public support initiatives directed towards young clean-tech ventures. Ultimately, the study will be summarized in a brief conclusion.

2 Theoretical background

Several streams of research have discussed the impact an effective board of directors can have on a high-tech new venture. One of the reasons the board can be so important for these firms is their tendency to face resource scarcity due to different liabilities (Daily and Dalton 1992, Fiegener 2000, Knockaert and Ucbasaran 2013). There is a wide range of liabilities that high-tech start-ups tend to face, but among the most important are the liabilities of smallness, newness, and in cases of firms that plan to extend rapidly into international activities, the liabilities of foreignness and outsidership. The *liability of smallness* faces all small firms, and explains the resource scarcity that automatically comes from being small and having a limited amount of both human, financial and other resources (Aldrich and Auster 1986). The *liability of newness* arises as new firms need to establish relationships with clients, suppliers, financial institutions and other stakeholders, and suggests that selection processes naturally favor older and more established companies (Freeman, Carroll et al. 1983). Furthermore, the *liability of foreignness* arise for those firms that try to establish operations in foreign countries. The liability of foreignness arise from the difficulties and costs a firm face in doing operations in other countries, mainly related to cultural differences, lack of market knowledge and geographical logistics costs (Hymer 1976, Zaheer 1995). However, recent literature argues that this liability of foreignness today stems more from a *liability of outsidership*, costs related to not having a position in a relevant network in the target country, and that this outsidership is the main reason why firms face difficulties in adapting to, and establishing themselves in, foreign markets today (Johanson and Vahlne 2009). These liabilities seem to offer reasoning behind high-tech firms using their board actively, as board executives can help remedy these liabilities through their experience, knowledge and networks, as well as potentially legitimizing the firm both nationally and internationally (Knockaert and Ucbasaran 2013).

The maturity of a firm will have a great impact on the contributions that can be expected from the board (Bjørnåli and Gulbrandsen 2010). Generally, a firm's maturity can be measured and divided along several variables. In this report, I have chosen to use the theoretical framework shown in Figure 2.1 to describe the different stages of maturity used for the analysis. Figure 2.1 describes the entrepreneurial events and board characteristics of firms at different stages of maturity. The events marking the evolution of a firm from one stage to another has been termed as the credibility threshold and the sustainability threshold.

At the credibility threshold the firm reaches the stage where it changes from an internal focus to a more external focus, relating to marketing, product development and such. At the sustainability threshold, the firm enters the mature stage, where the firm is focused on securing continued and sustainable operations. This contrasts with the previous stage, where the firm still needs to prove that there exists a market for the product, that the firm is able to sell it to customers and that the firm's necessary operations are possible to

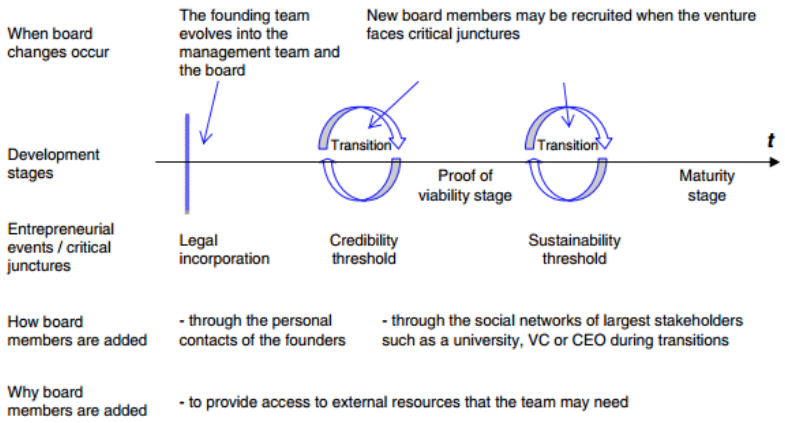

Figure 2.1 - Integrated theoretical framework of stages of evolution (Bjørnåli and Gulbrandsen 2010)

perform achieving positive economical results (Bjørnåli and Gulbrandsen 2010). The expectation is that the effect of the board's contribution through different board tasks will vary depending on the maturity stage the firm is in. Knockaert and Ucbasaran (2013) contributed to this in finding that boards in high-tech firms early in the technological development process to a higher extent engaged in the service role. This serves to underline the different roles a board can take in a firm's different stages of development.

As mentioned earlier the distance, both psychologically and physically, between boards and management teams tend to be smaller the earlier in its development a company is. This is illustrated in figure 2.2. In the early stages of a firm's development one might expect the CEO, as well as other TMT members, to be part of the board, and the distance therefore becomes short (Bjørnåli 2009). An extreme case of this is where the same person acts as both CEO and chairman of the board, something which is referred to as CEO duality (Kim, Burns et al. 2009). Other board members at this stage probably also have a close interest in the firm, as at this stage they are usually more involved in strategic processes and in many cases act as an extension of the TMT (Bjørnåli and Gulbrandsen 2010, Zhang, Baden-Fuller et al. 2011). On the other hand, as the firm matures, it becomes more likely that more external forces are gathered to constitute the board, both by awarding board positions to investors as well as realizing that knowledge and capabilities within specific fields are needed in the board to help develop the firm further (Bjørnåli and Gulbrandsen 2010).

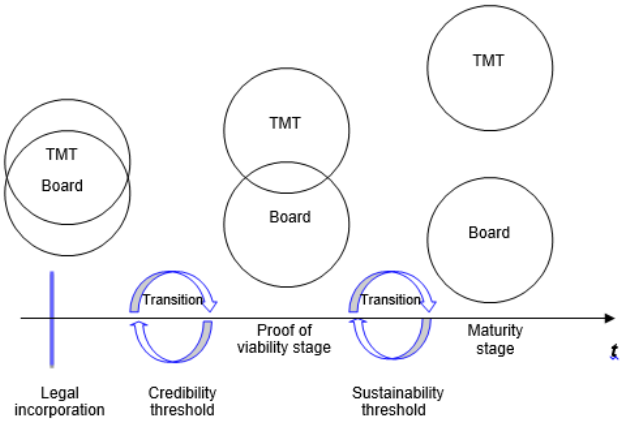

Figure 2.2 - TMT and board distance (Bjørnåli 2009)

As the firm develops, the nature of the contribution that can be expected from the board in the high-tech venture also changes. In the forming stages of the firm, when the board can be expected to work as an extension to the TMT (Zhang, Baden-Fuller et al. 2011), the interplay between the board and TMT should be very important in determining the contribution from the board. This follows the findings in recent TMT literature highlighting the importance of the TMT's behavioral integration in determining the growth and success of firms (Zhang, Baden-Fuller et al. 2011). Similarly, the cooperation between board members should be an important indicator of the contribution that the board can give to the high-tech firm throughout its development. Firms with a high degree of board behavioral integration should be able to exploit the capabilities and knowledge of their boards to facilitate for firm success.

In facilitating for firm success this study evaluates how boards contribute to the strategic action capabilities of the firm. The strategic action capabilities are manifested in the speed and breadth of a firm's strategic actions. These strategic actions cover the whole span of strategic aspects, including for example market position, introduction of new products or strategic collaborations. It is expected that a board can strongly contribute towards increasing the capabilities of a firm (Kim, Burns et al. 2009). For example, a board with a well-developed network might help a firm rapidly locate and evaluate new collaboration partners, while a board consisting of marketing experience might help the firm execute a range of activities securing the firm a superior market position. As the positive effect of strategic action capabilities on firm performance have been confirmed (Miller and Chen 1996, Baum and Wally 2003), these capabilities will be used throughout this report to describe and conceptualize the contributions of the boards of the study.

2.1 Effective boards

The creation of a board of directors that best suits a firm's needs can be divided into three aspects. These are the questions of the composition of the board's directors, the roles that the board should perform (Huse 2007), as well as how the board collaborates to fulfill its tasks. The three aspects of board effectiveness can thus be divided into the *who*, the *what* and the *how* of boards. It is important to get the combination of emphasis on these aspects right, to maximize the effect the board can have on a firm's growth. For example, a board consisting of some of the highest esteemed directors of an industry might still not be particularly effective if they are unable to collaborate effectively in supporting the firm. Similarly, a board that participates to a high extent in the strategic formation of a firm will not be particularly effective if their board members lack the necessary strategic knowledge and competencies. Getting this combination right could be as important as figuring out the perfect formula for either one of the aspects (Huse 2007). For young ventures these issues gain further complexity, as the board will have to be adapted to the changing conditions of the emerging firm. The effectiveness of the board will largely be decided by the contributions the board is able to bring to the firm's development and success. This report therefore uses the terms of board effectiveness and board contribution interchangeably, both terms describing the degree to which the board is able to influence the development of the firm. This section will present existing theory concerning the three aspects of board literature and elaborate on certain holes in the literature that this study will aim to cover.

2.1.1 Board composition

Concerning the people being recruited to a board there has been a few studies looking at the effect of having a board with a high degree of heterogeneity. Bjørnåli and Aspelund (2012) found that a high degree of functional background heterogeneity increased a firm's chance of having international activities, while age heterogeneity in the board had the opposite effect. Kim, Burns et al. (2009) argues that diversity in the board members' attributes, characteristics and experience increases both the breadth and speed of the TMT's strategic actions. Generally, there seems to be support that a diverse and heterogeneous board should have a positive effect on a firm's development, although this has not been empirically tested sufficiently in the setting of young, high-tech firms. It is thus unclear whether one should aim to achieve board heterogeneity along all measures and characteristics. Arguing for the other side, one can for example imagine a situation where a board of directors, due to its internal heterogeneity, is unable to communicate their vision and thoughts between each other, as well as the directors being unable to understand the thought processes and reasoning behind the arguments of their colleagues. People with different backgrounds, experiences and characteristics have different cognitive baselines (de Wit and Meyer 2010), and it has been argued that this cognitive distance within TMTs and boards might lead to an inefficient strategic reasoning process (Andrews 1987).

Adding to the issue of board heterogeneity the question of who should sit on the board also includes the consideration of what capabilities and experiences a firm needs. Several streams of literature have suggested that new board members are generally added because of their resources and experience, which complements that of the current board and management team (Gabrielsson and Huse 2005, Bjørnåli and Gulbrandsen 2010). In addition to supplying experience and knowledge, many boards of directors serve as signals of credibility for their companies, and help build legitimacy and reputation around the company (Huse 2007, Bjørnåli and Gulbrandsen 2010). This can mainly be done in two ways. Firstly, attracting a board member with a strong business reputation can increase the legitimacy of the company across many sectors and signals the ambitions of the firm. Secondly, if a company more specifically wants to signal its

specific intentions and purpose it could recruit a board member with an especially high standing within a certain field or industry. Attracting a board member with strong experience from the offshore oil and gas industry might for example be a strong signal of intention from a wind technology firm that wants to provide technology to offshore wind farms. Both of these tactics for legitimization can be efficiently set in effect by young companies, and might be an effective way of building traction within an industry (Huse 2007). Previous literature has concluded that young ventures in the early stages of development to a large degree recruit board members from their own personal networks or from the network of the board chair (Bjørnåli and Gulbrandsen 2010). As the chairman of the board is usually someone with vast experience, either within the industry or in other related fields, using his network to recruit further board members seemed to be a viable solution for the academic spin-offs (ASO) studied by Bjørnåli and Gulbrandsen (2010).

In evaluating the composition of the board, an important aspect is the relation between internal and external directors in the board. External directors refer to those directors that are not employed by the firm and are recruited externally. These could for example be investors, specific industry experts or functional experts. Several authors have pointed at the positive aspects of having external directors in the firm's board, both in supporting the monitoring of the firm (Garg 2013) and in performing service roles such as strategizing and networking (Gabrielsson and Huse 2005). Previous research have asserted that effective boards in high-tech ventures have significant contributions from external directors (Gabrielsson and Huse 2005, Garg 2013, Knockaert and Ucbasaran 2013), and this is therefore an important aspect of the composition of the board in these ventures.

One of the most significant groups of external directors are the Venture Capitalists (VCs). VCs are professional investors that have invested in the firm, in hopes of helping the firm grow and ultimately to attain a profit when the firm is sold further, either to new investors or through an initial public offering (IPO) at the stock exchange. Two specificities of the clean tech sector particularly explain why so many of the firms in this sector have received, or are trying to receive, venture capital investment. One factor is that the clean tech industry is an emerging industry, where start-ups have the potential to grow into significant contributors, thus potentially garnering higher returns on the investment (Fried and Hisrich 1995, Manigart and Sapienza 2000). The other factor is the need for capital to invest in technology development. Since the industry is in an emerging state, and new companies in the industry predominantly face long periods of product development before achieving their first sale, huge amounts of capital are needed to survive the so-called "blood bath" of technology development (Eyraud, Clements et al. 2013). To provide the capital most companies have to rely on public support initiatives as well as venture capitalists and other private investors.

Studies of boards in venture-capital backed firms have indicated that venture capitalists often are key stakeholders that have a significant contribution to the development of the board and firm. VC-backed boards have been found to be dominated by external board members appointed by the VC, rather than led by the firm's management (Rosenstein 1988, Fried, Bruton et al. 1998). VC directors might further help the firm by monitoring the firm's management and by developing efficient monitoring systems (Fried, Bruton et al. 1998, Garg 2013). Garg (2013) argues that to protect its interests and investment a board consisting of VCs will to a higher degree be involved in monitoring of the management. However, due to the VCs often extensive experience and networks within the industry, VCs will also be expected to add value to the firm through contributing with their additional experience, network and resources (Rosenstein 1988, Politis and Landström 2002, Gabrielsson and Huse 2005). Although these studies have been

performed on VC-backed firms specifically, most of these contributions are usually attained also from having other external directors on the board (Garg 2013, Knockaert and Ucbasaran 2013).

2.1.2 Board roles

Several researchers have argued that the roles the board fills is more important than the composition of the board's directors in determining the contribution of a board on the venture's development (Huse 2007, Pugliese, Bezemer et al. 2009). A firm's board can influence the firm in many ways, by interacting with the firm and management team through several different tasks. In this paper, these tasks have been grouped into two main roles of the board, which have further been divided into six different categories of board tasks. This grouping of tasks is depicted in Figure 2.3 and follows the grouping that has been done by other researchers at earlier board studies (Huse 2007, Minichilli, Zattoni et al. 2009). One board can perform any one of these tasks individually or have the responsibility of performing several, or all, of the tasks.

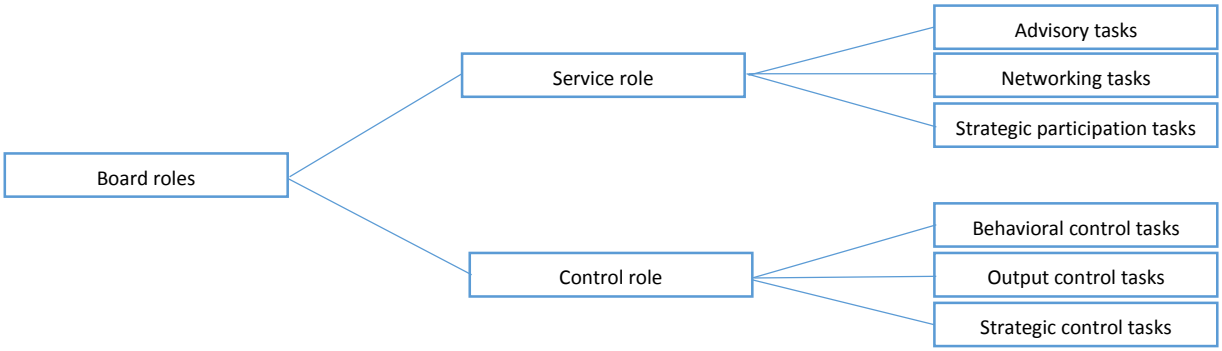

Figure 2.3 - Grouping of board tasks

The *advisory task* describes to what extent the board provides advice on different issues, regarding for example the management, finances or legal practices of the firm. Studies have shown that ventures lacking knowledge and resources within certain key areas can gain much help from their boards through the performance of advisory tasks (Gabrielsson and Huse 2005, Knockaert and Ucbasaran 2013). *Networking* concerns the degree to which the board provides the firm with linkages to external stakeholders, as well as the external legitimacy the board provides. Several streams of literature have also shown the importance of networks for the growth and development of new ventures (Gabrielsson and Huse 2005, Walter, Auer et al. 2006). Furthermore, *strategic participation tasks* regard those tasks related to being directly involved in promoting strategic initiatives, making strategic decisions or participating in the implementation process of the strategic decisions. With the directors on the board normally being experienced executives within the industry or with other relevant experience, there may be a great potential in involving the board of directors in strategic participation tasks (Zhang, Baden-Fuller et al. 2011). Together these three groups of tasks constitute the *service role* of the board and a measure of the degree of these tasks being present in a firm's board generally depicts the degree to which the board adds value to the firm by contributing with their own expertise, thoughts and resources.

The value creation capabilities of a board through the service role have generally been studied either with a resource-based view or through an upper echelon perspective. The resource-based view explains how the new venture, due to its usually inexperienced management, often lack several important resources, such as for example strategic knowledge, industry experience and network. The resource-based view thus suggests that the firm can gain much from exploiting the knowledge and experience of its directors through the performance of the service role, rather than employing them to monitor and control (Gabrielsson and Huse 2005, Bjørnåli and Aspelund 2012, Knockaert and Ucbasaran 2013). Similarly upper

echelon theory view the success and development of firms as a result of the cognitive value, experience and characteristics of its management (Hambrick and Mason 1984). This perspective suggests that the TMT can broaden the firm's cognitive values, experience and characteristics through the performance of the service role in collaboration between TMT and the board of directors, thus subsequently improving the firm's development.

However, from an agency theory perspective there can be significant incentives towards using the board of directors also to engage in the *control role* and work as the primary governance mechanism of the venture (Gabrielsson and Huse 2005, Garg 2013). The *control role* of a board constitute those tasks that allow the board to provide value to the firm through overseeing the firm's development from a more external standpoint and ensuring that the management team aims to achieve outcomes that are in the best interest of the firm's shareholders, as well as other stakeholders where that is relevant (Garg 2013). The control role constitute of the following three subtasks. The *behavior control tasks* regard tasks related to determining guidelines for, and monitoring, internal behavior. *Output control tasks* are to a larger extent related to the monitoring of a firm's output, specifically through monitoring the firm's activities and being kept informed and updated on the firm's finances, plans and budgets. Ultimately, *strategic control tasks* refer to the task of monitoring and evaluating strategic decisions. Agency theory suggests that a firm and management that is not monitored will run the risk of management taking decisions in their own self-interest, rather than in the interest of all shareholders (Eisenhardt 1989), thus potentially compromising the growth potential of the firm.

An important question regarding boards in entrepreneurial ventures is the degree to which the board should contribute to each of the above-mentioned tasks. Previous literature have found that boards can positively affect different aspects of a high-tech start-up's operations, such as mediating the relationship between the TMT's diversity and effectiveness (Bjørnåli, Erikson et al. 2011), using monitoring to improve firm performance (Garg 2013) or act as an extension of the top management team (Zhang, Baden-Fuller et al. 2011). At the same time literature has also found potentially negative aspects of having a board that is too involved in certain tasks, for example that companies that are depending on their boards' network and resources in going into international operations, to a lower extent are able to reach foreign customers (Bjørnåli and Aspelund 2012). The literature is inconclusive regarding the ideal board's focus on the service role versus the control role in high-tech ventures. This study adds to these findings by further examining how different board roles can affect the development of high-tech ventures, and which characteristics of boards and TMTs create boards that perform certain tasks well.

Previous literature has assessed how the structure of the board will affect the performance of different board tasks, through each board executive's different motivation towards performing certain tasks (Garg 2013). While a venture capitalist executive might have significant incentive to perform rigorous monitoring to protect the investment of the venture capital firm, independent external directors that have been recruited to the board because of their industry, functional or other expertise will likely be more inclined to contribute towards the strategic decision-making of the management (Garg 2013). Thus deciding what roles a board should fill might not only be a question of prioritization and desires from top management, but might be intrinsically decided by the executives recruited to fill the board positions. This realization leads to connecting the issues of board diversity and board roles, since the two aspects seem to be intertwined.

2.1.3 Behavioral integration

While the "who" and "what" of board effectiveness have been covered to some extent by existing literature, the question of how boards cooperate to maximize their influence on a firm has been left uncovered. *Behavioral integration* is a construct that has been developed to represent this aspect of internal co-operation in TMTs (Hambrick 1994, Simsek, Veiga et al. 2005, Hambrick 2007). As the behavioral integration of a team explains the degree to which a group engages in mutual and collective interaction (Hambrick 1994), several streams of literature have examined how it affects the effectiveness of TMTs (Simsek, Veiga et al. 2005, Carmeli 2008). This study introduces this concept into the area of board research, examining whether behavioral integration can be a similarly important characteristic of the performance of boards.

As mentioned, the behavioral integration of the TMT covers three main features: (1) the level of collaborative behavior, (2) the quantity and quality of information exchanged, and (3) the emphasis on joint decision-making (Hambrick 1994, Simsek, Veiga et al. 2005). A behaviorally integrated team is characterized by a high degree of interactive processes through which it displays these aspects of collective information exchange, collaborative behavior and joint decision-making (Hambrick 1994).

Previous literature has established that TMT behavioral integration has a positive association with firm performance (Hambrick, Nadler et al. 1998, Simsek, Veiga et al. 2005). TMTs that are behaviorally integrated are better able to exploit its human resources and achieve better quality of strategic decisions (Carmeli 2008). As Carmeli (2008) explains it: "*this is because a behaviorally integrated TMT works as a team […] who realizes the nature of integration and the value of exploiting complementary personalities, values, skills, experience, and knowledge for making optimal strategic decisions.*" While these results hold for TMTs, one might expect to find similar effects of behavioral integration on a board's effectiveness. The board is in many ways organized in the same way as the TMT, with a leader and several members with expertise within different fields. Thus, board behavioral integration should facilitate for boards to be better able to exploit their human resources, achieving higher quality of influence on the firm's development.

After cementing the importance of TMT behavioral integration, some researchers have started looking at what determinants facilitate for increased behavioral integration within a team. However, this stream of research is still young and the known and confirmed determinants are therefore few. TMT research has suggested that the CEO has a significant contribution on the behavioral integration of the TMT, both through the CEO's collectivistic orientation and tenure (Simsek, Veiga et al. 2005). On the other hand, TMT diversity and size has been found to negatively affect the behavioral integration of the TMT (Simsek, Veiga et al. 2005). Similar relations might be expected to be found for other teams, such as the board of directors. This study will evaluate these characteristics from TMT research, as well as others, to examine how they affect the behavioral integration of the board.

3 Methodology

To investigate the research questions I have chosen a multiple case, inductive study (Glaser and Strauss 1967, Eisenhardt and Graebner 2007). Multiple case logic regard the cases as a series of experiments, with each case providing reasoning for or against the conclusions drawn from the other cases (Yin 1994). This contrasts pooled logic, where each observation is part of a larger sample. The aim of a multiple-case study is to provide us with empirical richness, as well as hopefully generating generalizable and accurate theoretical insights (Eisenhardt and Graebner 2007).

The multiple case study method was chosen for two main reasons. Firstly, the areas of board composition, board roles and behavioral integration in high-tech ventures has not been addressed sufficiently in previous research. The focus of this study has therefore been to evaluate the mechanisms in order to build well-founded theory. Eisenhardt and Graebner (2007) believe qualitative case studies are especially fitting for fulfilling this task. Secondly, multiple case studies facilitate for in-depth studies of certain phenomenon to a higher degree than quantitative studies. By using multiple cases one can provide a detailed description of the mechanisms that drive the development within an area.

To go about analyzing the research questions I proceeded in two major steps. Firstly, to gain a complete understanding of the area of board research I thoroughly examined the existing literature on the field. The literature review included a range of articles and books, which led to the development of the theoretical basis for performing this study. The most prominent articles of this literature study have been cited in the chapter explaining the theoretical foundations (f.ex. Gabrielsson and Huse 2005, Huse 2007, Bjørnåli and Gulbrandsen 2010, Garg 2013).

Secondly, I started gathering data from the case firms. To be eligible for the study the firm would have to operate within the clean-tech industry and have been established within the last 15 years. Case firms also needed to have a minimum of two board members not already employed by the firm. Within these criteria, five firms were chosen to constitute the case firms of the study. Following theoretical sampling logic these firms were chosen based on their characteristics, in order for the cases to potentially be able to replicate the findings of the other cases (Yin 1994). Specifically theoretical sampling logic was used to make sure companies represented a variety of clean technologies and covered several stages of development. To cover the longitudinal aspect of boards in clean-tech start-ups it was deemed necessary for companies to represent a range of different stages of development. Furthermore, interviewing firms from a range of different clean technologies makes sure that it would be possible to reveal potential influences of technology and firm characteristics. Theoretical sampling was also used to make sure case companies were running actively and earning a decent revenue base. This was important to ensure that case companies were still actively aiming at increasing their activities, eliminating those companies that were created only to serve as a financial security for the founders.

Some key characteristics of the five case companies are depicted in Table 3.1. The case companies of this study represent different sub-industries within the clean-tech sector, with firms operating within solar technologies, hydropower, geothermal energy and heat pumps. All case firms were established between 2005 and 2008, and are thus younger than 10 years. All companies still employ relatively few employees, ranging from one employee in firm E to eleven employees in firm A. Revenue growth in the five firms varies significantly, with CAGR ranging from 11% to 90%. The boards of the five firms are similar in size, ranging from four to six members, and have a similar emphasis on engaging in the service role of the board. Ultimately, all firms except firm B have a relatively high behavioral integration.

Firm	A	B	C	D	E
Establishment year	2005	2006	2008	2008	2006
Industry	Solar	Heat pumps	Geothermal	Solar	Hydro
Full-time employees 2014	11	7	10	3	1
Stage of development	Proof of viability	Transition to maturity	Maturity	Maturity	Proof of viability
CAGR (revenue, 3 years)	11%	18%	90%	71%	78%
Board size	6	6	4	4	4
Number of external board members	4	6	3	3	3
TMT size	6	4	6	3	1
Board behavioral integration	High	Mid	High	Very high	High
Main board contribution	Discuss challenges and strategy	Strategy	Strategizing and implementation	Discussing strategies and controlling	Strategic discussions
Strategic action capabilities (speed/breadth)	Mid/mid	Low/low	High/mid	High/low	Mid/low

Table 3.1 - Description of case companies

The case companies were contacted directly via e-mail, followed by subsequent telephone contacts. Since CEOs were deemed best able to provide useful insights into the area of board contributions, the CEOs of the case firms were contacted directly. The choice of the CEO as source of information was due mainly to their direct communication with the board and overview of the areas in which the board has been able to influence the firm significantly. The CEOs of the companies that participated were interviewed for around an hour, as well as asked to fill out a survey to provide further quantitative data. The interviews were conducted by using a semi-structured questionnaire including both specific and more open questions.

In most of the cases, the CEO was also one of the founders, or at least entered the firm at a very early stage, and they therefore had a good recall of most important firm events. At one company, the interview was performed with the founder instead of the CEO, as the founder had worked as CEO from start-up until the recent appointment of his successor.

Besides the interview, further data was gathered on each firm by using free Norwegian databases, containing, among other things, accounting data and information on the board and top management. The databases used for this were Brønnøysundregistrene and Proff Forvalt. This data was used for two purposes. Firstly, the background data, combined with further research of newspaper articles, annual reports and company web pages, was used to tailor each interview to the setting of the case firm. Secondly, background data was used to check whether findings in the case study could be explained by certain anomalies in firm and board characteristics.

To ensure high levels of construct, internal and external validity, as well as reliability, the research was based on much of the advice given by Yin (1994). Starting with construct validity, Yin (1994) claims that to ensure a high level of this validity it is important to (a) define the concepts that you wish to study and (b) identify operational measures that match these concepts. The concepts that will be studied have been clearly defined by the research questions postulated earlier. Furthermore, the theoretical section of this report has cemented the operational measures of strategic action capabilities, behavioral integration and board role engagement, which are believed to adequately cover the desired concepts of study. The measurement of these concepts has been based on findings developed from other researchers (Simsek, Veiga et al. 2005, Huse 2007, Kim, Burns et al. 2009, Knockaert and Ucbasaran 2013). Construct validity has been further improved by ensuring a clear chain of evidence between the propositions that will be evaluated later and the connected findings from the case firms. These are further linked up to the research questions posed in chapter 1.

For increasing internal validity it is important to use sound techniques for analyzing case data (Yin 1994). The propositions of this study have been arrived at through using a pattern matching technique. By using rival and supporting theories as patterns for developing propositions the causal relationships presented in the study have been strengthened. The interviews with the CEO's were recorded and the recordings were subsequently gone through after the interview to assure that information had been noted in the correct way. A case study database was created to store key information from the interviews in a uniform system, and the data in this database was crosschecked with the recordings from the interviews. This helps increase both the internal validity and reliability of the study. This methodology section further serves to explain the steps that have been taken in performing this research, ensuring a high level of repeatability of the study, thus increasing the study's reliability (Yin 1994).

Ultimately, the replication logic of the study has been used to ensure high levels of external validity. Replication logic helps define the domain to which a study's findings can be generalized, thus ensuring the

study's external validity (Yin 1994). Another measure used to increase the study's external validity has been to use theory to support the findings and propositions developed later in this report. Supplementing the findings and propositions of the study with theoretical considerations further helps ensuring the generalizability of the study (Yin 1994).

4 Findings and development of propositions

The case study carried out in this work has revealed some interesting insights into different aspects of board effectiveness in young clean-tech firms. As well as confirming theories presented by other scholars, the study also revealed insights that can form the basis of new theory in previously unstudied areas of board research. In this section, I will present the key findings that have emerged, as well as attempt to develop propositions based on these findings to form the baselines of emerging theory regarding boards in high-tech ventures. Specifically I will evaluate the underlying research questions concerning the *why*, *what* and *how* of boards, and examine the effect that an effective board in each of these aspects have on the firm's strategic action capabilities.

4.1 Board composition

The composition of the board regards the diversity of board members along several characteristics, such as experience, age and personality. Board composition also consist of the issue of whether to recruit external board members. This section evaluates how clean-tech start-ups can compose their boards to be capable of contributing to the firm's development to an as high degree as possible. The findings of the study on this area are summarized in Figure 4.1.

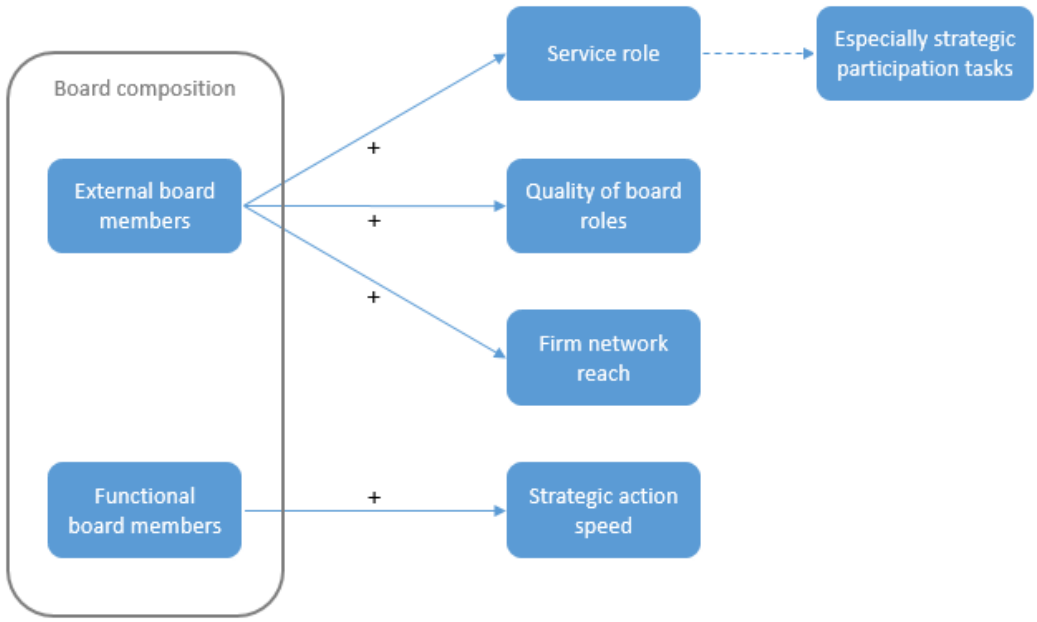

Figure 4.1 - RQ1: Who are the board members of effective boards?

Despite the literature being inconclusive regarding the settings in which board diversity is favorable (Andrews 1987, Kim, Burns et al. 2009, Bjørnåli and Aspelund 2012), clean-tech start-ups still seem to chase diversity in their recruitment of board members. All of the case firms interviewed emphasized the importance of the varied knowledge and capabilities within their board. As firm C exemplified it:

> *When recruiting board members the most important aspect has been knowledge within specific areas that are not already covered by the TMT or board.*

The board's diversity were also by some firms regarded as the reason why the firm had been able to pursue certain key strategic initiatives. Firm C holds their diverse board members as the reason why they have been able to expand so rapidly into the areas of industrial energy and offshore applications. Firm E

emphasizes the importance of their board's diverse experience and networks in helping the firm stay alive through some recent rough patches.

While background and experience heterogeneity seem to be considered key characteristics of the boards, heterogeneity within personality, age and education is not desired to the same degree. These characteristics are mostly homogeneous across the boards of all the case firms, with the exceptions being more a question of chance rather than a deliberate choice. These observations lead us to the following proposition:

Proposition 1a *Clean-tech start-ups strive for heterogeneity within the board regarding aspects of experience, knowledge and capabilities.*

Existing literature is inconclusive regarding the effect a high amount of external directors have on the performance of different board roles. Some authors argue that external directors, especially those with investments tied to the firm, will be more incentivized to perform rigorous monitoring of the firm (Fried, Bruton et al. 1998, Garg 2013). On the other hand, several other authors have emphasized the usually extensive experience and resources of external directors, that are most effectively put to use in the service role (Rosenstein 1988, Politis and Landström 2002, Gabrielsson and Huse 2005).

The case firms of this study point out that both the quantity and quality of the performance of the service role is higher in boards with a high degree of external directors. While the board performs the "obligatory" tasks of monitoring and control in these ventures, both firms A, B, C and E report that their boards add more value through spending the largest amount of time possible on the service role. The CEO of firm A conceptualizes this in his definition of the board of his company:

> *[The board is] a group of competent people that one can discuss challenges and strategies with. […] The board has the tools to monitor well when needed, but this has not been done in too much detail.*

The board of firm D also to a high extent focus on the service role, but they have a higher degree of focus put also on the control role, compared to the other case firms. All firms in the study have a large portion of external directors on its board, ranging from 67% (firm A) to 100% (firm B), and they all report a focus on the service role of the board. The qualitative explanations given for the choice of focus on the service role also emphasize the importance the external directors have had in turning the agenda of the board towards the service role. The following quotes exemplify this:

> *We have recruited strong board members that excel within their fields. [Because of this] we use the board mainly within strategizing and implementation.* (Firm C)

> *Strategic discussions is the main part of the board work. This is where our board members have the most to contribute.* (Firm E)

To specify the contribution of the board into the different tasks of the service role, it becomes clear that the one group of tasks that external directors especially contribute to is the strategic participation tasks. As described in the quotes above this is argued to be the case because the strategic participation tasks are the tasks where the external directors to the largest degree can contribute with their experience and knowledge. The external directors of this study have all started their own company, worked long within the industry or invested in several similar companies. Because of this, they are expected to have the

competence to contribute largely to evaluation and implementation of strategic initiatives. Summarizing, we get the following propositions.

Proposition 1b *The prevalence of external directors leads to a higher focus of the board on the service role, rather than the control role.*

Proposition 1c *The prevalence of external directors leads to a higher focus of the board on the strategic participation tasks, compared to other tasks.*

While external directors seem to influence the roles of the board they also seem to have a significant contribution on the quality of board tasks performed. This finding lies in line with findings from previous studies which highlight the positive effect of having external directors on the board (Fried, Bruton et al. 1998, Gabrielsson and Huse 2005, Garg 2013). In this study, two especially significant contributions of external directors in increasing the quality of the board's work have been identified.

Firstly, the CEOs interviewed all believe their external board members have contributed in increasing the general quality of their board's work. The inclusion of external board members has elevated the quality of the board's tasks, and facilitated for the growth of the companies. The CEO of firm B described the recruitment of external directors in the following way:

> *Our external board members have brought with them an increased "professionalism" to the board.*

Secondly, a particularly significant effect of recruiting external directors is the network they bring with them into the firm. While firms A and D believe their board has not contributed as much to the firm's network as might be expected, they still believe their external board members have increased the board's networking reach. Both firms B and E emphasize the importance their external board members have had in connecting the firm to important actors. Firm C is thus the only firm that believe their external directors have not significantly increased their board's network reach, but claims this is mainly due to "*the extensive experience within the industry of our TMT members*". The CEO of firm A, while being disappointed with the effect of the network of his board members, claims that this is mainly related to bad luck rather than poor networks:

> *It is not easy for our board members to go out and find large, willing investors. Those that they have connected us with have so far not worked out.*

On the other hand, the CEO of firm E holds its board's network contribution as one of the biggest reasons why the firm has been able to stay alive:

> *Our board has contributed a lot with their network, especially related to potential collaboration partners. […] Several of the deals and projects we are working on now have been put in place because of the board's network.*

The networks of the boards have mainly contributed to two aspects. One is the intra-industry network of the board, helping the firm locate potential collaboration partners or customers. The second is the network the board has within the financial markets, helping the firm attain investments and financing. The degree to which each of these aspects have been present in the network contribution of the external board members in this study varies greatly. Probably this is mainly caused by the differing needs and situations of the firms in the study. Summarizing the quality contribution of external board members, we get the following propositions:

Proposition 1d *External directors increase the quality of board roles performed*
Proposition 1e *External directors increase the network reach of the board*

The degree to which the board should constitute of technical or functional experts has been covered to a very limited degree in existing literature. There is thus little knowledge regarding which of these groups of board executives contribute the most to making an efficient board. The case firms confirm this uncertainty, in that the boards of the companies have very varying degree of technical versus functional experts. The boards range from almost a pure technical board in firm B to a pure functional board in firm C, with the remaining three lying somewhere in between.

Functional experts, such as experts within marketing, financing or sales, contribute to the firm by elevating its quality within the operations that the experts have experience from. Functional experts within the boards of these firms predominantly have experience with these functions in the same, or a similar, industry of the focal firm's industry. They will therefore have experience with their particular function in a setting similar to that of the firm they represent. This will allow them to apply their knowledge and experience efficiently into the situations of the company. A heterogeneous board of functional experts, each with their own functional niche, might therefore be expected to be very efficient in evaluating and performing strategic actions, securing the firm a high strategic action speed.

Firm C, being the firm with the most functional board, has been able to exploit the functional expertise of its board members to create a competitive advantage:

> *We have a strong board of experts within management and other functions. [The functional expertise] helps us reach strategic decisions quickly, exploiting their experience.*

Firm D further adds to this, explaining how their board's functional expertise has come to good use so far, but that there is also potential for improvement.

> *We have a board consisting of some technical and some non-technical people. In efficiently discussing strategic initiatives, the board contributes greatly. […] The board could be improved if we had a marketing expert within the board.*

While functional experts might be positive for ensuring the firm has a high strategic action speed, another important aspect is the relation between amount of functional experts and strategic breadth. People with similar backgrounds and experience might be expected to have similar cognitive baselines (de Wit and Meyer 2010). Cognitive baselines include the maps, abilities and activities that, amongst other things, hinder us from realizing all strategic alternatives, influence our perceptions and create a limit in our brains' processing capacities (de Wit and Meyer 2010). If a group of people, in this case the board, has the same cognitive baselines, the whole group will suffer from the same cognitive limitations. However, in a more heterogeneous group, the cognitive limitations of one member might be covered by another person, thus enlarging the collective cognitive area of the board.

Strategic breadth refers to the breadth of strategic activities of a firm (Kim, Burns et al. 2009). This relates to both the amount of strategic activities and the breadth of areas they cover. A firm that attempts several actions for entering a range of different market niches will for example have a higher strategic breadth. An effective firm with a high strategic action speed might be expected to be able to evaluate a high amount of strategic activities. However, if the speed is a result of a board and TMT constituting of people with similar experiences, the breadth of its strategic activities might be limited by their collective cognitive area.

These evaluations shine through in the case study, where there appears to be no relation between the amount of functional or technical board executives and the firm's strategic breadth. Both firms D and E, which have both functional and technical board members, evaluate their strategic breadth as quite poor. Specifically, these firms have a low strategic breadth due to their inability to introduce a range of new products and services to the market. Simultaneously, firm A has one of the highest strategic breadths of the study despite their board being quite similar in composition to that of firms D and E. Firm A has especially excelled in implementing actions to facilitate for market expansion. Firm A emphasizes the rigorous strategic discussions that take place between their TMT and board, caused in part by the "*diverse competences of their board members*". On the other end of the scale, firm E claim that the strategic breadth of their firm is not to any relevant degree positively influenced by the diversity of board members, claiming that the board still "*lacks knowledge within certain key areas*". The boards of firm B and C, which are the less heterogeneous boards in regards to functional or technical backgrounds, both report that their boards' limited contributions within certain areas reduces the breadth of strategic actions that the firm pursues, especially regarding new product and service introduction.

Thus, it appears strategic breadth is not a function of the backgrounds of the executives constituting the boards of clean-tech start-ups, but this seems to be the case for strategic action speed. Summarizing these insights regarding backgrounds of board members, we get:

Proposition 1f *The amount of functional experts in clean-tech start-up boards is positively related to the firm's strategic action speed.*

Firm	A	B	C	D	E
Functional/technical board members	2/4	1/5	4/0	2/2	2/2
Strategic action speed	Mid	Low	High	High	Mid
Strategic breadth	Mid	Low	Mid	Low	Low

Table 4.1 - Board composition and strategic action capabilities

Table 4.1 depicts the amount of functional experts, strategic action speed and strategic breadth of the case companies. Examples of high strategic action speed are the rapidity of international expansion activities shown by firm C and the effectiveness of firm D in increasing their network reach. Similarly, firm B show a low level of strategic action speed in their tardiness in getting new products and services to the market. Examples of strategic breadth are the wide innovative capabilities of firm C or the breadth of strategic actions that firm A have implemented in expanding their market reach. Firm B and E show low strategic breadth in the narrow span of their collaboration networks.

4.2 Board roles

As discussed in chapter 2, boards can provide value to a young firm through helping it overcome a range of liabilities, as well as monitor that the firm's operations and activities lies within the desired boundaries. Different theoretical perspectives evaluate differently whether effective boards should focus on the service or the control role (Gabrielsson and Huse 2005, Zhang, Baden-Fuller et al. 2011). This has also led to varied focus and findings in the different streams of research concerning board roles (Gabrielsson and Huse 2005, Garg 2013, Knockaert and Ucbasaran 2013). This section will discuss how the performance of different board roles can contribute to the development of the firm.

Despite the varying findings in the literature, the clean tech firms in this study showed a relatively uniform view of the importance of the two board roles. In the previous section, the influence of external directors

on a board's focus on the service role was explained. With the boards of all case firms in this study largely constituting of external directors, one would expect this focus on service roles to be present in most of these firms as well. This is also the case, exemplified by the answers given from the firms on the question of identifying the most important contributions of their boards. All firms mentioned participation in strategic processes as the most important contribution.

Considering that boards of external directors will have a tendency to want to participate more in strategic discussions, it is not surprising that the boards of this study participate more in the service role. However, quantity of participation does not necessarily equal effectiveness. That all CEOs in the case firms to a higher degree appreciate the service role that their board performs might still be an indication that this role is the one that is deemed to help firms grow and succeed to the most prominent degree. The CEO of firm B describes the nature of its board's contribution in the following way:

> *The board contributes the most to strategy in general, regarding both markets, organization and other strategic aspects. They are also heavily involved in networking and increasing the firm's legitimacy. The board also contributes to some aspects of control and monitoring, but this is not the most decisive contribution for us.*

Some of the CEOs' comments regarding their board's monitoring contribution further emphasize the view of clean-tech firms that the boards have the most to contribute with within service roles. The general impression is that the firms regard the control function as an "obligatory" role that must be performed by the board to some degree, but that its final contribution to the success of the firm is very limited. This does to some degree follow the argumentation of Garg (2013), who argues that a lot of the monitoring focus of boards is driven by the interest of investors or other shareholders. The TMT, on the other hand, feel they get more from exploiting the board's capabilities within the service roles. The quotes below serve to conceptualize this finding.

> *Our board is to a very limited degree involved in monitoring, except for monitoring of strategic decisions. [Monitoring] is not the area where I feel the board has the most to contribute with.* (Firm E)

> *The board has the tools to monitor well when needed, but this has not been done in too much detail. [Budgets, plans and the financial situation of the firm] is reported to the board, but it has not been acted upon to a high degree.* (Firm A)

> *We use the board mainly within strategizing and implementation. The board also performs the obligatory tasks of monitoring and control, but this is not the priority.* (Firm C)

From these findings the following proposition is formed:

Proposition 2a *The service role of boards is more prevalent than the control role in clean-tech start-ups.*

One aspect of a board's performance that has not yet been discussed rigorously is the quality of the performance of the board tasks. It has already been established that the prevalence of external directors tends to increase the quality of board role performance. The case firms in this study all have a large amount of external directors. Subsequently, this has led to all firms being relatively satisfied with their board's

performance across most tasks. Some firms had complaints regarding their board's lack of competence within certain specific areas, but the overall satisfaction with board performance was still high for all firms.

All of the firms attribute a significant part of their strategic action capabilities to the influence of their boards through the service role. Effective boards in the study are able to contribute to increasing both the strategic action speed and the strategic breadth of the firms through contributing with their significant experience and knowledge. This can be exemplified by the following quotes:

> *Our board contributes to our strategic capabilities by its ability to be a good discussion partner in regards to strategic evaluations.* (Firm A)

> *In efficiently discussing strategic initiatives, the board contributes greatly. [The breadth of contribution from] the board could be improved if we had a marketing expert within the board.* (Firm D)

In performing the service role, the board aims to use its experience, network and knowledge to advice the TMT regarding strategic issues and provide additional strategic opportunities (Knockaert and Ucbasaran 2013). This study reveals that boards that focus on the service role will be able to add to the firm's strategic breadth by contributing in rigorous strategic discussions, using their extensive knowledge to suggest a range of potential courses of action. Similarly, the previous experience of the board's executives may lead the service-performing board to contribute to a firm being able to more efficiently choose between strategic alternatives, thus increasing its strategic action speed.

All firms in this study report that their board's performance of different tasks related to the service role have helped them increase their strategic capabilities. For example, firm B emphasizes how the service role engagement of their board has contributed towards locating and securing coalition partners. The board of firm A contributed heavily in the firm's decision to pursue opportunities within civil projects, as well as to the subsequent implementation of the necessary measures to succeed with this market introduction. The firms in the study hold the board's participation in strategic discussions as the main way the board can contribute to increased strategic capabilities of the firm. This contribution regards both the strategic speed and breadth of the firms, although case companies in this study feel the contribution has mostly been noticed in the strategic action speed. Firm C exemplified this positive strategic action speed contribution in regards to the decision of international expansion:

> *When deciding on what market to enter next, we [the TMT] usually have the options ready. The board helps us effectively narrow the alternatives and choose markets that are both economically attractive and practically feasible.*

In performing the control role, the board uses its experience to establish monitoring systems that control the internal and external activities and behavior of the firm and the CEO (Garg 2013). A board that performs these activities in a good way will be expected to positively influence the strategic capabilities of a firm, although its contribution might be lower than that of the service role performance. The monitoring board will increase the firms strategic breadth by ensuring that strategic decisions are not affected by cognitive limitations and opportunism of the CEO and the rest of the TMT. Rigorous monitoring systems might however affect the speed of strategic actions negatively. These systems might lead the firm to sacrifice some speed of strategic decision making in order to ensure compliance with the rules and regulations of the firm's shareholders. Albeit being a measure that positively ensures the actions taken by management follows the best interest of the firm, this might negatively affect its strategic action speed.

Neither of these expectations have been observed to any relative degree by the case firms in this study. The firms believe that monitoring can aid the firm's success through ensuring that strategic actions are followed and that all actions are taken in the best interest of the firm. However, the effect on the strategic action capabilities is limited. None of the firms report that their board's involvement in monitoring the firm's activities have led to an increased ability of the firm to make strategic decisions rapidly, nor has it increased the breadth of strategic actions that the firms pursue. These findings regarding the board roles in clean-tech start-ups can be summarized as follows:

Proposition 2b *Board engagement in the service role is associated with higher strategic action capabilities in clean-tech start-ups.*

While control is not the primary role of the boards in this case study, it is still performed to some degree by the boards in all the case firms. Monitoring by the board aims at defeating the principal-agency problem, where the potential difference in alignment between management and shareholders is remediated (Eisenhardt 1989). The board, which represents the shareholders, ensures that the behavior, activities and plans of the firm follow the best interest of the shareholders at all times (Garg 2013). Literature has suggested several characteristics that may or may not inhibit increased monitoring by the board (Gabrielsson and Huse 2005, Garg 2013), but these have been tested empirically only to a limited degree.

In line with the argumentation of Garg (2013), the firms in this study report a change in monitoring focus throughout the different stages of development of the firm. However, while Garg (2013) argues there is a U-shaped relation between firm development stage and board monitoring, the results of this study seem to contradict this. Clean-tech start-ups appear to be monitored less by the board at early stages of development.

Firms C and D in this study are the firms that have reached the furthest in their stage of development. These are also the firms that are monitored the most by the board, as their boards have started monitoring more in recent years. As the CEO of firm D put it, "*the board gets more pressured by shareholders now to perform monitoring*". Similarly, several of the firms report that their early stage boards were lacking both in professionalism and in involvement, thus not participating greatly neither to the service nor the control role. Firm B explained the development of monitoring by their board in the following way:

> *Our initial board consisted of the founders. As the firm has grown and gathered financing, other actors have entered the board, and its participation has grown. [Recently] the representatives of our investors [on the board] have pushed for more monitoring.*

Firm B has thus seen its board's monitoring grow with the development of the firm. Although several of the companies had boards at start-up that were lacking in professionalism and contribution, this has not been the only reason why monitoring by firms has grown throughout their development. Firm C had the following to say regarding their initial board's role in the firm:

> *We had a professional board from start-up with plenty of strategic experience. The board members were thus used frequently in developing the framework for our strategic development. The monitoring contribution has come more lately, as pressure from shareholders to perform monitoring has grown.*

This study therefore agrees with Garg (2013) that firms at later stages of development are monitored by their board to a higher extent. However, in these clean-tech start-ups the degree of monitoring has only risen throughout the firm's stages of development.

As the board's engagement in the control role grows through the stages of firm development, one can expect the opposite development to be found in the board's engagement in the service role. At inception an incumbent firm usually faces a series of liabilities and resource scarcities that gets remediated by its board through engagement in the service role (Knockaert and Ucbasaran 2013). As the firm develops, the liabilities, especially those of smallness and newness, diminishes. For this reason, one might expect that the influence a board can contribute to the firm through the service role reduces as the firm develops through the stages of development and face less resource scarcities. The TMT of a firm that has evolved to the maturity stage will for example be expected to have developed more experience and a broader network. This will make it less dependent on its board's engagement in the service role. The TMT will be able to effectively implement strategic actions based on its experience, as well as use the same knowledge to eliminate some of its previous cognitive limitations. The evolution of the firm will therefore reduce the effect the board can have through engaging in the service role.

As the firms in this study entered consequent stages of development, their boards were to a lower degree included in the day-to-day strategic activities of the firm. Both firms A and E include their board executives in all strategic discussions, relying on their advice to guide the TMT through its development. On the other hand, the CEOs of firms C and D report that the TMT today is more independent of the board than what was the case at inception. This does not mean that the board is less exploited, as the CEO of firm C put it:

> *We have a strong TMT, which handle strategic evaluations efficiently. However, when we encounter difficulties we turn to the board immediately.* (Firm C)

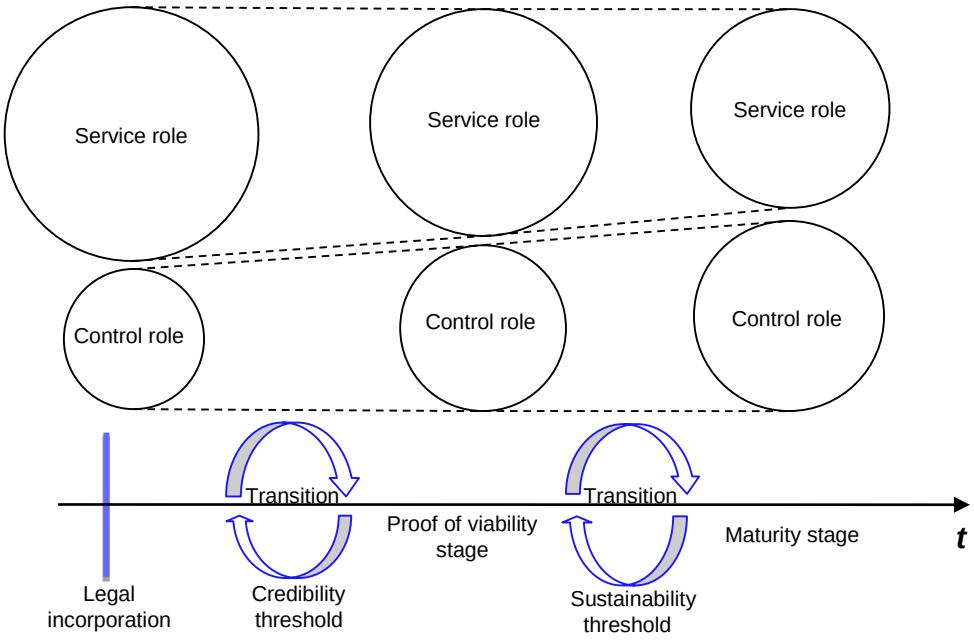

Figure 4.2 – RQ2: What roles do effective boards perform?

As firms develop through the stages of development, they become less dependent on getting input from their boards regarding all problems. The boards of more mature firms are thus used to a higher extent in evaluating specific strategic problems rigorously, rather than contributing on all aspects of the firm's development. The day-to-day activities that boards in mature firms are involved in are to a higher extent related to the control role of the board. This development of the engagement of the board in the two roles is depicted in Figure 4.2.

Furthermore, the findings of this study show that the firms at earlier stages of development to a higher degree hold their board as the reason why they have developed the strategic capabilities that they have. While all firms acknowledge that their board is important for their development, the boards of firms A and E, as well as to a lesser extent firm B, hold their boards as the main reason for their development. This contrasts firms C and D, which feel they are at a position where their board is no longer the most important contributor of growth and success. This underlines the transition in role engagement that boards make as the firms they represent advance through subsequent stages of development. Summarizing these findings we get the following propositions:

Proposition 2c *There is a positive relationship between clean-tech firm stage of development and the engagement of the board in the control role.*

Proposition 2d *There is a negative relationship between clean-tech firm stage of development and the engagement of the board in the service role.*

The positive effects a firm can attain from exploiting its board have been established. However, board contribution, or board reliance, might not have only positive repercussions. If the TMT can complement its abilities by exploiting the skills and knowledge of an experienced board, it will obtain better strategic capabilities, as discussed above. An issue arises when the exploitation of the board turns into dependency, as the TMT is unable to perform its responsibilities sufficiently without the involvement of the board (Bjørnåli and Aspelund 2012). An aspect in which this is especially visible is the network contribution of the board. Entrepreneurs in high-tech start-ups are often scientists or researchers, who have a well-developed network within academic circles, but who are to a much lower degree networked with influential people within financial and industry circles (Clarysse, Knockaert et al. 2007). Thus, many high-tech start-ups might be expected to rely on their board's network both in attracting investors and in discovering potential collaboration partners.

In this study both firms C and D report that they feel the network reach of their TMT has been sufficient to facilitate their growth, and that they have thus exploited the network of the board only to a limited degree. Firm C and D are also the firms in the study that have achieved the highest revenues, growth and strategic action speed. The CEOs of these firms emphasize the flexibility they achieve through not having to go through the board for all these connections. Furthermore, the firms that rely on their boards to contribute with their networks have not achieved the same growth and success. These firms to some extent attribute this lack of growth to their dependence on their boards' networks, such as the CEO of firm A exemplifies it:

> *Our growth is depending on financial resources. […] It has not been easy for the board to go out and find large, willing investors.*

Firms A and E both show clear signs of being unable to use their own network towards connecting with financial institutions. For that reason they have had to depend on their boards' networks within these

areas, which has not provided them with the contacts and finances needed to supply the expected growth of the firms.

Firm	A	B	C	D	E
Board network contribution	Mid	High	Low	Low-mid	High
3-yr CAGR	11%	18%	90%	71%	[1]78%
Strategic action speed	Mid	Low	High	High	Mid

Table 4.2 - Board network contribution, CAGR and Strategic action speed

The relationship between board network contribution, firm growth and strategic action speed is depicted in Table 4.2. These findings seem to amplify the importance of networks for management teams in clean-tech start-ups. Boards consisting of external board members are contributing towards increasing the network reach of the company, as evaluated in section 4.1. However, this network contribution does not seem to be sufficient for outweighing the lacking networks of the firms' TMTs. Hence, we get the following propositions:

Proposition 2e *Clean-tech start-ups that are dependent on their board's networking abilities achieve a lower strategic action speed.*

Proposition 2f *Clean-tech start-ups that are dependent on their board's networking abilities achieve lower revenue growth.*

4.3 Behavioral integration

The behavioral integration of the board can influence the development of the firm in many ways. However, the term, and which constructs lead to a high or low level of it, has not been evaluated rigorously, especially in the context of high-tech start-ups. Moreover, the construct of behavioral integration has usually been applied to TMTs and has not yet been applied to the board. Hence, this section evaluates the determinants of board behavioral integration discovered in this study, as well as findings regarding board behavioral integration's influence on board roles and strategic action capabilities.

4.3.1 Determinants of behavioral integration

Behavioral integration is a term describing the degree to which a group engages in mutual and collective interaction (Hambrick 1994, Hambrick 2007). This covers, among other things, the degree to which the group's members share information and help each other solve problems. In order for a group to participate in sharing information and gathering help internally, it is crucial that the members of the group share a mutual trust. If there is no trust between board members one would expect that sharing of information, resources and help between members is also very limited.

The findings of this study support this belief. The CEOs of all firms report that the mutual trust within their boards is high, and this seems to be associated with the high degree of behavioral integration in the boards of all case firms. While most of the case firms have had a high degree of trust and behavioral integration within their boards for their entire development, this has not been the case for firm D. The initial board of this firm consisted of the CEO and three external board executives. The CEO explained the situation in the following way:

[1] CAGR of firm E highly exaggerated due to unusually low revenues three years ago

> *At one point, the board tried to push the CEO out of the firm and out of ownership. Trust between board members diminished and it became increasingly impossible to get anything done.*

Other CEOs also comment positively on the trust between their board members, as well as their feeling that this trust is crucial for ensuring the efficient collaboration between board members. For example, the CEO of firm A stated that "*if our board members didn't trust in each other's abilities and integrity, I would expect mutual collaboration between board members to be impossible.*" Following these findings, we can formulate the following proposition:

Proposition 3a *Trust between board members is positively associated with the level of behavioral integration of the board.*

Other determinants were also found to be important for the behavioral integration of the board. Rather than diversity of backgrounds of board members, the degree of disagreement between the board members regarding important issues seemed to be detrimental for board behavioral integration. These important issues revolve around issues related to the strategic priorities of the firm, as well as how to secure the operation and profitability of the firm on a long-term basis. The degree of disagreement on these issues is in this report termed as the cognitive distance of the board. If the cognitive distance is high one would expect mutual and collective integration of board members to be lower, leading to a lower behavioral integration. High disagreement hinders cooperation, thus lowering behavioral integration.

The case firms in this study report the same relationship. While most firms have a relatively low cognitive distance within the board, there are at least some internal disagreements within all firms. Firms C and D have the highest behavioral integration of this study, which both firms partly attribute to the high agreement between board members. This is exemplified by this comment of the CEO of firm D:

> *After our board restructuring we have gotten board members that agree on the important aspects of the firm's development. This helps the board collaborate effectively in supporting the firm.*

On the other end of the scale, the CEO of firm B reports that their board largely disagrees on several key strategic aspects of the firm, especially regarding which goals should be prioritized. Because of this, the behavioral integration of the board has suffered somewhat:

> *Because of the disagreements, board members also have trouble understanding each other's problems. Our board members thus only to a limited degree help each other solve problems.*

As these aspects of collaborative behavior are regarded as important determinants of behavioral integration (Hambrick 1994), it becomes clear that the high cognitive distance within the board of firm B has negatively affected the firm's behavioral integration. Firms A and E both report that there are some diverging opinions between board members regarding some issues, but also explains that these disagreements are limited. These firms view the disagreements as basis for fruitful discussions and thus do not believe they significantly hamper the board's ability to efficiently collaborate. A limited degree of cognitive distance between board members might therefore not be negative for the board's behavioral integration. However, if the disagreements become to large they might threaten to reduce the collaboration between board members. Summarizing these findings we get support for the following proposition:

Proposition 3b *The cognitive distance between board members is negatively associated with the level of behavioral integration of the board.*

The last determinant that has been evaluated in this study is the effect the informal communication between board members has on board behavioral integration. A high degree of informal communication should imply that board members respect and value each other's contributions, as these are exploited also in situations where there are no formal obligations to communicate internally. This will be expected to further imply a high degree of collaborative behavior within the board.

This study has found indications that support these assumptions. All boards of this study communicate regularly, both internally and with the CEO. The CEO of firm A describe the informal communications he has with his board members in the following way:

> *We communicate often, but it varies somewhat. Recently it has been a lot due to some special issues. These conversations work to share information, get advice and input.*

Information and resource sharing are also established determinants of TMT behavioral integration (Hambrick 1994), indicating the positive effect that frequent internal communication has on a board's behavioral integration. The CEO of firm C underlined this point by claiming:

> *We have recruited strong board members that excel within their fields. […] I have the impression that our board members share a mutual admiration and communicate regularly, also regarding aspects not related to this firm. […] The mutual respect makes them cooperate well.*

Considering these findings we can assume the following proposition, identifying the third and last determinant of behavioral integration that has been examined in this study:

Proposition 3c *The amount of informal communication between board members is positively associated with the level of behavioral integration of the board.*

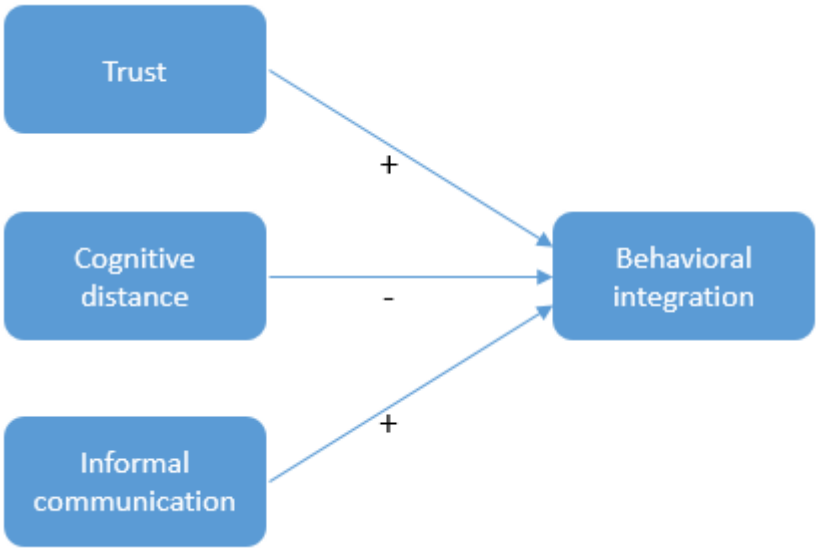

Figure 4.3 - Determinants of behavioral integration

Summarizing the research on determinants of board behavioral integration, this study has discovered three characteristics of boards that contribute to determining the level of behavioral integration of a board. Figure 4.3 shows these determinants as well as their relationship with behavioral integration. While this research has evaluated these determinants specifically in the area of boards, one might expect to find the same relationships when studying behavioral integration of other groups.

4.3.2 Relationship between behavioral integration and firm development

This section will evaluate the influence board behavioral integration can have on a firm's development. This will first be connected to the influence it has on the performance of the two board roles, before analyzing behavioral integration's direct effect on the strategic action capabilities of the firm. Lastly I will evaluate in what situations or settings behavioral integration of the board can be especially important for the firm's development.

High behavioral integration of the board indicates that the board members to a high degree are collectively integrated, allowing them to collaborate more effectively. As the board increases its effectiveness, one would expect the board to be able to contribute more to both the service role and the control role of the firm. The tasks of the service role, such as management advice and strategic evaluations, are often highly complex. Complex problems are usually solved better by teams that are able to pull on the knowledge and experiences of all its members, which gives behaviorally integrated teams a great advantage in solving such problems (Simsek, Veiga et al. 2005). Similarly, a behaviorally integrated board means more information and help is shared between board members. This could allow the entire board to stay updated on the situation of the firm at all times, prompting higher levels of monitoring by each board member.

Almost all firms in this study report similar relationships between behavioral integration and board involvement. The original board of firm D, which had a very low degree of behavioral integration, was the only board in this study which did not contribute significantly to the growth of its firm. Albeit attempts to contribute were initiated by some board executives, the lack of collaboration within the board ensured that neither the service nor the control role of the board were fulfilled. Furthermore, other firms report that one of the main reasons why their board contributes as much as they do is that they are able to achieve superior results through efficient collaboration. This can be exemplified by the following quotes, which explain how a behaviorally integrated board can contribute more both to the service role and to the control role:

> *Our board is a good discussion partner in strategic evaluations. This is caused in part by the diversity of experiences within the board and in part by the board's ability to collaborate effectively in adding value to the discussions.* (Firm A)

> *Our [new] board communicate information about the firm's activities effectively among each other. This has contributed to the entire board being active in monitoring.* (Firm D)

These findings lead us to assuming the following proposition:

Proposition 3d *Higher levels of board behavioral integration are positively associated with the engagement of the board in both the service role and the control role.*

Establishing that the behavioral integration of the board increases the engagement of the board in the two board roles, it should come as a natural extension that the behaviorally integrated board through this

increased engagement can improve the strategic action capabilities of a firm. A behaviorally integrated board will be able to contribute towards both the speed and breadth of strategic actions within the firm. Strategic action speed will be affected by the effectiveness a well-integrated board can bring to the process of evaluating strategic alternatives. Through exploiting the total amount of experience within the board effectively, the firm should be able to more rapidly evaluate and implement strategic actions. This should lead the firm to be able to act faster in introducing new products, entering strategic coalitions and expanding into international markets, among other things. Similarly, the integrated board can contribute to more fruitful strategic discussions within the board. This can be expected to unveil a wider range of strategic possibilities, thus increasing the firm's strategic breadth of actions within the aforementioned fields.

Firms C and D of this study appear to use their boards' superior behavioral integration to gain an edge by securing a higher strategic action speed. Both of these firms claim that their strategic action capabilities have been increased by the influence of their boards, where the aspect of efficient collaborative behavior within the board was an emphasized factor by both CEOs. For example, the board of firm D was an important factor in deciding to build a construction facility in Lithuania. The collaborative effort of the board has been able to further strengthen this decision through entering strategic partnerships in the country. Firm B is the firm that scores lowest on both aspects of strategic capabilities, as well as the firm with the lowest behavioral integration of the board. Their board does not engage in mutual problem solving and have thus not been able to positively influence the strategic action capabilities of the firm as much as the other boards in this study. Firm B is today very slow at introducing new products and services into the market, and have also not been able to connect to a breadth of strategic partnerships. These are factors that reduce the total strategic action capabilities of the firm. Firms A and E in the study show relatively low strategic action capabilities, despite behavioral integration being high in both firms. However, the interviews revealed that the strategic action capabilities of both firms have improved significantly lately, largely due to the contribution of their boards. Firm E explains the impact their board has had on the firm's strategic action capabilities in the following way:

> *We have just been through some tough times, where we were not able to compete with our competitors at all. The strengthening of the board has given us much help in increasing our strategic abilities. […] The board was strengthened mainly in aspects of knowledge and better internal collaboration within the board.*

Furthermore, the previous board of firm D acts as a good example of how a behaviorally unintegrated board will struggle to influence the firm in any way. Although firm D's board attempted to contribute to some aspects of the firm's development, their lack of collaboration reduced the importance and impact of the contributions. On the other hand, several examples from this study can be drawn on how a high behavioral integration of the board has helped it perform its service role to a larger extent. As examples can be held forward the "*many rigorous strategic discussions of a united board*" in firm A or the way the board of firm C "*act together in thoroughly securing good implementation of strategic initiatives*". Considering these findings, we formulate the following proposition:

Proposition 3e *Boards that have a higher behavioral integration will most probably be able to use its service role engagement to affect the strategic action speed and strategic breadth of the firm to a larger extent.*

Another interesting evaluation is whether there are certain situations in which high behavioral integration of the board is especially important for a firm's development. It has already been established that the board's influence on the firm is especially high at the early stages of firm development, and one can imagine that there are other characteristics of firms that moderate the effect a board can bring to its firm through its behavioral integration.

The complexity of the environment that the firm is operating within can be argued to be such a characteristic. As has been discussed previously, a board will strongly contribute to its firm's strategic action capabilities through exploiting the executives' experience and knowledge. In stable environments, the strategic decisions that a TMT needs to make become less time-sensitive and less decisive (Goll and Rasheed 1997, Davis, Eisenhardt et al. 2009). In such environments one could expect that the TMT would be able to come up with sufficient solutions without necessarily having to pull on the collaborative help of the entire board. However, in more complex situations the setting changes completely. In this environment an effective board will need to collaborate effectively in exploiting its combined competencies to secure the firm a competitive advantage in its speed and breadth of strategic actions. As time becomes an increasing scarcity in complex environments (Davis, Eisenhardt et al. 2009), TMTs and boards need to be effective in arriving at the correct strategic evaluations and implementing actions.

It will be expected that this relationship exists both for the strategic action speed and for the strategic breadth of the firm. Literature has established that the more complex the environment, the more importance will need to be put into having an efficient and rapid decision making structure (Davis, Eisenhardt et al. 2009). Thus, with increased environmental complexity, a board will try to contribute more towards increasing the firm's strategic action speed. If the board is behaviorally integrated, it is then also likely to succeed in increasing the action speed, through efficiently pulling on the experiences and knowledge of all board members. As the environment grows more complex it becomes increasingly difficult for board and TMT to fully evaluate the whole range of strategic possibilities. A behaviorally integrated board will be able to contribute to increasing the understanding of the environment, thus potentially increasing the firm's strategic breadth. This will be achieved through a collaborative effort of the board to combine each board member's capabilities into a strong unit for strategic analysis.

The findings in this study support the assumptions described above. While the industry of clean-tech firms is generally unpredictable and run by political pressure, society's attitudes and radical innovations (Tsoutsos and Staltiboulis 2005, Hoppmann, Peters et al. 2013), there are still some variations within the complexity of the environments of the case firms. Firms B, C and D, report a very high degree of environmental complexity. Of these firms, both firms C and D have exploited their boards' collaborative efforts to a high degree in securing relatively good strategic action capabilities. On the other hand firm B has a board that is less behaviorally integrated, and albeit performing the service role this board has not been able to fully grasp the situational realities of the firm. As a result firm B has low strategic capabilities. The CEO of the firm formulated this problem in the following quote:

> *Our board does not understand the technological aspects of our products and markets. This hinders their contribution to the TMT.*

Additionally one can also look at firms A and E, which both operate in less complex environments. Despite having a board that largely contributes to the service role, as well as a board that is highly integrated behaviorally, neither of these firms have managed to achieve high strategic capabilities compared to their competitors. This serves to reason for the assumption of environmental complexity as a moderator of the

effect of board behavioral integration. The contribution of the boards of these firms have not been enough to secure the firms a competitive advantage over its competitors in the speed and breadth of strategic actions. Together these findings are formulated in the following proposition:

Proposition 3f *Complexity of strategic evaluations positively moderates the relationship between behavioral integration and firm strategic action capabilities.*

In summary, this study has evaluated how behavioral integration is an important aspect of the effectiveness of boards in clean-tech start-ups. These findings related to the behavioral integration of boards are summarized in Figure 4.4.

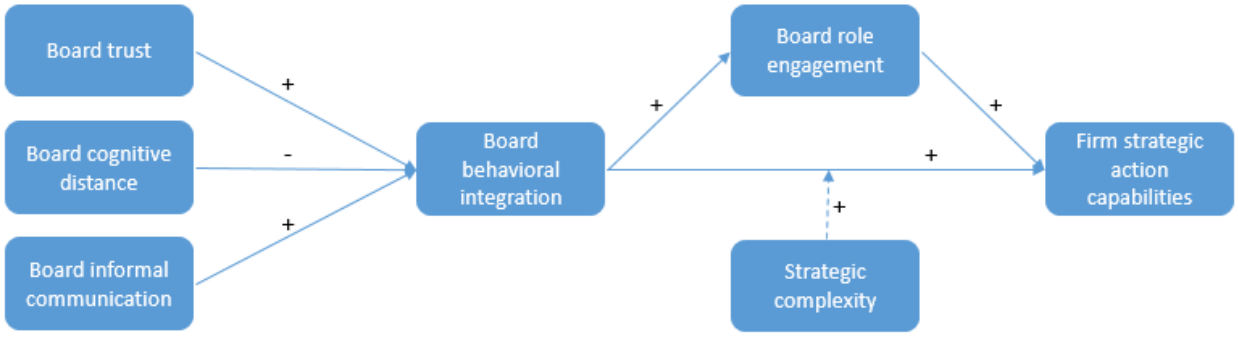

Figure 4.4 - RQ3: How do effective boards fulfill their roles?

5 Discussion

This study has revealed several important aspects regarding boards in entrepreneurial ventures. Specifically the *who*, *what* and *how* of board effectiveness have been evaluated. This has served to enlighten several aspects of board composition, board roles and board behavioral integration and have laid the foundation for considering how boards operate to facilitate for the development and success of clean-tech ventures. These aspects have contributed towards answering the question of what are the distinctive features of effective boards in clean-tech ventures. In this section, I will discuss what I deem to be the most important findings, as well as suggest what implications these findings should have for future researchers, strategizers and entrepreneurs. I will also consider the contributions that should be noted by the numerous support organizations that aim to support the growth of the Norwegian clean-tech industry. Ultimately, I will conclude with discussing some limitations of this study.

In this study, three main important determinants of the board's influence on the development of the firm have been examined. These determinants are the composition of the board, the engagement the board puts on different board roles and the behavioral integration of the board. Furthermore, other board characteristics, such as trust and communication, have been evaluated to examine their effect on the proposed main determinants of board effectiveness. Some key findings of the study are presented in Figure 5.1.

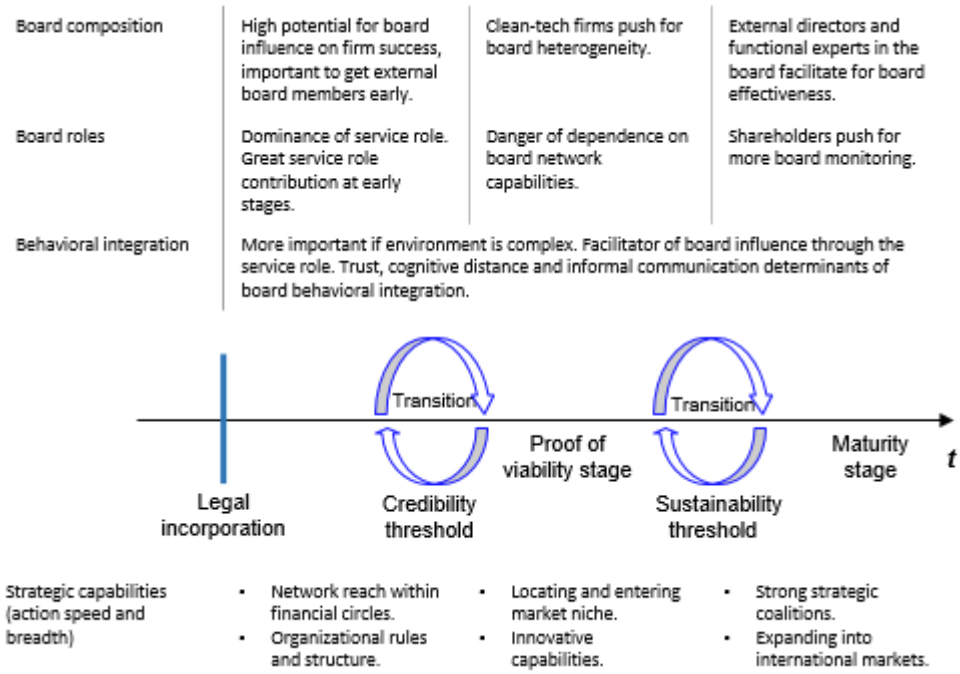

Figure 5.1 - Key findings

Regarding the roles that boards perform, we have seen that boards contribute the most to the firm's strategic capabilities the earlier in the cycle of development the firm is. The founding team in high-tech start-ups usually lack several key capabilities of successful firm development, due to lack of experience, lack of functional heterogeneity or other factors. These ensure that an effective board has an especially high amount of areas in which it could positively influence the firm. As discussed, the liabilities that young firms face in the start-up-phase also ensure that the board can play an especially important role in the

youngest firms. At subsequent stages of firm development, the board changes its focus towards engaging more in the control role. This study has shown that boards at later stages still can contribute significantly to the continued growth of the firm through this change of focus.

We have seen that boards engaging in the service role can positively influence the strategic action capabilities of a firm. Boards consisting of a high amount of external directors tend to prioritize focusing on the service role, and thus contribute greatly towards the development of the firm's strategic action capabilities. This contribution stems from the use of the board members' experiences and knowledge to better be able to analyze and evaluate different situations, as well as using the board's network to encounter possible partnerships. On the other hand, the board's engagement in the control role do not seem to have any significant influence on the firm's strategic capabilities. Boards of clean-tech start-ups have not been able to use their control function to increase neither the speed nor the breadth of strategic actions of their firms. However, several of the firms still report that they feel the control role of the board is an important one, ensuring operational continuity and optimization of management incentives. This becomes especially prevalent at later stages of development of the firm.

Rather than suggesting that the control role is an unimportant aspect of board effectiveness, this finding might suggest that the strategic action capabilities that have been used to measure board impact in this study do not completely cover the total scope of potential board contributions. Researchers have held both strategic action speed and strategic breadth as positive for firm growth and performance (Miller and Chen 1996, Baum and Wally 2003). However, in this study it appears that strategic breadth is not as important for the growth of clean-tech ventures as expected. This supports other researchers who consider strategic action speed to be the decisive characteristic of firms operating in dynamic environments (Eisenhardt 1989, Baum and Wally 2003). Additionally, this might suggest that other dimensions that have been proposed by previous research, such as strategic action aggressiveness (Chen, Lin et al. 2010), might better be able to capture the decisive strategic capabilities of high-tech start-ups.

One of the contributions to this study has further been to view the growth and success of firms along several characteristics. Firm growth has in this study been measured along firm development stages, strategic capabilities and revenue growth, all of which have differed along the case companies. By doing so, the study has better captured the different dimensions of firm growth. The study thus adds nuanced insights concerning firm growth to an underdeveloped stream of research on *how* a company grows, as opposed to widely produced studies looking at the *how much* of company growth (McKelvie and Wiklund 2010).

While the board's role engagement is an important aspect of board effectiveness, another important determinant of the influence a board can have is the quality of the board's task performance. Not surprisingly, boards that perform their tasks well contribute to a larger degree to the development of their firm. While task quality is a different value to measure, the study also discovered that all of the firms in the study were generally satisfied with the quality of their board. This quality was reported from most of the firms to come as an effect of the employment of external directors into the board. This serves to further underline the positive effect of external directors, supporting previous research in this area (Gabrielsson and Huse 2005, Garg 2013, Knockaert and Ucbasaran 2013).

In addition to the positive effects of having external directors on the board, the presence of functional experts has been shown to also have a positive effect on the firm's strategic action capabilities. Boards that consist of a group of functional experts, with expertise within different functional areas, are able to

positively affect the strategic action speed of the firm. Functional board experts have to a large degree encountered many of the problems that an emerging firm faces in their previous board experiences. This helps them influence the speed of a firm's decision-making, through quickly gaining an understanding of the range of strategic opportunities that exist in a given situation, such as potential market entry decisions or strategic coalitions.

While boards undoubtedly influence the development of high-tech firms positively, we have also seen that there are potential negative effects of relying too much on the board's contribution. Young clean-tech start-ups need to be cautious not to get too dependent on the contribution of their boards, as this can have potential negative long-term effects. In this study, this effect has been seen specifically for a firm's dependence on the networking capabilities of the board. Extensive literature coverage has confirmed the importance of networks on the growth and success of young ventures (Hoang and Antoncic 2003, Walter, Auer et al. 2006). As shown, esteemed board directors can have a lot to contribute with on this area, but if the TMT of the firm does not develop the network capabilities of its own simultaneously this will harm the long-term growth of the firm. A further interesting aspect would be whether other board dependencies might affect the capabilities of a firm similarly.

Regarding behavioral integration this study has added to current literature through establishing the importance behavioral integration can play in determining the impact of a board. While some researchers have previously emphasized the importance of behavioral integration in maximizing the effectiveness of a team (Hambrick 1994, Simsek, Veiga et al. 2005), this concept's effect on a board's contribution to its firm has not been considered. This study can therefore form the basis for further research covering this area of board literature.

Adding to previous literature on TMT behavioral integration, this study has suggested three determinants of behavioral integration in the context of boards. One of these is the mutual trust between board members, covering the degree to which board members are honest, trustworthy and have a high integrity. Subsequently, the cognitive distance of the board regarding certain key strategic areas and priorities, was also found to influence the behavioral integration of the board. The last determinant discovered in this study was the amount of informal communication between board members. A clear link was found between each of these characteristics and the behavioral integration of the board. This suggests that attempting to increase these characteristics of a board can contribute towards elevating the board's behavioral integration.

The importance of board behavioral integration has predominantly been emphasized by several important findings. Behaviorally integrated boards in this study were able to contribute to a higher degree towards important strategic decisions and actions of their firm. Boards with a higher behavioral integration were also found to be able to use their service role engagement to affect the strategic action capabilities of the firm to a higher extent. For a board to contribute effectively through performing the service role, it is thus decisive that the board operates as an efficient, integrated unit.

Furthermore, the study also discussed how the behavioral integration of a board contributes to its engagement in the two board roles. High behavioral integration was found to positively influence board engagement altogether, meaning it facilitates for an increased engagement both in the service role and in the control role. In the case study, there was especially one example of a board that due to its lack of behavioral integration were unable and unwilling to involve itself in aiding the firm. One might therefore

conclude that a behaviorally integrated board in general becomes more motivated to contribute to the firm, increasing its contribution across all tasks.

Ultimately, the complexity of the environment in which the firm operates was shown to be a moderator of the effect that the behavioral integration of the board can bring to the firm's strategic capabilities. With most clean-tech start-ups operating in complex environments, highly influenced by political actions and the trends of society, this further emphasizes the importance of board behavioral integration in these firms. Complex environments are especially demanding and therefore demand more from both the firm and the board to achieve success. However, as the complexity increases so do the rewards (Davis, Eisenhardt et al. 2009), amplifying both the importance and the rewards for clean-tech firms of having an effective board.

5.1 Contributions to future research

This study has produced valuable insights into the distinctive features of effective boards in clean-tech start-ups. Specifically, the propositions were developed concerning board composition, board roles and board behavioral integration. Considering the findings discussed above, future researchers can get several important insights into areas of board research in high-tech start-ups that need further evaluation. This section will discuss these possibilities and suggest several specific research questions, which if addressed by researchers would greatly add value to the stream of board research. These research possibilities are shortly summarized in Table 5.1. The table also assesses whether these research questions would be best covered through performing a theoretical study or an empirical study, either based on quantitative methods or on qualitative case studies.

Research area	Suggested research question(s)	Research method
General studies	How does the board facilitate for the development and success of high-tech firms?	Quantitative
	How can the effectiveness of a high-tech start-up best be captured? Which strategic priorities matter?	Qualitative or theoretical
Board composition	How do different external directors contribute to board effectiveness?	Quantitative or qualitative
	How can foreign board executives facilitate the internationalization of clean-tech firms?	Quantitative or qualitative
Board roles	How does a board's influence on a high-tech start-up vary with stage of development of the firm?	Qualitative
	How does overdependence on the board's network contributions affect the firm? How can firms and boards overcome this? Are there other critical dependencies?	Qualitative or theoretical
Board behavioral integration	What factors affect behavioral integration?	Quantitative or qualitative
	How does the strategic complexity of the environment influence the importance of board behavioral integration?	Quantitative or qualitative
	How does the behavioral integration between TMT and board of directors influence the contribution of the board towards the firm's development?	Qualitative or theoretical

Table 5.1 - Suggested further research

This study has significantly contributed towards broadening the area of research on board effectiveness. However, there are still uncertainties, especially regarding the generalizability of the findings arrived at in this study. The case study format chosen here has allowed me to estimate certain relationships in depth. These findings would be strengthened by research targeting some of these findings and examining them quantitatively.

Furthermore, this study has contributed to enlightening the aspect of strategic action capabilities in firms operating in dynamic environments. As discussed in the previous section, the strategic capabilities that were used to measure the board's contribution did not seem to act as perfect determinants of firm growth or success in this study. At least for the construct of strategic breadth there seemed to be no linkage with the firm's growth. While strategic breadth might be important for many companies, as confirmed by previous research (Miller and Chen 1996), these findings question whether it is a relevant capability for high-tech start-ups operating in dynamic environments. Future research related to high-tech ventures should thus consider redeveloping the concept of strategic action capabilities to capture what is decisive for the growth of these firms.

While board composition has been proven an important determinant of board effectiveness, this is still an area that deserves further attention in the literature. This study has further delved with the effect external directors have on a board's effectiveness. However, the group of external directors contains several different directors that will certainly bring different contributions to the board's work. External directors can be for example professional and private investors, representatives of large industry actors or esteemed business executives. Evaluating the different aspects these groups of external directors bring to a firm could provide value for emerging firms composing their board.

An especially interesting aspect in this regard could be the addition of foreign directors into boards of emerging clean-tech firms. All the case firms in this study follow previous research in stating that rapid internationalization into foreign markets is critical for the survival of young clean-tech firms (Menon 2011). As discussed, an important limitation of firms attempting to establish themselves internationally is the liability of foreignness and the liability of outsidership. These liabilities come as an effect of the differences culturally, geographically and in terms of networks between the firm and the target market. One can imagine that a foreign board member could help negate some of these liabilities, similar to the way domestic board members help negate the liabilities of smallness and newness in the domestic market. Future research could evaluate whether the addition of a board member originating from the target market, could help the clean-tech venture establish operations in a foreign country.

Board role engagement has been thoroughly discussed in this report and has been suggested as a major determinant of the effectiveness of a board. However, the study has also revealed that the importance of, and engagement in, different board roles varies depending on the stage of development a firm finds itself in. While we know how the focuses of boards change, we know little about the effect this change has on the board's contribution to different firm characteristics. Future research could help enlighten this area further, through performing an in-depth longitudinal study of how a board's influence on a high-tech start-up varies with age and development stage.

With board role engagement increasing there is also a risk of the firm ending up depending on some of the capabilities of the board or its members. In this study, a firm's dependency on the network capabilities of its board has been examined, and findings confirm the notion that TMTs must focus on increasing its own network simultaneously as exploiting the network of the board. One might imagine that the same goes also for other tasks that the board aids the TMT in doing. While the positive influence a board can have on its firm has gained coverage in literature, very few have examined the potential negative effects. Future research could aim at improving this, through examining how overdependence on different board contributions could affect the firm. An addition to this could be to examine how firms and boards can overcome these issues of overdependence.

This study contributes towards broadening the agenda of research into high-tech start-ups. While previous research has mostly considered which tasks boards perform, this study has incorporated the aspect of board behavioral integration as an important determinant of the board's effectiveness. Behavioral integration has previously been studied only in relation to TMTs, and this study thus contributes to introducing this aspect into the area of board research. Showing the importance of behavioral integration for establishing a board's contribution, this study suggests that behavioral integration of boards is an area that deserves more attention in future board and management research.

Specifically, future behavioral integration studies could evaluate other determinants of behavioral integration. With the importance of behavioral integration established, firms should aspire to employ a board that can achieve a high behavioral integration. While this study has discovered the determinants of trust, cognitive distance and informal communication, there are sure to be several other significant determinants of the construct. Studies evaluating and establishing further determinants of behavioral integration would facilitate the processes of firms and boards aiming to increase their behavioral integration, as well as reveal further insight into the construct of behavioral integration.

As has been shown, the positive effect of the board's behavioral integration increases with an increased degree of complexity of the environment. An interesting aspect would therefore be to consider how behavioral integration would affect firms in more stable environments. As has been noted, the area of research on board behavioral integration is largely uncovered. There is therefore a potential to build on the findings in this report by examining behavioral integration of boards in other start-ups, which operate in different levels of environmental dynamism and complexity. While most high-tech start-ups operate in dynamic environments, most start-ups in general do not. Expanding the research of board behavioral integration to cover these firms as well would therefore greatly contribute to the literature.

As has been discussed, in young companies the divide between board of directors and TMT is usually very short, in some cases so small that the board and TMT can be seen as the same group (Bjørnåli and Gulbrandsen 2010, Zhang, Baden-Fuller et al. 2011). This emphasizes the importance of studying boards and TMTs together in such ventures. Zhang, Baden-Fuller et al. (2011) argues that this finding means that previous research that has tried to view a board's strategic contribution separately from the TMT might have underestimated the effect the board had on the strategizing of the firm. It is therefore in further studies necessary to evaluate the behavior of the board of directors and the TMT together if we wish to get a better understanding of how the board can add value through the performance of certain board functions (Pettigrew 1992, Zhang, Baden-Fuller et al. 2011). This holds true also for behavioral integration, which might be fruitfully examined as a construct working between the board and the TMT. Further studies could enlighten this aspect by examining determinants and effects of the mutual behavioral integration between the TMT and board of directors.

5.2 Contributions to business

This study brings several important contributions to both clean-tech TMTs, board executives and other stakeholders of clean-tech firms. While these contributions are mainly the same across the different groups of people, there are some differences depending on the view from which you evaluate the situation. The following section will summarize how each actor in a young clean-tech firm should exploit the knowledge generated from this study.

The immense impact a board can have in the initial period of the firm has been established, together with the risk of growing dependent on the board. Emerging clean-tech entrepreneurs need to consider both

these aspects when employing their first board, to facilitate both for immediate growth and for a board that can leave the TMT better equipped for tackling future challenges. It might be easy for a TMT to focus on some key tasks and let the board take care of other tasks that it has superior knowledge of. However, at the same time it is detrimental for the firm that the TMT develops the capabilities to be able to contribute more and more in all aspects of firm development. This is also an aspect that board executives need to consider, focusing on the sharing of knowledge to facilitate for developing a stronger TMT.

Clean-tech entrepreneurs should furthermore prioritize attracting external directors into their board as early as possible. In addition to the positive effect this brings to both the engagement of the board in the service role and the quality of board tasks performed, external directors contribute towards increasing the general professionalism of the board. Through contributing with their networks, experiences and capabilities external directors have been shown to strongly influence the firm's development. The entrepreneur should also seek to add functional experts, predominantly ones that have their expertise within different functional fields, to facilitate for increasing the firm's strategic action speed.

Board executives need to be aware of the role they play in facilitating for firm growth. While the service role seem to be the main way of positively influencing an incumbent firm, as the firm grows more and more effort should be put into controlling the activities of the firm. Furthermore, board executives should be especially aware of the importance of behavioral integration in their performance of board roles. While many board executives are strong and insightful individuals it is evident that their contribution to the firm's development multiples if they are also able to collaborate effectively in supporting the firm. This grows especially important in high complexity environments, where decisions often need to be taken fast and without an overview of the whole situation.

Shareholders of clean-tech ventures should especially consider and control the trade-off between board contribution and board dependency. Board members might benefit from creating board dependency, as this creates a situation where the firm needs to retain them in the board in order not to lose important capabilities. Shareholders need to make sure this is avoided. For optimal exploitation of their resources, shareholders must make sure that board members have incentives for building not only a strong firm, but also a strong and competent TMT. Although there are sure to be many ways to achieve this, one suggestion could be to pay board remuneration mainly through shares in the company. In this way board members profit from making sure the firm is run effectively, and aligns the incentives of the board members with the incentives of other shareholders.

5.3 Contributions to support organizations

As the battle to reduce the climate impact of the world intensifies, an increasing amount of money is being invested into the technologies that can facilitate for a green development (IEA 2011, Eyraud, Clements et al. 2013). In line with money being invested, politicians and governments also increase their focus towards supporting the growth of a clean-tech industry, through support organizations and political initiatives (Tsoutsos and Staltiboulis 2005, Hoppmann, Peters et al. 2013). This section discusses how politicians and support organizations should incorporate the results of this study into the development of future support measures. These contributions will obviously be based on the political and support systems of Norway, but the baseline of the findings can still be applied by politicians and support organizations in countries worldwide.

A key issue of clean-tech start-ups was reported by the case firms to be the complexity and dynamism of the environment, much of it caused by uncertainty regarding future political actions. Many firms within

the clean-tech sector are still depending on economical retribution, for example in form of price tariffs or direct compensation (Eyraud, Clements et al. 2013). While the firms try to act, think and plan on a long-term basis they report that this becomes increasingly difficult when the political future that supports them is so unsure. This adds to the complexity of the strategic evaluations that the firms must make and in many cases make them more dependent on their boards to contribute, as was evaluated in the previous chapter. Politicians can greatly improve this aspect through providing more long-term guarantees, as well as implementing measures that will support the industry in the long term.

This study has underlined the importance for a clean-tech venture of having strong and knowledgeable board executives. Several of the firms in the study report that many of the current measures being put in place to support their firms are not working as intended, for various reasons. These can be measures of project financing and support, help with public information or help in internationalizing the firm. Politicians and support organizations could consider expanding their range of services into helping firms find effective and competent board members for their company. This is an area that clean-tech TMTs often lack competence around, especially in the incorporation stage, and there is therefore significant potential in aiding the firms through this process. This is exemplified by the fact that only one of the case firms in this study reported that they would have employed the same board as they did at inception if they got the opportunity to do it again.

All the firms of the study reported that their product and business model depends on reaching sales and collaborations internationally. Still, several of the firms feel that the help received from state organizations in facilitating this internationalization has been negligible. Firms C and D have both started a process of moving their administrative and legal headquarter out of Norway because of the lack of help in achieving international success. The help that has been desired by the firms has mainly been help with networking and getting in contact with actors in other markets. The importance of networks in the development of a high-tech firm has been discussed briefly in this report, but it has been more thoroughly examined by other actors (McDougall, Shane et al. 1994, Keupp and Gassmann 2009). Public support organizations can improve their work in this area, for example by increasing their capability of connecting emerging firms with international resource persons. These resource persons might also help emerging firms by entering their boards, potentially helping remediate several of the liabilities that young technology firms face in entering international markets.

5.4 Limitations

This report has several important limitations, which need to be clarified to the reader, to secure a better understanding of the findings in this study and their viability. Firstly, this study has only considered Norwegian start-ups. I believe the relationships and characteristics discovered will be similar to that of other countries that have similar cultures regarding boards and governance mechanisms, for example other Scandinavian and western European countries. However, regardless of similar cultures there might still be significant differences, caused by a long range of factors, for example different market mechanisms and variances in the business landscape. Similar studies in the context of other countries could therefore be necessary to assert whether the findings presented here can be applied to businesses outside Norway, and to discover eventual country-specific phenomena.

The nature of this study as a case study ensures that scholars might question the generalizability of the findings that have emerged. The main mission of this study has been to provide a baseline of research within boards in high-tech firms, guiding future researchers towards certain areas of board literature that

should be examined to a greater extent in regards to young ventures. Through explaining all findings based on both existing literature and detailed feedback from case firms, I believe that this report goes a great way in arguing for the generalizability of the findings. Still, further value could be added to the area by future research targeting some of the aspects discussed in this report and examining them quantitatively.

The aspect of generalizability is also affected by the choice of clean-tech firms as focal firms in this study. Clean-tech firms were chosen due to research interest and to ensure relative industry homogeneity within the sample of firms. I believe most of the findings regarding boards will hold for early stage high-tech firms also in other industries. However, testing these findings in the context of other industries is needed to ensure this generalizability. Finding similar relationships in studies considering other high-tech industries would further strengthen the validity of the findings presented in this report.

The measurement of the constructs of behavioral integration, trust and cognitive distance used might be another limitation to the study. Behavioral integration is a relatively young phenomenon in terms of performed research, and there is thus significant uncertainty regarding the measures that should be used to evaluate this construct. Behavioral integration, trust and cognitive distance are all constructs that are hard to grasp and evaluate for a CEO or board member directly, and thus might require other ways of measurement. That all the firms in this study report such high levels of both behavioral integration and trust might be an indication that the measurement of these aspects have not been performed optimally. Developing a uniform way of measuring these aspects across boards and management teams would significantly strengthen future research into this area. This goes especially for behavioral integration, which due to proposed the high importance it has on the board's effectiveness, needs an adequate measure for easing its inclusion into future research.

This study has only evaluated the contribution of the board from the perspective of the CEO. The construct validity of the study would increase through gathering information also from other actors (Yin 1994), such as board members and other TMT members. However, this research design was chosen on purpose, as CEOs are the ones believed to best be able to evaluate this situation. While other TMT members might not have a full overview of the contributions that the board has brought to the firm, board members might have biased views on their role in the development of the firm. As the CEO in most cases sits as a board member as well – four of five CEOs in this study were also board members – it was believed that the CEOs were the persons that would have the most to contribute with on this area.

Furthermore, the bounds of rationality of humans (Simon 1957, Williamson 1981) have undoubtedly bounded me both in the gathering and analysis of data in this study. The bounds of rationality are mainly caused by three factors; limited information sensing ability, limited information processing capacity and limited information storage capacity (de Wit and Meyer 2010). This could for example mean that information gathered from the interviews have been wrongly interpreted, or that the case firm CEOs were affected by the presence of the interviewee when providing answers at the interviews. To overcome this challenge, interviews were based on a semi-structured questionnaire, providing each CEO with the same base set of questions. Potential mistaken interpretations will appear in the rigorous case study database, and are thus easily examined by potential interests.

6 Conclusion

This study has uncovered and evaluated several important aspects of the operation of boards in clean-tech start-ups. Building on the limited amount of research performed in this area, the study has furthermore contributed towards forming a basis for future research.

Clean-tech start-ups usually operate in dynamic environments and face a range of different liabilities to overcome before achieving sustained growth. This study has shown how boards can help the firm overcome these liabilities and contribute to improved strategic action capabilities. The main determinants of board effectiveness that have been covered in this study have been the board's composition, its engagement in the board roles and the behavioral integration of the board. All these determinants have been shown to be important for the effectiveness of the board.

Boards in clean-tech start-ups emphasize contributing towards the service role rather than the control role, especially at the early stages of firm development. Both boards and TMTs believe the board can maximize its positive influence on the firm through prioritizing the service role. This prioritization has been shown to be grounded, as the board's engagement in the service role positively influences the strategic action capabilities of the firm. However, boards can be expected to contribute most to the firm at early stages of firm development, thus firms do wisely in employing a qualified board at an as early stage as possible. This study can hopefully facilitate clean-tech entrepreneurs in their search for new board executives and in establishing the roles and tasks they want their board to contribute towards.

One of the reasons boards prefer performing the service role is the prevalence of external directors in the studied boards. External directors have been shown to have a positive effect both on the board's engagement in the service role and the quality of board tasks performed. These findings combine with previous literature on external board executives to argue for the introduction of external directors into the board of high-tech start-ups at an early stage.

The behavioral integration of a firm's board is also an important determinant of the board's effectiveness. A behaviorally integrated board strongly moderates the influence the board has on the firm through its engagement in the service role. As other studies have confirmed that teams with a high degree of behavioral integration are more effective and achieve better results, this study expands these findings into the area of start-up firm boards. The area is expanded further through the discovery of trust, cognitive distance and informal communication as key determinants of behavioral integration.

While board behavioral integration is important in general, this study has shown that it is especially important in firms that operate in complex and dynamic environments. This implies that behavioral integration is very important in clean-tech firms, while there remains some doubts regarding firms operating in more stable environments. However, the general importance of behavioral integration in determining the influence of the board further underlines the importance of increasing the attention that this concept has gotten in the literature.

Summarizing, these findings give important contributions, both to researchers, stakeholders in young clean-tech firms and public support organizations aimed at supporting clean-tech firms. While this study has introduced and evaluated several important aspects in the literature on board effectiveness in high-tech start-ups, the area is still widely uncovered. Researchers in the field of board research are therefore urged to utilize this study as a basis for locating areas that deserve further attention.

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