

Growth Strategies for New Technology-Based Firms

Master thesis submitted to Delft University of Technology
in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE

in **Complex Systems Engineering and Management**

Faculty of Technology, Policy and Management

by

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To be defended in public on July 13th 2018

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GROWTH STRATEGIES FOR NEW TECHNOLOGY-BASED FIRMS

Selecting Growth Strategies by Combining The Resource-Based View,
Transaction Cost Economics and Contingency

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Delft, July 11th, 2018

EXECUTIVE SUMMARY

Over the past few decades, new technology-based firms (NTBFs) have been considered an important engine of economic development. Consequently, a better understanding of the characteristics and attributes of these firms has become a primary goal for researchers and policy makers. While numerous studies found evidence of the relation between growth performance and strategy, clear methods and strategy formulation tools for NTBF managers are lacking. The main objective of this research is to offer *guidance* in formulating growth strategies for NTBFs, while considering their specific characteristics and environment.

This research designs a solution for a large and complex contemporary socio-technical problem. In this, several contributions to technology entrepreneurship literature are made. Firstly, internal and external variables are identified that influence strategy making for NTBFs. Secondly, strategies and tactics that are applicable for NTBFs in specific situations and environments are defined. Thirdly, a conceptual framework that enables to select growth strategies for NTBFs by using an extensive “matchmaking” process is build and validated. This conceptual framework was built around three strategy management theories: Transaction Cost Economics (TCE), the Resource-Based View (RBV) and Contingency. Accordingly, this research investigates and reveals some theoretical implications for applying these theories to NTBFs specifically.

The designed framework suggests that a strategy is subject to the internal and external environment, where the interpretation of this environment and the final decision is made by the management team of a NTBF. Feasible growth strategies for NTBFs are built around four regimes: Vertical Integration, Inter-firm Cooperation, Technology Transfer and System Integration. Two important clusters divide NTBFs and their suitable growth strategies; the ones with a strong financial position and the ones with a suitable situation for collaboration. When having a strong financial position, NTBFs can choose to vertically integrate or become a system integrator. Collaborative strategies can be subdivided in backward and/or forward strategic alliances, exclusivity agreements, equity strategic alliances, joint ventures and an IP-based technology transfer. NTBF founders use similar strategic tactics to deal with shared challenges.

This research did not strive for prediction and certainty but strived to reduce the *complexity* for managers of NTBFs in choosing their growth strategy. Empirical findings and theoretical knowledge were bundled to *understand* the phenomenon, where this understanding is located on a higher level than the empirics itself. Especially since there will always be exceptions. Accordingly, the complexity of the research problem was reduced by using abstraction instead of generalisation. Generalisation was minimised where it is assumed that generalisation in NTBF growth strategies has significant shortcomings where too many variables interact. The art is within the clustering of variables, where these clusters are matched with a specific, optimal growth strategy on an abstract level.

The multi-disciplinary abstraction approach of this research enabled to bridge the gap between research and practical execution. The designed conceptual framework is based on flexible conceptual terms rather than rigid theoretical variables and causal relations and aims to help to understand phenomena rather than to predict them. The input for the conceptual framework was holistic, using interviews and theory. In-depth interviews

with founders of NTBFs were used to review the object of study from different, practical perspectives. Moreover, four theoretical viewpoints were used complementary: contingency, strategy, transactions (TCE) and resources (RBV). No attempt was made for theoretical integration or synthesis of theories. Rather, theories were combined in such a way as to enhance the qualities of each other. TCE theory was used for the identification of strategies, where RBV theory was used for the identification (or a lack) of resources, for which specific strategies and tactics can be executed. Contingency theory served as the overarching theme of the framework, where strategy forms the common thread in this research. An in-depth case study could be used to validate the conceptual framework by reflecting on a real-life case. A single case study was used, while context-dependent knowledge was assumed to be more valuable than predictive theories.

The framework as designed in this research can be used for NTBFs when selecting their growth strategy. Further research is needed to examine the suitability of the framework for different NTBFs, where this research only validated the framework with a single case study. This can be done by executing several in-depth single case studies that lead to a more complete and usable framework. Data should not only be gathered from NTBFs but should also be gathered from researchers when it comes to the critical assessment of the used theories (RBV and TCE) and possible extensions of the conceptual framework.

Keywords: *New technology-based firms; growth strategy; strategic management; resources-based view; transaction cost economics; contingency; in-depth case study; strategic decision-making.*

FOREWORD AND ACKNOWLEDGEMENTS

Not so long ago, I came across this Chinese proverb saying; “*during a hurricane, even turkeys can fly.*” It was used to describe a booming market in which you can never tell the winners from the losers. New technology-based firms (NTBFs) can be considered to operate in “booming” markets, while they often develop unique products and services that can be exploited on a global scale. However, most NTBFs show low rates of growth. The obvious question to be asked is; *why?*

As a co-founder of a NTBF, I decided that I not only wanted to answer this question,; I wanted to solve the problem that is, in my opinion, the cause of this question. NTBFs are different than normal firms, since they are new (scarce resources) and technology-based (resource-intensive). These characteristics need to be considered when thinking about strategy selection, decisions and action. A significant amount of scientific evidence is available that shows the relation between strategy and growth performance. Yet, no clear methods and strategy formulation tools are available for NTBF managers specifically. *How* on earth should NTBF founders know which growth strategy to select and execute?

I am most grateful that I had the opportunity to answer this question and design a solution for this contemporary problem for the successful completion of the master’s programme Complex Systems Engineering and Management (CoSEM) at Delft University of Technology. This graduation project allowed me to scientifically look at a socio-technical problem that is extremely relevant to me. In this thesis, I combined my own daily thinking with my educational background. I have a passion for technique, yet, I am primarily interested in innovative technology that contributes to a better world. Technology can only generate value for a society with the help of enterprising and innovation, for which an interdisciplinary approach is needed, that integrates the technology, systems engineering and management aspects to bring innovations to life. This is exactly what my study in CoSEM has taught me. It enables me to creatively design interventions which contain both effective management strategies and system engineering approaches to deal with technological complexity.

This thesis could only have been written with the help and support of my supervisors: Dr. Aad Correljé, Associate Professor and Dr. Roland Ortt, Associate Professor. Both Aad and Roland helped me where necessary and let me free in executing this research in my own way and time. Their different perspectives – Political Science and Institutional Economics versus Innovation management and Entrepreneurship - gave an extra dimension to this research. In addition, I would like to acknowledge all interviewees that cooperated in my research for sharing their experiences and knowledge in this field. Without them this accomplishment would not have been possible. Finally, I want to thank my team at Qlayers, my family, friends and boyfriend Sebastian for providing me with unfailing support and continuous encouragement through the process of researching and writing this thesis in combination with my fulltime job as co-founder of Qlayers.

This thesis is dedicated to the memory of my father

ABBREVIATIONS

Abbreviation	Meaning
B2B	Business-to-business
CEO	Chief Executive Officer
CFO	Chief Financial Officer
COO	Chief Operating Officer
CTO	Chief Technology Officer
EJV	Equity joint venture
GVC	Governmental venture capital
HR	Human Resources
NTBF	New technology-based firm
NTV	new technology venture
RBV	Resource-based view
R&D	Research and Development
TCE	Transaction cost economics
TRL	Technology Readiness Level
VC	Venture Capital
VIB	Backward vertical integration
VIF	Forward vertical integration

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1. INTRODUCTION

1.1 BACKGROUND TO THE RESEARCH

New technology-based firms (NTBFs), also called new technology ventures (NTVs), are generally defined either as businesses whose products or services depend largely on the application of new scientific or technological knowledge, or as businesses whose activities embrace a significant technology component as a major source of competitive advantage (Brierley, 2001). Over the past few decades, these NTBFs, or high-tech start-ups, have been considered an important engine of economic development (Balboni, Bortoluzzi, & Tivan, 2014; Coleman & Robb, 2012; Koellinger & Roy Thurik, 2012; Morris, 2011; Praag & Versloot, 2007). Yet, most NTBFs show very low rates of growth, if any at all (Balboni et al., 2014). Consequently, a better understanding of the characteristics and attributes of such firms, their growth drivers and the possible obstacles to their development has become a primary goal for researchers, policy makers and the organizations whose mission is to promote and drive economic development.

NTBFs are different than normal firms, since they are new (scarce resources) and technology-based (resource-intensive). A NTBF must establish a position quickly in the face of high uncertainty (Roure & Keeley, 1990), while at the same time being dependent on reaching technological milestones and developing their product or service to be able to enter the market (Pinkwart, Proksch, Schefczyk, Fiegler, & Ernst, 2015). Moreover, the fact that NTBFs are operating in high-velocity environments demands significant speed of strategic choices (Montiel Campos, Solé Parellada, Aguilar Valenzuela, & Magos Rubio, 2015). To survive, a firm's growth strategy is a strategic decision of major importance (Song, Podoyntsyna, Bij, & Halman, 2008). The challenge for NTBFs is to develop a long-term growth strategy, that develops the own technology from simple to complex where this technology generates value for different actors in the system. Consequently, this will result in increasing revenues for the start-up and company growth.

While numerous studies found evidence for the relation between growth performance and strategy clear methods and strategy formulation tools for NTBF managers are lacking. The main objective of this research is to offer guidance in formulating growth strategies for NTBFs, while considering their specific characteristics and environment. In doing this, the research attempts to make several contributions to technology entrepreneurship literature. Firstly, it identifies internal and external variables that influence strategy making for NTBFs. Secondly, it identifies strategies and tactics that are applicable for NTBFs in specific situations and environments. Thirdly, it builds a conceptual framework that can be used by NTBFs to formulate their growth strategy. The research was built around three strategy management theories: Transaction Cost Economics, the Resource-Based View and Contingency. Accordingly, the research investigates and reveals some theoretical implications for using these theories for NTBFs specifically.

1.2 SIGNIFICANCE AND AIM OF THE STUDY

KNOWLEDGE GAP

Numerous studies on new venture growth have considered the importance of a venture's strategy and strategic planning for its growth performance (Berry, 1998; Eisenhardt & Schoonhoven, 1990; Robert Baum, Locke, & Smith, 2001; Song et al., 2008; O. E. Williamson, 1989). Yet, the study of new firm growth suffers from an absence of conceptual models that can filter and assimilate diachronic evidence (i.e. on change over time) at the firm level and interpret this in terms of a shared discourse (Garnsey, Stam, Heffernan, & Hugo, 2003). Conceptual models are needed to build on prior work and make connections between related fields of study, e.g. management, strategy, entrepreneurship, innovation and network studies to understand the differences between firms and use these to formulate strategies for NTBFs.

NTBFs, other than (new) firms in general, have some unique characteristics that should be considered when formulating a growth strategy (Feeser; & Willard, 1990). Yet, the available literature on the growth processes of new ventures operating in the high-tech and science-based sectors is still very limited (Bortoluzzi, Tracogna, & Venier, 2014) and consequently, the unique characteristics of NTBFs and their consequences and effects are not widely understood. The limited research mainly identifies factors and determinants that can explain new firm growth, from which its presence is found empirically by executing multiple, often quantitative case studies of established NTBFs. Yet, almost no intrinsic case studies can be found wherein theory is matched with reality to understand the coherence and relations between all different variables and constraints that affect the choice of NTBF growth strategies in complex environments.

Empirical results regarding the success factors for new technology ventures are often controversial and fragmented (Song et al., 2008). Even studies such as the research of Garnsey et al. (2003) that try to integrate findings from attribute studies, find it a very big challenge; different samples and time frames have come up with contradictory or inconclusive results. To gain more understanding of the factors that influence strategic success of NTBFs, it seems logical to not generalize firms, but rather dive into the differences of these new ventures. For this, it is essential to talk with experts and execute in-depth case studies. Synthesizing analyses and interpretations in a conceptual strategy framework allows to emphasise some fundamental aspects and to provide a system view of strategy. In contending that there are one or more distinct strategic solutions for an organization, depending upon its characteristics and external situation, such a strategy framework should be contingent, integrative and general (Cândido, 2001).

The current available strategy formulation frameworks have several shortcomings and cannot easily be used for NTBFs (see Appendix A for an overview of the most important matching strategies tools). In general, strategy formulation models are often considered to be too simplistic, by not considering enough variables that reflect the true nature of the business and the market. Moreover, indicators are often overlooked by only working with two axes. The challenge is to develop a strategy formulation framework that is applicable and useful, yet, also accurate on an abstract level. This strategy framework should consider the independent variables affecting

the choice of the strategy, as well as the mediating variables affecting the success of the strategy since these have a feedback relation with the choice of strategy.

THE CASE COMPANY: QLAYERS B.V.

The author's firm offers a perfect case for this research, where an in-depth case study enables to get more real-life insights of a NTBF that is in the middle of its survival stage of growth. Qlayers (the "Case Company") is a NTBF with an international approach that wants to bring nature-inspired innovation in functional coatings from lab to market. Qlayers develops a proprietary coating head that can apply functional sharkskin coatings to reduce the drag of a wind turbine, airplane, ship and other vehicles. In this way, efficiency and speed can be improved and fuel consumption can be reduced. A first partnership has been settled with a large company wherein Qlayers develops an automated printing head for this partner that can be used to coat oil storage tanks. The developed automated coating process will make the conventional process cleaner, more efficient and highly controlled. While coating oil storage tanks does not really fit the vision of the company, the partnership will enable to generate a significant amount of revenues in a short time. In this way, Qlayers can invest these revenues in its own firm growth to realise its vision: to apply functionality to large surfaces, next to colour and protection.

Qlayers is at a critical stage. Several validated market segments (maritime industry, aircraft industry, wind turbine industry) show interest in the start-up's technology. However, nobody wants to be the first: the risk for investment is still too high due to the significant capital needed, the uncertain payback period and the level of reliability. Together with the conservative attitude of industrial companies in these market segments, this makes it hard for Qlayers to obtain high growth in a short time. Moreover, several investors showed their interest in the Case Company, which makes it even more critical to decide on a growth strategy for the company. Decisions have to be made regarding the tactics to be executed to launch the technology and enter the market successfully.

1.3 RESEARCH QUESTIONS

The purpose of this study is to understand how strategy management works for NTBFs and to find relationships and clusters of variable impact factors, enabling to reduce the complexity for NTBFs in selecting their growth strategy. The aim is to adjust theoretical knowledge for practical problems. Accordingly, the main research question in this study is as follows:

HOW TO SELECT A GROWTH STRATEGY FOR A NEW TECHNOLOGY-BASED FIRM?

The outcome of this research will be a conceptual strategy framework that can help NTBFs with formulating their growth strategies. Four related sub-questions can be distinguished in this primary research question. These questions, including their explanation, approach and outcomes are explained in Table 1.

TABLE 1: RESEARCH FRAMEWORK FOR THE ANALYSIS PART, INCLUDING THE USED APPROACH AND THE OUTCOME PER RESEARCH QUESTION

Research Question	Explanation	Approach	Outcome
<i>“What kind of strategy options are feasible for new technology-based firms?”</i>	NTBFs have some specific characteristics that need to be considered when thinking about strategy selection, decisions and action.	Literature review from four different viewpoints: contingency theory, strategy management, transaction cost economics, resource-based theory. Thematic comparison of 10 interviews with NTBF founders and 6 advisory reports.	Overview of different strategies for NTBFs, including strategic tactics that enable the implementation of the strategies.
<i>“Which variable concepts should be considered while selecting a growth strategy for a new technology-based firm? ”</i>	Variable concepts are internal and external variables that influence strategy making and the decision criteria used to make a match between strategy and tactics and the specific environment in which a NTBF operates.	Categorization of variables based on literature review, interviews and advisory reports. Identification concepts and their values. Showing suitable combinations of variables by defining clusters.	Conceptual framework that shows relations between variable concepts and their characteristics that influence strategy formulation.
<i>“What fit can be made between the strategy options and the influencing variables?”</i>	A match is made between feasible strategy options and strategic tactics for NTBFs and the internal and external variables that influence strategy making.	Semi-structured data collecting and logical reasoning and interpretation.	Logical combinations between variables, strategies and tactics.
<i>“Which strategic alternatives can be identified for the case company regarding this fit?”</i>	A strategy advice is given for the Case Company based on the internal and external environment of the firm and its current maintained decision criteria.	Descriptive, in-depth case study using deep knowledge of company and environment. Identify the external and internal variables for the Case Company by using the conceptual framework.	Comparison of conceptual framework with currently used strategy in Case Company.

1.4 RESEARCH METHODOLOGY AND LIMITATIONS OF STUDY

This research uses a qualitative research approach, which fits with the aimed contributions: expanding existing theory and applying this theory to an in-depth analysis. The research methodology is discussed more extensively in chapter 2.

The research contains both theoretical parts based on secondary data and empirical parts based on primary data. A desk research is executed for the theoretical study. The literature review enables to study the phenomenon from different theoretical viewpoints. Namely from the perspective of strategy, transactions and resources. Bundling these perspectives enables to get a deeper understanding of the phenomenon. The conceptual framework is further build by using validated learning based on rich, deep contextual data. Instead of generalizing statistical associations between variables, in-depth interviews with founders of NTBFs, advisory reports and a descriptive in-depth case study were used to understand and reduce the complexity of the research problem.

Case Company specific qualitative data is collected by analysing documents and using observations and experiences. While the author is one of the co-founders of the NTBF, it will be easy to get all data needed to execute the case study. The author beholds a function of CEO in the Case Company, which results in a deep understanding of the firm and increases the societal and economic value of the research while the generated insights can directly be implemented in the company.

Several limitations of this study can be identified, which are discussed more elaboratively in Paragraph 6.2. Since only one case study is used and the author is an entrepreneur by herself, a chance of bias towards the author's firm is present which would decrease the generalizability. Yet, the question is if generalisation is even possible when selecting growth strategies for NTBFs, while considering all variables (context, geographical, institutional and resources, by naming a few) in real life that impact firm growth. Therefore, this research will consider contingency theory, presuming that the optimal course of action is contingent (dependent) upon the internal and external situation. As stated by Hofer (1975), "unless one is willing to admit the possibility that there exists some strategy or set of strategies which are optimal for all businesses (corporations) no matter what their resources and no matter what environmental circumstances they face - an assumption that is inconsistent with all research studies on business (corporate) strategy conducted to date - any theory of business (corporate) strategy must be a contingency theory". Therefore, the in-depth case study does not serve to predict, but rather serves to understand the phenomena of NTBF growth strategies better. In this way, it is essential that this research will be perceived and used as a start of more elaborated qualitative or even quantitative case study research in the future, aiming to establish statistical associations between the variables and constraints that are highlighted in this research.

Another limitation is the use of a conceptual framework analysis to normalize all data found in the literature review. Different researchers may have different conceptions of the same phenomenon and may create different conceptual frameworks. Yet, the use of a conceptual framework has some important advantages as well. For example, it is based on flexible conceptual terms rather than rigid theoretical variables and causal relations and aims to help to understand phenomena rather than to predict them. Also, it enables to develop theory prior to the collection of case study data, which can be considered as an essential step in doing case studies (Yin, 2009). Moreover, the conceptual framework is optimized by using an iterative approach and validated learning based on 10 interviews with founders of NTBFs.

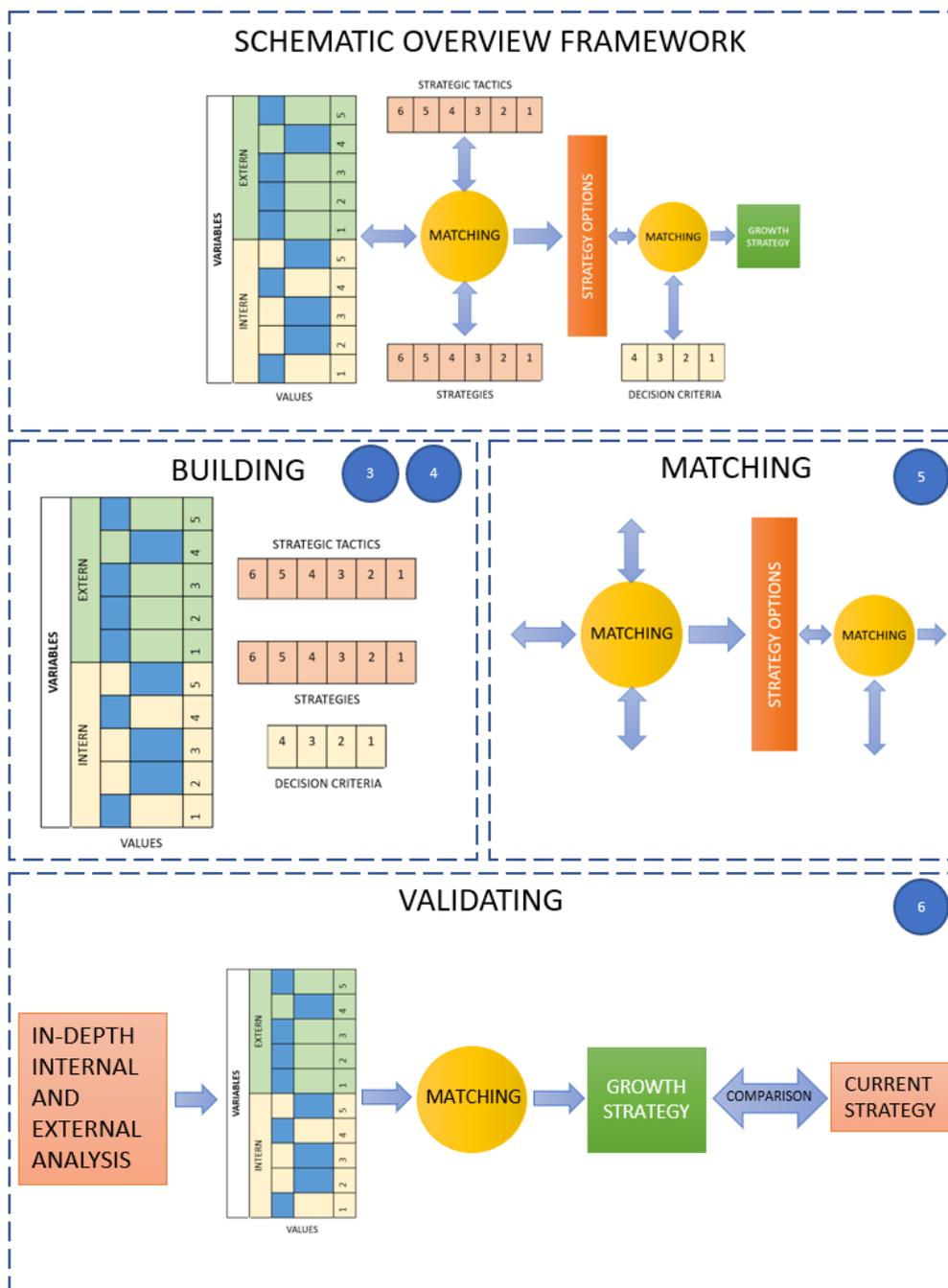
1.5 RESEARCH ORGANIZATION

The main outcome of this research will be a conceptual framework that helps to formulate growth strategies while considering all variables and constraints that influence successful strategy making. Chapter 1-2 serve to introduce the research. Chapter 1 formulates the research problem and Chapter 2 discusses the methodology of the research. Chapter 3-6 serve as the analyses and results part in which the research questions as displayed in Table 1 are answered. Chapter 7 concludes with a critical discussion of the overall research, the main research findings, a research agenda and some concluding remarks.

The analysis part of this research serves to fill in and validate the theoretical strategy formulation framework, from which a schematic overview is shown in Figure 1. An iterative qualitative research methodology was used to gather insights and learning to allow the conceptual framework to be developed by repeated interfaces. Each round of research showcased a "new and improved" version of the framework. The final framework and its explanation can be found in Paragraph 4.6: Framework. As shown in Figure 1, Chapter 3 and 4 (in figure: BUILDING) serve to identify and fill in all the building blocks of the framework. These are

mainly dependent, independent and intervening concepts that are positioned in different ways: as internal and external variables, as strategies and tactics or as decision criteria. Chapter 5 (in figure: MATCHING) matches strategies with internal and external variables to enable strategy formulation. Chapter 6 (in figure: VALIDATING) validates the framework by executing an in-depth case study of a NTBF. A comparison is made between the advised strategy and the current maintained strategy by the NTBF.

FIGURE 1: SCHEMATIC OVERVIEW OF THE CONCEPTUAL FRAMEWORK THAT IS FILLED IN THREE STEPS: BUILDING (CHAPTER 3 AND 4), MATCHING (CHAPTER 5) AND VALIDATING (CHAPTER 6)



2. RESEARCH METHODOLOGY

The research methodology for this research followed the procedure that is suggested by Yin (2009): plan, design, prepare, collect, analyse and share. There was a repetitive interplay between the collection and analysis phase, which can be described as an inductive-iterative process (Bryman, 2012). During the collection of data, preliminary analyses were made under which new data was gathered (Van IJzendoorn, 1988). The chosen research methods and techniques per research part are described in the sections below, including the rationale behind the chosen research approach. Additionally, the exploited data collection and analysis methods are characterized.

2.1 STRATEGY, TRANSACTIONS AND RESOURCES

The literature research enables to understand NTBF growth strategies from the perspective of strategy, contingency, transactions and resources. The argumentation to bundle these perspectives is discussed below.

CONTINGENCY STRATEGY

A growth strategy is a strategic decision of major importance (Song et al., 2008). Since the early 1980s, Michael Porter's strategic typology has been one of the most widely accepted methods of discussing, categorizing, and selecting company strategies (Akan, Allen, Helms, & Spralls, 2006). Porter's novel idea that strategies can be classified into generic types (differentiation, cost leadership, focus or combination) has been the basis for much of the strategy research and practice in the past quarter century. However, previous research has not identified tactics associated with each of the generic strategies, hindering manager's attempt to implement these generic strategies (Akan et al., 2006). For this reason, this research considers strategic tactics that can be used to implement generic strategies at the operational level. The strategic tactics are assumed to answering the "how" questions, such as: "How should the company implement the strategy? How to design the partnerships? How to enter the market?" Strategic tactics utilize specific resources to achieve sub-goals that support the defined growth strategy.

This research assumes that the objective of strategy formulation in NTBFs is to achieve company growth. Consequently, existing literature and previous research is reviewed and described to identify and list growth factors and barriers that have a significant impact on the strategy options for NTBFs. It should be stated that the list of growth drivers and barriers will have shortcomings, due to the many variables (context, geographical, institutional environment) in real life that impact start-up firm growth. These variables are changing in time, for which contingency theory is discussed. Contingency theory claims that the optimal course of action is contingent upon the internal and external situation, which serves as the common thread running through this research. While contingency theory forms the overarching theme, transactions and resources are used to define the building blocks of the conceptual framework that is designed in this research. Accordingly, transaction and resource choices are built on internal and external contingencies.

TRANSACTIONS AND RESOURCES

This research assumes that the growth of NTBFs can be explained from two perspectives that have to complement each other. First, the organization-specific resources of the NTBF of the firm should be considered, as proposed by Penrose (1959). Second, the start-up should be able to make a perfect fit between its own resources and position and the characteristics of the business environment in which they operate. This includes building its external network with potential partners, customers and investors and other important parties. To summarise, any theory of the firm should explain how internal causes of agency interact with external causes in the form of conditions of technology, markets and institutions (Nooteboom, 2009). Both Resource-Based View (RBV) as Transaction Cost Economics (TCE) theory consider internal and external characteristics in explaining firm growth and are therefore often used to explain phenomena in strategy management.

The famous TCE theory, as established and expanded in the work of two Nobel prize winners Ronald Coase (1937) and Oliver Williamson (1975) can be considered as one of the most established theories to address the fundamental question of creating value through growth by governing complex contractual relationships. Within the field of new institutional economics, TCE is considered to be one of the most prominent contemporary approaches (Rindfleisch, Heide, & Vol, 1997). Few issues of top journals such as the *Academy of Management Review*, *Academy of Management Journal*, and *Strategic Management Journal* are published without at least one paper mentioning transaction cost logic in one way or another. TCE theory assumes that as the firm and the entrepreneur gain advantages in governing additional transactions, firms will grow and incorporate additional activity.

Strategic Management is dominated by one particular theory, namely the Resource-Based View. Over 100 articles are published from this perspective each year (Rouse & Daellenbach, 2002). RBV theory was found based on the evidence of differential performance between firms in a same industry (Rumelt, 1991), showing the need to look at the inner workings of a firm. Edith Penrose (1959) is one of the first to dare look inside the firm and open the so-called “black box”. Whereas, neoclassical economics portrayed the firm as a production function, she stressed the importance of looking at the ingredients of the box. Her definition of the firm as following: “a firm is a collection of resources, each of which is a “bundle of potential productive resources, bounded together in an administrative framework”.

Various scholars suggested explanatory value could be increased if TCE and RBV theory would be integrated with one another (Duursema, 2007). Even the “operationalising” father of transaction cost theory, Oliver Williamson (1999) is convinced that “both transaction cost economics and the resource-based view are needed in our efforts to understand complex economic phenomena as we build towards a science of organization”. Yet, to the scope and resource constraints (both time and expertise) of this research, no attempt is made for theoretical integration or synthesis of the theories. Rather, the theories will be used complementary to understand the complex socio-technical problem of selecting growth strategies for NTBFs from different perspectives. Accordingly, the theories are combined in such a way as to enhance the qualities of each other. RBV theory can be used to define valuable resources that should be kept within the firm, where these resources are based on internal and external heterogenic variables and should change in time. The make-or-buy decision depends on

these resources and the costs of insourcing and outsourcing activities, which can be defined by using TCE theory.

2.2 WHY A SINGLE CASE?

A case study approach was used to validate the conceptual framework and to get a better understanding of the difference between normative theory and a real case. In this research, a single case study is chosen where it is assumed that this will be more valuable in extending the current theory than a quantitative case study.

ARGUMENTATION

The case study is a research strategy which focuses on understanding the dynamics present within single settings (Eisenhardt, 1989). Quantitative multivariate methods have the advantage of allowing researchers to measure and control variables, but have the disadvantage that the resulting theory often fails to take account of the unique characteristics of individual cases (Edwards, 1998). This research tries to minimise any specific generalisation where it is assumed that generalisation in NTBF growth strategies has significant shortcomings where too many variables interact. The art is within the clustering of variables, where these clusters are matched with a specific, optimal growth strategy on an abstract level. In this way, observations from a particular context are not over-specified and generalised but are abstracted in a way so to enable understanding rather than prediction. This aligns with the notion of Edwards (1998), which states that the “ultimate task of science should not be to map to a vast matrix of variables from which predictions can be derived”.

An analogy can be made between human behaviour and corporate strategy making. Where strategic choices are decisions that a company makes rather than an individual, the experience and outcome of these choices varies widely due to the characteristics of the company, its team, technology and location, as well as its environment when it comes to the market, industry and relevant institutions. Just like it's hard to predict the most optimal decisions for individuals, it's as hard to predict the most optimal growth strategies for companies. As an example, many researchers try to explain factors that influence managerial decision-making (Stephens-Warren, Howat, & Hume, 2011; Zavadskas, Turskis, Vilutienė, & Lepkova, 2017). However, research just doesn't seem to get a full understanding of the generalised, normative success formula for managerial decisions where these are made in complex and fragile contexts and are highly influenced by the personal characteristics and the usage of biases and heuristics of the manager. The same counts for company growth strategies. In any given industry, a broad set of firms begin their lives with a wide variety of strategic choices (Gavetti, Levinthal, & Rivkin, 2005). Each firm's decisions and its routines are gradually perturbed in ways that enhance immediate performance, in a process that behavioural theorists of the firm (Cyert R, 1963) and evolutionary scholars (Nelson R., 1982) depict as largely automatic, experiential, and emergent (Mintzberg, 1978). A few fortunate firms happen upon highly effective sets of choices and survive an ensuing shakeout. The question that this research tries to answer is how to select optimal growth strategies, which is even more challenging in the current times of change and unfamiliar environments (Gavetti et al., 2005).

In research areas such as (clinical) psychology, it has already been recognised that the group-based research process fails to contribute the kind of knowledge base that is of direct application (Edwards, 1998). Yet, in literature regarding growth strategies for NTBFs of general small firms, the majority of research is empirical, using statistical research methods to find generalised growth factors and barriers (Bertoni, Colombo, & Grilli, 2011; Colombo & Grilli, 2005; Croce, Martí, & Murtinu, 2013; Grilli & Murtinu, 2014; Huynh & Patton, 2006; Kazanjian & Drazin, 1990; Unger, Rauch, Frese, & Rosenbusch, 2011; Yli-Renko, H., Autio, E., & Tontti, 2002). Therefore, this case study will add to the current research by executing one in-depth case study which allows to validate the conceptual framework designed by reflecting on a real-life case.

DESIGN

For the execution of the case study, the framework described by Eisenhardt (1989) is used, following several steps with their accompanying activities that enable to build theory from the case study. First, a case was selected. In doing so, attention was paid to make sure the case is most likely to replicate or extend the emergent theory. The design of the case study research follows the general stages of a formal strategy formulation process: gathering information needed to formulate strategies (input stage), generating feasible alternative strategies by aligning key external and internal factors (matching stage) and evaluating feasible alternative strategies (decision stage). Finally, the feasible strategies were compared with the currently used strategy in the Case Company and the “why” is searched behind relationships and differences between the findings. The comparison allows to confirm, extend and sharpen the conceptual framework.

2.3 DATA COLLECTION

In this research, an indeterministic conceptual strategy framework was proposed that can help with strategic decisions in NTBFs when aiming high firm growth. The input of the conceptual framework was multidisciplinary, which enabled holistic mapping and complete data collection to ensure validity. Moreover, to enlarge the quality of the obtained quality data, several external data sources were used.

LITERATURE REVIEW

A systematic review research methodology was used in this research. A systematic review is defined as “a specific methodology that locates existing studies, selects and evaluates contributions, analyses and synthesizes data, and reports the evidence in such a way that allows reasonably clear conclusions to be reached about what is and is not known” (Denyer 2009). To find relevant articles for this study, literature was searched via the scientific search engine Google Scholar. Keywords and acronyms were defined per topic. These topics were: *growth drivers* and *growth barriers*, *strategy management*, *contingency*, *transaction cost economics* and *resource-based view*. After having a general understanding of the topics, more in-depth information was sought by extending the search formulation with “for/in *new technology-based firms*” along with synonyms (e.g. *new high-technology ventures*, *high-tech start-ups*) and abbreviations. The searches were conducted between February-July 2018. Several inclusion and exclusion criteria were defined in order to focus on relevant and important papers. As example, the papers reviewed all had at least one of the following words in their keywords

(or derived words, such as strategy versus strategies): *growth, strategy, management, transaction cost, resource, high-technology*. Papers were mostly selected on the amount of citations. Backward and forward snowballing was used to identify additional papers by using the reference list and the citations of a paper. Information was extracted from the collection of these papers, from which the methodology is described in section 2.4.

INTERVIEWS

In-depth interviews with founders of NTBFs were used to review the object of study from different perspectives. To eliminate the bias of “group thinking” a face-to-face setting was used instead of focus groups, enabling free expression and brainstorming. The objectives of the interviews were: (1) to review, validate and improve the conceptual framework, (2) to find logical combinations of variables, (3) to match these with strategy options and (4) to evaluate how the conceptual framework’s constructs can be used. In this way, the interviews were used in a co-creating way.

Interviewees were selected based on their special knowledge and experience which is related to their professions and conscious practical and action knowledge (Bogner, Littig, & Menz, 2009). 10 interviews were executed with founders of NTBFs that managed the firm for at least 2 years. Data was collected in a semi-structured way based on the objectives of the interviews. The total interview design is discussed elaborately in Appendix B. The interviews were based on general topics and themes but avoided closed questions and a prefixed guideline. Accordingly, the interviewees were not “framed” and came up with topics themselves. General themes were: (1) the starting point of the firm with relation to the core technology, (2) the trial-and-error process of strategy adaptations along the way including all variables that cause these adaptations and (3) the current strategy. Interviews were being taped, enabling transcription of thematically relevant passages. Summaries were sent to the interviewees and permission was asked to use quotes and paraphrases. All names and entities were anonymised, referring to “new technology based-firm X” (X is a number between 1 and 10). The total data analysis of the interviews can be found in Appendix C.

ADVISORY REPORTS

In addition to interviews and literature, another data collection method was used. Since the interviews and literature are subject to the biased view of the author, the opinions of 25 groups of four students of the master’s programme *Management of Technology* of the Delft University of Technology were reviewed. This was done in collaboration with Dr. R. Ortt, Associate Professor at the TU Delft. The students were asked to write an advisory report for the Case Company wherein they were asked to answer the following main question: “What do you advise the company as the strategy to enter the market?”. Sub-questions to be considered were: “What do you see as drivers and barriers to deal with? What do you consider alternative strategies? Which product-market combination would you advise to start with? Which organizational setting or partners would you advise to pursue? How should the company implement your strategy?”. The reports were reviewed by Dr. Ortt. The ones with a higher grade than 8/10 were analysed for this research (see Appendix C for the elaborated analysis of the advisory reports). Since the students wrote their reports based on limited information (website and a short presentation) about the Case Company, it’s assumed that their advice is generally applicable to all NTBFs. In

total, 6 reports gave input on the conceptual framework and the case study and are referred to as “REPORTX” (X is a number between 1 and 6).

CASE STUDY

For the data collection, a formal strategy formulation process for the Case Company was executed by using the conceptual framework. Internal and external values were chosen based on a resources analysis and a competitive analysis. For the data input, the archives of the Case Company were analysed, and personal observations and reasoning were considered.

2.4 DATA ANALYSIS

The literature review, summaries of the interviews and the advisory reports were read and reread to identify relevant concepts. These concepts were coded and validated.

CODING

The literature review, summaries of the interviews and the advisory reports were read and reread to identify relevant concepts. Coding was used to analyse the interviews and advisory reports. Coding is the process of labelling data and grouping related data together (Coffey & Atkinson, 1996). An open coding process was done in NVIVO 12 software, which simplified the coding and analysis process. In NVIO 12, a so called “node scheme” was made, starting with five nodes: (1) challenges, (2) decision-making criteria, (3) strategic tactics, (4) strategies and (5) variables that influence strategy making. When reading all data material, the coding structure got more hierarchic, adding nodes along the way. Important paragraphs and sentences were coded and dragged towards a node. New nodes and hierarchies were created when sentences did not fit the current nodes. The final coding book and data analysis can be found in Appendix C.

VALIDATION OF CONCEPTS

This research clearly distinguished validation from verification. Concept validation was used to qualitatively validate the relevance of concepts in specific situations. It does not say anything about the actual importance of these concepts nor about their effect. This open conceptualisation process fits the objectives of this research, where specificity and prediction are avoided and lists of concepts are assumed to be never complete. When certain themes or concepts were identified, a new literature search was executed to validate this specific theme. As an example, when a paper stated that “founder’s business management expertise and general technological expertise positively affected new high-technology venture survival, but founder’s academic status did not” (Gimmon & Levie, 2010), a new search formulation was used to validate the effect of the founding team and it’s characteristics on firm survival and growth. Accordingly, a new search formulation would be: “founding team as growth driver of NTBFs”. When this search formulation resulted in a relevant paper, the objective for reading this paper was written down to make sure that the paper was read purposefully. Also, additional considerations, control variables and questions were written down. In this case, one question would be: “what is the difference between NTBF survival and growth?”

3. LITERATURE REVIEW

The total literature review serves as a blueprint for the data and analysis part of this study. Firstly, contingency theory is discussed while forming the common thread and overarching theme in this research. Secondly, strategy management literature is reviewed including success factors (growth drivers), constraints (growth barriers), strategies and tactics for NTBFs. Thirdly, the phenomenon is approached from the perspective of transaction cost economics (TCE) theory and resource-based view (RBV) theory. The chapter ends with a paragraph that discusses the complementary use of TCE and RBV theory.

3.1 CONTINGENCY

This paragraph provides a fundamental understanding of contingency theory, together with its implications and usefulness for decision making and strategy making.

THEORY

Contingency theory claims that there is no best way to lead a company or to make decisions, but the optimal course of action is contingent upon the internal and external situation. The appropriate form of organizing depends on the kind of task or environment one is dealing with (Morgan, 2007). Some researchers state that any theory of business (corporate) strategy must be a contingency theory (Hofer, 1975). For a proposition or “law of interaction” to hold, assumptions must be made about starting premises, boundaries and systems states (Drazin & Van de Ven, 1985; Dubin, 1976). In short, organizations are heterogeneous and face different contingencies. Accordingly, they require different ways of managing.

In contingency theory, a well-known analogy is made between managerial selection perspectives and natural selection. Where natural selection is based on an adaptable evolutionary process, managerial selection is based on an adaptable strategy making process. Both are based on a *fit* between the object of study and its environment, where the environment is subject to *change*. Accordingly, all organizational contingency models share in common an underlying premise that context and structure must somehow fit together if the organization is to perform well (Drazin & Van de Ven, 1985). However, the way this *fit* is defined varies widely among different contingency theory definitions and perspectives. Many definitions are based on single contextual factors that affect single structural characteristics. An example is the fit between organizational levels and their contexts. Where macro-levels are more general, they cannot take into account all influencing contextual factors at micro-levels. Switching rules function as guidelines for managers, enabling them to adjust structures at micro-level to new contingencies. Only the variables that are not prescribed at the macro-level should interact with the context to explain variations in performance (Drazin & Van de Ven, 1985). These type of definitions are based on reductionism, a theory that is highly challenged by holism and systems theory.

The systems definition of contingency theory asserts that context-structure performance relationships can only be understood by addressing simultaneously the many contingencies, structural alternatives, and performance criteria that must be considered holistically to understand organization design (Drazin & Van de

Ven, 1985). In summary, the systems approach maintains that two basic choices confront the organizational designer: (1) to *select* the organizational pattern of structure and process that matches the set of contingencies facing the firm, and (2) to *develop* structures and processes that are internally consistent.

INTERNAL AND EXTERNAL

Contingency theory is built around contingencies, which can be internal and external. Formula wise, this would result in a relation between y and x , wherein y is dependent on independent variables x . The x values are the contingency factors, because they influence a firm's performance, strengths and weaknesses (internal) and opportunities and threats (external). Contingency theory asserts that firm's internal resources and capabilities must be aligned with the external environment to improve firm performance (Gresov, 1989). This "fit with the environment" perspective has been emphasized in strategy research (Das & Joshi, 2012), which has also argued that the external environment affects the links between organizational variables and organizational outcomes (Miller, 1988). Environmental hostility is generally interpreted as having unfavourable external conditions for a firm that may be caused by intense competition, industry structure, governmental regulations, limited resources, or a relative lack of exploitable opportunities, all of which are stressful to the organization (Calantone, Garcia, & Droge, 2003). In contrast, benign environments have high levels of munificence, low risk, and are rich in investment and market opportunities (Covin & Slevin, 1989). Only when the organizational competencies are aligned with the environmental conditions, is there a possibility that the firms gain a competitive advantage (Teece, Pisano, & Shuen, 1997).

IMPLICATIONS FOR STRATEGY MAKING

Several implications can be derived from contingency theory for NTBFs strategy making. According to contingency theory, the performance of an organization depends on the fit made between an organization and contingency variables that require different ways of management. The right fit depends on *if* statements in combination with a strategy or tactic that can deal with this contextual factor. As an example, *if* there is strong competition and a high degree of technological change, decisions about new products and marketing strategies have to be changed frequently and be taken close to the market. Consequently, this situation does not fit a formal structure with a high degree of centralisation. When a right fit is found, this can lead to *changes* or *adaptations* in the strategy, structures and processes of the organization. While NTBFs are small companies, it does not really make sense to differ between macro- and micro-level. In addition, while NTBFs operate in dynamic business environments their strategies need to be dynamic and adaptable too. Accordingly, it seems that strategy making for NTBFs should be dynamic and adaptable to its environment and contingency variables at all times.

IMPLICATIONS FOR DECISION MAKING

The fact that NTBFs are operating in high-velocity environments demands significant speed of strategic choices (Montiel Campos et al., 2015). In the survival stage, the speed of the decision-making process helps to innovate and adapt to the environment (Aspelund, Berg-Utby, & Skjevda, 2005). According to contingency theory, strategy is based on a fit between the organization and its contingency variables. This means that strategy *decisions* are subject to these variables, where these variables can serve as constraints and limit the strategy

options. Accordingly, strategic choices are limited by their environment. In addition, managerial decision making is subject to the personal interpretations of the environment. Cognition in complex worlds inevitably involves simplification (Gavetti et al., 2005). As an example, reasoning by analogy is a cognitive bias that involves the use of simple analogies to make sense out of complex environments. Another cognitive bias is representativeness or anchoring, which is rooted in the tendency to generalize from a small sample or even a single vivid anecdote (Hill & Jones, 2011). The study of Busenitz & Barney (1997) explored differences between decision-making of entrepreneurs and managers in large organizations. The study shows that entrepreneurs are more susceptible to the use of biases and heuristics like overconfidence and representativeness. This implicates the importance of managerial decision making for NTBFs choice of growth strategy, while the alignment of internal and external contingencies with the organisation is subject to personal interpretations of the decision makers.

3.2 FIRM GROWTH, BARRIERS AND DRIVERS

A significant amount of different types of contingencies (contextual variables) can be found in literature. To identify these variables for NTBFs specifically, growth drivers and barriers are reviewed.

3.2.1 FIRM GROWTH

Firm growth is basically a proportionate change in some firm-level variable (Cressy, 2006), e.g. a positive change in cash flow profits. Firm growth brings significant benefits to a firm (Balboni et al., 2014), such as increased market power, reputation and investment capacity. Different metrics for growth can be found in literature, where each of these measures is subject to limitations as a growth indicator (Garnsey et al., 2003). In this research, high (or explosive) firm growth is defined as having an average of 20% or more annual growth in the number of individuals employed (input) and in the assets (value) and 20% or more annual revenue growth (output). Moreover, this research considers high potential NTBFs: sales average should be more than €300.000 three years after formation (Roure & Keeley, 1990).

Apart from firm growth, it's important to consider the stage of development of the technology – also called, technology readiness. Numerous models of technology development stages can be found in literature, where all of them are based on the following phases: research, development, demonstration, deployment and improvement. NTBFs usually undergo a research and development phase, in which they develop their technologies further before commercialising them (Autio, 1994). Often, the development of a technical innovation is an iterative and complex process. A generally accepted method to estimate technology maturity is the Technology Readiness Level (TRL) method. The TRL method uses 9 values of technology readiness, going from basic technology research (level 1) to launch and operations (level 9). Regarding the final evolution stage, the predominant view is that NTBFs achieve full vertical downstream integration as successful products are developed, manufactured and marketed (Kollmer & Dowling, 2004).

Different companies in different environments will have different growth “paths”. A study of Garnsey et al. (2003) showed that dynamic processes in the early development of young firms result in variations in the timing, magnitude, duration and rate of change of growth as between firms and in the same firm over time. The

developmental model that they propose explains why growth in the new firm is non-linear, prone to interruptions, amplifying forces and setbacks. To find optimal growth strategies that result in a continuous, healthy growth path, it is essential to identify common growth barriers and challenges, while overcoming these barriers will most likely result in firm growth. Accordingly, Kazanjian & Drazin (1990) state that “growth depends on the ability of the venture’s managers to create a fit between the design of the organization (its structure and process) and the problems associated with its stage of growth”, where each stage of growth asks for different strategies.

3.2.2 GROWTH DRIVERS

According to the available literature, growth drivers for NTBFs can be simplified by subdividing them under the following categories: founding team, funding, value proposition, alliances, market and organizational structure. Below, these categories are further explained.

FOUNDING TEAM

New firm’s competitiveness and growth depends on the founding team’s capacity to acquire resources (Jones, Lanctot, & Teege, 2001) and to configure them in a value creating fashion (Barney, 1991; Teece, Pisano, & Shuen, 1997; Brinckmann, Salomo, 2011). The characteristics of the founding team are often important criterion when assessing NTBFs and their performance. Accordingly, the research of Roure & Keeley (1990) found that the completeness of the founding team is an important measure for the successfulness of new technology based ventures. In short, there are three types of human capital: an individual’s education, experiences and skills that help in the tasks of getting one’s work done. A research of Unger et al. (2011) found that the effect of the human capital is larger when its task related (knowledge, skills) rather than education/experience related. In addition, the results of a longitudinal study of NTBFs on the influence of initial resources on new venture survival by Aspelund, Berg-Utby, & Skjvedal (2005) emphasises the importance of the heterogeneity in the functional experience of the founding team. While many investors look at the professional experience of the founding team, no statistically significant benefits were found in literature when it comes to the effect of the professional experience on firm survival.

FUNDING

The study of (Becchetti & Trovato, 2002) shows that financial constraints and access to foreign markets have a significant impact on growth for small and medium sized firms. The entrepreneurship literature generally agrees that the human capital of founders and access to venture capital (VC) are two key drivers of the success of NTBFs (Colombo & Grilli, 2010). VC is reputed to be the most tailored financing mode for the growth of high-tech entrepreneurial firms, as recognized by academics (Gompers & Lerner, 2001) and (European) policymakers (European Council, 2008). Getting VC in an early stage without all required human resources means taking a high risk but can claim the market in an emerging environment (Clarysse, Degroof, & Heirman, 2001). The roles of VC can be subdivided into three types of support: the funding itself, management coaching and network sharing (Croce et al., 2013). Some researchers claim that the positive impact of VC on firm growth is not because

of the value-adding services by the venture capitalists, but because of the “screening” process (Colombo & Grilli, 2010): the best prospect NTBFs are getting the venture capital. However, the available empirical evidence points steadily toward a positive impact of venture capital on firm growth (Bertoni et al., 2011; Croce et al., 2013). Surprisingly, governmental venture capital (GVC) investors are not found to exert any sizeable effect on firm growth, either in the magnitude or in statistical significance, regardless of the growth measure employed (Grilli & Murtinu, 2014).

While a lot of research can be found about VC backed firms, a significant amount of NTBFs prefer to grow organically. These NTBFs often use their own equity (of the founders) and government subsidies to grow their company. A research of Colombo & Grilli (2010) found that VC-backed firms mostly rely on the “coach” function performed by the venture capitalist, while non-VC backed firms mostly rely on their own human capital: the founders’ skills and capabilities. Firms with greater internal resources are less inclined to source externally (Jones, Lanctot, & Teegen, 2001).

VALUE PROPOSITION

A sound technological base, a broad product variety and structured co-specialised assets are variables strongly correlated to start-up probability to survive and grow (Marco S. Giarratana, 2004). Innovation is the key to open new market niches, avoid entry barriers and discover new potential customers. The study of Aspelund et al. (2005) states that a technology with a degree of radicalness is prone to reduce the likelihood of firm failure. The study of Roure & Keeley (1990) shows that product superiority is a good predictor of success.¹ Patents are very important tools to defend firm knowledge assets (Baron & Hannan, 2002). Patents can help to build a market for technology that is essential in shaping competitive outcomes.

Related to technological superiority is the question of how much time to spend on product development. A major contributor to a company's competitive advantage is the speed at which it is able to bring the next technological generation to market (Beard & Easingwood, 1996). NTBFs are dependent on reaching their technological milestones and developing their product or service to be able to enter the market; an extension of the development period might therefore lead to negative consequences (Pinkwart et al., 2015). Given the emphasis on urgency, a short development time seems desirable; however, this may be overdone. If the development time is very short, the product may be easily imitated. Accordingly, the research of Roure & Keeley (1990) found an inverted U-shape relationship between development time and the success of a venture, where the optimum development time is 12 months.

Another aspect that is important while discussing the value proposition is the degree of service orientation. The study of Aspelund et al. (2005) found that NTBFs with a high degree of service orientation seem to have a greater probability of survival than product oriented firms. The study distanced between four groups ranging from: (1) product-oriented manufacturers, and (2) service-oriented manufacturers, to (3) physical service providers, and (4) digital service providers. The first group refers to new ventures emphasizing

¹ Product superiority is a judgmental measure. Therefore, when measuring this growth driver it’s important to measure it together with other non-judgmental measures that support it (Roure & Keely, 1990)

the product they intend to produce, whereas the second group refers to those ventures relying more on the value adding services they add to the product. The third group refers to ventures focusing on offering service wherein there is physical contact with the customer. The fourth group includes ventures offering services where digitalized information is the core product.

MARKET

A market has different characteristics. It can be established/new, reliable/risky and fast-changing/conservative. These are all dynamic factors that influence the growth of NTBFs. NTBFs, particularly those that develop their business around a new technological platform, are likely to be impacted by globalisation, in terms of both pace of innovation and pressure of competition (Onetti, Zucchella, Jones, & McDougall-Covin, 2012). The business strategy should be modified in response to changing conditions in the market. According to the study of Beard (1996), successful new technology ventures are inclined to be small, highly focused and flexible. In addition, Roure & Keeley (1990) found that the optimum buyer concentration for NTBFs is 60 customers.

ALLIANCES

NTBF survival and growth relate to strategic partnering alliances and open innovation within technology clusters (Segers, 2015). The “combination of specialized complementary assets” appears to be a key driver of the formation of alliances by NTBFs (Colombo, Grilli, & Piva, 2006; D. J. Teece, 1986). For commercializing university owned intellectual property, a joint venture with an industrial partner may overcome some of the potential problems associated with managing resource weaknesses and inadequate capabilities (M. Wright, Vohora, & Lockett, 2004). Strategic partnerships allow NTBFs to gain a foothold in high-cost, high-risk industries. In addition, NTBFs typically lack the strategic and operational rigidities that can stifle innovation in established firms (Minshall, 2006). Inter-firm alliances are therefore regarded as one of the most important conditions for the success of NTBFs (Aldeano & Magdaleno, 2007).

These alliances are often driven by the social capital of the NTBF. Social capital is often defined as the sum of resources that a firm (individual, organization) can access or mobilize by virtue of possessing a durable network of relationships (Bourdieu & Wacquant, 1992). Internal and external social capital influence the acquisition and creation of knowledge, and knowledge is a key resource driving the (international) growth of NTBFs. Social capital exploitation improves the development of dynamic capabilities, which in turn increases firm performance (Huynh & Patton, 2006). Moreover, a study of Shan (2016) shows that the propensity to cooperate is positively correlated with the distance of firms' competitive position in relation to their rivals. The research of McEvily & Zaheer (1999) broadly supports the link between firms' networks and the acquisition of competitive capabilities. The research shows that firms in geographical clusters that maintain networks rich in bridging ties and sustain ties to regional institutions are well- positioned to access new information, ideas, and opportunities.

ORGANIZATIONAL STRUCTURE

The research of Kazanjian (1988) indicates that higher performing ventures demonstrate, in general, greater formalisation and functional specialization and less centralisation as the firm progresses through stages. The

internal organizational structure and decision-making processes should match to the stage of growth (Kazanjian, 1988). A venture that adopts structures and processes that are congruent with its stage of growth should grow faster than an organization that does not (holding other growth-related factors such as the viability of the firm's technology and the acceptance of its product in the market constant). In the survival stage, the speed of the decision-making process helps to innovate and adapt to the environment. In this way, smaller teams have an increased probability of survival (Aspelund et al., 2005).

3.2.3 GROWTH BARRIERS

A NTBF must establish a position quickly in the face of high uncertainty (Roure & Keeley, 1990). This involves a series of challenges, in literature often called "growth barriers". Growth barriers can be the current market rules, institutions, the legal and geographical environment in which the company operates and the availability of funding in the market (economy related). Growth barriers can be internal and external (Yli-Renko, H., Autio, E., & Tontti, 2002) and can be different depending on the stages of growth of the NTBF (Kazanjian & Drazin, 1990). Overcoming certain problems or barriers can trigger mechanisms that determine the start of new stages in firm growth (Greiner 1972; Churchill and Lewis 1983; Kazanjian 1983; Kazanjian 1988). In some cases, the barriers serve as constraints and there should be searched for a way to cope with these barriers. The sub-paragraphs below discuss the most important growth barriers for NTBFs.

SCARCE RESOURCES

NTBFs have few resources in terms of organizational features and physical assets in the earliest stages of growth (Aspelund et al., 2005). For NTBFs specifically, different barriers are found regarding the financial resources needed in an early stage (Jones et al., 2001; Roure & Keeley, 1990). While NTBFs are often capital intensive, these firms are highly dependent on access to external (financial) resources for survival and growth (Garnsey, 1998). This has several reasons: the research and development efforts are very intensive, highly skilled labour is needed, production facilities and the sales and distribution systems are expensive. To develop the product, the founder commits limited personal funds, assumes the risk of failure and puts in time and effort (so called 'sweat equity'). It is likely that the founder's personal funds will be exhausted, and some source of outside funding is usually necessary due to the long product lead time (Groen, Cook, & Van der Sijde, 2015).

EXPERIMENT AND RISK

NTBFs differ from the general population of start-ups in that they are characterised by an intensive period of research and development (Kazanjian & Drazin, 1990). Founders bring their knowledge and experience with them into a new firm, and this becomes the firm's initial cognitive base and shapes its initial strategies (Hambrick and Mason, 1984; Shane, 2000). During early phases of development, founders, particularly first-time founders, have little history of how the environment will respond to their actions, and every strategic action can be viewed as an experiment. The technology NTBFs often asks for fundamental transformations of the status-quo, having far-reaching implications for both companies and customers (Meuter, Ostrom, Roundtree, &

Bitner, 2000). In addition, start-up firms typically do not have the time and resources to engage in formal strategic planning processes (Davis & Olson, 2008).

HIGHLY SKILLED PERSONNEL

Another challenge for NTBFs is to attract additional key employees to achieve quick technical progress on the new product, which in practice turns out to be very difficult. Internally, the professional experience and skills of the founding team can serve as a growth barrier, where the social capital is an essential precondition for gaining human capital and funding. The employment strategy often used by NTBFs can be described as an “engineering model”, which involves attachment through challenging work, peer group control, and selection based on specific task abilities (Baron & Hannan, 2002). Employees should be able to solve theoretical as well as practical or experimental problems. The latter is very hard to find, while young engineers often have a solid base of theoretical knowledge, but a lack of practical, hands-on working experience, while more experienced engineers require a very high salary. Ackroyd (1995) found that NTBFs growth is often constrained by skills shortage.

MARKETING

Another aspect of NTBFs that forms a barrier to firm growth is the marketing and business planning (Roure & Keeley, 1990). Previous research has identified marketing and business planning as key areas of weakness within NTBFs where management often tend to over-emphasise the purely technological side of their business and neglect other key strategic issues. A major consequence of technology’s growing role is a commensurate growth in self-service technologies that call for customers to interact with technology-based systems rather than company personnel (Meuter et al., 2000). A market barrier for NTBFs might be that the customers must be educated about the benefits of the technology and that external marketing should include appropriate training of the employees of the customer company to make them ready for technology adoption. Effective marketing of services requires extra emphasis on two additional forms of marketing: internal and interactive (Parasuraman, 2000). For B2B firms that are developing high-tech solutions for other companies, marketing is becoming more knowledge intensive. Therefore, internal marketing plays an increasingly important part in implementing the marketing concept in high-technology companies (Möller, 1999).

3.3 STRATEGIES

NTBFs are different than normal firms, since they are new (scarce resources) and technology-based (resource-intensive). These characteristics need to be considered when thinking about strategy selection, decisions and action. This research assumes that a growth strategy is a combination of a survival (entry) strategy which focuses on the initial capabilities and the strategic mechanisms and tactics used to grow the company by using its capabilities and external opportunities. A NTBF growth strategy includes the corporate strategy, the business strategies per market, technology and product or service and strategic tactics. In the paragraphs below, relevant strategies for NTBFs are discussed, after which strategic tactics are discussed in Paragraph 3.4.

GENERIC

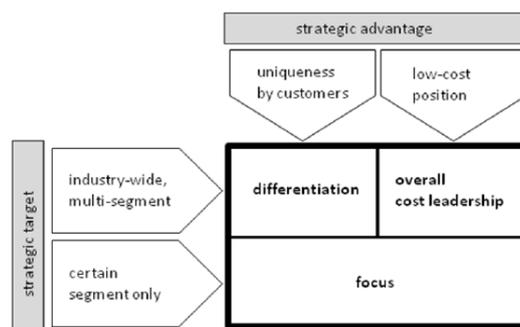
Generally, a corporate strategy defines how an added value is planned to be produced to customers and shareholders (Jarva, 2011). A corporate strategy is different from a business strategy, where a business strategy (or business model) can differ per technology or product. In this way, the corporate strategy is often more generic. Porter (2004) introduces three generic strategies to choose between when making decisions upon main strategies. These are, namely: overall cost leadership, differentiation and market focus (Figure 2). A combination of the type of strategic target (industry-wide or focused segment) and strategic advantage (low-cost or unique market position) results in one of the three generic strategies. The research of Murray (1988) states that Porter's "generic strategies" are not mutually exclusive and that each strategy may be linked to a variety of strategic means that are dependent on the presence of certain external conditions, specifically on industry structures or customer characteristics and preferences. Mintzberg, Ahlstrand, & Lampel (2005) emphasize that a strategy is an engagement between external opportunities and internal strengths, including resources and capabilities. The more urgent and feasible management believes a strategic issue is, the stronger will be the momentum for change in strategy (Dutton & Duncan, 1987; Saemundsson & Candi, 2014).

COMPETITION-ADJUSTED

Competitive advantage is necessary for an organization's long-term success and survival (Coulter, 2013). Competition-adjusted strategies enable to compete in a dynamic business environment, where carefully created strategies lead to competitive advantages (Jarva, 2011). Competition is indicated to be driven by five competitive forces: competitors, buyers, suppliers, substitutes and potential new entrants. Those forces are important for industry and competitor analyses purposes when defining strategies (Porter, 2004). The academic literature recognizes that suppliers of raw materials and/or basic labour have a major influence on a company's competitive strategy (Davis & Olson, 2008).

As also shown in Porter's generic strategies (Figure 2), competitive advantage can be achieved by two perspectives: positioning and resource-based. The former emphasizes the environment as the source of competitive strategies, while the latter emphasizes the resources controlled by a firm (Saemundsson & Candi, 2014). There is a long standing understanding within strategy research and practice of the need to reconcile the two (Andrews, 1971).

FIGURE 2: GENERIC STRATEGIES (PORTER, 1980)



INNOVATION

Innovations occur as a result of the interaction of the marketplace, the science base and the organization's capabilities (Trott, 2008). The level of innovation, both at start-up and during early development, can be expected to affect the likelihood of NTBFs' superior performance and growth (Saemundsson & Candi, 2014). A regime of appropriability refers to the environmental factors, excluding firm and market structure, that govern an innovator's ability to capture the profits generated by an innovation (D. J. Teece, 1986). It is found that mixed teams are more likely to change their innovation strategy in response to the characteristics of the environment (Saemundsson & Candi, 2014). A technology should be innovative enough so to gain a unique market position, yet, should also consider the characteristics of the targeted industry. Exploratory innovation can be used to deliver a unique mix of value and achieve competitive advantage by focusing on new possibilities, experimentation and radical and revolutionary innovations (March, 1991).

According to Abernathy & Utterback (1975), technology evolves through periods of incremental innovation, interrupted by periods of radical innovation. The development of a radical innovation leads to a fluid phase in an industry, during which time many firms enter and compete based on different product designs. When the rate of change in the "state of the art" is rapid, firms should focus their R&D efforts on new product designs and product improvements. When it is slow, they should focus on process improvements (Ansoff & Stewart, 1967; Hofer, 1975). According to Barras (1986), a different model operates in service industries, which he called the "reverse product cycle". We can see that manufacturing industries start with radical innovation and move to incremental innovation, while service industries start with incremental innovation by adopting technology from a goods industry and move to radical innovation.

3.4 STRATEGIC TACTICS

Strategy and tactics go hand in hand in achieving strategic alignment for a company. Especially for NTBFs since they are relatively short-term oriented. While strategy refers to the choice of business model through which the firm competes in the market place, tactics refer to the residual choices open to a firm by virtue of the business model it chooses to employ (Casadesus-Masanell & Ricart, 2010). An essential element of strategy is the set of 'committed choices' (of policies, assets and of their governance structures) made by management in setting the business model up, which often are not easily reversible. Tactical choices - such as prices, the intensity of advertising or of R&D, minor product modifications and so on - on the other hand, are relatively easy to change. The implementation of strategies is basically tactical, where different tactics can be coherent with the same strategy. Marketing tactics are often divided among four areas, also called the four P's: Product, Price, Place and Promotion. In the paragraphs below, these four areas are reviewed for NTBFs specifically.

PRODUCT

While NTBFs are commercialising very advanced technologies, product tactics seem inevitable. The research of (Akan et al., 2006) studied 200 organizations to identify a set of key tactics to describe each of Porter's generic strategies that were related to higher levels of organizational performance. Table 2 shows an overview

of groups of tactics that were associated with a specific generic strategy. As shown, product tactics are associated with differentiation and focus strategies. In addition, according to Davis & Olson (2008), almost every successful start-up relies on distinct product or service differentiators, rather than low cost, to enable them to capture small market segments. Nyström (1990) has argued that new technology tends to be marketed not on the basis of specific products, but on the basis of a vision of a technological future communicated to an informed marketplace, encompassing many products based in both the present and future. The implications of these views lead to a product approach that is technology-led rather than market-led (Beard & Easingwood, 1996), where NTBFs should develop a broad range of new products or services that fit within their envisioned technological future. At the other hand, Wright (1987) claims that small firms can per definition only viably compete with a focus strategy due to their lack of resources. In a focus strategy, a firm targets a specific, often narrow, segment of the market (Akan et al., 2006). A focus strategy is viable if customers' needs within the given product class are heterogeneous and if synergies between the associated value chains are zero or negative (Murray, 1988).

PRICE

Strategic pricing has become essential to the success of business. Although different strategies can achieve profitable results even within the same industry, nearly all successful pricing strategies embody three principles. They are value-based, proactive, and profit driven (Nagle & Müller, 2018). The study of Hultink & Schoormans (1995) clearly shows the importance of pricing when deciding on market entry strategies. This research identifies two groups that are used by Dutch consumer electronics to enter a market: the penetration and the skimming cluster. Their major difference is the pricing strategy. Findings of Hultink (1997) suggest that a skimming (high to low) price policy would be more appropriate for a project that is more innovative than competition, a penetration (low to high) pricing policy would be more appropriate for projects that are as innovative as their competition, and neither policy is appropriate for less innovative projects. Penetration pricing is most commonly associated with marketing objectives of enlarging market share and exploiting economies of scale or experience (Tellis, 1986). A penetration strategy seems to be particularly attractive for firms with a focus on the low-price segment. But even firms that are positioned in the higher price tiers of the market may benefit from penetration pricing (Spann, Fischer, & Tellis, 2015). However, the study of Davis & Olson (2008) states that start-ups rarely succeed based on a low cost, low price, low margin strategy (cost leadership). In some cases, when low values of production should be justified, establishing an exclusive position will enable to price the product premium by using a skimming price policy. Depending on the portfolio of products and the segments of markets targeted, marketing managers should consider a mix of dynamic pricing strategies for their pricing decisions (Spann et al., 2015).

PLACE

The locations of sales, distribution channels and production are tactical choices that influence NTBFs growth and survival. The location of the activities affect all kinds of external variables of the NTBF such as the appropriability regime, competition, legislation and regulation, and so on. In addition, the ambition of NTBFs

TABLE 2: GENERIC STRATEGIES AND THEIR ASSOCIATED TACTICS. THE TACTICS THAT WERE SIGNIFICANTLY RELATED TO HIGHER ORGANIZATIONAL PERFORMANCE ARE SHOWN IN BOLD (AKAN ET AL., 2006)

Differentiation strategy	Cost leadership strategy	Focus/cost strategy	Focus/cost strategy
Extensive training of marketing personnel	Vigorous pursuit of cost reductions	Providing outstanding customer service	Providing specialty products and services
Developing a broad range of new products or services	Tight control of overhead costs	Improving operational efficiency	Producing products or services for high price market segments
Refining existing products or services	Minimizing distribution costs	Controlling the quality of products or services	Dropping unprofitable customers
Developing brand identification		Extensive training of front-line personnel	Targeting a specific market
Innovation in marketing technology and methods		Extensive supervision of front-line personnel	
Utilizing advertising			
Building a positive relationship within the industry for technological leadership			
Forecasting existing market growth			
Forecasting new market growth			
Fostering innovation and creativity			
Building high market share			

in terms of growth influences their location decision. NTBFs embarking on a strategy of rapid internationalisation choose foreign market entries that minimise transaction costs and the related risks of failure (Coeurderoy & Murray, 2008). This shows that the ambition of NTBFs in terms of growth influences their location decision. It is clear that, at a local level, a Science Park is a much valued and prestigious location for new firms in Europe (Storey & Bruce, 1996). However, the research of Ramírez-Alesón & Fernández-Olmos (2018) which is based on 7691 observations associated with 1933 Spanish NTBFs (2007-2013) shows no evidence of a direct relationship between being located on a Science Park and the innovation performance of the NTBFs. Still, Science Parks and Incubators can attract NTBFs with high capabilities, which may enhance a moderating collaboration effect between these NTBFs.

PROMOTION

The promotional tactics power awareness, branding, sales and customer loyalty. Tactics vary from using media, word-of-mouth, alliances and partnerships and more. Marketing, positioning and communication tactics are included. According to Beard & Easingwood (1996), marketing actions and tactics should be the focus of marketing activity for the launch of high-tech products. Emphasizing the technological superiority of a new high-tech product is perhaps the most common when strategically positioning this product. While NTBFs are often advised to target niche-markets (Lubik, Garnsey, & Minshall, 2012), some technologies are generic and have a number of markets and applications open to them. The research of Lubik et al. (2012) shows that the more commercially successful ventures are targeting mainstream markets by working closely with large, established competitors during early development.

Given that many high-tech buying decisions involve several people, not all of whom are specialist engineers capable of translating technical specifications into everyday benefits, a more benefit-specific positioning tactic may prove to be more successful (Beard & Easingwood, 1996). In other words, the technology should be positioned on benefits rather than features. In this case, great emphasis should be placed upon the

quality of the engineering. Although this is a tactic frequently used by small, new-to-market producers, it is a position that cannot be rapidly established.

3.5 TRANSACTION COST ECONOMICS

In this paragraph, Transaction Cost Economics (TCE) theory is explained in general, after which it is applied to strategy making for NTBFs.

3.5.1 TCE THEORY

TCE theory as defined by Coase (1937) states that the goal of an organization is to minimize the costs of exchanging resources in the environment and the costs of managing these inside the organization. In this way, a clear-cut line is drawn between the firm and the market, by differentiating between the relative transaction costs of external and internal exchange. External exchange, also called outsourcing, includes the costs of selling a product, negotiation and transport. Internal exchange, also called insourcing, includes the cost of communication (meetings, decision-making process), labour and material.

Williamson (1975) operationalised the underlying constructs of Coase's theory in the Organizational Failures Framework (OFF). Whereas Coase had emphasized the ex-ante costs of search and contract negotiations, Williamson (1985) focuses on both ex-ante and ex-post transaction costs, which arise from an inability to enforce contracts after signature of agreement (though the emphasis lies on the latter). The OFF framework is built upon three sources of transaction costs, which are mainly: (1) environmental uncertainty and bounded rationality (lack of information), (2) opportunism and small numbers of suppliers and (3) risk and specific assets (developing a specific asset for a small target group that may not be interested).

Opportunism becomes especially dangerous in situations with unequal bargaining power, similar to Porter's (1980) notion of "bargaining power of customers" and "bargaining power of suppliers" as described in his 'five forces' model. In this way, the particular market segment in which the company operates influences the transaction costs strongly. *Vertical integration* can function as a "safeguarding measure" to ensure investments in specialized technology in the face of potential behaviour (Duursema, 2007). Vertical integration is based on a pure systems seller's offering where technology, products and proprietary interfaces are incorporated internally.

MAKE-OR-BUY

Managing the decision between insourcing and outsourcing is strongly related to strategy making and impacts the success of a company. The comparative assessment to choose between make or buy is characterized along three dimensions, namely *asset specificity*, *environmental uncertainty* and *frequency of transaction*. In this respect, low asset specificity, low uncertainty and low frequency would favour a market-like contract. However, a transaction characterized by a high level of asset specificity in combination with high environmental uncertainty and/ or high frequency of transaction should be optimally governed within one firm, which is also called vertical integration. The relationship between these three transactional variables and the appropriate

TABLE 3: WILLIAMSON'S (1985) FRAMEWORK SHOWING DIFFERENT DEGREES OF HIERARCHICAL COORDINATION

	Buying (market)	Sharing (hybrid)	Making (firm)
Asset specificity of activity	Low	Medium	High
Uncertainty	Low	Medium	High
Frequency of activity	Low	Medium	High

governance form is graphically depicted in Table 3. In between the make-or-buy decision, a company can choose to ‘share’ in the form of alliances, strategic partnerships and joint ventures.

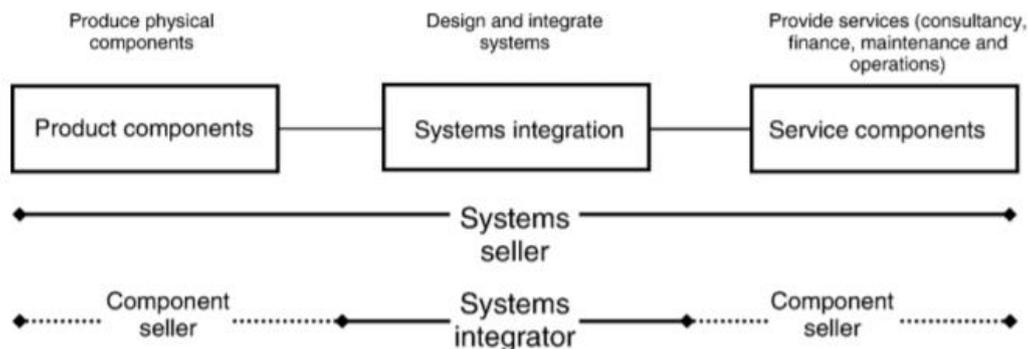
Porter (2004) suggests that vertical integration is a combination of technologically distinct production, delivery, sales and other economic processes inside one company (Jarva, 2011). In literature, vertical integration is referred to as ‘systems selling’ (Figure 3). Vertical integration means that a company chooses internal system development to produce many or all components of the system and combine them into a tailored solution (Davies, Brady, & Hobday, 2007). The foreseeable benefits are an improved return on investment (ROI) due to integrated operations, cost savings in internal control and coordination functions, as well as economies of information creation and stable collaboration relations. Vertical integration can be used to strategically differentiate (Jarva, 2011). It typically reduces some risk and transaction costs, but it requires heavy setup costs, and its coordination effectiveness is often dubious (Stuckey & White, 1993).

Four reasons to vertically integrate are, mainly: (1) the market is too risky and unreliable (it ‘fails’), (2) companies in adjacent stages of the industry chain have more market power than companies in your stage, (3) integration would create or exploit market power by raising barriers to entry or allowing price discrimination across customer segments, or (4) the market is young and the company must forward integrate to develop a market, or the market is declining and independents are pulling out of adjacent stages. Surprisingly, all these reasons are market contingent. The first reason – vertical market failure – is the most important one (Stuckey & White, 1993).

SYSTEM INTEGRATION

Next to vertical integration, several authors have identified a new contrasting type of customer-centric organization for solutions provision, namely the *system integrator*: a prime contractor organization responsible for designing and integrating externally supplied product and service components into a system for an individual

FIGURE 3: SYSTEMS SELLER AND SYSTEMS INTEGRATOR (DAVIES ET AL., 2007)



customer (Davies et al., 2007). This form of organization emphasizes the advantages of specialization and modularity in component supply, standardization of interfaces, and the ability to specify and integrate multi-vendor sources of technology and product supply. System integrators deliver turnkey system solutions to their customers (Figure 3).

COSTS OF ALLIANCES

In between the make-or-buy decision, a company can choose to ‘share’ in the form of alliances. However, these alliances will always be accompanied with some costs. The costs of alliances are the sum of the transaction costs incurred by each individual party and the management costs of alliance operations (Colombo et al., 2006). The former category includes: (1) The costs of the search for suitable partners; (2) the costs of partners’ assessment and selection; (3) negotiation and other contractual costs and (4) the appropriability hazards engendered by the alliance. Given their inexperience and limited resources, NTBFs are vulnerable to their more established partners’ potential opportunism (Haeussler, Patzelt, & Zahra, 2012). Management costs mainly coincide with the opportunity costs of the time and effort that firms’ managers devote to the organization, management and control of the alliance, to the detriment of other activities (Colombo et al., 2006).

3.5.2 APPLICATION TO STRATEGY MAKING

Several implications can be derived from TCE theory for NTBFs strategy making. Analysing TCE from the perspective of the decision to “make or buy”, the theory predicts that managers will implement the organizational form that minimises transaction costs (van Hoek, 2000). If transaction costs are zero, the processes of creating, capturing and protecting value do not pose any strategic problems. However, when transaction costs are positive, opportunities for value creation through the reduction of inefficiencies caused by transaction costs exist, and protecting and appropriating value are costly activities that dissipate value (Foss, 2003). If only resources are considered in strategy making, this means that perfect competition is needed. However, every market has failures and therefore, it is essential to consider transaction costs with respect to the comprehending processes of creating, capturing, appropriating and protecting value.

Transaction costs can have different dimensions while influencing crucial decisions (Onetti et al., 2012). The first is the location of the activities² (Coeurderoy & Murray, 2008), the second is the relationships with other players and about organizational boundaries³ and the third is the selection of activities on which the company’s efforts are concentrated (Prahalad and Hamel 1990; Amit and Schoemaker 1993; Delay et al. 1997; Wernerfeldt 1984) since “successful business focus on creating advantage through a small numbers of core activities”. This is also emphasized by Meyer & Roberts (1986), who found evidence that the degree of “strategic focus” is directly related to corporate growth in that small firms with more restricted degrees of technological and market change in their successive products outperform companies with wide diversity.

² i.e. local vs. foreign based activities, inward-outward relationships with space, entry modes, local embeddedness.

³ i.e. insourcing and outsourcing of activities along social and inter-organizational ties, inward-outward relationships with other players, strategic alliances.

Inter-firm cooperation allows businesses to achieve their common goals more effectively. Literature contains an exhaustive list of synergistic effects created as a result of the pooling of resources by cooperating partners (Shan, 2016). One of the primary benefits of alliances is the access to previously unavailable resources and the joint development of new resources through the alliance. As such, alliances have been examined as a means for developing and exploiting the firm's resource base (Tsang, 2000). Transaction cost theory is one of the traditional explanations of alliance formation (Oliver E. Williamson, 1991), where these alliances can be designed in very different ways; from contractual joint ventures to manufacturing consortia. The costs of alliances should always be considered when deciding on strategic partnerships. As an example, when complementary assets are specialized or cospecialized, contractual relationships are exposed to hazards, because one or both parties will have to commit capital to certain irreversible investments which will be valueless if the relationship between innovator and licensee breaks down (D. J. Teece, 1986). In this case, it's wise to vertically integrate these cospecialized assets within the firm.

According to the research of Neves, Hamacher, & Scavarda (2014), the activities that should be performed internally are identified in the first stage of growth of a start-up, where TCE has more to do with the examination of the activities that can be performed externally in later stages. When a NTBF is just established, an entrepreneur can avoid price mechanisms in the market by allowing transactions to migrate within the firm. At a certain point, the marginal costs of organizing an internal transaction is greater than the cost of transacting in the market or the cost of organizing the transaction with another entrepreneur. At this point, the firm would cease to grow (Neves et al., 2014).

TCE supplies an understanding of the foundational issues as the existence, boundaries and, to a smaller extent, the internal organization of the firm, and several derived issues (e.g. the structuring of joint ventures, franchise contracting, diversification, etc.). However, in general, literature acknowledged that TCE seemed to be limited to corporate strategy issues; implicitly, it was acknowledged that TCE had very little to say about competitive strategy, that is, issues relating to positioning in an industry and defending such a position (Foss, 2003), where the competitive advantage of a firm is mostly based on its value-creating potential. For this reason, another, complementary theory will be added to this literature review: the resource-based view.

3.6 RESOURCE-BASED VIEW

In this paragraph, the resource-based view (RBV) theory is explained in general, after its implications for strategy making in NTBFs is discussed.

3.6.1 RBV THEORY

A firm is a collection of resources, each of which is a "bundle of potential productive resources, bounded together in an administrative framework (Penrose, 1959). With this bundle of resources, a firm creates value to the market which allows to gain a competitive advantage. In this light, instead of viewing the firm as an opportunism-minimizing agent as in TCE, one could define the firm in positive terms as a value-creating vehicle consisting of bundles of strategic resources. The inner workings of the firm allow to explain differences in

performance between firms in a same industry (D. J. Teece, Rumelt, Dosi, & Winter, 1994). RBV theory allows to analyse a firm's competitive advantage according to its own capabilities. The decision whether resources are kept within the firm or whether they are transferred to external contractors should be made with regard to their strategic value for the firm. Resources can be subdivided in two main groups: initial resources and dynamic capabilities.

INITIAL RESOURCES

The initial resources of a company are highly related to growth drivers and barriers, as also discussed in paragraph 3.2.2 and 3.2.3. Social capital may lead to human capital, an incubator and a network which can lead to venture capital correspondingly. Strategic alliances can be established due to the resources of the founding team. Heterogeneity in the functional experience of the founding team and technology with a degree of radicalness are especially prone to reduce the likelihood of firm failure (Aspelund et al., 2005). Properly managing the internal resources in the commercialization process is fundamental for the success of a company. The available credit impacts strategy making significantly, where credit constraints contribute to small business failure (Robert Cressy & Bonnet, 2015). To generate positive cash flows, a NTBF sometimes has to adapt its strategy in order to be competitive. Roberts (1991) found a relationship between founder team composition and performance in NTBFs. He argued that increased team diversity, especially the combination of technical and business orientation, can be a way to balance NTBFs' inherent tendency for a strong technology bias with the business orientation needed for sustained performance (Saemundsson & Candi, 2014).

DYNAMIC CAPABILITIES

The capabilities that allow firms to survive in the first place are completely different from those yielding firm growth (Marco S. Giarratana, 2004). Dynamic capabilities theory deals with the capability of an organization to adapt its organization's resource base. Successful firms can build capabilities by combing resources in unique ways, such as establishing superior organizational routines and partnering with firms that have complementary assets. Managers are likely to revise their representations in response to ambiguities and irregularities that do not fit their initial representations (Saemundsson & Candi, 2014). Dynamic capabilities lead the company to achieve a complex fit between activities that exploit their resources to the full and capabilities that assure good short-term results (Vivas López, 2005). Eisenhardt and Martin averred that dynamic capabilities 'are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die' (Newbert, 2006). An enterprise with strong dynamic capabilities will be able to profitably build and renew resources, assets, and ordinary capabilities, reconfiguring them as needed to innovate and respond to (or bring about) changes in the market (Paradkar, Knight, & Hansen, 2015). The process of reshaping an initial business model creates opportunities that contribute importantly to success (Chesbrough & Rosenbloom, 2002). As an example, product-oriented firms might become more service-oriented, or the other way around.

Dynamic capabilities remain one of the most popular, but also one of the most controversial topics in current knowledge and innovation research (Burisch & Wohlgemuth, 2016). Fully flexible organizational capabilities

might not be achievable and continuous adaptation to every kind of environment change is simply impossible. On the contrary, RBV emphasizes sustainable competitive advantage rather than the issue of competitive survival. Therefore, it can be concluded that RBV is more practical from a systems theoretic approach. For this reason, this research mostly focuses on RBV theory, where dynamic capabilities are interpreted as the ability to adapt a strategy according to the needs of the market and the firm.

3.6.2 THE VRIO FRAMEWORK

RBV gives special attention to the factors that cause the differences between firms that are active within the same industry. Jay Barney (1991) his Value-Rare-Inimitability-Organization (VRIO hereafter) is most robust at the level of formalisation and practicality in use of RBV theory.

Barney (2002) defines resources as “all assets, capabilities, competences, organizational processes, firm attributes, information, knowledge and so forth that are controlled by a firm and that enable the firm to conceive of and implement strategies designed to improve its efficiency and effectiveness”. Valuable resources should be kept within the firm, while less valuable resources should be outsourced to external providers. To be able to distinguish these from one another, Barney developed the VRIO framework, which allows a firm to analyse whether its internal resource bundle is of optimal composition to gain a competitive advantage (Barney, 1991, 2002). The framework assumes that each firm has a unique combination of resources and capabilities such that no two firms are “twins” and that these resources cannot easily migrate to competing firms. A resource must be valuable in that it lowers production costs or increases the value of the product in the eyes of the customers. Moreover, the value of a resource is not only determined with reference to the end product, but should be equally based on the extent to which the resource can be leveraged throughout the organization (Barney, 1991). The better the fit between resources and organization, the more fruitful the leverage.

Key strategic resources can be sources of strategic competitive advantage if they are scarce, difficult to imitate, non-substitutable, and valuable (Barney, 1991; Madhani, 2014). Barney (2002) considers that if the number of firms that possess a particular valuable resource is less than the number of firms needed to generate perfect competition in an industry, that resource may be considered as rare. Firms that control valuable and rare resources enjoy a competitive advantage (Duursema, 2007). Valuable and rare resources do not lead to a sustainable competitive advantage as such. For this, these resources similarly need to be costly to imitate for a competitor. There must be some barrier to future duplication of the resource. A resource can be imitated either by acquiring the same resource (duplication) or by creating the same outcome by a different resource (substitution). According to Barney (1991) and his VRIO framework, the measurement of imitability is the costs required for a competitor to imitate. These costs depend on four criteria: value, rarity, imitability and organization. In case a resource meets these four interconnected criteria, it is a high level ‘strategic’ resource.

An analysis based on the VRIO framework allows a manager to pinpoint the potential strength and weaknesses of his or her firm. Different competitive levels can be associated with the degree to which a firm’s resources comply with the four required characteristics. Table 4 shows a summary of the questions that one should ask oneself to know the competitive implications of the strategic resources for a firm. As an example, in

case a firm possesses resources or capabilities which are not valuable, a firm is at a competitive disadvantage. These resources would increase a firm's costs and/or decrease its revenue if employed (Duursema, 2007). For a competitive advantage to be sustainable a firm must internalize the most valuable and rare resources, which are also difficult to imitate for competitors.

3.6.3 APPLICATION TO STRATEGY MAKING

Several implications can be derived from RBV theory for NTBFs strategy making. The VRIO framework can be used to see if a NTBF has a sustained competitive advantage with its current resources. If it doesn't have this advantage yet, it must try to acquire these resources. Firms with greater internal resources are less inclined to source externally (Jones et al., 2001). In this way, the better the qualities of the founding team, the product and the cash flows, the lower the need for external resources such as funding. As technological knowledge generally is the main, if not the unique asset of NTBFs it is often the key source of their competitive advantage. When this resource is easy to imitate and the appropriability regime is weak, this means that the NTBF has no sustained competitive advantage according to the VRIO framework.

While Barney's (1991) expression of the RBV over time has a rather static nature, the processes by which NTBFs can exploit resources and reconfigure competences to address rapidly changing environments should be considered. While it is understood that it is no doubt necessary for a firm to possess valuable, rare, inimitable, non-substitutable resources and capabilities, it is also understood that such a condition is nonetheless insufficient. In addition to possessing these ingredients, firms seeking a competitive advantage must also demonstrate the ability to alter them in such a way that their full potential is realized. While the dynamic capabilities theory gives the expression to deal with this complexity, it's a rather vague, not practical theory. Therefore, in this research, RBV theory is mostly used to find internal and external variables that make companies different and heterogenic, where the ability to adapt to the environment is expressed in the (competitive) strategies used in the NTBFs. RBV theory simply cannot be used to formulate strategies, where strategies are always based on the environment and relative resources. Other than possessing valuable resources, firms must demonstrate the ability to alter these resources in a way that their full potential is realized.

TABLE 4: BARNEY'S (2002) VRIO FRAMEWORK

Valuable?	Rare?	Costly to imitate?	Exploited by organizations?	Competitive implications
No	No	No	No	Competitive disadvantage
Yes	No	No	No	Competitive Parity
Yes	Yes	No	No	Temporary Competitive advantage
Yes	Yes	Yes	Yes	Sustained Competitive Advantage

3.7 COMPLEMENTARY USE OF THEORETICAL VIEWPOINTS

The different theoretical viewpoints as discussed in the paragraphs above shouldn't be unified. Rather, they should be used complementary while they are addressing different aspects of the same phenomena. This paragraph will briefly discuss the complementariness and implications of the four main viewpoints regarding the object of study: TCE, RBV, contingency and strategic management.

TCE AND RBV

TCE and RBV have several differences. First, they use different units of analysis. TCE is based on transactions while RBV is based on using resources for value creation. While resources enable a NTBF to survive in the first place, TCE has more to do with the examination of the activities that can be performed externally in later stages. In the beginning, a firm needs to achieve a competitive advantage which is mostly based on a firm's value-creating potential. What differs one NTBF from the other is mostly the core technology. Accordingly, the study of Aspelund, Berg-Utby, & Skjvedal (2005) found that technology with a degree of radicalness is especially prone to reduce the likelihood of firm failure. Due to the lack of capital in the early stages of growth, the initial resources seem the most important factor that can contribute to the further growth of the firm. TCE doesn't say much about these initial resources, but says more about the actual organizational governance form, including its location and activities. Transactions are based on resources, and the return of these resources depends on the effective management of the accompanied transaction costs. In this way, an initial resource based on TCE would be to have the capability of managing resources internally and externally over time to realise maximum value creation and protection. Consequently, one might argue that TCE could be unified with the dynamic capabilities theory. However, the dynamic capabilities theory strives for continuous adaption to every kind of environment change, which makes it inapplicable for NTBFs specifically. Especially while evidence is found that for small firms, the degree of *strategic focus* in terms of technology and market is directly related to corporate growth (Meyer & Roberts, 1986).

TCE and RBV are not mutually exclusive. TCE theory says a lot about partnering for pooling resources, which is dynamic process. With every transaction, a NTBF should make a trade-off between the costs internally and the prices in the market. The amount of resources needed by using partnerships depends on the firm's internal resources. In this way, this research uses TCE and RBV theory complementary. TCE can be used mainly for the identification of strategies, where RBV theory can be used for the identification of resources or a lack of resources, for which specific strategies and tactics must be executed.

CONTINGENT TRANSACTIONS AND RESOURCES

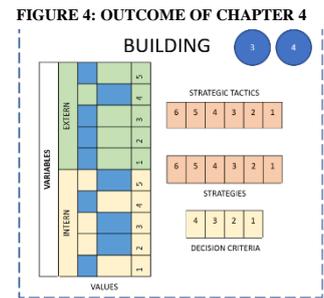
Contingency, TCE and RBV theory are all strategy management theories. While they address different aspects of the same phenomena, they do overlap somehow. Contingency theory explains the alignment of transactions and resources, which forms the basis for strategy making. Organizations are affected by uncertainty from environmental factors that organizations cannot control (Shin, 2003). Organizations, then, respond to those factors by actions that decrease uncertainty, where these actions are deduced from the formulated strategy. As suggested by Thompson (1967), vertical integration is "a major way of expanding organizational domains in

order to reduce or eliminate significant contingencies”. By internalising contingencies, external factors can be controlled. Accordingly, TCE theory explains outcomes of organizational designs that are subject to contingency theory. The same counts for RBV theory, wherein the strength of the internal strategic resources is subject to external contingencies such as competition, market trends, political, legal and regulatory environment and the economy. Consequently, the actual *value* of resources depends on the external contingencies.

Strategy management deals with internal and external contingencies and variables by using transactions and resources in a way to create value and firm growth. Operating under the principles of contingency theory means always evaluating multiple inputs that all may contribute to a certain outcome, where this outcome is *affected* by the executed strategy and strategic tactics. It seems that contingency theory has similarities with dynamic capabilities theory while both theories focus on creating new capabilities and resources which are the source of sustainable competitive advantages and thereby adaptability over time (Endres, 2018). Competitive advantages like specialized knowledge or company-owned technologies can only exist for a transient period. Yet, while contingency theory is focused on reactive adaptation to circumstances, dynamic capabilities are more focused on the proactive handling or influencing of the environment. Accordingly, contingency theory seems to be more of practical use.

4. CONCEPTUAL FRAMEWORK

The outcome of this chapter is a framework that shows relations between variable concepts and their characteristics that enables to formulate strategies for NTBFs. This framework was adapted in three iterations; after the literature review (chapter 3), after the semi-structured interviews with managers and after the advisory reports. The total data analysis can be found in Appendix C: Data analysis This chapter serves to build the input “lists” of concepts (see Figure 4). The relevant



concepts are divided in five groups: (1) uncontrolled internal and (2) external variables, (3) controlled strategy and (4) strategic tactics and (5) decision criteria used to decide which strategy will be executed. The most important reasoning derived from literature, primary data and own interpretations are discussed and summarized per topic in the paragraphs below. Quotes of the managers of NTBFs and paraphrases of the advisory reports are used to support the argumentation. Every paragraph ends with a table overview.

4.1 EXTERNAL VARIABLES

External variables are the environmental factors that influence strategy making. An overview of all variables can be found in Table 5.

BEHAVIOUR OF INDUSTRY

A very important factor that influences strategy making is the industry and its characteristics. This factor plays a role when defining the threat of competition according to Porter’s five forces (Porter, 2004). Also, environmental certainty is an aspect of the Organizational Failures Framework (OFF) of Williamson (1975). The market and its trends should be analysed to know what kind of strategy the company should execute.

“A company should analyse the market and its trends to know what kind of strategy it should execute.” (NTBF4)
 Large companies often lack the expertise and knowledge to utilise high-tech solutions. Convincing industry is hard where NTBFs are often developing high-tech products and processes for which most companies are not ready yet. The NTBFs must establish a new market, while dealing with conservative attitudes, reliability issues and existing contractual agreements between companies and their customers.

“The sector barely innovates.” (NTBF8)

“A big challenge for our start-up is to be innovative and radical in conservative industries.” (NTBF7)

“Education plays a large role. Client’s employees often lack the expertise and knowledge to actually use our technology.” (NTBF7)

“Large companies often have good ideas, but they simple do not have the ecosystem to execute these ideas due to, for instance, bureaucracy. (NTBF9)

One important aspect that should be analysed before entering a market is the presence of market failures. Market failures are mainly that a market is risky and unreliable, that companies adjacent stages of the industry chain

have more market power than others, the presence of price discrimination or monopolies, or a lack of information (Stuckey & White, 1993).

MARKET SIZE, DEMAND AND CUSTOMERS

NTBFs choose their markets based on size and growth potential. Simply said: without a large market you can't grow your company. Market size can be measured in quantity or in quality, where the latter means delivering specialty products to the same market.

"The market potential of our targeted industries definitely affected the successfulness of our company" (NTBF1)

"We target high-potential and growing markets" (NTBF6)

"The product is applicable in different markets and diverse companies." (NTBF9)

An important factor that influences the market size is the actual demand. When the demand is declining this might result in companies from adjacent stages to pull out, which might be a reason to vertically integrate (Stuckey & White, 1993). Another factor is the level of buyer concentration. While establishing close links with potential customers is not possible with large numbers of customers (Roure & Keeley, 1990), Porter (1980) notes that depending on a very small number of buyers increases their bargaining power. Accordingly, Roure & Keeley (1990) found that the optimum buyer concentration for NTBFs is 60 customers.

"The sales conversion rate was over 40%." (NTBF8)

"The founders started the company due to a demand from industry." (NTBF9)

AMOUNT OF POTENTIAL MARKET SEGMENTS

The amount of potential market segments will influence strategy making. While NTBFs are often advised to target niche-markets, some technologies are generic and have several markets and applications open to them. The research of Lubik et al. (2012) shows that more commercially successful ventures are targeting mainstream markets. Opportunities may be missed when focusing too much on one specific segment among a high number of potential segments.

ADOPTION OF A TECHNOLOGY

The adoption of technology clearly influences strategy making; proving the reliability of the technology takes time and effort. There is a chance that the market is just not ready for the technology yet. In addition, the research of (Parasuraman (2000) indicates an increasing customer frustration in dealing with technology-based systems. A major consequence of technology's growing role is a commensurate growth in self-service technologies that call for customers to interact with technology-based systems rather than company personnel (Meuter et al., 2000).

POSITION IN VALUE CHAIN

B2B companies need a different kind of approach than B2C companies in terms of marketing and core activities. For B2B firms that are developing high-tech, complex solutions for other companies, marketing is becoming more knowledge intensive. In addition, internal marketing plays an increasingly important part in implementing

the marketing concept in high-technology companies (Möller, 1999). While collaborating, the one that is facing the end-consumer often gets the highest profit margin and so this can be a topic for negotiation.

“Our value proposition is only a small part of the total value chain. The discussion about who is facing the end-consumer can be an important topic when discussing collaboration opportunities.” (NTBF9)

AVAILABILITY OF FUNDING

The financial environment and the availability of funding is important for the survival of NTBFs, where these need to overcome funding gaps (Gompers & Lerner, 2001; Luukkonen, Deschryvere, & Bertoni, 2013). The study of (Becchetti & Trovato, 2002) shows that financial constraints and access to foreign markets have a significant impact on growth for small and medium sized firms.

“The Dutch financial environment for high-tech hardware is quite dramatic, where only a small number of large investors are present.” (NTBF7)

Due to the long lead time and lack of capital, NTBFs are often dependent on subsidies to finance their technology development in early stages.

“We financed more than half of the prototype by subsidies” (NTBF1)

“Until this moment, the company relied on subsidies and government loans” (NTBF5)

“We make use of subsidies to build our company and enter market segments.” (NTBF10)

COMPETITION AND APPROPRIABILITY

Competition-adjusted strategies enable to compete in a dynamic business environment, where carefully created strategies lead to competitive advantages (Jarva, 2011). Competition is indicated to be driven by five competitive forces: competitors, buyers, suppliers, substitutes and potential new entrants (Porter, 2004). Most NTBFs start their companies based on a gap in the market or a demand from industry. Accordingly, they often have a first mover advantage (REPORT1).

“The threat of competitors is relatively low.” (NTBF8)

However, large companies may adapt quickly to a disruptive technology, even more in case of a weak appropriability regime. In industries with large developmental and prototyping costs and where innovation of the product concept is easy, one would expect that the probability that the innovator would emerge as the winner or amongst the winners at the end of the preparadigmatic stage is low (D. J. Teece, 1986). Technological knowledge generally is the main, if not the unique asset of these firms and so it is the key source of their competitive advantage. A NTBF should always be aware of possible substitutes and potential new entrants.

SUPPLIERS

The academic literature recognizes that suppliers of raw materials and/or basic labour have a major influence on a company's competitive strategy (Davis & Olson, 2008; Porter, 1979). In addition, the importance of having good suppliers was clearly stated in the interviews. Suppliers should be able to expand when the company increases production.

“A company can ruin itself by having bad suppliers. The more components a product has, the more suppliers and the higher the risk of delay. We had several suppliers per component.” (NTBF1)

“If demand increases, your suppliers should be able to expand with you. You simply can’t collaborate with suppliers that are not able to grow.” (NTBF1)

It’s important to distinguish between having a high number of suppliers per component or having a high number of suppliers due to the high number of components. While TCE theory states that a small number of suppliers may lead to opportunism, this is clearly meant for the former.

INFORMATION

Barney (2002) defines information as a valuable resource that enables a firm to implement strategies designed to improve its efficiency and effectiveness. When information is open, this can stimulate innovation. Sharing confidential information with one partner can help to increase the competitive position.

“We exchange information with our suppliers to get costs down.” (NTBF8)

“We had the option to start a joint venture, however, the other company did not want to share all information; there was a clear lack of trust.” (NTBF1)

REGULATION AND LEGISLATION

Numerous studies have indicated that many factors —tax system, disadvantageous legal, political and institutional framework conditions and its laws— hamper the creation and development of innovative young firms (European Commission, 2000, 2001, 2004). In addition, high-tech solutions often must deal with heavy regulations and legislations regarding safety measures. For some solutions, the legislation has not been established yet. Moreover, some industries (e.g. aircraft) maintain costly and time-consuming certification processes (REPORT4).

“The safety aspect of our product is very important since we have to deal with strict regulations. It’s not allowed by current regulations to use our product outside. Therefore, we focus on indoor environments now.” (NTBF3)

SYSTEM COMPLEXITY

Value chains are often complicated. Nevertheless, this doesn’t impact the strategy to choose significantly and therefore, this variable will not be considered further on in this research when selecting growth strategies.

“The value chain is complicated” (NTBF7)

“Often, the system solution for the end-customer is very complex and we cannot build it completely by ourselves.” (NTBF9)

SYNTHESIS

Table 5 shows the synthesised data as discussed in the paragraphs above, by listing all external variables that influence strategy making for NTBFs. The variables have certain characteristics that are categorized into so called “values”. Most values were found by logical reasoning of the author, using contrasting antonyms. The

last column shows the references used to define the values and variables based on the paragraphs above and the data analysis in Appendix C. These variables and their values serve as input for the conceptual framework (Figure 5). Even though the variables are considered to be “uncontrollable”, a firm can still choose to change its structure and/or organization when a variable influences the company in a negative and/or constraining way. For instance, the company can choose to penetrate a different market, hire new employees, change location and so on. In this way, strategy and the influencing variables are interacting.

FIGURE 5: THE EXTERNAL VARIABLES

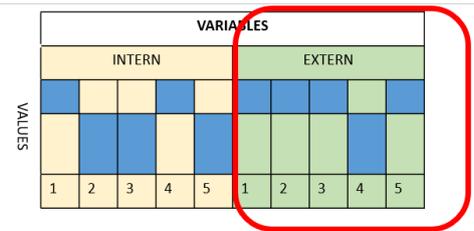


TABLE 5: ENVIRONMENTAL STRATEGY-SHAPING FACTORS BASED ON LITERATURE, ADVISORY REPORTS AND INTERVIEWS

Variables	Values		References
<i>Number of components</i>	High	Low	NTBFs[1, 7, 8], REPORT1, Davis, Williamson (1975; 1985)
<i>Availability of funding</i>	High	Low	NTBFs[1, 2, 3, 5, 7, 8, 10], Gomper & Lerner (2001), Luukkonen et al. (2013), Becchetti & Trovato (2002)
<i>Market</i>	New	Established	REPORT6, REPORT1, NTBF9
	Innovative (Fast-changing)	Conservative (Slow)	NTBFs[4, 8, 7, 9], REPORTS[3, 6]
<i>Market power in industry</i>	High ⁴	Low	REPORT1, Williamson (1975; 1985), (Stuckey & White, 1993)
<i>Market size</i>	Large	Small	NTBFs[1, 6, 9]
<i>Demand</i>	Declining	Rising	NTBFs[8, 9]
<i>Number of customers</i>	High	Low	REPORT1, NTBF9, Porter (1980, Roure & Keeley (1990)
<i>Competition</i>	High threat	Low threat	Porter (2004), Jarva (2001), REPORTS[1, 3], NTBF8
<i>Position in value chain</i>	Close to end-user (B2C)	Early in value chain (B2B)	NTBF9, Möller (2009)
<i>Appropriability regime</i>	Strong ⁵	Weak	Colombo et al. (2006), (D. J. Teece, 1986)
<i>Information</i>	Open and available	Confidential and protected	Barney (2002), NTBs[1, 8]
<i>Legislation/regulation</i>	Discouraging	Supportive	REPORT4, NTBs[3, 10], (Coeurderoy & Murray, 2008), (European Commission, 2000, 2001, 2004)
<i>Adoption of technology</i>	Yes	No	(Parasuraman, 2000) (Meuter et al., 2000)
<i>Amount of potential market segments</i>	High ⁶	Low	(Lubik et al., 2012)
<i>Complexity system</i>	High	Low	NTBFs[7, 9]

⁴ Price discrimination, monopolies, established agreements and contracts

⁵ Not easily imitable or reproducible

⁶ Restricted degrees of technological and market change in successive products outperform companies with wide diversity (Meyer & Roberts, 1986)

4.2 INTERNAL VARIABLES

Internal variables can be subdivided into five themes: the founding team, the value proposition, current state of company and technology and organizational structure. An overview of all internal variables can be found in Table 6.

FOUNDING TEAM

As also stated extensively in the literature review (Paragraph 3.2.2), the characteristics and personalities of the founding team are very important influencers of strategy making and consequently, firm growth. The founding team of NTBFs are often highly educated engineers.

“Our board and founding team exists of highly educated engineers.” (NTBF2)

Some founders didn't have any experience with starting a company. However, most of them have affinity with entrepreneurship.

“We didn't have experience in setting up a company.” (NTBF8)

“The founding team was committed, complementary and entrepreneurial.” (NTBF1)

“The entrepreneurial mindset of the founders helped to identify market opportunities.” (NTBF2)

“Founder always wanted to start his company.” (NTBF3)

“Before starting the company, the founders already had experience with entrepreneurship.” (NTBF9)

“Both founders have experience with entrepreneurship and found several companies.” (NTBF10)

Some founding teams didn't have any professional experience but came fresh from the university. Others know the industry well.

“The founding team had no professional experience, they all came fresh from the university.” (NTBF1)

“One of our founders worked for more than a decade in industry and knows the industry very well.” (NTBF7)

Teams are often complementary when it comes to their personalities and responsibilities and this is also something that the NTBFs strive for. When having a monodisciplinary background, a more commercial team member is sometimes added along the way.

“The founding team and their complementariness played an essential role in the growth of the company.” (NTBF7)

“The founding team is complementary in their behaviour and responsibilities. The capabilities of the team are a driving force behind the business.” (NTBF9)

“The most important influencer of strategy making is the team; that the people fit well together in terms of personality and drive.” (NTBF10)

“Our board exists of engineers that do not have a lot of business expertise yet. We are currently hiring someone with a commercial background.” (NTBF2)

“Our two founders are both engineers. We are thinking about involving a third founder who can help with the business side.” (NTBF3)

VALUE PROPOSITION

According to Beard & Easingwood (1996), a value proposition should be positioned based on clear benefits to the market. In addition, the study of Roure & Keeley (1990) shows that product superiority is a good predictor of success. Technical superiority is often emphasized, and the business case is quantified based on benefits such as cost reduction and quality.

“Our product has clear benefits compared to conventional products in terms of costs and quality.” (NTBF8)

“The value proposition needs to be very clear to customers and potential partners.” (NTBF2)

“We have a clear value proposition to the market based on benefits (e.g. reducing costs and improving quality) which helps to communicate the business case.” (NTBF7)

Having a product that can be easily customized can enlarge the market size.

“An essential part of the core product is its adaptability; the product can be commercialised in different markets and diverse companies.” (NTBF9)

The innovation type will have a significant effect on strategy making. The more radical the core technology of the new venture, the lesser the advantage held by competitors (Aspelund et al., 2005). However, the more radical, the more conservative potential customers might be, especially when the innovation has disruptive implications.

CURRENT STATE OF COMPANY AND TECHNOLOGY

The maturity of the technology influences strategy making. When a technology is mature (TRL > 4) it will be easier to find investors, partners and launching customers. The lower the TRL, the longer the road to market, the higher the R&D costs (REPORT3) and the higher the threat of competition. Different strategies and tactics are needed to get the technology to the next (readiness) level. A lot of research, tests and proof-of-concepts are needed to convince industry (REPORT2), which is a very time-consuming process. In addition, the required trial & testing will probably increase the payback period (REPORT5).

“When it comes to the technology development, it turned out to be much harder than we initially thought.” (NTBF5)

The research of Roure & Keeley (1990) found an inverted U-shape relationship between development time and the success of a venture, where the optimum development time is 12 months.

“Unfortunately, the technology has a very long lead time.” (NTBFs[5, 7])

“We changed our strategy to decrease the development time per solution” (NTBF9)

“The lead time would take rather long and therefore, the project would turn out to be quite expensive.” (NTBF6)

The number of products and services, the location and amount of core activities affect strategy making. The study of Akan et al. (2006) shows that a tactic to differentiate can be to develop a broad range of new products or services developed for high price market segments or turned into specialty products and services. The use of these tactics depends on the current number of products and services. The research of Feeser & Willard (1990) measured a significant influence of having non-domestic sales or foreign-based activities on the growth rate of firms. The research of Coeurderoy & Murray (2008) provides evidence that entrepreneurial young firms choose to enter country markets offering better regulatory protection for their intellectual property. In addition, the

research of Onetti et al. (2012) shows the influence of the amount of core activities on crucial decisions. When a product is finished and is ready for standardisation and economies of scale, a company might focus more on the operational efficiency of the organization's activities, including supply chain, distribution, sales and maintenance. Standardising production means that a firm's boundaries are enlarged, which is a decision that depends on the internal capabilities of the firm. Accordingly, firms having greater experience with a particular process technology are more likely to internalize manufacturing activities than firms lacking such production experience (Leiblein & Miller, 2003). Similarly, firms with high levels of sourcing experience are more likely to outsource their production than firms that do not have such experience.

NICE TO HAVES

Networking skills help to find launching customers, partners, suppliers and other strategic alliances. These can differ from end-users to system integrators. For some business models, a significant amount of alliances is needed. A study of Shan (2016) shows that the propensity to cooperate is positively correlated with the distance of firms' competitive position in relation to their rivals. The research of McEvily & Zaheer (1999) broadly supports the link between firms' networks and the acquisition of competitive capabilities.

"Our network helped us to find a launching customer." (NTBF9)

"We developed some skills in networking which helped us a lot in setting up our company." (NTBF10)

When the technology is patented, this opens new opportunities regarding collaboration, partnerships and funding. A patent is a valuable resource which strengthens the competitive position of a NTBF.

"We use patents and trade secrets to protect our intellectual property" (NTBFs [1, 2, 7, 9])

The amount of money on the bank impacts strategy making significantly. Different kinds of funding strategies and tactics influence the financial position of the NTBF.

"The amount of money on the bank impacts strategy making significantly. If you want to be profitable, you sometimes have to adapt your strategy to be competitive." (NTBF1)

"If we would have more cash, we maybe would have chosen a different approach." (NTBF8)

ORGANIZATIONAL STRUCTURE

All interviews were with founders of independent NTBFs. The drive, vision and resources of university spin-offs and spin-outs might be different. For instance, it's assumed that university spin-offs might have different capabilities and resources than a free-standing firm. University spin-outs (where university-based inventions are "spun-out" into separate companies) typically lack the financial means and managerial expertise to acquire the resources and develop the capabilities they need in order to fully exploit the commercial potential of their technologies (M. Wright et al., 2004). However, these statements that distinguish spin-offs from free-standing firms are dependent on other variables, such as: lack of professional experience, lack of financial means, lack of prior knowledge of the industry, lack of entrepreneurial skills and a lack of collaboration capabilities. Therefore, this research will not consider the type of organization (university spin-off vs. independent) to be an internal variable on itself.

SYNTHESIS

Table 6 shows the synthesised data based on the paragraphs above, by listing all internal variables that influence strategy making for NTBFs. The variables are divided within four main groups and have certain characteristics that are categorized into so called “values” based on contrasting antonyms. These variables serve as input for the conceptual framework (see Figure 6), where certain values match with certain strategies.

FIGURE 6: THE INTERNAL VARIABLES

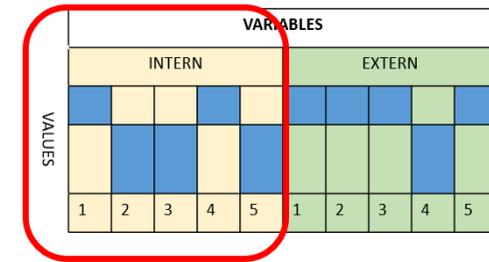


TABLE 6: INTERNAL STRATEGY-SHAPING FACTORS BASED ON LITERATURE, CASE STUDY REPORTS AND INTERVIEWS

		Values		References
Founding team	<i>Team composition</i>	Multidisciplinary ⁷ and complementary	Monodisciplinary	NTBFs[1, 2, 3, 7, 8, 9, 10]
	<i>Entrepreneurial skills</i>	High	Low	NTBFs[1, 2, 3, 4, 8, 9, 10], (M. Wright et al., 2004)
	<i>Professional/functional experience</i>	High	Low	NTBFs[1, 7], (M. Wright et al., 2004)
	<i>Education level</i>	High	Low	NTBF2
Value Proposition	<i>Value proposition (VP)</i>	Clear benefits	Unclear benefits, features based	REPORT1, (Beard & Easingwood, 1996), NTBFs[1, 2, 7, 8]
	<i>Product superiority</i>	High	Low	(Beard & Easingwood, 1996)(Roure & Keeley, 1990), NTBFs[7, 9]
	<i>Innovation type</i>	Radical	Incremental	Aspeland et al. (2005)
	<i>Adaptability</i>	High	Low	NTBF9
Nice to haves	<i>Cash</i>	High	Low	NTBFs [1, 8], (M. Wright et al., 2004)
	<i>Technology can be patented</i>	Yes	No	NTBFs[1, 2, 7, 9]
	<i>Collaboration capabilities</i>	High	Low	NTBFs[9, 10], Shan (2016), McEvily & Zaheer (1999), Wright et al. (2004)
Current state	<i>TRL of technology</i>	Mature	Low (≤ 4)	NTBF5, REPORTS[2, 3, 5]
	<i>Number of products and services</i>	High	Low	(Akan et al., 2006)
	<i>Product development</i>	Short	Long (>12 months)	NTBFs[5, 6, 7, 9]
	<i>Production level</i>	Standardization/economics of scale	Low	(Leiblein & Miller, 2003),
	<i>Location of activities</i>	Local	Foreign-based	(Feeser; & Willard, 1990)(Onetti et al., 2012), (Coeurderoy & Murray, 2008)
	<i>Number of core activities</i>	High	Low	(Onetti et al., 2012), (Leiblein & Miller, 2003)

⁷ Having at least one business developer in the team.

4.3 STRATEGIES

The strategies identify clear broader goals that advance the overall organization and organize resources. The strategies that are considered in this research are built around four regimes: (1) Vertical Integration, (2) Inter-firm Cooperation, (3) Technology Transfer and (4) System Integration. An overview of all strategies can be found in Table 7.

STRATEGY OPTIONS

Strategies manage the initial resources (technology, founding team) by making decisions regarding markets, technologies and competitive postures to be pursued by the firm (Feeser; & Willard, 1990). Some examples (non-exhaustive) of decision subjects are: (1) the product/service to deliver, (2) the market to penetrate, (3) the customer to approach, (4) the business model to be used, (5) the way the company finances his activities and (6) the organizational structure maintained. The strategies that are considered in this research are built around four regimes: Vertical Integration, Inter-firm Cooperation, Technology Transfer and System Integration. These regimes are defined based on the *make-or-buy decision*; a common principle used in TCE theory that differs strategies based on firm boundaries.

In general, end-users desire turnkey solutions. There are different ways to deliver these solutions. By using vertical integration all core activities are insourced. Inter-firm cooperation enables to combine resources, where contracts are settled, and one party faces the end-consumer. In this research, a distinction in collaborative strategies is made between backward and/or forward strategic alliances, exclusivity agreements, equity strategic alliances, joint ventures and IP-based technology transfer. Horizontal alliances are left out, due to their high risk of failure; alliance partners at the same level of the value chain are often rivals (Gnyawali & He, 2014). In addition, the hypercompetitive environment in which many NTBFs operate increases the risk of opportunistic partner behaviour in horizontal alliances (Haeussler et al., 2012). Technology transfer basically means that a partner faces the end-user and so a significant part of the risk is outsourced. System integration allows to deliver a turnkey solution by outsourcing activities to other parties.

VERTICAL INTEGRATION

When a market fails, it might be strategically wise to vertically integrate. Following the precepts of TCE theory, it can be argued that vertical integration is a more efficient form of organization than market contracting in transactions that involve either highly specific assets or high levels of uncertainty (Williamson, 1975, 1985).

Vertical integration can be backward (upstream) or forward (downstream). *Backward* vertical integration (VIB) is when a downstream producer buys up an upstream supplier and has residual rights of control (Acemoglu, Griffith, Aghion, & Zilibotti, 2010). VIB can be advantageous to the primary business if control of the business that is downstream the supply chain provides a guaranteed supply of inputs. VIB can be used as a competitive method to support long-term buyer contracts (Mcdougall & Robinson, 1990). The additional amount of capital to accomplish VIB suggest that this is the most aggressive group of new ventures (Mcdougall & Robinson, 1990). Another type of integration is *forward* vertical integration (VIF), which means taking on a downstream activity. According to the research of Mcdougall & Robinson (1990), a major emphasis on VIF toward the

consumer is accompanied by a reliance on common (public domain) processes and technologies easy to access and use cost-effectively rather than heavy reliance on building and protecting proprietary processes/technologies that drain resources away from forward integration efforts. Another integration type is called systems selling, which is based on *balanced* integration and means that a company chooses internal system development to produce many or all components of the system and combine them into a tailored solution to the market (Davies et al., 2007). Balanced integration is a combination FIV and BIV. One example of smart systems selling is to have a basic modular system of components that can be easily configured and reconfigured for a variety of customer needs. In this way, suppliers can combine the cost advantages of producing standardized product components with high flexibility in system design (Mattson, 1973).

For NTBFs that lack resources, vertical integration is not a very common approach since it's based on a business model for the supply of products and services as integrated solutions. Tackling an area outside of the NTBF's expertise might be risky; the firm needs to acquire capabilities far beyond the basic strengths of their core business (Kathryn Rudie Harrigan, 1986). However, sometimes no other way is possible since the market is not established yet, or it fails. This means that supply chains and distribution networks may be undeveloped or risky. Kathryn Rudie Harrigan (1986) posits that in young industries firms may need to integrate forward to create channels of distribution.

"An idea is to build an experience centre. Another idea is to drive around the country and transport the products to customers. However, this costs a lot of money and a requires a different kind of business." (NTBF8)

"The start-up invests, builds and operates their own machines and provides a service to customers." (REPORT1)

"Uncertainty that arises when a start-up moves first to a market in terms of undeveloped supply and distribution networks can be a threat." (REPORT6)

INTER-FIRM COOPERATION

Lots of partnering and inter-firm cooperation is used to deal with the challenges that NTBFs face, such as a lack of capital. *Inter-firm cooperation* is used to strengthen the market position and gain access to valuable (human, capital, social) resources and competencies (REPORTS[2, 3, 6]. Also, these alliances enable to share risk and improve credibility. Other motivational reasons are mandated, formation, cost minimisation, learning and strategic positioning (Keil, 2000).

"Collaboration with market parties is essential for survival. Large companies have certain resources (knowledge, funding) with which new firms can never compete." (NTBF2)

"When collaborating and building long-term relationships, it's essential that partners have some knowledge or resources that we don't have." (NTBF9)

Collaborating with experienced partners enables to deal with the industry's challenges (REPORTS[2,4]). The research of Yli-Renko, Sapienza, & Hay (2001) suggests that by relaxing formal contractual mechanisms governing a relationship, NTBFs can derive benefits from key customer relationships that are characterized by a high level of dependence.

BACKWARD AND/OR FORWARD STRATEGIC ALLIANCES

Instead of insourcing activities by integrating them in the company, a firm can make use of backward and forward alliances. This means that companies can realize the gains associated with vertical integration without having to bear the associated bureaucratic costs. Backward and forward strategic alliances are often based on long-term supply contracts, co-production or distribution agreements between two companies. Both make a commitment to work together and seek ways of lowering the costs or raising the quality of inputs into the downstream company's value-creation process. An ideal strategic alliance is one where both parties are mutually dependent.

"Collaboration with the industry is essential in growing your company. In the beginning, we collaborated with SME's. Yet, later we changed to multinationals for strategic alliances." (NTBF4)

"We make use of collaborations to strengthen our market position" (NTBF9)

EXCLUSIVITY AGREEMENTS

Exclusivity is sometimes used to establish collaboration with large customers. Most of the time, these large companies don't have the technical know-how in-house to develop the technology themselves, but they still want to use the technology to gain a competitive advantage (REPORT6). Exclusivity can help when the technology is still risky, and a launching customer is sought.

"We established a very nice collaboration with a large customer, who gets some exclusivity. We can't collaborate with other parties without involving this partner. This gives us some advantages, while we are dependent on the resources of this partners when it comes to the execution and operational part of the inspection. The collaboration enables us to deliver a turnkey solution to the end-user." (NTBF2)

"We established a partnership with a launching customer based on exclusivity for a certain period within a certain area." (NTBF9)

In some cases, an exclusive deal can be a burden that prevents the NTBF of becoming the new dominant design in the market. For instance, when the exclusive partner only has a small share of the market and competitors start to develop similar products in the meantime. Exclusivity is useful when the technology is still risky, and a launching customer is needed. To stimulate high growth, exclusivity should be used when this customer has a large share of the market, or when the company has no ambition to stay within the certain market segment or region within the licensee period.

"We are very careful with exclusivity deals. When giving exclusivity to a partner other market parties will soon get to know. They will start developing similar products while in the meantime, our company will be stuck with one exclusive partner." (NTBF6)

"We are open for profit sharing models, but there should be a clear advantage. For instance, the other party should employ expertise, knowledge and funding" (NTBF2)

EQUITY STRATEGIC ALLIANCES

Several traits explain the transaction cost differences between equity arrangements and non-equity arrangements (Colombo, 1998). Equity arrangements include joint ownership, ex-ante commitment of resources, formation

of a specialized organizational unit with responsibility for control and coordination. Three forms of equity alliances exist: joint ventures; minority stakes; and cross-shareholdings. While joint ventures involve the creation of a separate new entity and not all joint ventures are equity based (De Man, 2013), this type of collaboration is considered separately (see sub-paragraph below). Minority stakes and cross-shareholdings can be used when a NTBF is in finance need. Cross-shareholding constructions may result in a complex network of indirect relations of ownership (Dietzenbacher & Temurshoev, 2008). An equity strategic alliance reduces the incentive to compete, enhances control and makes takeovers more difficult, reducing the risk of the large partner that a competitor takes over the NTBF.

“High R&D costs are handled by a strategic alliance that contributes in the initial development expenses in return for a percentage minority stake.” (REPORT6)

JOINT VENTURES

Joint ventures involve the creation of a separate new entity (De Man, 2013). Joint venture partners provide financial capital and other resources to the newly created firm, which typically has its own management team reporting to a board composed of representatives from the joint venture partners. Joint ventures can be both equity (EJV) as contractual based (CJV). In case of the interviewed NTBFs, joint ventures are considered, yet, not often executed. Large companies may desire to take over or share the proprietary technology, which most NTBFs don't want. In practice, joint ventures are used more frequently to reap economies of scale, to share the risks associated with big projects, and to gain access to foreign markets than for R&D and innovation (De Man, 2013).

“We had the option to start a joint venture, however, the other company did not want to share all information; there was a clear lack of trust.” (NTBF1)

“Instead of focusing on joint ventures with starting companies, the company currently focuses on strategic alliances with multinationals since these have money to spend.” (NTBF6)

TECHNOLOGY TRANSFER

A NTBF might choose to transfer its technology by having a business model based on IP. This means that the NTBF doesn't develop or produce the product internally but will receive a revenue stream that can be used for investments in R&D (REPORT1). However, licensing a patented technology to companies offers little opportunity for the development of new capabilities in the long run (REPORT1). In addition, NTBFs are often passionate about their own technology and want to keep their IP (including patents, copyrights and trade secrets) in their own hands. Also, when the founding team is entrepreneurial it will most likely have a clear vision about what they want to do with their technology. Only licensing technology and generating some small revenues may not meet their ambitions.

“Having a business model based on IP was expected to be less profitable in the long-term.” (NTBF1)

“It is essential to keep the IP (copyright and trade secrets) in our own hands. Some parties want to collaborate and take over all technology, which is not an option.” (NTBF2)

“We choose not to license our technology.” (NTBF6)

SYSTEM INTEGRATION

Another strategy is to become a system integrator, which means having a business model based on the components supplied by external firms, which are coordinated and integrated by the system integrator who faces the end-customers. A service-based system integrator emphasizes the advantages of specialization and modularity in component supply, standardization of interfaces, and the ability to specify and integrate multi-vendor sources of technology and product supply (Davies et al., 2007). At the other side, being a system integrator demands quite extensive knowledge of business and complex management of stakeholders, contracts, customer involvement and so on, where the business depends highly on subcontracting. For NTBFs with monodisciplinary engineering teams, this might not be the ideal first business.

A new type of business is integrating systems by using IT platforms. Blockchain technology offers new possibilities for this kind of system integration. The effectiveness and value of an IT platform is directly correlated with the number of end-users (consumers and suppliers). An IT platform can eliminate intermediaries, market failures and industrial market power by using open and available information.

*In our platform, we use the input of all stakeholders to find a system solution by using blockchain technology”
(NTBF10)*

SYNTHESIS

Table 7 shows the synthesised data as discussed in the paragraphs above and Appendix C, by listing all strategies including their descriptions. The last column shows the references used to identify the strategies. These strategy options will serve as input for the conceptual framework (Figure 7), wherein they will be matched with strategic tactics and external and internal variables that influence strategy making.

FIGURE 7: FEASIBLE STRATEGIES

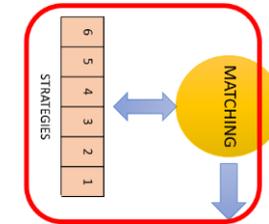


TABLE 7: STRATEGY OPTIONS FOR NTBFS BASED ON LITERATURE, REPORTS AND INTERVIEWS

	Strategy	Description	References
Vertical integration	Systems selling	A business model for the supply of capital goods based on the provision of products and services as integrated solutions to individual customer's needs. Finding new ways to segment an existing market by differentiating products and services (Davis & Olson, 2008)	(Davies et al., 2007), Davis & Olson (2008), (Mattson, 1973)
	Backward integration	Involves the purchase of, or merger with, suppliers up the supply chain; moving backward in the industry's chain to include intermediate goods.	(Acemoglu et al., 2010), (Mcdougall & Robinson, 1990)
	Forward integration	Manufacturing firms are achieving this by integrating forward into service-based activities previously undertaken by their customers—large business or government-owned agencies. Use own distribution channels to carry products to the end-consumers. Execute external marketing and after-sales services.	(Mcdougall & Robinson, 1990), NTBFS
Inter-firm cooperation	Backward and/or forward strategic alliances	Used to strengthen the market position and gain access to valuable (human, capital, social) resources.	NTBFS[4,6,9] REPORTS[2,3,4,6]
	Exclusivity	Deliver product exclusive to strategic partner, combining skills and resources. Farsighted contracting that blocks another firm's capture. Strategic partner is delivering solution to end-user. Business model of NTBF is selling products including a royalty fee. Right of first refusal and/or minimum off-take.	REPORT6, NTBFS[2, 6, 9]
	Joint ventures	Combining skills and resources by strategically forming a business together with a partner. Can be equity or contractual based. Both technological as commercial (sharing) agreements.	(Colombo et al., 2006), (M. Wright et al., 2004), NTBFS[1, 6]
	Equity strategic alliances	Including minority stakes, cross-shareholdings and equity joint ventures.	(Colombo & Grilli, 2005), (De Man, 2013; Dietzenbacher & Temurshoev, 2008)
Technology transfer	IP-based	Contractual models used to license the technology to other companies. Generating revenues by royalty fees per product or per service used.	(Chesbrough & Rosenbloom, 2002), (Kollmer & Dowling, 2004), NTBFS[1, 2, 6], REPORTS[1, 6]
System integration	Service-based	Operating as prime contractor organization responsible for the overall system design and integrating product and service components supplied by a variety of external suppliers into a functioning system (Davies et al., 2007).	NTBFS[9, 10], (Davies et al., 2007) (Treacy & Wiersema, 2003)

4.4 TACTICS

Strategic tactics utilize specific resources to achieve sub-goals that support the defined mission. Tactics are used by all NTBFs to deal with the shared challenges that they face: lack of resources, long lead times, a high level of experiment and risk, complexity of the product and a need for highly skilled employees. Using these tactics can help to enhance the competitive position. Table 8 summarises all tactics that were identified in the data analysis (Appendix C), where some of them are confirmed by literature.

AGILE TECH APPROACH

A tactic often used by NTBFs is to have an *agile tech approach*. This means that the technology is developed from simple to complex, where a first product is brought to the market as fast as possible. An agile tech approach enables to generate revenues and traction by starting with a relatively simple (test product) with a shorter development time.

“We are trying to generate revenues by starting with relatively simple (test) products with a shorter development time. This enables to get some traction and revenues to invest in further development of the technology.” (NTBF5)

“We aim to have a basic system (core product) to which several components can be added in a modular way (plug-and-play) based on customer needs. This adaption in strategy decreases the development time per solution significantly.” (NTBF9)

An agile tech approach enables to generate revenues and traction by starting with a relatively simple (test product) with a shorter development time. The tactic can be used for both hardware as software developments and is extremely useful when the company wants to grow in an organic way. To convince industry that it's worth adapting, the technology must be proven first.

“We must proof that our technology works to convince industry that it's worth adapting” (NTBF7)

Also, it's expected that the real learning process begins after the first product has entered the market. Installation and manufacturing costs are often underestimated, while most founding teams do not have a lot of experience in industry.

“The intermediate product allows to enter the market after which the real learning process begins.” (NTBF8)

In addition, customer needs may turn out to be different than expected. An agile tech approach enables to apply a trial-and-error process for the technology and business development. A so called intermediate product can be used to make the next step towards the end-product with the help of market feedback. When volume increases along the way, extra modular (customized) components can be developed based on the needs of the customer. This guarantees revenues and is making sure that every development step is paid.

“Based on the prototype, an intermediate product was designed that forms a nice first step towards the envisioned end-product” (NTBF8)

MINIMIZE HARDWARE RISK

A tactic which is often used by NTBFs is to *minimize the hardware risk*. Developing technology takes time and involves a lot of experiment and trial-and-error. The more components a start-up develops, the more risk it

takes. Often, off-the-shelf components are used, and core activities are outsourced as much as possible. This allows the company to focus on their key strength and expertise.

“An essential part of our strategy is to minimize the hardware risk.” (NTBF3)

“The strategy is to “not invent the wheel again”. If possible, components are bought off-the-shelf.” (NTBF9)

SERVICE ORIENTATION

Another way to minimize the risk is to start with a high *service orientation*. When starting as an advisory or consultancy company, the NTBF can slowly generate traction, get to know the industry and build up their company and resources, before changing to a hardware orientation. The study of Aspelund et al. (2005) found that NTBFs with a high degree of service orientation seem to have a greater probability of survival than product oriented firms. By generating revenues with a service business model, NTBFs can deal with long lead times.

“We started as a small engineering advisory firm. After a while, we began to sell manufacturing machines.” (NTBF4)

“Due to our long lead time, we started with engineering consultancy projects to generate revenues, built up technical know-how and traction” (NTBF7)

“Since our company develops a service, our biggest costs are labour costs where we (almost) do not have to buy any materials.” (NTBF9)

OUTSOURCING/INSOURCING

The *make-or-buy decision* is a decision that every NTBF encounters. While the NTBF will probably outsource as many organizational (HR, accountancy) and administration activities as possible in the beginning, it may not have the resources to do so. Some NTBFs try to outsource their development, where others try to outsource their sales. The research of Leiblein & Miller (2003) indicates that firm-level capabilities and strategies independently and significantly influence firm’s vertical boundary choices. Strategic partnerships are established with suppliers to get costs down. In other cases, R&D teams are being insourced in exchange for equity to increase the value of the company and decrease development costs (by paying the team based on costs instead of value).

“We decided to outsource the development of the user interface software. This turned out to be very expensive, but just didn’t belong to the core activities of the company.” (NTBF2)

“The “make-or-buy decision” clearly plays an important role for our go-to-market strategy. Our sales are outsourced by collaborating with dealers, who take 30 to 40% of the profit.” (NTBF8)

“For the development of our technology, we insourced another company in exchange for equity.” (NTBF10)

TECHNOLOGY-PUSH/MARKET-PULL

While it’s common to start with a *technology-push* approach, most NTBFs shift to a *market-pull* approach after doing their market analyses and validation. Based on pivoting, the product, service and business model may change along the way and the strategy is iterated constantly with market and customer feedback.

“We developed a technology by using a technology-push model. After a while, we found that there was no money and a lack of commercial value in the specific industry for technology development. Accordingly, we had to look for other applicable market segments.” (NTBF2)

“The two founders maintain a clear market-pull strategy: first define and validate a problem and then find a solution for that problem. Pivoting is used to iterate their strategy.” (NTBF10)

FOCUS AND TARGET FLEXIBILITY

Focussing, both technology as market wise, allows the NTBF to have a very specific specialization with which it can compete with large corporates. A focus strategy aims at growing market share through operating in a narrow market or niche segment more effectively than larger competitors. Focusing allows the firm to direct its resources to certain value chain activities to build its advantage. When having a lack of focus, this can lead to a very long run up-to the first market ready product. A strategic focus on certain industries and markets is needed to offer a clear proposition to the market, where customer needs may differ widely per segment. However, when a standardised product can be sold to different market segments, the company should be flexible with their target groups to adapt when opportunities arise (REPORT4).

“Except for some small PR projects, our product is very focused on these industries only, offering a clear proposition to the market.” (NTBF1)

“We should focus on our key strengths and core activities” (NTBF8)

“We find it hard to balance between small projects and developing the core product.” (NTBF9)

NICHE MARKET AND LAUNCHING CUSTOMER

To prove the technology, it can help to start within a *niche market* with favourable environmental conditions (REPORT5). In addition, industries’ conservativeness can be bypassed by engaging in component applications rather than focusing on large markets directly (REPORT2).

“We decided to focus on one or two niche markets to prove our technology.” (NTBF3)

A *launching customer* can help to proof the technology and build the company. A proof-of-principle, proof-of-concept and prototype can be developed for the launching customer, after which the product or service is standardised and prepared for economies of scale.

“We are working on one product for one launching customer with which we already did some testing.” (NTBF5)

“A launching customer will be needed to bring the technology to the market.” (NTBF6)

“We established a partnership with a launching customer. This customer helped with building our company.” (NTBF9)

INTELLECTUAL PROPERTY

Patents, trade secrets and copyrights are used to protect *intellectual property*. Most NTBFs choose to maintain a clear IP strategy.

“We use patents and trade secrets to protect our intellectual property.” (NTBF7)

“We want to keep our IP in-house in collaborations.” (NTBFs[1, 2, 9])

PRICING

Pricing can be used as a strategic tactic for increasing the revenues. Penetration pricing can be used to increase the overall market share (REPORT6). A cost-plus pricing model can be used when costs are not known yet, for instance in a first partnership with a launching customer. Another method is to start immediately with pricing based on value. However, finding the exact value of a new product can be a challenge. When pricing on value, you want to get the cost price as low as possible, which will happen when economies of scale are reached. Yet, you only get economies of scale in terms of demand when you have a low-cost price. This is a circle that must be broken by establishing smart pricing methods.

“The price of our product is based on its value rather than costs. When volume increases, the price will go down.” (NTBF8)

MARKETING

A strategic tactic that is used by every company is *marketing*. For NTBFs specifically, marketing can enable to attract pioneering customers. Marketing stunts and storytelling can attain media attention (REPORT6). Joining programmes, fairs and events can help with brand awareness. Visual attractiveness of the product can also be used as a marketing instrument.

“Pioneering customers were inspired and attracted by the product its appearance. Visual attractiveness of our product turned out to be an important marketing instrument.” (NTBF1)

“Our technology is quite hot and up-to-date in terms of market trends, which assists our company with its marketing and communication.” (NTBF10)

NETWORK

A *network* is an important tool to build relationships with potential partners and clients and to find out their true needs.

“Winning the trust of your customers and partners is very important to grow a high-tech start-up.” (NTBF4)

“Building relationships with potential partners and clients to find out their true needs is of key importance for the company.” (NTBF7)

COMPANY ENTRY

Tactics should be used to *enter companies*, while the network of young NTBFs may not be capable of reaching towards the highest level of management. A different approach is needed for different departments of a company.

“We combine approaches to enter companies; through senior management and through R&D management. Senior managers are often less scared for failures than the R&D managers. However, entering through R&D gives some opportunity to emphasize technical superiority.” (NTBF7)

FORMALISATION DECISION-MAKING

The level of *decision-making formalisation* can be used in a strategic and tactical way. Some NTBFs maintain a clear structure for functions and responsibilities, where others maintain a low level of formalisation to encourage innovative and creative thinking (REPORT3). The research of Kazanjian (1988) indicates that higher

performing ventures demonstrate, in general, greater formalisation and functional specialization and less centralisation as the firm progresses through stages. In the beginning, a consensus model is often used to make decisions, often resulting in very time consuming and inefficient decision-making processes. Along the way, the managers will implement some tools to make their decision-making process more efficient. Decision-making tools are used to evaluate new projects according to certain, predefined criteria. This helps to strategically focus in terms of organization, value proposition and target market. The interviewed NTBFs all supported the relevance of shared leadership, which underpins previous work such as the research of Patton & Higgs (2013).

“Our board uses a consensus model.” (NTBFs[3, 5, 6, 8])

“Until October last year, we used a consensus model for the decision-making. Now, only the CEO is competent and responsible for the commercial decisions.” (NTBF2)

“Decision-making is formalized. We use a decision-making tool for new projects. In evaluating new projects, the costs, generated value and technical feasibility are analysed.” (NTBF9)

“We have different responsibilities and interests, yet, no clear function within the team. We both use the title “founder”.” (NTBF10)

EMPLOYMENT

How to manage *employment* can also be part of the strategy. Where resources are often lacking, task-based employees or interns are hired based on their capabilities and educational background. In this case, the functional specialization of team members will be high. In other cases, NTBFs choose employees based on their commitment, mindset and motivation. This might work better in case the strategy is still being formed and employees with certain skills might become unneeded.

“New employees are hired based on their commitment.” (NTBF1)

“People are not hired because of their capabilities or education, they are hired because of their mindset and motivation to contribute to our company and ambition.” (NTBF10)

FUNDING

Funding is a very important part of strategy. All NTBFs struggle with a lack of capital due to high R&D costs, where these R&D costs are caused by long lead times. The start-ups that are developing hardware must carry the burden of material costs in addition to the very high labour costs. Some companies grow organically where some choose to have external investors with a minority share. Others choose bank financing and small family, friends and fools (3Fs) funding rounds, crowdfunding, partnerships or so called initial coin offerings (ICOs). Convertible loans can be an option, however, if an investor will be closely involved in the decision-making these loans might result in a conflict of interest. Subsidies are often used to finance the technology development. *Smart money* can contribute to both the financial as the operational part of the company.

“We have 10 informal, minority investors.” (NTBF8)

“Investors were essential for our survival. They do not only help with funding, but they also give legal and business advice and some coaching. Because of the investors, the value of the company rose significantly. Moreover, the investors have a broad network which enables to find new investors.” (NTBF2)

“In the beginning, we were able to finance our activities and growth organically by using bank financing and investments of the founding team. Later, we used equity finance to scale up.” (NTBF4)

“Currently, we are making the company ready for an investment round. We prefer convertible loans over equity finance.” (NTBF5)

“The founders did a small 3F financing round to start with.” (NTBF6)

“The company is still owned for more than 80% by its founders. To fund our development, we mostly focus on convertible loans. Also, 9,5% of equity finance is involved.” (NTBF7)

“Investors are welcome when the product is finished to enable our company to scale up.” (NTBF9)

“We set up an ICO roadmap for our funding rounds with which we are going to raise millions of euros capital. Currently, we are building a prototype to convince investors and reduce their risk.” (NTBF10)

The research of Presse & Terzidis (2018) observed different strategies from NTBFs for the first financing round compared to the following rounds. At first round, entrepreneurs may be divided in two categories. On the one hand, those who chose to create a firm with minimum fund and, on the other hand, those who chose to build a financing platform by attracting equity investors. The former wants to focus on first sales and preserve ownership while the latter wants to accelerate development and get guidance on strategic issues. After this first round, they however all tend to prefer non-dilutive sources such as grants or debts (Presse & Terzidis, 2018).

CO-CREATION

Co-creation refers to collaboration with customers for the purposes of innovation and has become a foundational premise of the service-dominant logic (Lusch, Vargo, & O'Brien, 2007). When co-creation is used, the customer becomes a co-developer, which reduces the market entry barrier. Co-creation or co-development can help a NTBF to understand the problems that the end-users are facing, especially when professional, industrial experience is lacking. In addition, co-creation can be used as an education tool to make customers ready for technology adoption. When developing an innovative, high-tech product for a conservative customer, the customer may not be able to implement the product in its processes by itself or may not be ready for the technology. The employees of these customers must learn how to work with the new technology. In addition, co-creation can be used as a tool to win the trust of customers and to involve the resources (e.g. knowledge) of customers.

“To win the trust of customers, it can help when a plan is being developed together with the customer. Also, it helps to be transparent about the problems that are faced.” (NTBF4)

“We need very specialized domain-specific knowledge for which we need the help of the client. After building our product, we provide the customers tools that they must make their own.” (NTBF9)

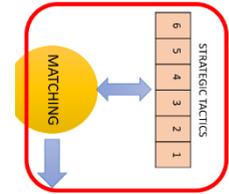
SYNTHESIS

Table 8 shows the synthesised data as discussed in paragraph 4.4, by listing all tactics including their descriptions. The last column shows the references used to define the tactics. The tactics listed in Table 8 will be used in the conceptual framework (Figure 8), wherein they will be matched with strategies and variables.

TABLE 8: STRATEGIC TACTICS FOR NTBFS BASED ON LITERATURE, REPORTS AND INTERVIEWS

Tactic	Description	References
Agile tech approach	Develop technology from simple to complex, where a first product is brought to the market as soon as possible.	NTBFs[5, 7, 8], REPORT2, REPORT3
Minimize hardware risk	Use off-the-shelf components and outsource activities to minimize experiment and development time.	NTBFs[3,9]
Service orientation	Generate short-term revenues with a service (advisory/consultancy) business model to fuel long-term growth.	NTBFs[1, 4, 6, 7, 9]
Outsourcing / insourcing	Make-or-buy decision based on transaction costs.	NTBFs[2, 5, 8, 9, 10]
Technology-push / market-pull	Use key strengths and core technology to find most suitable market and customer; customize technology.	NTBFs[2, 5, 10]
Focus	Offer a clear, focused proposition to one market, where customer needs may differ widely per segment.	NTBFs[1, 8, 9, 10], Murray (1988)
Target flexibility	Be flexible with target groups to adapt when opportunities arise.	REPORT4
Niche market	Start in niche market with favourable conditions.	NTBF3, REPORT4, REPORT5
Launching customer	Find a launching customer to proof technology.	NTBFs[5, 6, 9]
Intellectual property	Maintain a clear IP strategy.	NTBFs[1, 2, 7, 9], REPORT4, REPORT6
Pricing	Premium pricing based on exclusivity and value.	NTBF8, (Beard & Easingwood, 1996; Hultink, 1997; Hultink & Schoormans, 1995)
	Overall cost leadership used to maximize short-term revenues by penetration pricing.	Porter (2004), REPORT6
Marketing	Use marketing (stunts) and visual attractiveness of the product to attract pioneering customers and attain media attention; use internal marketing to improve external marketing; educate consumers.	NTBFs[1, 6, 10], REPORT6, Möller (1999), (Akan et al., 2006)
Network	Build relationships with partners and clients and validate markets, customers and business model.	NTBFs[1, 4, 7], REPORT6
Company entry	Enter companies based on the objective enter through R&D when the desire is to do tests together, enter through senior management for partnerships, enter through PR for marketing stunts.	NTBF7
Formalisation decision-making	Clear structure of functions and responsibilities; models and tools used to make decisions more efficiently.	NTBFs[1, 2, 3, 5, 6, 7, 8, 9, 10], REPORT3, (Patton & Higgs, 2013), (Kazanjian & Drazin, 1990)
Employment	Adapt employment strategy based on envisioned organizational form.	NTBFs[1, 10]
Funding	Adapt funding strategy based on envisioned organizational form and use smart money.	NTBFs[1, 2, 4, 5, 6, 7, 8, 9], (Presse & Terzidis, 2018)
Co-creation	Using user involvement to facilitate market-oriented product development by collaboration.	NTBFs[4, 9], (Kristensson, Matthing, & Johansson, 2008), (Shan, 2016), (Lusch et al., 2007)

FIGURE 8: STRATEGIC TACTICS



4.5 DECISION CRITERIA

Strategic decision-making is generally influenced by the personal characteristics of the founders, the organizational characteristics and environmental characteristics (Montiel Campos et al., 2015). The decision criteria used by managers of NTBFs based on the interviews and literature are summarized in Table 9. These criteria are used to make strategic choices for the product/service to deliver, the market to penetrate, the customer to approach, the business model to be used, finance decisions, location decisions and so on.

AMBITION

For most firms, the vision and *ambition* are leading decision-making.

“The vision, ambition and mission were always leading.” (NTBF1)

“Our ambition is to become the new global standard.” (NTBF10)

Growth orientation was mentioned in the research of Yli-Renko, H., Autio, E., & Tontti (2002), which takes into account the effect of growth orientation on international growth of NTBFs. Also, the research of Onetti et al. (2012) states that strategic decisions of NTBFs are characterized by a deep interrelationship amongst the processes of internationalisation, innovation and entrepreneurship. Since growth orientation was not specifically mentioned in any interview, it's considered to fit under the criterium *Ambition*.

VISION

Having a long-term *vision* and planning helps the NTBFs to focus.

“Decisions are made based on the corporate vision and personal motives of the managers.” (NTBF2)

“Our vision had always been to become a manufacturing company.” (NTBF7)

“The long-term vision and planning helps us to focus.” (NTBF8)

In some cases, a NTBF has a very clear end-goal in terms of the product or service they want to deliver to the market. In other cases, a clear vision would frame the company too much.

“We use a vision-oriented approach for our product design.” (NTBF8)

“We make decisions based on the problem that we want to solve. The problem matters more than the way of execution. Having a vision based on a solution would frame our company too much.” (NTBF10)

YEAR PLAN

NTBFs maintain a *year plan* and roadmaps to which they try to stick at all times. This plan is influenced by the market, the technology, the vision, the team and the core values of the company.

“The management team has written a year plan to which they stick at all times. This also causes the company to say no to some assignments.” (NTBF2)

“The year plan is always leading.” (NTBF8)

“A project is only chosen when it fits the roadmap.” (NTBF7)

CORE VALUES

The research of Baron & Hannan (2002) showed that even though companies can be concentrated in the same industries, located in the same part of the country and founded by a set of people who are tightly connected by

virtue of the labour mobility, dense social networks (as is the case in Silicon Valley), founders embrace very different mental models of the ideal organizational form for a technology start-up. The *core values* of a NTBF can influence the HR strategy (Baron & Hannan, 2002), the funding strategy and the organizational form. Establishing core values can help to create a nice work environment in which everyone acts according to certain rules and policies.

“At all times, it is essential that a start-up makes decision according to its core values. Making choices according to the core values increases the decision speed significantly, while no discussion is possible about things that do not match with the core values.” (NTBF1)

COMMERCIAL VALUE

The *commercial value* is always considered, for which the external environment is analysed. Commercial value can be a reason to amend the roadmap.

“The commercial value of a project is a very important decision criterion.” (NTBF2)

“This product includes recurring revenues, which was a precondition for us to continue.” (NTBF5)

“We investigate where large investments are going, and which customers have money to spend.” (NTBF9)

“We maintain only one reason to execute a project which doesn't fit our vision, which is that we can generate a significant amount of money with it.” (NTBF9)

CAPACITY IN-HOUSE

The *capacity* (e.g. team availability and technology) in-house is considered when making decisions. The technical know-how of the team can play a role in decision-making too. The capacity in-house is very much depended on the age and size of the company.

“In all cases, decisions should be made based on the capacity of the in-house technology” (NTBF2)

“the capacity (e.g. team availability) constraint should be considered. The ambition is to add one engineer per project. At the most, we run two projects in parallel.” (NTBF7)

“Factors that are influencing our strategy making are the team, financials, customers, people and the organization” (NTBF5)

SHAREHOLDERS OPINION

The research of Davis & Olson (2008) discusses eleven factors that influence strategy making in start-ups, including *investor expectations* and *shareholder/investor risk tolerance*, which shows the importance of shareholders opinion in making decisions. For the start-ups that already have external investors, the shareholders that participate in the board are influencing the decision-making.

“The shareholders are influencing our decision-making” (NTBF4)

PR VALUE

PR Value is considered when making decisions. Sometimes, projects are executed purely for their PR value. However, most of the time projects are executed because they fit within the roadmap and year plan.

“Except for some small PR projects, our product is very focused on these industries only, offering a clear proposition to the market.” (NTBF1)

“In case the project isn’t self-funded, then at least it should allow the team to learn something new or it should have PR value” (NTBF7)

TECHNOLOGY

Since most of the founders are engineers with a passion for *technology*, they are less interested in low-tech projects. Regarding the make-or-buy decision, most founders are interested in building high-tech products themselves, rather than only commercializing technology. Also, being innovative and radical will help to attract talented team members. However, when the NTBF founders have a background or some experiences in business or entrepreneurship, they give the expression that they are more interested in the (long-term) commercial value than in the technology itself.

“We mostly use three decision criteria: commercial interest, the interests of the employees and the passion for technology.” (NTBF5)

“Three important factors influence our strategy making: commercial interest, making people happy and technical superiority.” (NTBF6)

CUSTOMER

All NTBF’s are very focused on the *customer’s* opinion and needs that are leading almost every decision.

“The customers are king, and your proposition should meet their needs.” (NTBF1)

“The customer’s opinion and needs are leading every decision.” (NTBF4)

“We focus very much on the end-user in our decision-making. The end-product design might be adapted based on the customer feedback” (NTBF8)

“We are extremely customer driven. We started our company by developing customized technology. When a decision is made, the decision is validated with the customer.” (NTBF9)

SYNTHESIS

Table 9 shows the synthesised data as discussed in paragraph 4.5, by listing all decision criteria that are used for strategy making in NTBFs. The last column shows the references used to define the decision criteria. The list of criteria gives an indication of what kind of factors influence the final decision for which growth strategy will be executed by a NTBF (Figure 9).

FIGURE 9: THE DECISION CRITERIA ARE USED TO MAKE THE FINAL DECISION REGARDING THE GROWTH STRATEGY TO BE EXECUTED

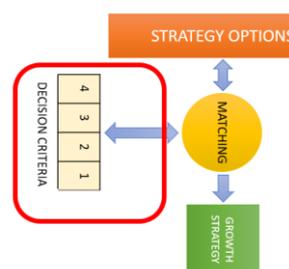


TABLE 9: DECISION CRITERIA THAT ARE USED BY MANAGERS OF NTBFS

Decision criteria	Description	References
Ambition	Quantified, concrete goals and objectives. Growth orientation included: Does the company want to scale up exponentially? Does the company want to target global markets?	NTBFs [1, 4, 10] (Yli-Renko, H., Autio, E., & Tontti, 2002)(Onetti et al., 2012), (Coeurderoy & Murray, 2008)
Vision	Corporate vision and personal vision for the company, both in the short-term as the long-term.	NTBFs [1, 2, 7, 8, 9, 10]
Year plan	Year plan, milestones and roadmap should be considered in every decision.	NTBFs [2, 7, 8]
Commercial value	Short-term and long-term value. In terms of cash, PR value and impact.	NTBFs [2, 5, 6, 7, 9]
Capacity in-house	Team availability: enough employees to execute a certain project?	NTBFs [2, 5, 7]
Core values	Consider the values of the team. Ideal organizational form included (bureaucratic, flat, hierarchy).	Baron & Hannan (2002), NTBFs [1, 2]
Shareholders opinion	When external investors and/or advisors participate in the board.	(Davis & Olson, 2008), NTBF4
PR Value	PR can help in establishing partnerships and get new customers.	NTBFs [1, 7, 8]
Technology	Since most of the founders are engineers with a passion for technology, they will be less interested in low-tech projects. Founders must decide if they want to make or buy. Being high-tech or low-tech will influence the team.	NTBFs [5, 6]
Customer	In the end, the customer’s opinion and needs are leading.	NTBFs [1, 4, 8, 9]

4.6 FRAMEWORK

Based on all data analyses and the building blocks as discussed in paragraph 4.1-4.5, a conceptual framework was build that can be used by new technology-based firms to select a suitable growth strategy (Figure 10). The following steps explain how to use the framework:

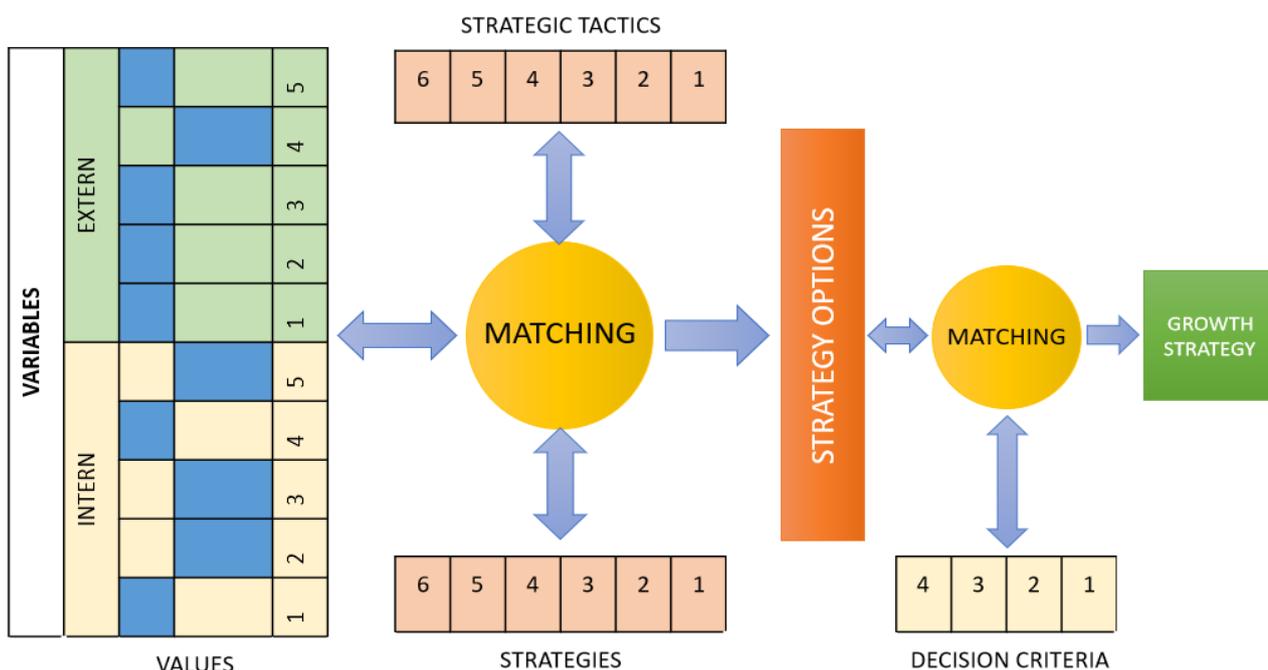
1. For each internal and external variable, a contrasting, suitable value is chosen. This results in a *path of value combinations* (see “blue” cells on the left side of Figure 10);
2. A matchmaking process will take place in which the blue path is matched with suitable strategic tactics and strategies (“matching stage 1”). This results in some *strategy options* that seem suitable for the NTBF in its specific situation;
3. The strategy options are matched with the used decision criteria maintained by the management of the NTBF (“matching stage 2”). This results in a most suitable *growth strategy*, including strategic tactics that can be implemented by the NTBF.

Some considerations were made while designing this framework. The first is to use antonyms for the values of variables, which allows to simplify the situation. It’s assumed that a manager of NTBF has all the information it needs to decide which contrasting value fits the NTBF more than the other. The second consideration is about tech-push or market-pull approaches. As discussed in chapter 3, these approaches should be merged. Therefore,

internal and external variables are considered simultaneously. Another consideration is the use of both double-headed and single-headed arrows. The matching process is an iterative process by going back and forward between different building blocks. However, after strategy options are defined and one moves to matching stage 2, focus should be maintained by not moving back to matching stage 1. There is a chance that the chosen strategy options do not match with the decision criteria. In this case, the decision criteria might be changed or, when these criteria serve as constraints, one might move back to matching stage 1, changing internal (e.g. change team and/or value proposition) and external (e.g. change industry) variables so that other strategic tactics and strategy options can be matched.

The framework was designed by having contingency theory as the overarching theme. Not only is every strategy and tactic contingent to the internal and external environment, the decision for the growth strategy is contingent to the decision criteria maintained by the NTBFs. The two matching stages enable to make a *fit* between strategy and its context. Cognition biases are limited by using extreme values of the influencing internal and external variables.

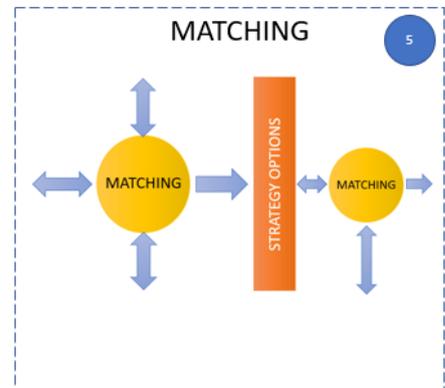
FIGURE 10: CONCEPTUAL FRAMEWORK THAT CAN BE USED BY NEW TECHNOLOGY-BASED FIRMS TO SELECT A GROWTH STRATEGY



5. MAKING THE MATCH

To assist in matching stage 1, this chapter uses logical reasoning supported by the theoretical background discussed in chapter 3 and the data analysis discussed in Appendix C: Data analysis to match external and internal variables with strategies and tactics. The outcome of this chapter will be an overview of matches between specific variables, strategies and strategic tactics. First, logical combinations of variables called *clusters* are identified. Second, strategies and tactics are linked with clusters and variables. All results are summarised in a final matchmaking table (Table 11).

FIGURE 11: SCHEMATIC OVERVIEW OF MATCHMAKING STAGE 1 AND STAGE 2



5.1 COMBINATIONS OF VARIABLES

The lists of variables that are defined in Chapter 4 can be thematised. These themes can be translated into so called *clusters* or combinations of variables. These clusters allow to reduce the amount of value combinations.⁸ It should be stated that other combinations of variables are possible too, however, are less applicable in this research. The most important reasoning behind the clustering process is discussed in the paragraphs below. Each cluster has been given a name and, in case it's suitable, a contrasting cluster is identified. The names of the clusters may confuse the reader while they are commonly used in literature where they might have different meanings. Therefore, it's essential to read this chapter carefully.

SOPHISTICATED

The *sophisticated* cluster will occur when a radical innovation has been introduced to a conservative and established market. The sophisticated cluster matches the “technology innovation” group defined by Beard & Easingwood (1996); The way in which producers see their technology may change dramatically, but the need customers perceive for the technology does not change.

<i>Innovation type</i>	Radical	Incremental
<i>Market</i>	Innovative (fast-changing)	Conservative (slow)
	New	Established

RADICAL VS. INCREMENTAL

The *radical* cluster will occur when a radical innovation is introduced in a fast-changing environment. At the other hand, incremental innovations and process improvements are introduced when rate of change in the “state of the art” is slow (Abernathy & Utterback, 1975). Regarding the “reverse product cycle” established by Barras (1986), incremental innovations are introduced in the first and second stage of the product cycle to make services

⁸ The number of total paths is simply a multiplication of the number of concepts and their values (2 values and 20 concepts = 1.048.576 path options).

more efficient and effective. The third stage is when the technology is used to create new services, making changes at this stage radical. Consequently, the *incremental* cluster is when an incremental innovation is introduced to a slow and conservative industry.

<i>Innovation type</i>	Radical	Incremental
<i>Industry/market behaviour</i>	Innovative (fast-changing)	Conservative (slow)

DIVERSIFICATION VS. STANDARDISATION

The *standardisation* cluster is when the amount of products and services are low, while the production level is standardised. Products are developed over time in a predictable manner with initial emphasis on product performance, then emphasis on product variety and later emphasis on product standardization and costs (Abernathy & Utterback, 1975). When a dominant design has occurred, a company may achieve a competitive position by focusing on the last step. Vice versa is the *diversification* cluster. By having a diversification cluster, the company might benefit from market opportunities while having a great product diversity among competitors. Diversification is one of the four main growth strategies defined by Igor Ansoff's Product/Market matrix (Ansoff, 1975), wherein it's considered to be the most risky strategy. Diversification usually requires a company to acquire new skills and knowledge in product development as well as new insights into market behaviour simultaneously.

<i>Amount of products and services</i>	High	Low
<i>Production level</i>	Standardisation/economies of scale	Low

RISKY TECHNOLOGY VS. SECURE TECHNOLOGY

A *risky technology* is a technology with a low TRL and long lead time that has not been adopted by the market yet. Vice versa a *secure technology* that is mature, easy to develop and has been adopted. A risky technology might be even more riskier when the amount of components is high and the amount of suppliers per component is low.

<i>TRL of technology</i>	Mature	Low (≤ 4)
<i>Adoption of technology</i>	Yes	Not yet
<i>Long product development</i>	Long	Short

COLLABORATIVE

When a NTBF has high collaboration capabilities in combination with an immature technology, no experience in industry and a weak financial position, the NTBF might do best to collaborate. This cluster of variables is called *collaborative*.

<i>Collaboration capabilities</i>	High	Low
<i>TRL of technology</i>	Mature	Low (≤ 4)
<i>Founding team: professional/functional experience in industry</i>	High	Low
<i>Cash</i>	High	Low

WEAK FINANCIAL POSITION VS. STRONG FINANCIAL POSITION

A *weak financial position* is when the TRL of the technology and the amount of cash are both low. It means that a budget for R&D is lacking, while material and labour expenditures must be made in order to proof that the technology is reliable. The weak financial position is also included in the *collaborative* cluster. When the

amount of cash is high and the TRL is mature, this means that a company has a strong financial position, while the company has a budget to develop and revenues will soon be generated with the technology. A *weak financial position* means that funding is needed, yet, funding might not always be available (on good terms), making the financial position of the NTBF even weaker.

Cash	High	Low
TRL of technology	Mature	Low (= < 4)

HIGH ENTRY BARRIERS

The *high entry barriers* cluster is when market power in industry is high and the market is established and conservative. Market power can have different designs, from price discrimination to monopolies to established agreements and contracts. This in combination with a conservative, risk averse industry might hinder a NTBF to enter the market.

Market power in industry	High	Low
Market	New	Established
	Innovative	Conservative

MARKET FAILURES VS. PERFECT MARKET

Market failures are a combination of market power, a lack of information while being confidential and protected and an undeveloped and thus new market. The presence of market failures make a market risky and unreliable. A *perfect market* would be an established market with no market power, no price discrimination or monopolies and open and available information and perfect competition.

Market	New	Established
Market power in industry	High	Low
Information	Open and available	Confidential and protected

HIGH MARKET POTENTIAL VS. LOW MARKET POTENTIAL

A *high market potential* means having a market with a significant size where demand is rising and the amount of potential market segments is high. Having only one market segment means a higher risk, where it might be difficult to enter this market. Therefore, a *low market potential* is when having a low amount of small, declining market segments.

Amount of potential market segments	High	Low
Market size	Large	Low
Demand	Rising	Declining

HIGH TRADING RISK VS. LOW TRADING RISK

A *low trading risk* is when the amount of customers and suppliers is high, which consequently means that both the buyers as the suppliers have no bargaining power. This is in accordance with Porter's five forces model (Porter, 1979), which states that when suppliers are concentrated compared to buyers supplier bargaining power is high and vice versa. A *high trading risk* occurs when both customers and suppliers are low.

Amount of customers	Low	High
Amount of suppliers	Low	High

HOSTILE ENVIRONMENT VS. BENIGN ENVIRONMENT

A *hostile environment* is a combination of high threat with a weak appropriability regime. Having a high threat means the presence of a threat of new entrants and substitutes and the industry's competitive structure. The appropriability regime consists of a combination of means to protect knowledge and the return of investments made on innovation (Smit, 2014). When the appropriability regime is weak, this means that the technology is easy to replicate. This doesn't say anything about the radicalness of the technology; large companies may easily copy the technology when knowing the principle behind it. A low TRL with a long road to market can make the threat of competition even higher.

<i>Competition</i>	High threat	Low threat
<i>Appropriability regime</i>	Tight	Weak

CLEAR VALUE PROPOSITION

Emphasizing the technological superiority of a new high-tech product is perhaps the most common when strategically positioning this product. Given that many high-tech buying decisions involve several people, not all of whom are specialist engineers capable of translating technical specifications into everyday benefits, a more benefit-specific positioning tactic may prove to be more successful (Beard & Easingwood, 1996). In other words, the technology should be positioned on benefits rather than features. When the technology can be patented, this means the technology is unique in the market. Combining clear benefits with product superiority and intellectual property results in a *clear value proposition*.

<i>Value proposition (VP)</i>	Clear benefits	Unclear benefits, features based
<i>Product superiority</i>	High	Low
<i>Technology can be patented</i>	Yes	No

5.2 STRATEGIES AND ENVIRONMENT

The list of strategy options that are identified in chapter 4 can be matched with the most suitable and applicable clusters and variables. It should be stated that other matches are possible too, however, are less applicable. The most important reasoning behind the matching process is discussed in the paragraphs below.

SYSTEMS SELLING

Systems selling seems applicable when the market is risky, unreliable and involves high market power. Funding is needed to offer integrated, specific solutions to the end-user for which high professional experience is needed. Systems selling can offer a competitive advantage within complex business environments.

BACKWARD INTEGRATION

Backward integration (VIB) should be used when the supply chain is unreliable or can't cope with the high growth and production level of the NTBF. This high growth is stimulated by a large market size, rising demand and/or a high amount of potential market segments (high frequency of transaction). Having only one supplier for one component can be risky. A company may choose to integrate backwards while market-like contracts may turn out to be more expensive than making the components by itself. Most of the time, professional

experience within the field is a precondition to make something cheaper than the market does. A strong financial position is needed to be able to optimise and standardise production processes.

FORWARD INTEGRATION

Forward integration (VIF) should be used when distribution channels are unreliable, undeveloped or fail. High market power in industry might result in high transaction costs when distribution is outsourced to, for instance, dealers. The important differences between VIF and BIF are that VIF is most applicable when the technology has not been adopted and the number of products and services are relatively high where the production level is low. The amount of core activities increases, where the NTBF will specialize itself in distribution, sales and possibly marketing and communication. This means that the NTBF grows by using related diversification. Defensive reasons to diversify may be spreading the risk of market contraction or being forced to diversify when current product or current market orientation seems to provide no further opportunities for growth. Offensive reasons may be conquering new positions, taking opportunities that promise greater profitability than expansion opportunities, or using retained cash that exceeds total expansion needs (Calori & Harvatopoulos, 1988).

BACKWARD AND/OR FORWARD STRATEGIC ALLIANCES

Market-like contracts between companies can help to strengthen the market position. Contracting rather than integrating is likely to be the optimal strategy when the innovators appropriability regime is tight and the complementary assets are available in competitive supply (D. J. Teece, 1986). In addition, patent holding NTBFs that have developed ready-to-use proprietary technological knowledge are considered more attractive as alliance partner than firms that are granted no patents (Colombo et al., 2006). Strategic alliances are especially beneficial when the number of components is high, and the amount of core activities is low. The alliances can help to increase the activities by contracts. By collaborating with other market parties, transaction costs can be minimised while the market can execute the activities more efficient than the NTBF. High entrepreneurial skills and collaboration capabilities are needed to establish these kinds of strategic alliances.

JOINT VENTURES

Joint ventures pay off when the founders of NTBFs lack professional experience and prior knowledge of the industry. When the technology is still below TRL 4 and has not been adopted yet and financial means are lacking, a joint venture with a large, industrial company can help to enter the market. Especially when this market maintains high entry barriers and slow market growth. According to the Grand Strategy Matrix⁹ that can be used for strategic planning, a joint venture should be used when having a dominant competitive position in a slow growth market (Hoffman & Preble, 1991). In this kind of collaboration, the patented technology is the core resource of the NTBF. Accordingly, joint ventures are applicable to university spin-outs.

⁹ The Grand Strategy Matrix is one of the matrix models of strategic planning used for strategy formulation (see Appendix A).

EQUITY STRATEGIC ALLIANCES

When having a risky technology and weak financial position, one way to collaborate is by giving equity to a partner or more partners. The partner is rewarded in this way for taking a risk to invest in the technology. Also, the partner reduces the risk that the NTBF is taken over by a competitor. An equity strategic alliance allows a NTBF to enter a difficult market by using the resources of the partner and investor. An equity strategic alliance is most suitable when the threat of competition is high. This means that the NTBF alone may not be able to commercialise the technology on short notice.

EXCLUSIVITY AGREEMENTS

When the technology is still risky and the NTBF lacks financial means, it helps to establish a partnership with an exclusive partner. Especially when the appropriability regime is tight and entry barriers are high. Exclusivity is mostly based on one product or service within a certain market and period. When the total amount of customers in the market are low, this means that the exclusive partner will have a relatively large pie of the market which is beneficial for the NTBF. Since exclusivity is a type of collaboration, operationalisation of the product or service may be executed by the partner in some cases.

TECHNOLOGY TRANSFER

In the case of a tight appropriability regime and high entry barriers, contractual modes such as licensing agreements are recommended to profit from technological innovation. An IP-based strategy is most suitable when the founders of the NTBF lack entrepreneurial and professional skills and financial means. It's suited for risky technologies that can be patented and are superior. Information in the market should be confidential and protected (if not, competitors might duplicate the technology quite easily).

SERVICE-BASED SYSTEM INTEGRATION

Service-based system integration can be used as a competitive advantage, especially when the trading risk is low. For this type of integration, a significant amount of alliances, subcontracting and cash is needed. Collaboration capabilities are a must. System integrators are positioned close to the end-user and will need professional experience, entrepreneurial skills and multidisciplinary teams.

5.3 TACTICS AND ENVIRONMENT

The list of strategic tactics that are identified in chapter 4 (Table 8) can be matched with the most suitable and applicable clusters (Table 10). It should be stated that other matches are possible too, however, are less applicable. The most important reasoning behind the matching process is discussed in the paragraphs below.

An *agile tech approach* should be used when a radical technology is developed for a conservative and established industry, to make industry ready with small changes. When having a weak financial position, it would be tactical to *minimise the hardware risk* and maintain a *service orientation* and clear *funding* strategy. A funding strategy is especially beneficial when the market potential is high.

TABLE 10: TACTICS MATCHED WITH CLUSTERS OF INTERNAL AND EXTERNAL VARIABLES

TACTIC	MATCHING CLUSTERS
<i>Agile tech approach</i>	Sophisticated
<i>Minimise hardware risk</i>	Weak financial position
<i>Service orientation</i>	Weak financial position
<i>Technology push</i>	Standardisation, clear value proposition, radical, strong financial position
<i>Market-pull</i>	High entry barriers, diversification, incremental, sophisticated
<i>Focus</i>	Standardisation, sophisticated, clear value proposition
<i>Target flexibility</i>	Hostile environment, radical
<i>Niche market</i>	Collaborative
<i>Launching customer</i>	Collaborative, hostile environment
<i>Intellectual property</i>	Hostile environment , high entry barriers
<i>Premium pricing</i>	Clear value proposition, diversification
<i>Penetration pricing</i>	Standardisation
<i>Marketing</i>	Radical, sophisticated, no adoption of technology, risky technology, position close to end-user
<i>Network</i>	Collaborative, hostile environment, collaboration capabilities
<i>Company entry</i>	Clear value proposition, collaborative
<i>Funding</i>	Weak financial position, high potential market
<i>Co-creation</i>	Risky technology, radical innovation, weak appropriability regime, market failures

When having a radical innovation for an innovative industry with a clear value proposition, a *technology push* approach can be used to enter the market with a strong financial position by using economies of scale. In case of high entry barriers and conservative and established industries, a market pull approach is most suitable. This is also the case when the number of products and services is relatively high.

Focus can help to commercialise a clear value proposition to established and conservative industries, especially when the goal is to have economies of scale. Yet, for some new technologies, the initial market is so new, small, and esoteric that targeting and positioning tactics are unnecessary or inappropriate (Beard & Easingwood, 1996). In this case, *Target flexibility* enables a NTBF to deal with high threat of the competition. A *launching customer* can enable to enter a *niche market*, which is most suitable in case of a collaborative cluster. *Intellectual property* should be used in case of high competition and a tight appropriability regime.

Premium pricing should be used in case of a clear value proposition and low values of production, where *penetration pricing* should be used when having economies of scale. Marketing can help to communicate radical innovations to the market, especially when the technology has not been adopted yet and is risky. A network can be *beneficial* in case of having collaboration capabilities and a hostile environment. A network can also help for entering companies. *Co-creation* should be used to educate consumers and make them ready for adaption. Co-creation is extremely useful for radical innovations that are not adopted by industry yet. In addition, it appears that innovators in weak appropriability regimes need to be intimately coupled to the market so that user needs can fully impact designs (D. J. Teece, 1986). When the TRL of the technology is low and the development time is long, co-creation can help to customize the technology to enable market-pull.

Three identified tactics will not be included in the matchmaking process. These are: employment, decision-making formalisation and insourcing/outsourcing. The insourcing/outsourcing tactic is included in the strategies (table 7), where decision-making formalisation is included in the decision criteria (table 9). *Employment* has been left out, since its direct relation with growth strategies is assumed to be insignificant.

Strategies regarding these tactics will change over time and are subject to the age and size of the company. While these tactics are left out in the matchmaking process, they are still worth mentioning and should be considered in strategic planning.

5.4 STRATEGIC MATCHMAKING

An overview of bundles of clusters and variables that match with certain strategies and tactics can be found in Table 11. This table can be used for “matching stage 1” (Figure 12) in the following way:

1. Based on the path of *value combinations* of a NTBF, clusters can be identified using paragraph 5.1;
2. Following the “bundles” of clusters and variables as defined in Table 11, suitable *strategies and tactics* can be found that match a specific row of bundles.
3. Most likely, more strategy options seem suitable for the specific situation of the NTBF. These strategy options are ranked by using the existing *decision-making process* maintained by the NTBF. In this way, a *growth strategy* can be formulated.

Some considerations were made while designing Table 11. The framework is based on the assumption that when companies have limited resources, the decision-making and strategic alternatives are quite limited (Edelstein, 1992). While Table 10 shows that tactics can be matched with clusters, Table 11 matches the tactics to strategies based on the bundles of clusters and variables within the specific table row. In fact, all tactics are worthwhile to consider. However, certain tactics are most applicable to certain strategies. Since the strategies are defined on a higher level, the strategy decides which tactics should be used and not the other way around. Table 11 was built after a tremendous amount of iterations, where the starting point was to minimise the number of bundles and variables to increase the amount of feasible, realistic strategy options for the NTBF. It is possible that no successful match can be found between a NTBFs clusters and variables and an applicable strategy. In that case, a NTBF might formulate a strategy to *change* its internal and external variables, based on its dynamic capabilities. When these variables serve as constraints, a NTBF can choose the strategy that fits the variables best. As an example; a NTBF might develop one standardised product with a high level of production but needs to integrate forward to sell it.

FIGURE 12: MATCHING STAGE 1

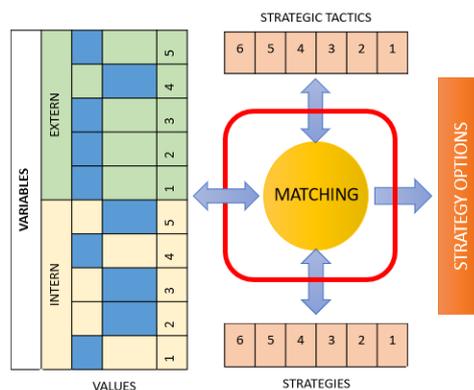


TABLE 11: AN OVERVIEW OF BUNDLES OF CLUSTERS AND VARIABLES THAT MATCH WITH CERTAIN STRATEGIES AND TACTICS

BUNDLE 1	BUNDLE 2	BUNDLE 3	VARIABLES	STRATEGY	TACTICS
Strong financial position			High professional experience	Systems selling (/Balanced integration)	Technology push, co-creation
	Market failures	Standardisation	High professional experience	Backward integration	Technology push, focus, penetration pricing, co-creation
		Diversification (related)	High professional experience No adoption of technology	Forward integration	Technology push, market-pull, premium pricing, marketing, co-creation
		Low trading risk	Position close to end-user Professional experience Collaboration capabilities	Service-based system integration	Technology push, marketing
Collaborative	Market failures		Tight appropriability regime	Backward and/or forward strategic alliances	Niche market, launching customer, network, company entry, co-creation
	High entry barriers Risky technology		Number of customers low Tight appropriability regime	Exclusivity agreements	Service orientation, minimize hardware risk, market-pull, niche market, launching customer, network, company entry, intellectual property, marketing, funding, co-creation
		Hostile environment	Technology can be patented	Equity strategic alliances	Service orientation, minimize hardware risk, market-pull, target flexibility, niche market, launching customer, network, company entry, intellectual property, marketing, funding, co-creation
		Low threat of competition	Technology can be patented	Joint venture	Service orientation, minimize hardware risk, market-pull, target flexibility, niche market, launching customer, network, company entry, intellectual property, marketing, funding, co-creation
			Lack of professional skills Technology can be patented Tight appropriability regime	IP-based technology transfer	Service orientation, minimize hardware risk, market-pull, niche market, launching customer, funding network, company entry, intellectual property, marketing

6. CASE STUDY

The main objective of this chapter is to test the conceptual framework by using a case study of Qlayers B.V. (“Qlayers”, also referred to as the “Case Company”). First, values of variables are defined based on an in-depth analysis of the Case Company. Then, the *path of value combinations* is matched with suitable strategies and strategic tactics. The decision criteria that the Case Company currently maintains are used to match a most suitable *growth strategy*, including strategic tactics. Finally, the defined growth strategy by using the conceptual framework is compared with the current used strategy of the company (figure 13).

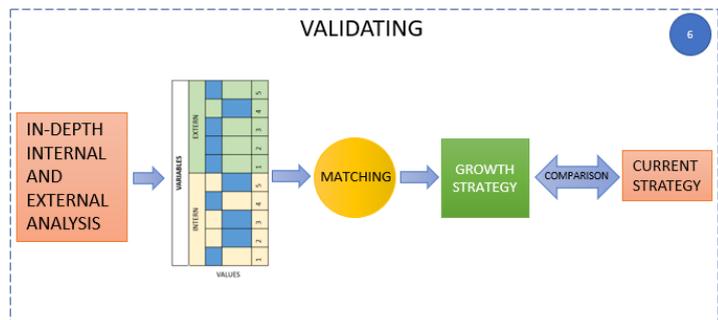


FIGURE 13: SCHEMATIC OVERVIEW OF THE VALIDATION STEPS

6.1 INTERNAL AND EXTERNAL ENVIRONMENT

6.1.1 BACKGROUND

Qlayers is a young, passionate start-up with an international approach that develops a new revolutionary coating head for applying (functional) coatings on large surfaces. The coating head will allow innovative functional coatings to break out of research labs and be deployed onto large and visible surfaces. Now, a trend can be found in the development of functional coatings, e.g. self-healing, self-cleaning and drag reducing coatings. However, the main problem is the application of these coatings outside the lab. Therefore, Qlayers’ team started testing a new technique for the application of coatings in 2016. With this technique it became possible to print sharkskin coatings. The idea to apply micro-structured coatings on sailboats, transportation ships, yachts, rowing boats, pipes, wind turbines, formula 1, high-speed trains and aircraft to make them faster and cleaner, won Qlayers several awards. Qlayers was officially found in August 2017 after being admitted into the incubation programme of Yes!Delft which was ranked second by UBI global for the top business incubators 2017/2018.

To apply functional coatings on a larger scale, an automated coating robot is needed. However, the coating of large structures is still done by hand. That’s why Qlayers started to develop an automated coating head to coat large surfaces on any location (including offshore) under any weather conditions. With the first coating print head, the *Slash100*, painting companies can slash man-hours needed for the coating of large surfaces by over two orders of magnitude. It is a print head which can apply existing coatings autonomously in a locally controlled environment (Figure 14). This avoids large coating facilities, ensures a consistent quality, uses up to 50% less paint and creates a safer workplace. On the long-term, the *Slash100* will be used to print functional microstructures, such as a sharkskin microstructure, in a controlled coating environment. Applying

FIGURE 14: THE PRINTING HEAD WILL BE ABLE TO APPLY (FUNCTIONAL) COATINGS ON WIND TURBINES, SHIPS AND AIRCRAFT (GROOT, 2018)



this microstructure on wind turbine blades and aircrafts will reduce the drag or friction with the air which results in a higher energy efficiency and a lower cost of energy. At this moment, Qlayers is the only one that can print functional microstructures with its own technology, called the *Graviton*.

The mission of Qlayers is clear: to become the go-to platform worldwide to apply and certify functional coatings on large surfaces. The ultimate confirmation of this mission will be the penetration of the high-barrier, but steadily growing, aircraft coating market. In preparation for this final step, fast painting in a locally controlled environment will be achieved on a large oil storage tank in 2018. Increased safety, ease of certification and quality insurance will be proven on a wind turbine in 2019.

Currently, Qlayers has three board members and co-founders. The CTO, Ruben Geutjen, graduated from Novel Aerospace Materials (TU Delft) in 2016. Amber Van Hauwermeiren is the COO and graduated from Novel Aerospace Materials (TU Delft) in 2018 on micro-structured anti-icing coatings for aircraft and wind turbines. Josefien Groot, CEO, is graduating from Complex Systems Engineering and Management (TU Delft) and has already found and sold a company under the age of 21. The complete team consists of 11 employees, outside the 3 co-founders there are 5 engineers and 2 interns.¹⁰ It is a multidisciplinary team specialized in mechanics, electronics, fluid mechanics, software and business development. A potential CFO is currently having his trial period.

6.1.2 INTERNAL VALUES

In this paragraph, the internal values of Qlayers will be discussed in brief (see Table 12 for an overview). A more elaborated analysis can be found in Appendix D: Detailed analysis for internal values of Qlayers.

FOUNDING TEAM

The Qlayers founding team is multidisciplinary and complementary, both with their educational background as in their personalities (See Appendix D1: Background and Personal Profiles of Management Team of Qlayers). The founders have affinity with entrepreneurship and are highly educated.

VALUE PROPOSITION

The value proposition of Qlayers is based on clear benefits and radical product superiority. The Slash100 printing head reduces labour and material costs, ensures a consistent quality and layer thickness, uses up to 50%

¹⁰ See teampage on the Qlayers website: <https://www.qlayers.com/team.html>

less paint and creates a safer workplace. Furthermore, applying sharkskin microstructures with the Graviton on large structures such as wind turbines, airplanes, ships and high-speed trains reduces friction with the air or water with 3-8%. This translates directly into more energy generation of wind turbines and lower fuel usage and CO2 emission reductions for ships and airplanes. The printing head that Qlayers develops can be customized for different market segments, where the core product will stay the same (see Appendix D2: Technology and value proposition).

NICE TO HAVES

Qlayers established a network within different potential market segments. Also, Qlayers takes advantage of the network of the incubator programme Yes!Delft and is well connected to TU Delft. Currently, the company has a weak financial position. The development costs of the *Slash100* was paid by some seed capital, a small 3F funding round, prize money, small revenues by printing assignments with the *Graviton* and a Dutch SME subsidy; a MIT R&D Cooperation Project of €200 K. The *Slash100* has a long lead time, wherein a whole team of engineers work intensively to get the product finished. This means high labour and material costs and a negative cash flow for almost a year. Both the *Slash100* as the *Graviton* can be patented. The patent for the *Graviton* is currently filed¹¹ and other patents are in preparation.

CURRENT STATE

The TRL of the *Slash100* is still low but will quickly increase the next few months. The *Graviton* is at TRL 4 and requires significant R&D investments before its ready for commercialisation. Even though Qlayers is a small start-up, the number of products and services offered is relatively high. Small 5x5 cm samples with micro-structured surfaces are sold to customers who want to test the technology. Also, small consultancy assignments are executed for a large engineering company. The main project is the *Slash100*, where this printing head will start with coating pipes and oil storage tanks in September 2018. The production level in the beginning will be low: Qlayers must establish its supply and manufacturing chain after which these processes need to be optimised. Also, different customers and segments might have different needs for which the printing head must be customised. Qlayers will start by penetrating the Dutch coating industry, with the ambition to enter the international market in the long-term. Qlayers' strength is its technical R&D know-how. The core activities focus on these key strengths, while 9 out of the 11 team members are engineers fresh from university.

¹¹ First patent filed on June 8th 2018 at the Dutch patent office (application no: P33536NL00/PGI – title: *Controleren printproces*), which covers the core aspects of our microstructure coating technology (the 'Graviton')

TABLE 12: THE INTERNAL VALUES OF QLAYERS SHOWN IN BLUE

	Values	
Team composition	Multidisciplinary and complementary	Monodisciplinary
Entrepreneurial skills	High	Low
Professional/functional experience in industry	High	Low
Education level	High	Low
Value proposition (VP)	Clear benefits	Unclear benefits, features based
Product superiority	High	Low
Innovation type	Radical	Incremental
Adaptability	High	Low
Cash	High	Low
Technology can be patented	Yes	No
Collaboration capabilities	High	Low
TRL of technology	Mature	Low (= <4)
Number of products and services	High	Low
Product development	Short	Long (>12 months)
Production level	Standardization/economics of scale	Low
Location of activities	Local	Foreign-based
Number of core activities	High	Low

6.1.3 EXTERNAL VALUES

In this paragraph, the external values of Qlayers will be discussed in brief (see Table 13 for an overview). A more elaborated analysis can be found in Appendix E: environmental analyses for Qlayers.

INDUSTRY

The targeted industrial surfaces are respectively: pipes, storage tanks, wind turbines and aircraft (see Appendix H2) Other potential surfaces are high-speed trains, yachts and ships. These segments are established, conservative industries that already spend a significant amount of money on coating, coating processes and its maintenance. Customers are blade manufacturers and operation and maintenance (O&M) departments of airline companies. The number of customers is respectively low, where one large customer will already bring in a significant amount of recurring revenues. Yet, to find a launching customer is hard. The markets involve failures such as price discrimination, monopolies, established agreements and contracts that are already established between large parties for years. The value chain is complex and full of strategic alliances. Moreover, information is often treated as confidential and is protected, which makes it tough for new companies to enter these markets. In addition, the automation within these industries is slow, due to the large capital investment requirements and strict quality and safety demands.

After the *Slash100* is proven by coating pipes and storage tanks, the first growth market for Qlayers is the wind energy sector. To achieve national (Dutch) and international climate targets, it is estimated that the amount of offshore wind turbines will increase rapidly the upcoming years (ABN Ambro, 2015). In 2016, the number of wind turbines, on land and offshore, grew over 26% worldwide (WindEurope, 2017). The ideal long-term growth market for Qlayers, is the steadily growing, predictable aircraft sector. Aircraft manufacturers

desperately need to reduce manufacturing cost and time, to keep up with some doubling demand every 15 years (Airbus, 2017; Boeing, 2017).

INSTITUTIONS AND ECONOMICS

The institutional environment for Qlayers is supportive, while environmental regulations are being strengthened, forcing manufacturers and operators to reduce fuel consumption and increase energy efficiency. Yet, at the other hand, certification is the main issue holding back the automated application of innovative coatings as specific coating parameters and safety needs to be guaranteed always. Funding is available for Qlayers in the form of Angel Investments, subsidies and Venture Capital. While the chance of getting subsidies is quite small, bringing investors on board at this moment would result in bad deals while Qlayers is still a risky start-up with low TRLs.

FORCES OF THREAT

Qlayers has a high amount of hardware components. While the final supply chain for the printing head still must be established, the R&D of the printing head is already very dependent on the supply of components. The *Slash100* and the *Graviton* are disruptive and only a few large players worldwide are capable of competing. The great majority of R&D has been carried out by research institutions and has reached only a low maturity stage. Qlayers maintains a tight appropriability regime. However, intensive competitive analysis executed by Qlayers¹² with the use of Porter's widely accepted approach showed that the threat of competition is high. Table 25 (see Appendix D) gives a qualitative comparison of how the manual spray painting state-of-the-art automated spray paint systems would compare to the *Slash100* on certain predefined criteria. For the *Graviton*, the main competitor is the German institute Fraunhofer IFAM, which uses templating to produce these microstructures. Also, the TU Delft faculty of 3mE sells Drag Reduction Riblet Films. Table 26 (see Appendix H2) gives a qualitative comparison of how the *Graviton* would compare to competitive technologies on predefined criteria. When it comes to the suppliers, two components have the risk to be exploited. These components are only offered by one or a few suppliers making Qlayers dependent.

¹² Internal document of Qlayers

TABLE 13: ENVIRONMENTAL STRATEGY-SHAPING FACTORS BASED ON LITERATURE, THE ADVISORY REPORTS AND INTERVIEWS

	<i>Values</i>	
Number of components	High	Low
Availability of funding	High	Low
Market	New	Established
	Innovative (Fast-changing)	Conservative (Slow)
Market power in industry	High	Low
Market size	Large	Small
Demand	Declining	Rising
Number of customers	High	Low
Competition	High threat	Low threat
Position in value chain	Close to end-user (B2C)	Early in value chain (B2B)
Appropriability regime	Tight	Weak
Information	Open and available	Confidential and protected
Legislation/regulation	Discouraging	Supportive
Adoption of technology	Yes	No
Amount of potential market segments	High	Low
Complexity system	High	Low

6.2 MATCHMAKING STAGE 1

CLUSTERS

Based on the values of Qlayers as shown in table 12 and 13, the following clusters of variables are identified: *Collaborative, Risky Technology, Weak Financial Position, High Entry Barriers, High Market Potential, Sophisticated* and a *Clear Value Proposition*.

STRATEGIES

By matching the clusters of variables with the strategies according to Table 11, two suitable strategies for Qlayers can be identified: an inter-firm collaboration based on *exclusivity* and an *IP-based technology transfer*. The exclusivity is based on the collaborative characteristics of Qlayers, its weak financial position, high entry barriers, the risky technology in combination with a tight appropriability regime. Also, the number of customers is low, which favours an exclusive partnership for market penetration. The technology transfer is based on the collaborative characteristics. Also, it's based on a lack of professional skills of the founding team and the fact that the technology can be patented.

TACTICS

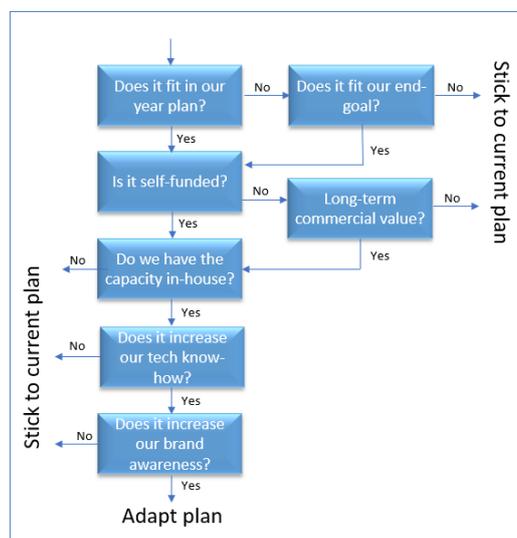
According to Table 11, the tactics that fit an exclusivity strategy are: *service orientation, minimize hardware risk, market-pull, niche market, launching customer, network, company entry, intellectual property, marketing, funding* and *co-creation*. The tactics that fit a technology transfer are the same, except for the funding and co-creation tactic that are less applicable. Tactics that are left out are the agile tech approach, focus, target flexibility and pricing.

6.3 MATCHMAKING STAGE 2

DECISION CRITERIA

Recently, Qlayers implemented a decision-making tool that can be used to analyse new projects (Figure 15). This tool was needed, since Qlayers is approached by a significant amount of market parties from different industries which makes it hard to focus. The decision-making tool is in the form of a tree that leads towards the end vision: to become a platform for functional coatings. The founders are very passionate about technology and want to change the world with material science by making each surface functional. The ambition is to automate the coating process of storage tanks, wind turbines and aircraft, covering 30.000.000 m² by 2022.

FIGURE 15: DECISION-MAKING TOOL USED BY QLAYERS



Qlayers doesn't have any external investors in the board yet, which means all decisions are made by the three founders. The founders envision a company based on organic growth and a flat hierarchy. Qlayers uses a year plan based on Objectives and Key Results (OKRs). A project must fit the year plan, be self-funded, increase the tech know-how and brand awareness before it can be executed. Also, the capacity in-house in terms of team availability, developed technology, age and size of the company and core activities and capabilities are considered. Currently, the team exists mainly of engineers fresh from university and lacks professional experience. The team is enthusiastic and motivated to learn but may not be capable of rolling out a leading global manufacturing company in the short-term. The commercial value of projects plays a role, where projects with recurring revenues in the long-term will have a higher priority. When this is not the case, a project should at least be self-funded and match the end-goal of the company.

STRATEGY DECISIONS

Table 14 shows the match of the two strategies that came out of matchmaking stage 1 with the decision criteria maintained by Qlayers as described above. Working together with an exclusive partner allows to enter the market quickly, where this partner will operationalise the technology. This enables Qlayers to focus on its key strength and in-house capacity, while developing high-tech solutions. Giving exclusivity to one partner might hinder total market penetration, decreasing the commercial value of this strategy. Also, exclusivity increases the risk of being “stuck”, while the ambition is rapid growth. The IP-based technology transfer will lead to relatively small revenues based on a licensing model. In addition, a transfer of technology does not fit the vision of Qlayers to become a platform for functional coatings. However, a technology transfer might enable Qlayers to deal with high entry barriers by licensing the technology to companies that have a stronger market position. This will enable Qlayers to achieve its ambition to automate the coating process within conservative and established industries, without rolling out the technology itself.

TABLE 14: THE TWO APPLICABLE STRATEGIES MATCHED WITH QLAYERS' DECISION CRITERIA

	Ambition	Vision	Commercial Value	Capacity in-house	Core Values	PR Value	Tech
Exclusivity	Yellow	Green	Yellow	Green	Green	Green	Green
Technology transfer	Green	Yellow	Red	Green	Green	Green	Green

TACTICAL DECISIONS

While the conceptual framework shows that a significant amount of tactics might be of use to Qlayers, not all of them fit the decision criteria of Qlayers (see Table 15). Minimising the hardware risk will help to reduce lead time and technology risk. However, the Qlayers team exists of scientists that love to build things perfectly and from scratch. In addition, some components that Qlayers uses are very expensive in the market. As an example, some sensors are 30.000 euros per unit. If a Qlayers team member calibrates a cheap sensor of 10 euros this can save a lot of money. Yet, the sensor may work less perfectly. Qlayers already took some consultancy assignments to generate some revenues in the short-term. While these assignments don't fit the end-goal of the company, they enable Qlayers to grow in an organic way without external investors. Qlayers is a typical high-tech start-up that started with the technology and then a suitable market for the technology. A market-pull strategy doesn't fit the developed technology. While the end-goal of Qlayers is not market or application specific, it seems hard to focus for Qlayers. Different projects are executed at the same time, while the capacity in-house is not able to cope with these different projects, leading to stressful situations. Marketing may help Qlayers to increase its brand awareness, however, Qlayers doesn't have the resources yet to hire a marketing expert. Using marketing for educational purposes seems not really necessary now but might turn important in the future when other parties will work with Qlayers' printing heads. While Qlayers wants to grow organically, organising funding rounds may not be suitable at the moment. However, more cash on the bank might enable Qlayers to hire professional experts, which will strengthen its market position. An exclusive deal with a potential customer can also be used to strengthen Qlayers' financial position. Co-creation is a very suitable tactic for Qlayers, since Qlayers develops customised solutions and the team lacks professional experience in industry.

TABLE 15: ALL TACTICS MATCHED WITH THE DECISION CRITERIA MAINTAINED BY QLAYERS

	Ambition	Vision	Commercial Value	Capacity in-house	Core Values	PR Value	Technology
Minimize hardware risk	Green	Green	Yellow	Green	Green	Green	Yellow
Service orientation	Green	Yellow	Green	Green	Green	Green	Green
Market-pull	Green	Green	Green	Yellow	Green	Green	Yellow
Niche market	Green	Green	Green	Green	Green	Green	Green
Launching customer	Green	Green	Green	Green	Green	Green	Green
Intellectual property	Green	Green	Green	Green	Green	Green	Green
Marketing	Green	Green	Green	Red	Green	Green	Green
Network	Green	Green	Green	Green	Green	Green	Green
Company entry	Green	Green	Green	Green	Green	Green	Green
Funding	Green	Green	Green	Green	Yellow	Green	Green
Co-creation	Green	Green	Green	Green	Green	Green	Green

6.4 FRAMEWORK VS. REALITY

FRAMEWORK'S GROWTH STRATEGY ADVICE

To develop a competitive advantage, Qlayers should establish collaborations to obtain resources in terms of funds, information, technology, markets and consumers. Qlayers should use its key strength based on technical superiority and intellectual property to enter a niche market with a large, launching customer. To find this launching customer, Qlayers should use its network to enter companies in a smart way. The launching customer is preferably an exclusive partner which pays Qlayers a royalty fee to make use of Qlayers' printing head, allowing Qlayers to price the product premium. This exclusive collaboration should be used in a *co-creating* way so that market-oriented product development is facilitated. While Qlayers' technology is applicable in a significant amount of very different segments, Qlayers may adopt a hybrid commercialization strategy based on both products and IP. When a launching customer can't be found within a specific segment, a technology transfer strategy can be used to still enter the segment, by licensing the technology only in this specific market. Having several growth strategies means high traction in a short time frame while considering the limited capacity in-house. When a strong financial position is achieved by the generated revenues, professional experts can be hired and Qlayers has the possibility to change its growth strategy by becoming a systems seller of automated, modular coating systems easily customised for different market segments.

REALITY: CURRENT SITUATION

Qlayers will generate the first large revenues from a collaboration with a launching customer active in the storage tank maintenance industry. Qlayers signed a collaboration agreement with this customer, where Qlayers will sell the *Slash100* printing head by using a cost-plus pricing model with a mark-up percentage of 35% for both the actual printing head as the maintenance service. Moreover, in exchange for an exclusive license in the oil storage tank industry for 2 years, the partner will pay a royalty fee based on 50% of the savings in (material and labour) costs realised by the new printing system of Qlayers. This royalty fee is measured per square meter of coated surface. The strategic nature of this partnership allows Qlayers to reduce their initial investment. Future customers that buy the *Slash100* pay a relatively low initial investment, after which they pay every 6 months for a maintenance contract of at least 3 years based on cost-plus pricing. In this way, recurring revenues are insured. The ambition is to change this cost-plus pricing model to a fixed pricing model when a better view on the actual cost of the maintenance process is achieved.

The next market will be the wind energy sector. The strategy for this market is to establish strategic alliances. Qlayers signed a NDA with a blade manufacturer. Together with this manufacturer Qlayers applied for a government grant called "Wind op Zee R&D project". The "Wind op Zee R&D project" is a small project when comparing it to the actual coating process of wind turbines in production. However, it allows Qlayers to show its capabilities and know-how to the manufacturer to convince them to invest in Qlayers even though the technology is risky.

Qlayers signed a “proof-of-concept contract” with a large airliner, which purpose is to find out how Qlayers’ technology fits within the maintenance processes of the airliner’s aircraft. In addition, Qlayers is having conversations with a NTBF that raised a serious amount of VC to develop an automatic paint robot. The NTBF maintains a service-based system integration strategy; all R&D is outsourced to suppliers and a turnkey solution is offered by the NTBF to the end-users. The NTBF wants to deliver sharkskin coatings to aircraft manufacturers as a premium service that reduces fuel consumption. The NTBF already spoke with the competitors of Qlayers, yet, no collaboration agreement has been signed. The NTBF is interested in Qlayers’ technology (the *Graviton*). At the moment, possible collaboration options are being discussed. The NTBF would prefer an equity collaboration to eliminate the possibility that Qlayers will be acquired by competitors of the NTBF. This is not an option for Qlayers. Also, a technology license is not considered to be commercially attractive. Preferably, Qlayers would sell its printing heads directly to the NTBF to get a higher profit margin. However, while the threat of the competition is quite high in aircrafts specifically and the lead time to enter this market is extremely long due to certification processes, licensing the Graviton might offer a simple solution to enter the aircraft industry in the short-term.

7. CONCLUSIONS

In this chapter, all research findings are summarised, after which its limitations are mentioned. These limitations will put forward suggestions for improvement in a research agenda. Finally, some concluding remarks are discussed.

7.1 RESEARCH FINDINGS

Throughout this research, the centre of attention has been to understand how strategy management works for NTBFs and to find relationships and clusters of variable impact factors to answer the main research question:

HOW TO SELECT A GROWTH STRATEGY FOR A NEW TECHNOLOGY-BASED FIRM?

The most important outcomes of this research are a conceptual framework that enables to select growth strategies, and the validation of this conceptual framework by using an in-depth case study. The research was built around three well-known strategy management theories: Transaction Cost Economics, Resource-Based View and Contingency. Theoretical knowledge was bundled with practical experiences of founders of NTBFs to look at the complex problem by using different perspectives complementary. In this chapter, an integrated overview of the outcomes and insights of the different analyses will be provided to answer the initial research question. The sub-headings are matching the four sub-questions.

7.1.1 FEASIBLE STRATEGIES AND TACTICS

What kind of strategy options are feasible for new technology-based firms?

This research suggests that feasible growth strategies for NTBFs are built around four regimes: Vertical Integration, Inter-firm Cooperation, Technology Transfer and System Integration. These regimes are defined based on the make-or-buy decision; a common principle used in TCE theory that differs strategies based on firm boundaries. System integration allows to deliver a turnkey solution by outsourcing activities to other parties. When a market fails, it might be strategically wise to vertically integrate. Yet, for NTBFs that lack resources, vertical integration is not a very attractive approach since tackling an area outside of the NTBF's expertise might be risky; the firm needs to acquire capabilities far beyond the basic strengths of their core business. To still gain access to valuable (human, capital, social) resources, inter-firm cooperation can offer an alternative. This research suggests that collaborative strategies can be subdivided in backward and/or forward strategic alliances, exclusivity agreements, equity strategic alliances, joint ventures and an IP-based technology transfer.

The interviews with founders of NTBFs provide evidence that these firms often use strategic tactics to deal with the shared challenges that they face: lack of resources, long lead times, a high level of experiment and risk, complexity of the product and a need for highly skilled employees. By thematising and coding the interview summaries and advisory reports, this research identified 18 strategic tactics. An *agile tech approach*, a *service*

orientation and minimisation of hardware risks enable a NTBF to reduce its lead time. NTBFs should make careful decisions about the firm's *boundaries, focus and targets* regarding their small amount of resources. A *technology-push* or *market-pull* approach can be used to enter a (niche) market with a *launching customer*. To attract and find customers, a *network* and *marketing* can be used strategically. Pricing can be used tactically to increase revenues. Smart funding strategies allow to cope with the burden of high material and labour costs before the technology is ready for the market.

7.1.2 STRATEGY SHAPING FACTORS

Which variable concepts should be considered while selecting a growth strategy for a new technology-based firm?

In this research, a framework was designed that shows relations between variable concepts and their characteristics that enable to formulate strategies for NTBFs (Figure 10). The framework suggests that a strategy is subject to the internal and external environment, where the interpretation of this environment and the final decision is made by the management team of a NTBF. The building blocks of the framework are dependent and intervening concepts that are positioned in different ways: as internal and external variables, as strategies and tactics or as decision criteria. This research suggests that internal variables that influence strategy making can be subdivided into five themes: *the founding team, the value proposition, current state of company and technology* and *organizational structure*. External variables are the environmental factors that influence strategy making. The external variables can be found by executing market and competitive analyses. The framework suggests that the final choice of which strategy and tactics to be executed is subject to the current decision criteria maintained by the NTBF, which are influenced by the personal characteristics of the management team. This supports previous work, for example the literature review of Steptoe-Warren, G., Howat, D., & Hume (2011) that reveals that managerial cognition as well as individual and corporate values affect strategic decision-making.

7.1.3 MATCHMAKING

What fit can be made between the strategy options and the influencing variables?

This research matched internal and external variables with strategies and tactics (chapter 5). In doing so, logical combinations of internal and external variables called clusters were identified. These clusters allow to reduce the amount of value combinations, which in turn reduces the complexity of the matchmaking process. An example of a cluster is a *risky technology*; a technology with a low TRL and long lead time that has not been adopted by the market yet. Clusters are not favourable or unfavourable on itself, but might turn into this when the chosen strategy doesn't suit these clusters. This research suggests that every threat can turn into an opportunity when smart strategies are executed, where these strategies are only suitable in certain situations. The strategic tactics are more generally applicable, while they are all worthwhile to consider.

This research suggests that two important clusters divide NTBFs and their suitable growth strategies into two groups; the ones with a strong financial position and the ones with a suitable situation for collaboration. When having a strong financial position, NTBFs can choose to vertically integrate or become a system integrator; using platforms or a strong service orientation to design and integrate externally supplied product and service components into a system for an individual customer. System integration demands quite extensive knowledge of business and complex management of stakeholders, contracts, customer involvement and so on, where the business depends highly on subcontracting. For NTBFs with monodisciplinary engineering teams without professional experience in industry, this might not be the ideal first business. Vertical integration means that the NTBF will build cospecialised assets within their boundaries. Having a weak appropriability regime and an uncertain environment increases the incentive to integrate into relevant cospecialized assets. This aligns with the notion of implications for integration discussed by Teece (1986). For NTBFs that lack resources, vertical integration is not a very common approach since it requires to tackle areas outside of NTBF's expertise and core strengths. However, if it works out, it allows a NTBF to grow exponentially based on high profit margins.

For NTBFs specifically, collaboration is often used for exploitative purposes. When the market fails, backward and/or forward strategic alliances should be used. When the technology is still below TRL 4 and has not been adopted yet and financial means are lacking, a joint venture with a large, industrial company can help to enter the market. Another way to collaborate is by giving equity to partner(s), called equity strategic alliances. An equity strategic alliance allows a NTBF to enter a difficult market with high entry barriers and competition by using the resources of the partner and investor. Exclusivity agreements might be used for partners that own a significant part of the market and when having a tight appropriability regime. In case of a tight appropriability regime and high entry barriers, contractual modes such as licensing agreements are recommended to profit from technological innovation.

7.1.4 CASE STUDY ADVICE

Which strategic alternatives can be identified for the case company regarding this fit?

The conceptual framework was validated by using a case study of a NTBF called Qlayers. This start-up was found in August 2017 and develops an automated printing head with which (functional) coatings can be applied on large industrial surfaces. After executing internal and external analyses of Qlayers, a most suitable growth strategy including strategic tactics was identified by using the conceptual framework. The framework suggests two suitable growth strategies for Qlayers: an inter-firm collaboration based on *exclusivity* and an *IP-based technology transfer* strategy. The advised tactics according to the framework are; *service orientation, minimize hardware risk, market-pull, niche market, launching customer, network, company entry, intellectual property, marketing, funding* and *co-creation*. The framework suggests that when only a technology transfer is used, the *funding* and *co-creation* tactic are less applicable. Both strategies and tactics were analysed by using the decision criteria used by Qlayers' management, after which a suitable growth strategy advice was given.

According to the framework, Qlayers should establish strategic alliances to obtain resources in terms of funds, information, technology, markets and consumers. Qlayers should use its key strength based on technical superiority and intellectual property to enter a niche market with a large, launching customer. The launching customer is preferably an exclusive partner who pays Qlayers a royalty fee to make use of Qlayers' technology. While Qlayers' technology is applicable in a significant amount of very different segments, Qlayers may adopt a hybrid commercialization strategy based on both products and IP. When a launching customer can't be found within a specific segment, a technology transfer strategy can be used to still enter the segment, by licensing the technology only in this specific market.

By comparing the strategy advice with the actual strategy as currently maintained by Qlayers, several important differences can be identified. First, Qlayers is not executing any technology licensing models to generate revenues. Moreover, the *Graviton* and the *Slash100* are not patented yet due to a lack of financial capital. While the key strength of Qlayers is its superior technologies, this research suggests that Qlayers should put more focus on protecting and commercialising these specific technologies. Especially since the *Graviton* is still at TRL 4. This supports RBV theory that indicates that when having a tight appropriability regime, this results in having a comparative advantage that can lead to a competitive advantage when legal methods of protection are exploited. According to this research's framework, the tactic to minimise the hardware risk seems applicable for Qlayers. However, the team currently builds a significant number of components from scratch. This means that Qlayers is integrating activities while not having the financial resources to do so. While Qlayers wants to grow organically, it may be wise to consider external minority investments so that professional experts can be hired. The differences between the advised strategy and the actual strategy may have several reasons, from which the decision-making and criteria used by Qlayers is one. Accordingly, this research provides evidence of the importance of decision-making in NTBFs when it comes to selecting growth strategies.

7.2 RESEARCH LIMITATIONS

7.2.1 COMPLEX TO SIMPLE TO COMPLEX

This research tried to design a solution for a large and complex contemporary socio-technical problem. The complexity of this problem was reduced by using abstraction instead of generalisation. Yet, the danger in doing this is always to oversimplify. An example is the clusters of variables. These clusters reduce the difficulty of the matching process. However, may not grasp the real complexity of the problem and names can be misinterpreted. As an example, the name "entry barriers" can be associated with very different kinds of entry barriers. The question to be asked is if the terms abstraction and generalisation can even be separated for this specific research topic. Karl Popper once stated that "there are uncertain truths — even true statements that we may take to be false — but there are no uncertain certainties" (Popper, 1991). This research did not strive for prediction and certainty but strived to reduce the complexity for managers of NTBFs in choosing their growth

strategy. Readers are encouraged to question and criticise every component of the framework, while trial-and-error is the only way to really learn something new.

The framework as designed in this research reduces the complexity by not differentiating between all kinds of variables that interact with each other in different ways. As an example, no distinction was made between intervening, moderating and mediating variables. Also, no clear distinction was made between independent contingency factors and dependent factors. Accordingly, the framework might be oversimplified.

This research used a single in-depth case-study. Often, scientists argue that single case studies have no scientific value, while generalisation from a single case is not possible and the case study would turn out to be subjective, giving too much scope for the researcher's own interpretations (Flyvbjerg, 2006). As a counterargument, this research focuses on abstraction rather than generalisation. Moreover, isn't all human learning built on single cases? Our ancestors survived as they learned from their mistakes while doing. Without single case studies, knowledge cannot be passed down into practical use. This is also emphasised in the study of Flyvbjerg (2006), who states that "predictive theories and universals cannot be found in the study of human affairs. Concrete, context-dependent knowledge is, therefore, more valuable than the vain search for predictive theories and universals". One should ask one selves if *objective* knowledge actually exists, and what this knowledge would be worth. In times of these when artificial intelligence is slowly conquering the world, we should focus on what make our solutions and ideas different than the ones from a machine learning quantum computer. Our subjectivity helps us to find creative solutions and ideas that might not be found by only using rational thinking.

7.2.2 LIMITATIONS OF THEORY

To make this research applicable for practical use, this research studied three fundamental strategic management theories, TCE, RBV and contingency, to build further on what has already been done. Other theories, models and frameworks were not considered thoroughly. However, these might be of value when trying to understand this research problem from complementary perspectives. Consequently, the literature review of this research has some shortcomings while using exclusive search formulations. Moreover, the author of this research has no expertise in TCE, RBV or contingency theory specifically, which might have influenced the interpretation and operationalisation of the theories while not considering their differences in terms of the methodological premises. However, it should be questioned if the integration of theories is even desirable. From a practical point of view; does a unified theory reduces the complexity of selecting growth strategies for NTBFs? This research suggests that normative theory should be based on descriptive research. It can never be proved, logically, that a theory presents an accurate or "true" view of what it explains, whereas it is always possible—again, logically—to prove a theory is false by identifying data contrary to that which the theory explains (Mills, Durepos, & Wiebe, 2009). Empirical findings should be bundled to understand phenomena, where this understanding should always be located on a higher level than the empirics itself. Especially since there will

always be exceptions. Nevertheless, more research is needed to verify the positioning and usage of RBV, TCE and contingency theory in this research.

This research used RBV and TCE in a complementary way, addressing different aspects of the same phenomena. TCE theory was used to identify feasible NTBFs growth strategies. However, the question can be asked if TCE theory fits with the specific characteristics of NTBFs, while they are *technology-based*. As an example, while TCE theory points out that new firms grow while internal transactions will most likely be cheaper than external market prices, a tactic often used by NTBFs is to reduce their hardware risk by outsourcing as much risky R&D as possible. When a NTBF grows, it might migrate more and more transactions and activities within the firm. The fundamental idea of transaction costs is still valid in this case, however, the actual way of execution changed. Still, the author found it easier to apply TCE than RBV theory in the framework. The theoretical idea behind the RBV seems logical, however, the practical implications were not easy to identify. This supports the research of Newbert (2006), who states that the actual level of empirical support for the RBV remains uncertain. The resource-based view assumes that resources can only lead to a distinctive competitive when developed or acquired in-house (Dursema, 2007), while this research indicates that collaborative strategies, often based on outsourcing, can be very effective when aiming high firm growth for NTBFs. This striking contrast might indicate that the RBV is not very suitable in the context of strategy management of NTBFs specifically. However, RBV turned out to be useful when determining the appropriability regime and competitive advantage.

Both TCE and RBV were useful in this research. Yet, the question is if these theories are actually applicable to NTBFs specifically. When trying to answer this question, one should focus on the aspects that make NTBFs different than normal firms. NTBFs have very long, risky lead times, leading to high *sunk costs*. While sunk costs are no transaction costs nor related to creating value, they do make NTBFs different from “normal” firms. One might argue that sunk costs are related to irrational decision making instead of strategy making and therefore, it doesn't make sense to take these costs into account when formulating growth strategies. Yet, sunk costs are directly related to the initial resources, where they are most likely used to develop the core technology. When decisions are made purely based on transaction costs, the competitive advantage of the company might be lost.

The question should be asked if a new theory and/or paradigm is needed to study NTBFs and their growth strategies. Moreover, when NTBFs are left to contingency, does it even make sense to make a conceptual framework for strategy making? In case of a risky technology and a hostile environment, one might argue that a NTBF should just be satisfied with every chance it gets to enter the market. The conceptual framework designed in this research assumes that a NTBF has strategic options. Yet, the question is if this assumption is realistic. Competitive advantages like specialized knowledge or company-owned technologies can only exist for a transient period, showing the urgency for NTBFs to enter the market as soon as possible. In addition, in a fast-changing environment, it seems illogical to bind strategies with performance. However, this research still argues that *understanding* the factors that influence strategy making and knowing the strategic options will reduce the biases of decision makers. When strategy is subject to contingency and environments are fast-

changing, the only option left is to *abstract* strategy to a such a high level so that growth strategies can be stable and focused, while micro-level processes and structures are adapting continuously within the “borders” of the multi-dimensional, overarching strategy. Yet, while NTBFs are small companies, it does not really make sense to differ between macro- and micro-level. Implicitly, this reasoning shows the need for more research regarding the applicability of contingency theory for NTBFs.

7.2.3 LIMITATIONS OF FRAMEWORK

While this research is all about new *technology*-based firms, one might ask oneself; “where is the technology?”. So many different types of technology exist, and these technologies certainly need much more attention while they influence strategy making and the applicable strategic tactics significantly. Only approaching this complex problem by using TCE, RBV and strategy making is not enough. It seems logical to include a technical aspect to the framework by considering the type of technology that is being developed. Especially since the strategic tactics are technology-based. However, the question is how much this *technology* component would add to the general usability of the framework. In the beginning, the “product or service” variable was included in the internal variable list. However, the interviews with NTBF founders showed that this is more related to strategy rather than something that can’t be changed. Hardware development may go hand in hand with some small consultancy assignments, where service development may go hand in hand with the development of software or electronical programmes that can be sold as products. While the technology forms the core strength of the NTBF, this technology is adaptable to its environment, industry, customers and its founders. Also, the technology might change *owner*, or might be shared with another partner according to TCE theory. Accordingly, there was chosen to not differentiate for different types of technologies in this research. However, according to RBV theory, the technology should be included since it may lead to a sustained competitive advantage. One might argue that the strategies used in the framework are not considering different types and levels of competitive advantage, while they are designed based on TCE theory. More research is needed to include the *technology* component in the framework, by adding RBV theory to the designed growth strategies.

The conceptual framework and its fundamentals were changed significantly along the way. Concepts were adapted or rejected, where other concepts were merged or moved from one list to another. More specifically, concepts were rejected when they had been identified by using subjective reasoning but no evidence in all data or literature was found to proof their significance. An example is the cultural environment for technology. While this variable impacts the technology and its acceptance, it was not mentioned in the interviews. In this research, the cultural environment as well as the geographical environment were considered to affect other variables such as location of activities, threat of competition and adoption of technology. In this way, these variables could be merged. Several other variables were rejected because they turned out to affect or be dependent on other variables. For instance, venture capital results in cash and coaching, coaching has an influence on the decision-making in the form of shareholders where cash strengthens the financial position. Another example is the age and size of the company, where a numerical evaluation will come short while the needed size of the company

depends on other variables such as the value proposition and market. In addition, the influence of age on growth varies widely per company. Same counts for the implications of the innovation (merged with radical or incremental innovation, where implications are external oriented) and being a university spin-off or having a risky or reliable market (which depends on the available information, established market, market power and failures and so on). Some variables were not really discussed in the interviews nor literature (e.g. number of products and services, foreign-based activities and core activities) but are still included in the conceptual framework due to logical reasoning. While this reasoning is subjective and biased, the framework is not ready to use, except when the purpose is purely for understanding.

This research tried to bundle as much data as possible, yet, the framework (Table 9) is far from complete. This might be caused by the shortcomings of the research approach used to build the framework. In addition, the literature review was systematic but still very limited and the concept validation process was highly subject to the author's biases. In addition, some concepts are overlapping or conflicting. As an example, the strategic tactics found in the interviews do not really fit within the 4Ps division as maintained in the literature review. This might be caused by the limitations of the literature review or conflicting use of definitions. Moreover, using the advisory reports as data sources should be questioned, while the authors are students and no experts yet. While the framework is far from complete, this doesn't hinder the usability; the framework is designed in such a way that the input lists can be easily adapted, extended and improved. This is in align with contingency theory, which emphasises comprehensiveness instead of exclusiveness. However, the *fit* made in this research between strategies, tactics and the internal and external variables and decision criteria does not predict an outcome such as high firm growth or better performance. The framework designed in this research serves as a tool that enables decision making, where the whole filling in of the framework is biased against the author's interpretation of the situation.

7.2.4 LIMITATIONS OF INTERVIEWS

10 interviews were used to reduce the author's biases and look at the complex research problem from other perspectives and different companies. Yet, the question should be asked if these companies were not too different to compare them in terms of establishment year, business sector, time to first sale, degree of service orientation and so on. The second question to be asked is if the interviewees share too many similarities, while the NTBFs are all located in Zuid-Holland in The Netherlands and no spin-offs nor spin-outs were included. In addition, the interviewees were all found by using the personal network of the author with not more than two degrees of separation. Clearly, the sample size is not large enough to offer generic conclusions for all NTBFs. Yet, the findings do provide insights on the strategy options, tactics and external and internal variables that influence strategy making of NTBFs. Accordingly, the interviews were used to increase the amount of qualitative data and identify similar themes. However, some important variables that were found in literature were not found in the interviews. This might be caused by the fact that the interviews were not really structured. At the other hand, the interviews made sure that the interviewees really talked about topics that they consider

as being essential when it comes to strategy making. This approach enabled to widen the information gathering funnel as much as possible, increasing the amount of qualitative data retrieved from the interviews.

7.3 RESEARCH AGENDA

All interviewed NTBF founders are interested in the results of this research, which shows the relevance for an optimised conceptual framework that enables NTBFs to select their growth strategy. As stated in the paragraphs above, the conceptual framework as designed in this research is clearly not finished yet. However, the foundation has been laid. More theory and empirical data is needed to optimise the framework iteratively to make it more complete for different types of NTBFs. Time, with all its accompanied variable changes and learning processes should be considered in the framework. Also, the framework should be applicable for NTBFs that develop different products and services for different markets, while *focus* may not always be applicable. Further research is needed to examine the suitability of the framework for different NTBFs, where this research only validates the framework with a single case study. This can be done by executing several in-depth single case studies that lead to a more complete and usable framework.

. The author recommends setting up a platform to gather data of NTBFs, that can be used to continuously improve the conceptual framework. Similar platforms are already used for personality tests, such as the Facet5.¹³ This research's framework assumes that managers will have a general idea about all internal and external variables. An *unknown* option should be incorporated to improve the usability of the framework. When developing the algorithm, a correlation between time and certainty should be included (the faster the manager answers, the more certain he/she is). The output should be clearly understandable for managers of NTBFs, who should be able to *play* with certain variables to see which variables are decisively applicable to certain strategies. This will provide the NTBF with information that can lead to the adaption of the internal and external environments in which it operates. Data should not only be gathered from NTBFs but should also be gathered from researchers when it comes to the critical assessment of the used theories (RBV, TCE and contingency) and definitions and possible extensions of the conceptual framework. In addition, quantitative research is needed to verify the result of the actual execution of strategies in certain situations.

7.4 CONCLUDING REMARKS

This research can be of significant value for NTBF founders. While the reason for attracting professionals and *smart money* into a NTBF is often a lack of expertise, this lack of expertise is based on a lack of knowledge. Most NTBF founders simply do not have the professional experience yet to set up a complete business. However, what makes them different from the “experts” is a lack of experience; learning by doing and making mistakes. If a framework would exist that could help these NTBFs to learn from the mistakes of others, this

¹³ <https://www.facet5global.com/>

could decrease the “bounded rationality” bias of NTBF managers. While the NTBFs clearly struggle with similar challenges, this gives the expression that once they know the tools and options to deal with these challenges, this would lead to better performance of these firms.

While the author of this research is an entrepreneur herself this research clearly reflects an entrepreneurial approach to solving problems. While writing this thesis, the author was working fulltime on her own NTBF which is also used as the single case study in this research. Many scientists would state that this is completely against all research norms and values that aim objective research. However, isn't this research even more valuable while it is so related to current practices? How often does it happen that the *object of study* executes the research itself? This research executed an in-depth case study; it is not going to be more “in-depth” than this. When researchers have any critics on the content of this study, it can be interesting to find out if these critics are based on a lack of scientific or practical expertise of the author. In case of the latter, the importance of bridging the gap between research and the “real world” becomes even more relevant.

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APPENDIX

APPENDIX A: EXISTING STRATEGY MAKING TOOLS

Different tools can be found that enable to match strategies with a circumstance contingent environment. An overview of the most important matching strategies is shown in Table 16. While these use different dimensions, they are all based on the same principle. Most of them use two axes to evaluate the internal and external environment, based on several variables that are ranked/scaled on importance, impact and/or beneficial characteristics. All matching strategies result in an output of 3 to a maximum of 4 strategy groups or strategy styles that are based on the fit between the internal and external environment: aggressive/offensive in case both are favourable (focused on growth), competitive/reactive or adjusted/conservative in case one is favourable, and one is not (focused on maintaining) and a defensive strategy in case both are unfavourable (focused on harvesting resources). Some tools, such as the SPACE and the BS-IA matrix are based on numerical values that are assigned to the variables, enabling to make the strategy formulation process quantifiable. Yet, also less applicable; it's almost impossible to exclude any subjectivity in the weighting of the factors.

TABLE 16: OVERVIEW OF THE MOST IMPORTANT STRATEGIC MATRICES

Matching strategy	Input	Output (types of strategies)
TWOS Matrix	Internal strengths (S) and weaknesses (W) External opportunities (O) and threats (T)	Four types of strategies: be offensive (SO), reactive (ST), adjusted (WO), defensive (WT). Defensive = shows central strategic issue.
SPACE Matrix	Internal dimensions: Financial strength and Competitive advantage. External dimensions: environmental stability and industry strength. Dimensions are defined by selected variables	Aggressive, conservative, defensive, competitive strategies
Business Strength - Industry Attractiveness (BS-IA) Matrix¹⁴	Data about market (size, growth, customers, price values, profitability, regulations) and company (size, growth, market share, customer loyalty, margins, distribution, technology skills, patents, marketing, flexibility, organization)	Green business (having high scores on BS and IA): organization has enough skills to take advantage of the market. Red business (lack market opportunities and company capabilities): harvest resources. Yellow: need selective investments, caution for operating style.
Internal-external (IE) Matrix	Internal factor evaluation (IFE) matrix is evaluating a firm's internal weaknesses and strengths. External factor Evaluation (EFE) matrix is identifying external opportunities and threats.	High and strong = grow and build High weak, low, strong = hold and maintain Weak low = harvest or divest
Grand strategy Matrix	Two dimensions: competitive position (weak, strong) and market growth (slow, rapid).	Based on strategic tactics that should be used per combination (4 quadrants): (1) Product/market development, backward/forward integration. (2) Product/market development, horizontal/vertical integration, liquidation. (3) Retrenchment, diversification. (4) Diversification, joint ventures.
Technology strategy framework (Bijl, 2017)	Two dimensions: competitive position and strategic impact.	Identification of implications of strategic positioning of technology. Determine development action per technology: accelerate, adjust, react or slow down. Determine how it needs to be done (strategic tactics)

¹⁴ The BCG growth-share matrix is not considered due to shortcomings: is meant for multi-divisional firms, not for NTBFs. Therefore, the improved BS-IA matrix is used. Yet, this matrix is still subject to subjective weighting of factors. Also, the results are very sensitive to the definition of the product market and scope of the market segment.

APPENDIX B: INTERVIEW DESIGN

CONTACT

All NTBF founders were contacted through LinkedIn or email. Interviewees were found by using the personal network of the author. They were invited for an interview through Google Calendar with the following message:

Some more information about my research. The subject is “selecting growth strategies for new technology-based firms”. The main outcome of this research will be a conceptual framework that enables to formulate growth strategies while considering all variables and constraints that influence strategy making. Themes that we will discuss during this interview: (1) the starting point of the firm with relation to the core technology, (2) the trial-and-error process of strategy adaptations along the way including all variables that cause these adaptations and (3) the current strategy. Thank you very much for your help!

After the interview, an email was send with a short summary of the interview:

Thanks again for the interview!

Attached to this email you can find a short summary of the interview. Can you quickly scroll/read through it to see if my interpretations of your words are correct?

The total summary will not be attached to my MSc thesis. However, I would like to use some quotes and paraphrases. Is that okay for you? Of course, all names and entities will be anonymised.

Please let me know if you have any questions or comments. I will share the results of my research before the end of the summer.

SET-UP

The interviews took around 60 minutes and had a semi-structured set-up. For every interview, around 8 pieces of white paper and a pen were used to write down keywords per category: *challenges, decision making, internal and external strategy making factors, starting strategy, strategy adaptations and current state*. At the start of the interview, a general introduction about the research was given as also shown above in the Google Calendar invite message. In addition, the interview set-up was discussed. Then, a definition of strategy was explained as a combination of choices for the product/service to deliver, the market to penetrate, the customer to approach, the business model to be used, the finance decision and so on. The following questions were discussed, sometimes in random order.

The start:

1. Can you tell me something about your technology and the starting point of your company.
2. With which strategy did you start?
3. What were all the variables that influenced your strategy, intern and extern?

Process:

1. Trial-and-error: did your strategy change long the way?
2. If yes, which factors and constraints led to these strategy adaptations?
3. If no, why didn't your strategy have to change?
4. Did your organization change (structure and processes) due to its growth? (relation with stage of growth?)

What are the most important challenges that you had to tackle? How did you do this?

Current

1. What is the current stage of the company?
2. How much did your firm grow in % of revenues and employees this year compared to last year?
3. What is your current strategy? How would you describe this strategy in terms and keywords?
4. How did you came up with this strategy?
5. Which criteria do you use to make organizational decisions?

Vision:

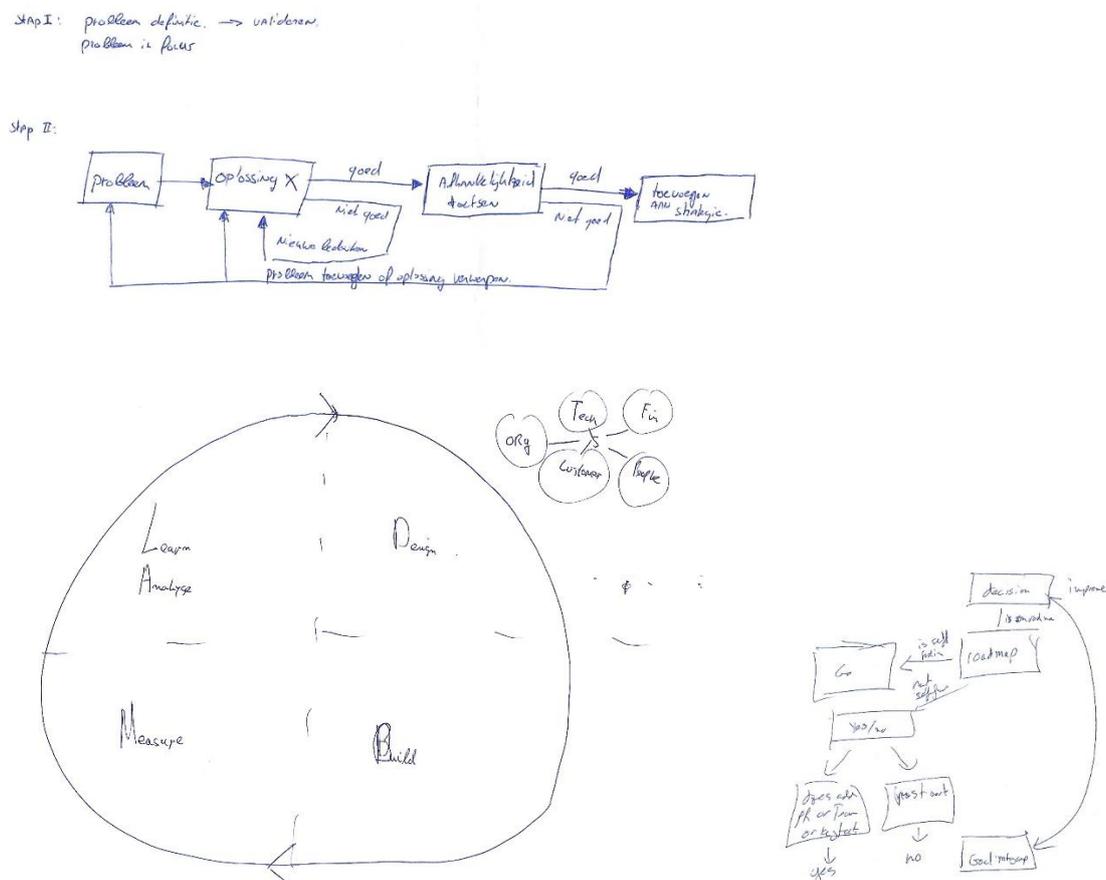
1. What are your ambitions for the upcoming five years?
2. What is the vision of your company?

At the end of the interview, the following questions were asked:

1. Take a look at the paper (keywords of internal and external variables that influence strategy making according to discussion in interview). Are there any more factors that we missed?
2. If you think about a sort of method or framework that could help you with formulating your growth strategy, how would that look like? Incl. building blocks, inputs and outputs and effects.

To answer the last question, the interviewees could use a pen and paper. This resulted in very creative and diverse drawings of interpretations of strategy formulation. Some examples of these drawings are shown in figure 16. Even though these drawings were not formally used in this research, the discussion of the drawings led to new insights.

FIGURE 16: DRAWINGS OF NTBF FOUNDERS THAT SHOW THEIR STRATEGY MAKING PROCESS



APPENDIX C: DATA ANALYSIS

The tables below are the outcomes of the data analysis by using a coding scheme in NVivo12.

1. CHALLENGES

TABLE 17: QUOTES AND PARAPHRASES OF NTBF FOUNDERS AND ADVISORY REPORTS REGARDING THE CHALLENGES FACED

Name	Description
Human resources	<p>“One of the main challenges was and is to find new suitable team members.” (NTBF2)</p> <p>“Since the company is developing complex technology, someone with a business background may not grasp the possible market applications and opportunities.” (NTBF5)</p> <p>“A challenge is to capture the knowledge of interns and/or temporary employees to keep this knowledge within the company.” (NTBF7)</p> <p>“A challenge is to offer team members an environment in which they can be free and creative and take responsibility” (NTBF9)</p> <p>“it’s hard to attract talented new team members.” (NTBF9)</p> <p>“It’s hard to keep structuring the communication between team members when the company grows. Also, it’s sometimes hard to delegate tasks and responsibilities.” (NTBF10)</p>
Lack of capital	<p>“Funding is needed to scale up the technology.” (NTBF3)</p> <p>“Since the company is producing hardware, the amount of financial resources needed is significant.” (NTBF5)</p> <p>“Huge R&D costs” (REPORT1)</p> <p>“There is a massive lack in venture capital. This will hinder technological development and eventual roll-out possibilities of the technology.” (REPORT3)</p> <p>“Acquiring funds plays a key role in the starting phase of a company.” (REPORT6)</p> <p>“Economies of scale are only possible when a significant number of products is being fabricated, for which you need capital.” (NTBF8)</p> <p>“If we would have more cash, we may had chosen a different strategy.” (NTBF8)</p> <p>“we already have some customers; however, external funding is needed to turn our start-up into a revolutionary global company” (NTBF10)</p> <p>“Raising capital is quite a challenge.” (NTBF10)</p>
Lead time	<p>“The product has a very long lead time.” (NTBF5)</p> <p>“When it comes to the technology development, it turned out to be much harder than we initially thought.” (NTBF5)</p> <p>“The lead time would take rather long and therefore, the project would turn out to be quite expensive.” (NTBF6)</p> <p>“Unfortunately, the technology has a very long lead time.” (NTBF7)</p> <p>“More research, tests and proof-of-concept have to be performed to make this technology more compelling.” (REPORT2)</p> <p>“Being the first means you have to face the brunt of R&D costs” (REPORT3)</p> <p>“The required trial & testing of the product will probably increase the payback period and the uncertainty of ROI.” (REPORT5)</p>
Complexity (being high-tech)	<p>“The software solutions that we develop are complex, and companies often do not understand how to use it.” (NTBF9)</p> <p>“If you have an innovative, high-tech product for a conservative customer, the customer may not be able to implement the product in its processes.” (NTBF9)</p> <p>“Client’s employees often lack the expertise and knowledge to actually use our technology.” (NTBF7)</p> <p>NTBF4</p> <p>“The fundamental problem for our company is that we are developing technology for which most companies are not ready yet; 90% of all companies do not value high-tech solutions.” (NTBF9)</p>

2. DECISION-MAKING

TABLE 18: QUOTES AND PARAPHRASES OF NTBF FOUNDERS AND ADVISORY REPORTS REGARDING THE DECISION CRITERIA USED TO FORMULATE STRATEGY

Name	Description
Ambition	<p>“The vision, ambition and mission were always leading.” (NTBF1)</p> <p>“We want to increase the total amount of revenues over four times in four years” (NTBF4)</p> <p>“Our ambition is to become the new global standard.” (NTBF10)</p> <p>“We make decisions based on the problem that we want to solve. The problem matters more than the way of execution.” (NTBF10)</p>
Capacity in-house/team	<p>“In all cases, decisions should be made based on the capacity of the in-house technology” (NTBF2)</p> <p>“the capacity (e.g. team availability) constraint should be considered. The ambition is to add one engineer per project. At the most, we run two projects in parallel.” (NTBF7)</p> <p>“Factors that are influencing our strategy making are the team, financials, customers, people and the organization” (NTBF5)</p>
Commercial value	<p>“The commercial value of a project is a very important decision criterion.” (NTBF2)</p> <p>“A project is only chosen when it fits the roadmap and is self-funded. In case the project isn’t self-funded, then at least it should allow the team to learn something new or it should have PR value” (NTBF7)</p> <p>“This product includes recurring revenues, which was a precondition for us to continue with this customer.” (NTBF5)</p> <p>“The team investigates where large investments are going and which (preferred) customers have money to spend.” (NTBF9)</p> <p>“There is only one reason to execute a project which doesn’t fit with your vision, which is that you can generate a significant amount of money with it.” (NTBF9)</p>
High-tech	<p>“We mostly use three decision criteria: commercial interest, the interests of the employees and the passion for technology.” (NTBF5)</p> <p>“Three important factors influence our strategy making: commercial interest, making people happy and technical superiority.” (NTBF6)</p>
Shareholders	<p>“the shareholders are influencing our decision-making” (NTBF4)</p>
Vision	<p>“An important decision criterion for high-tech start-ups is the vision to make or buy. Does the team want to make the technology themselves, or only commercialize and sell it?” (NTBF1)</p> <p>“Decisions are made based on the corporate vision and personal motives of the managers.” (NTBF2)</p> <p>“Our vision had always been to become a manufacturing company.” (NTBF7)</p> <p>“The long-term vision and planning helps the company to focus” (NTBF8)</p> <p>“We use a vision-oriented approach for our product design” (NTBF8)</p> <p>“At all times, it is essential that a start-up makes decision according to its core values. Making choices according to the core values increases the decision speed significantly, while no discussion is possible about things that do not match with the core values.” (NTBF1)</p> <p>“We want to build a platform with which we can scale up.” (NTBF9)</p> <p>“having a vision based on a solution would frame the company too much. We focus on the problem that we want to solve, which matters more than the actual way of execution” (NTBF10)</p>
PR value	<p>“Except for some small PR projects, our product is very focused on these industries only, offering a clear proposition to the market.” (NTBF1)</p> <p>“We should focus on our key strengths and core activities” (NTBF8)</p> <p>“In case the project isn’t self-funded, then at least it should allow the team to learn something new or it should have PR value” (NTBF7)</p>

Name	Description
Year plan	<p>“The management team has written a year plan to which they stick at all times. This also causes the company to say no to some assignments.” (NTBF2)</p> <p>“The management team works with a very clear plan that forms the corporate strategy. This plan is influenced by the market, the technology, the vision and the core values of the company.” (NTBF2)</p> <p>“The year plan is always leading” (NTBF8)</p> <p>“A project is only chosen when it fits the roadmap” (NTBF7)</p>
Core values	<p>“The management team works with a very clear plan that forms the corporate strategy. This plan is influenced by the market, the technology, the vision and the core values of the company.” (NTBF2)</p> <p>“At all times, it is essential that a start-up makes decision according to its core values. Making choices according to the core values increases the decision speed significantly, while no discussion is possible about things that do not match with the core values.” (NTBF1)</p>
Customer	<p>“The customers are king, and your proposition should meet their needs.” (NTBF1)</p> <p>“We focus very much on the end-user in our decision-making.” (NTBF8)</p> <p>“The end-product design might be adapted based on the customer feedback” (NTBF8)</p> <p>“The customer’s opinion and needs are leading every decision.” (NTBF4)</p> <p>“We are extremely customer driven. We started our company by developing customized technology.” (NTBF9)</p> <p>“When a decision is made, the decision is validated with the customer.” (NTBF9)</p> <p>“We have preferred customers. These are customers that are far enough with their development and are ready for our high-tech solutions” (NTBF9)</p>

3. STRATEGIC TACTICS

TABLE 19: QUOTES AND PARAPHRASES OF NTBF FOUNDERS AND ADVISORY REPORTS REGARDING STRATEGIC TACTICS

Name	Description
Agile tech approach	<p>“We are currently trying to generate revenues by starting with relatively simple (test) products with a shorter development time. This enables to get some traction and revenues to invest in further development of the technology.” (NTBF5)</p> <p>“We must proof that our technology works to convince industry that it’s worth adapting” (NTBF7)</p> <p>“Based on the prototype, an intermediate product was designed that forms a nice first step towards the envisioned end-product” (NTBF8)</p> <p>“When volume increases, extra modular components will be developed based on the needs of the customers. ” (NTBF8)</p> <p>“The intermediate product allows to enter the market after which the real learning process begins.” (NTBF8)</p> <p>“Always try to build things that just do what they want (function based, don’t make it too complex)” (NTBF8)</p> <p>“An agile approach, by focusing on components rather than complete vehicles and constructions, affects the learning and network affects and brings the opportunity to increase the proof-of-concept” (REPORT2)</p> <p>“The industries’ conservativeness can be bypassed by engaging in component application” (REPORT2)</p> <p>“First get your name out there and get a proof of concept by collaboration” (REPORT3)</p> <p>“Importance of experimental purpose in trial phase” (REPORT5)</p> <p>“Currently, we aim to have a basic system (core product) to which several components can be added in a modular way (plug-and-play). In this way, we provide customized solutions while still focusing on our own value proposition and strength. This adaption in strategy decreases the development time per solution significantly. The plug-and-play product can be easily adapted based on customer needs.” (NTBF9)</p>

Name	Description
Marketing	<p>“Pioneering customers were inspired and attracted by the product its appearance. Visual attractiveness of our product turned out to be an important marketing instrument” (NTBF1)</p> <p>“We got selected for an incubator programme, which helped our branding” (NTBF6)</p> <p>“Use non-conservative partners in industry that feature high media coverage” (REPORT6)</p> <p>“A successful collaboration would attain media attention” (REPORT6)</p> <p>“Implement a marketing stunt” (REPORT6)</p> <p>“We got into an incubator programme which allowed us to build up a network and funding” (NTBF10)</p> <p>“Our technology is quite hot and up-to-date in terms of market trends, which assists the company with its marketing and communication.” (NTBF10)</p>
Company entry	<p>“We combine approaches to enter companies; through senior management and through R&D management. Senior managers are often less scared for failures than the R&D managers. However, entering through R&D gives some opportunity to emphasize technical superiority.” (NTBF7)</p>
Decision-making formalisation	<p>“All responsibilities are divided, and a clear structure is maintained” (NTBF1)</p> <p>“We, the founders, use a consensus model” (NTBF3, NTBF5, NTBF6, NTBF8)</p> <p>“We use a consensus model for making decisions. If we have some disagreement, this is mostly due to a lack of information (or knowledge).” NTBF5)</p> <p>“Until October last year, we used a consensus model for the decision-making. This resulted in a very time consuming and inefficient decision-making process. Now, only the CEO is competent and responsible for the commercial decisions. The CTO makes decisions about the technology and the CPO about the product. Of course, all main points are communicated. Yet, clear roles and responsibilities are defined. Every manager has the responsibility to execute tasks according to the corporate strategy, the annual plan including budgets and the defined targets. In the end, the CEO has the final vote.” (NTBF2)</p> <p>“The CFO plans the long-term financing, raises and negotiates funds. This enables the CEO to focus on the main points instead of detailed terms.” (NTBF7)</p> <p>“A low level of standardization and formalisation works better to encourage innovative and creative thinking.” (REPORT3)</p> <p>“Decision-making is formalized. We use a decision-making tool for new projects. In evaluating new projects, the costs, generated value and technical feasibility are analysed.” (NTBF9)</p> <p>“We have different responsibilities and interests, yet, no clear function within the team (we both use the title “founder”).” (NTBF10)</p>
Employment	<p>“New employees are hired based on their commitment. Also, graduating projects were used to hire new students that often started working for the company in case of a good match.” (NTBF1)</p> <p>“People are not hired because of their capabilities or education, they are hired because of their mindset and motivation to contribute to our company and ambition. If they cannot tell anything about this central problem, it’s a no go. Capabilities and skills are things that you can learn, but the drive is something that should already be there. Hiring people for their personalities also helps to be adaptable and lowers the risk of firing someone; when people are hired because of their skills they might become unneeded in case of a strategy shift.” (NTBF10)</p>
Focus	<p>“Except for some small PR projects, our product is very focused on these industries only, offering a clear proposition to the market.” (NTBF1)</p> <p>“We should focus on our key strengths and core activities” (NTBF8)</p> <p>“We find it hard to balance between small projects and developing the core product. At least, these small projects should contribute to the technology know-how. Also, they should bring us a small step closer towards our vision” (NTBF9)</p> <p>“We started with a focus on consultancy, where we changed the product, service and business model along the way. We use pivoting to iterate our strategy constantly.” (NTBF10)</p>
Target group	<p>“As this is a long-term proposition, it is advised that the start-up follow the plan as a guideline, but as new opportunities might arise, should be flexible and adaptive regarding the roll-out.” (REPORT4)</p>

Name	Description
Funding	<p>"The way you finance your company is an essential part of your strategy." (NTBF1)</p> <p>"We have 10 informal, minority investors." (NTBF8)</p> <p>"Investors were essential for our survival. They do not only help with funding, but they also give legal and business advice and some coaching. Because of the investors, the value of the company rose significantly. Moreover, the investors have a broad network which enables to find new investors." (NTBF2)</p> <p>"In the beginning, we were able to finance our activities and growth organically by using bank financing and investments of the founding team. Later, we used equity finance to scale up." (NTBF4)</p> <p>"Finding the right investor turned out to be a big challenge. Luckily, we found a suitable investor that is currently owning a minority stake in the company." (NTBF4)</p> <p>"Currently, we are making the company ready for an investment round. we prefer convertible loans over equity finance." (NTBF5)</p> <p>"The founders did a small 3F financing round to start with." (NTBF6)</p> <p>"The company is still owned for more than 80% by its founders. To fund our development, we mostly focus on convertible loans. Also, 9,5% of equity finance is involved." (NTBF7)</p> <p>"Investors are welcome when the product is finished to enable our company to scale up. " (NTBF9)</p> <p>"Start-ups should focus on raising "smart money", where the investor can contribute to both the financial and the operational part" (REPORT4)</p> <p>"We set up an ICO roadmap for our funding rounds with which we are going to raise millions of euros capital. Currently, we are building a "coding" prototype to be able to convince investors and reduce their risk." (NTBF10)</p> <p>"Raising capital is quite a challenge. It involves a process of negotiation and finding the right investors. Currently, we focus mainly on VC's and corporates rather than Angel Investors, where we found out that Angels really want to be involved in the company. VC's are generally more on a distance but can still provide "smart" money in terms of coaching and networking." (NTBF10)</p>
Launching customer	<p>"We are working on one product for one launching customer with which we already did some testing." (NTBF5)</p> <p>"A launching customer will be needed to bring the technology to the market." (NTBF6)</p> <p>"We established a partnership with a launching customer. This customer helped with building our company." (NTBF9)</p>
Market niches	<p>"We decided to focus on one or two niche markets to prove our technology." (NTBF3)</p> <p>"Industries' conservativeness can be bypassed by engaging in component applications." (REPORT2)</p> <p>"Start in a niche market to proof the concept." (REPORT4)</p> <p>"Find an entry market with favourable environmental conditions." (REPORT5)</p>
Minimize hardware risk	<p>We focus on software development, where hardware development is riskier. An essential part of our strategy is to minimize the hardware risk. We are using off-the-shelf components, where we work fulltime on the software programme." (NTBF3)</p> <p>"The strategy is to "not invent the wheel again". If possible, components are bought off-the-shelf." (NTBF9)</p>
Network	<p>"The network of the university helped our start-up significantly." (NTBF1)</p> <p>"Winning the trust of your customers and partners is very important to grow a high-tech start-up" (NTBF4)</p> <p>"Building relationships with potential partners and clients to find out their true needs is of key importance for the company." (NTBF7)</p> <p>"Use the established network to convince bigger players to invest in complementary goods that could enhance their production process" (REPORT6)</p>
Patent (IP)	<p>"We use patents and trade secrets to protect our intellectual property" (NTBF7)</p> <p>"In this phase it is of utmost importance that proprietary technology is protected by means of patents to recoup their initial investments" (REPORT4)</p> <p>"Patents are crucial to win the race to market" (REPORT6)</p> <p>"We want to keep our IP in-house in collaborations"(NTBF1, NTBF2,NTBF9)</p>
Pricing	<p>"The price of our product is based on its value rather than costs. When volume increases, the price will go down."(NTBF8)</p>

Name	Description
	<p>"Use penetration pricing; resenting itself as a perfect alternative to competitors, at a lower price. This will not result in profit, it does however increase the overall market share." (REPORT6)</p>
Service orientation	<p>"We wanted to sell our product first but changed to a service business model" (NTBF1)</p> <p>"We started as a small engineering advisory firm. We didn't see any opportunity to further scale up our company by only delivering advice and consultancy. After a while, we began to sell manufacturing machines." (NTBF4)</p> <p>"We moved from a service to a hardware orientation" (NTBF6)</p> <p>"Due to our long lead time, we started with engineering consultancy projects to generate revenues, built up technical know-how and traction" (NTBF7)</p> <p>"Since our company develops a service, our biggest costs are labour costs where we (almost) do not have to buy any materials." (NTBF9)</p>
Approach: Tech push or market-pull	<p>"It would help a lot if the company would have a product that companies could just buy off-the-shelf." (NTBF5)</p> <p>"We developed a technology by using a technology-push model. After a while, we found that there was no money and a lack of commercial value in the specific industry for technology development. Accordingly, we had to look for other applicable market segments."(NTBF2)</p> <p>"The two founders maintain a clear market-pull strategy: first define and validate a problem and then find a solution for that problem. Pivoting is used to iterate their strategy" (NTBF10)</p>
Outsourcing/insourcing	<p>"We decided to outsource the development of the user interface software. This turned out to be very expensive, but just didn't belong to the core activities of the company." (NTBF2)</p> <p>"When outsourcing activities, we make a trade-off based on the value of time and transaction costs." (NTBF2)</p> <p>"We tried to outsource some of the development, but this didn't work out" (NTBF5)</p> <p>"The "make-or-buy decision" clearly plays an important role for our go-to-market strategy. Our sales are outsourced by collaborating with dealers, who take 30 to 40% of the profit." (NTBF8)</p> <p>"We use strategic partnerships to collaborate with our suppliers. We exchange information to get costs down." (NTBF8)</p> <p>"Our value proposition is only a small part of the total value chain. The discussion about "who is facing the end-consumer" can be an important topic when discussing collaboration opportunities." (NTBF9)</p> <p>"For the development of our technology, we insourced another company in exchange for some equity shares. This decision has positive consequences for our company. First, the company increases its value significantly. Second, in the short-term, it saves a lot of development costs where we normally would have been paying the development team based on value instead of costs. Third, the team expands size quite rapidly but with people that are already working together for quite a long time. This means that all struggles of growing a company, structure and processes wise, are prevented. " (NTBF10)</p>

4. STRATEGIES

TABLE 20: QUOTES AND PARAPHRASES OF NTBF FOUNDERS AND ADVISORY REPORTS REGARDING STRATEGIES

Name	Description
Launching	<p>“If one client is serviced with a significant improvement, then every other competitor in the market will follow, resulting in a new dominant design.” (REPORT1)</p> <p>“The first launching customers helped us with our marketing. Also, this customer helped with our network and helped us to contact with other customers.” (NTBF9)</p>
Strategic alliances	<p>“In the beginning, we collaborated with SME’s. Yet, later we changed to multinationals for strategic alliances.” (NTBF4)</p> <p>“Collaboration with market parties is essential for survival. Large companies have certain resources (knowledge, funding) with which new firms can never compete.” (NTBF2)</p> <p>“We make use of collaborations to strengthen our market position.” (NTBF9)</p> <p>“When collaborating and building long-term relationships, it’s essential that partners have some knowledge or resources that we don’t have.” (NTBF9)</p> <p>“Collaboration with the industry is essential in growing your company.” (NTBF4)</p> <p>“A collaboration strategy to increase industry credibility and to tap into resources that are otherwise not available.” (REPORT2)</p> <p>“Collaborating with firms familiar with the industry challenges, rather than trying to penetrate the market in isolation” (REPORT2)</p> <p>“Collaboration should be sought with firms familiar in the industry. This positively affects learning and network effects. This will result in improved credibility.” (REPORT2)</p> <p>“For a start-up, it seems logical to form a strategic alliance with a large firm to tap their greater capital resources, marketing capabilities and credibility.” (REPORT3)</p> <p>“It is advised to find partners that have experience in the market” (REPORT4)</p> <p>“A partnership could be the solution for the lack of capital” (REPORT6)</p> <p>“Risk sharing and access to new competencies (resources, knowledge) due to stakeholder involvement” (REPORT6)</p> <p>“Instead of focusing on joint ventures with starting companies, the company currently focuses on strategic alliances with multinationals since these have money to spend.” (NTBF6)</p> <p>“High R&D costs are handled by a strategic alliance that contributes in the initial development expenses In return for a percentage minority stake. ” (REPORT6)</p> <p>“The discussion about “who is facing the end-consumer” can be an important topic when discussing collaboration opportunities.” (NTBF9)</p>
Co-creation	<p>“To win the trust of customers, it can help when a plan is being developed together with the customer. Also, it helps to be transparent about the problems that are faced.” (NTBF4)</p> <p>“What is important is that customers have some resources to experiment and take risk.” (NTBF2)</p> <p>“We use co-development as an education tool. If you have an innovative, high-tech product for a conservative customer, the customer may not be able to implement the product in its processes. We need very specialized domain-specific knowledge to run its software. This knowledge often comes from system engineers and maintenance engineers that are already working in the field for more than 20 years. We must translate the intuition of these engineers into a model. After building the model, we provide the customers tools that they must make their own.” (NTBF9)</p>
Exclusivity	<p>“A partner will get exclusive rights to use the product in their industry, which offers a substantive source of competitive advantage” (REPORT6)</p> <p>“We established a very nice collaboration with a large customer, who gets some exclusivity. We can’t collaborate with other parties without involving this partner. This gives us some advantages, while we are dependent on the resources of this partners when it comes to the execution and operational part of the inspection. The collaboration enables us to deliver a turnkey solution to the end-user.” (NTBF2)</p>

Name	Description
	<p>“We are very careful with exclusivity deals. When giving exclusivity to a partner other market parties will soon get to know. They will start developing similar products while in the meantime, our company will be stuck with one exclusive partner. ” (NTBF6)</p> <p>“We are open for profit sharing models, but there should be a clear advantage. For instance, the other party should employ expertise, knowledge and funding” (NTBF2)</p> <p>“We established a partnership with a launching customer based on exclusivity for a certain period within a certain area” (NTBF9)</p>
Joint ventures	<p>“We had the option to start a joint venture, however, the other company did not want to share all information; there was a clear lack of trust.” (NTBF1)</p> <p>“look at possible collaborations with potential customers instead of substitutors. Invite them to invest the development what could be combined proprietary technology. This could help in establishing a key player in the industry and drawing attention to their technological expertise, allowing them to capitalize on the knowledge gained.” (REPORT3)</p>
Leasing	<p>“Leasing hardware (a part of the total product) seems currently the best strategy for our company, instead of establishing joint ventures or licensing our technology” (NTBF6)</p>
Technology transfer	<p>“We decided that we really want to make the technology ourselves, rather than just selling it and having a business model based on IP which was expected to be less profitable in the long-term” (NTBF1)</p> <p>“It is essential to keep the IP (copyright and trade secrets) in our own hands. Some parties want to collaborate and take over all technology, which is not an option.” (NTBF2)</p> <p>“We choose not to license our technology” (NTBF6)</p> <p>“Licensing the patented technology to companies offers little opportunity for the development of new capabilities in the long run” (REPORT1)</p> <p>“By licensing, the start-up doesn’t need to develop or produce the product internally but will only receive a revenue stream. This revenue stream can then be used for investment in R&D.” (REPORT6)</p>
Vertical integration	<p>“An idea is to build an experience centre. Another idea is to drive around the country and transport the products to customers. However, this costs a lot of money and a different kind of business.” (NTBF8)</p> <p>“The start-up invests, builds and operates their own machines and provides a service to customers.” (REPORT1)</p> <p>“Challenges that can result from moving first into the relatively undiscovered market are the innovation and R&D costs that are needed to establish a market. ” (REPORT6)</p> <p>“Uncertainty that arises when a start-up moves first to a market in terms of undeveloped supply and distribution networks can be a threat” (REPORT6)</p>
System integration	<p>In our platform, we use the input of all stakeholders to solve the system problem by using blockchain technology” (NTBF10)</p>

5. EXTERNAL VARIABLES

TABLE 21: QUOTES AND PARAPHRASES OF NTBF FOUNDERS AND ADVISORY REPORTS REGARDING THE EXTERNAL VARIABLES THAT INFLUENCE STRATEGY MAKING

Name	Description
Customers	Focus on scoring large scale clients that dictates its respective market (REPORT1) “Our customers are mainly end-users and system integrators.” (NTBF9)
Market segments	“We focus on three markets” (NTBF9)
Suppliers	“A company can ruin itself by having bad suppliers. The more components a product has, the more suppliers and the higher the risk of delay. We had several suppliers per component.” (NTBF1) “If demand increases, your suppliers should be able to expand with you. You simply can’t collaborate with suppliers that are not able to grow.” (NTBF1) “We have a low number of suppliers” (NTBF7) “We prefer off-the-shelf components, however, most of the time buying off-the-shelf is not an option. Therefore, we use strategic partnerships for our supply chain” (NTBF8) “establishment of supplier and distributor network.” (REPORT1)
Adoption of technology	“Products are (almost) not sold without testing possibilities.” (NTBF8) “Market trend with widespread adoption of technology and its effectiveness” (REPORT1) “Our technology is quite hot and up-to-date in terms of market trends, which assists the company with its marketing and communication.” (NTBF10)
Availability of funding	“The Dutch financial environment for high-tech hardware is quite dramatic, where only a small number of large investors are present.” (NTBF7) “We started after getting a government loan, which enabled us to build our first prototype” (NTBF8)
Competition	“Advantage of being a first mover to the technology.” (REPORT1) “The absence of competitors provides the company a blue ocean, where they are free to conquer the market.” (REPORT3) “Such first mover advantages give the opportunity to exploit monopoly rents, however, the burden of being the first mover also constitutes laying the foundation to all these issues” (REPORT3) “the current (near) absence of competition in this particular technology” (REPORT3) “The threat of competitors is relatively low.” (NTBF8)
Demand	“The sales conversion rate was over 40%.” (NTBF8) “The lesson learned was to get to know your partners and customers better before you start negotiating; you must know where the threshold is located to propose something viable.”(NTBF6) “The founders started the company due to a demand from industry.” (NTBF9) “Rising demand is a driver.” (REPORT1)
Industry	“The sector barely innovates.” (NTBF8) “A company should analyse the market and its trends to know what kind of strategy it should execute.” (NTBF4) “A big challenge for our start-up is to be innovative and radical in conservative industries.” (NTBF7) “Education plays a large role. Client’s employees often lack the expertise and knowledge to actually use our technology.”(NTBF7) “Challenges that can result from moving first into the relatively undiscovered market are the innovation and R&D costs that are needed to establish a market.” (REPORT6)

Name	Description
	<p>“Nobody wants to go first, conservative attitude, reliability issues. Existing contractual agreements between companies and their customers” (REPORT1)</p> <p>“Growing industry” (REPORT2)</p> <p>“A barrier is the conservativeness and inertia of the industry” (REPORT3)</p> <p>“Threat of conservativeness in the market, proposed companies might not be willing to invest.” (REPORT6)</p> <p>“Large companies often have good ideas, but they simple do not have the ecosystem to execute these ideas due to, for instance, bureaucracy. High-tech start-ups are often radical and disruptive. For large companies it can be beneficial to outsource their innovation to increase creativity and freedom.” (NTBF9)</p> <p>“External factors that influence decision-making are market trends, competitors and suppliers.” (NTBF9)</p>
Information	<p>“We exchange information with our suppliers to get costs down.” (NTBF8)</p> <p>“We had the option to start a joint venture, however, the other company did not want to share all information; there was a clear lack of trust.” (NTBF1)</p>
Legislation and regulation	<p>“The implementation of the technology in industry requires a costly and time-consuming process of certification” (REPORT4)</p> <p>“The safety aspect of our product is very important since we have to deal with strict regulations. It’s not allowed by current regulations to use our product outside. Therefore, we focus on indoor environments now.” (NTBF10)</p>
Market size	<p>“The market potential of our targeted industries definitely affected the successfulness of our company” (NTBF1)</p> <p>“We target high-potential and growing markets” (NTBF6)</p> <p>“the product is applicable in different markets and diverse companies.” (NTBF9)</p>
Subsidies	<p>“We financed more than half of the prototype by subsidies” (NTBF1)</p> <p>“We got some subsidies to finance our technology development” (NTBF2)</p> <p>“Currently, we are dependent on subsidies and our own investments in the company” (NTBF3)</p> <p>“Until this moment, the company relied on subsidies and government loans” (NTBF5)</p> <p>“We make use of both national and European subsidies to build our company and enter market segments.” (NTBF10)</p>
System complexity	<p>“The value chain is complicated” (NTBF7)</p> <p>“Often, the system solution for the end-customer is very complex and we cannot build it completely by ourselves.” (NTBF9)</p>

6. INTERNAL VARIABLES

TABLE 22: QUOTES AND PARAPHRASES OF NTBF FOUNDERS AND ADVISORY REPORTS REGARDING THE INTERNAL VARIABLES THAT INFLUENCE STRATEGY MAKING

Name	Description
Organizational Structure	<p>“Organizational processes must be adapted when a company grows. Communication must be structured, the critical path must be defined, and responsibilities must be divided. Tools are used for the communication and meetings are scheduled to evaluate progress. A clear structure is maintained within the company regarding responsibilities and strategy making. While the team is growing, the founders must manage people through people. To stimulate creativity and innovation, the team exists of very diverse people that think in a different way.” (NTBF9)</p>

Name	Description
	"Formalizing the company structure and processes forms a challenge. For instance, how to structure communication between team members. Also, it's sometimes hard to delegate tasks and responsibilities." (NTBF10)
Development time	"We changed our strategy to decrease the development time per solution" (NTBF9)
Founding team: Education	"the technical expertise of the university students, which provides them with in-house R&D capabilities" (REPORT3) "Our board exists of highly educated engineers" (NTBF2) "Both founders have an engineering background" (NTBF2)
Founding team: Entrepreneurial skills	"We didn't have experience in setting up a company" (NTBF8) "The founding team was committed, complementary and entrepreneurial" (NTBF1) "The entrepreneurial mindset of the founders helped to identify market opportunities." (NTBF2) "Founder always wanted to start his company" (NTBF3) "Some reasons for the successfulness of our company is that the managers are very ambitious and are willing to take risks. Also, the managers can convince important stakeholders" (NTBF4) "The start-up identified a market opportunity" (NTBF6) "Before starting the company, the founders already had experience with entrepreneurship" (NTBF9) "Both founders already had experience with entrepreneurship and business and found several companies." (NTBF10)
Founding team: Professional experience	"The founding team had no professional experience, they all came fresh from the university." (NTBF1) "Our board exists of engineers that do not have a lot of business expertise yet. We are currently hiring someone with a commercial background." (NTBF2) "Technical know-how can help to convince market players." (NTBF4) "One of our founders worked for more than a decade in industry and knows the industry very well." (NTBF7)
Team composition	"The biggest advantage of our founding team was the complementariness" (NTBF1) "One of the founders took care of the budgets in the CFO role, which turned out to be a very important strategic step that helped the company to maintain a positive cash flow at all times." (NTBF1) "The CFO plans the long-term financing, raises and negotiates funds. This enables the CEO to focus on the main points instead of detailed terms." (NTBF7) "The founding team and their complementariness played an essential role in the growth of the company." (NTBF7) "One founder is developing the business where the other is developing the product." (NTBF8) "Our two founders are both engineers. We are thinking about involving a third founder who can help with the business side." (NTBF3) "The capabilities of the team are a driving force behind the business" (NTBF9) "The founding team is complementary in their behaviour and responsibilities" (NTBF9) "The most important influencer of strategy making is the team; that the people fit well together in terms of personality and drive." (NTBF10)
Cash	"If we would have more cash, we maybe would have chosen a different approach." (NTBF8) "The amount of money on the bank impacts strategy making significantly. If you want to be profitable, you sometimes have to adapt your strategy to be competitive." (NTBF1)
Network	"Our network helped us to find a launching customer." (NTBF9) "We developed some skills in networking which helped us a lot in setting up our company." (NTBF10)
Value proposition	"Our product has clear benefits compared to conventional products in terms of costs and quality." (NTBF8) "At all times, a high-tech start-up should focus on its core strengths and value proposition." (NTBF4) "Except for some small PR projects, our product was very focused on these industries only, offering a clear proposition to the market." (NTBF1)

Name	Description
	<p>“Customers are king, and your proposition should meet their needs.” (NTBF1)</p> <p>“The value proposition needs to be very clear to customers and potential partners.” (NTBF2)</p> <p>“Entering through R&D gives some opportunity to emphasize technical superiority” (NTBF7)</p> <p>“We have a clear value proposition to the market based on benefits (e.g. reducing costs and improving quality) which helps to communicate the business case.” (NTBF7)</p> <p>“Cost reduction (5 to 10 times) and improved quality can increase the value proposition compared to existing technologies offered by competitors” (REPORT1)</p> <p>“An essential part of the core product is its adaptability; the product can be commercialised in different markets and diverse companies.” (NTBF9)</p>

APPENDIX D: DETAILED ANALYSIS FOR INTERNAL VALUES OF QLAYERS

1. BACKGROUND AND PERSONAL PROFILES OF MANAGEMENT TEAM OF QLAYERS

BACKGROUND

The management team exists of the three original co-founders. Qlayers was started in 2016 by Ruben Geutjens and Amber van Hauwermeiren. Josefien Groot joined the team in 2017 to lead the business development. What binds the managers together is a strong, shared vision to improve the world with material science. They have proven to share enthusiasm, dedication and motivation to build a global company that can really aid in suppressing climate change and fastening the energy transition. All team members have quite different individual skills and interests (as also shown in the personal profile by the Facet5 test, see next paragraph). It is this combination that results in a powerful management team. The founding team hired a new CFO from July 2018 on, who is having his test period at the moment of writing.

Ruben Geutjens | CTO



MSc Aerospace Engineering, Novel Aerospace Materials, TU Delft

Responsibilities: R&D, technology management

Experience: Aerosol research at TU Delft and UMN (US)

Aerospace component manufacturing at Sabca

Amber van Hauwermeiren | COO



MSc Aerospace Engineering, Novel Aerospace Materials, TU Delft

Responsibilities: Operational effectiveness, supply chain management

Experience: Design at Studio Roosegaarde

Marketing and communication at TU Delft

Sales at FeedbackFruits

Josefien Groot | CEO



MSc (Student) Complex Systems Engineering and Management, TU Delft

Responsibilities: business modelling, human resources, strategy management

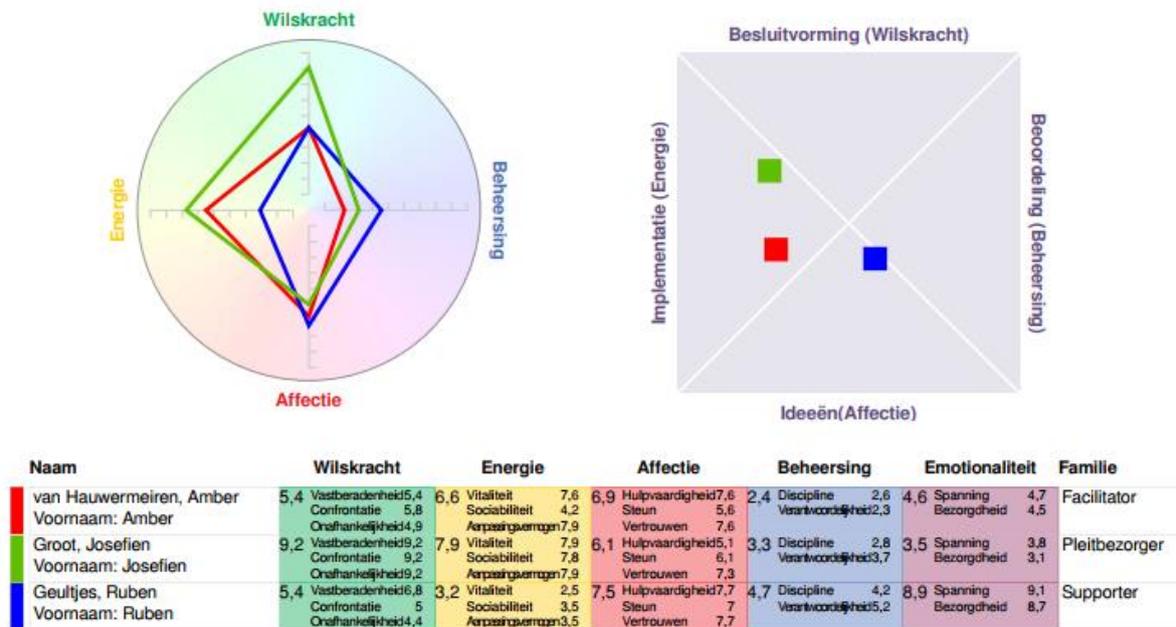
Experience: Business Developer at ECN

Founded and sold Yogachicks

PERSONALITY PROFILES

In the spring of 2017, the management team of Qlayers performed a Facet5 test that measured the specific characteristics of the personalities of the founding team. As shown in Figure 15, all three managers have a different personality type. The square on the right shows that the management team may be extended with an additional member who is naturally better in controlling.

FIGURE 17: AN OVERVIEW OF THE FACET5 PERSONAL PROFILES OF THE MANAGEMENT TEAM (VAN IERSCHOT B.V. , 2017)



2. TECHNOLOGY AND VALUE PROPOSITION

PROBLEM

Industrial processes are being automated more and more. However, the coating of large structures is still done by hand, often with a roller and brush, due to regulations and the impact of spray coating on the immediate environment of the coated structure. This results in a time consuming, dangerous and expensive process that faces several problems for the workers, coating companies, end-users and the environment. Firstly, part of the coating is wasted due to overspray and low transfer efficiencies of conventional spray systems. Secondly, expensive, energy-consuming and unsafe coating facilities are needed to keep the sprayed coating from contaminating the environment. Thirdly, people need special education to execute the coating process. However, as the job of painting is tedious, dangerous and demanding, these skilled workers are becoming rare. Lastly, the available onsite coating processes can be extremely costly. This, for example, results in unsafe maintenance of offshore wind turbines which in turn makes the operation of a wind farm financially unattractive. The industry requires an automated onsite coating process that does not contaminate its environment. On the longer term, the end-user desperately needs his surfaces to fulfil a set of functions that are not offered by current

industrial coatings. Next to adding colour and surface protection, additional functionality can reduce fuel consumption and CO2 emissions for vehicles, as well as avoid expensive methods for de-icing, cleaning and maintenance of many objects in the energy and transport sector. Unfortunately, there is no commercially available, scalable, cheap, fast and reliable tool to apply new functional coatings yet.

SOLUTION

THE SLASH100

Qlayers develops a coating print head, the *Slash100*, which applies existing coatings autonomously in a locally controlled environment. This enables Qlayers to safely coat large surfaces on any location (offshore) under all weather conditions. Moreover, the release of toxic solvents is limited, which makes the coating process much healthier and less demanding for workers. For coating companies and their customers, a high coating speed reduces maintenance costs significantly. Using existing sensing technology, non-destructive testing can be performed by the printhead in real-time by checking the health of the covered structure and registering the layer thickness of the coating. In this way, the amount of weight added by the coating can be minimized and expensive or unreliable inspection procedures are eliminated. The first print head will be designed, constructed and tested until September 2018, after which it will be commercialized.

The *Slash100* avoids large energy consuming coating facilities, ensures a consistent coating quality, uses up to 50% less paint and creates a safer workplace. The customer gets ‘hardware as a service’, where Qlayers works constantly to improve speed and reliability of the *Slash100*. The hardware iterations will add extra functions to the *Slash100*, as demanded by customers, the automation of the (pre-)treatment process of the surface. The current certification of coatings happens through education of manual workers. By curing in a controlled environment and real-time coating data collection, the current certification process can be made much cheaper and more reliable. With digitally controlled sensors and valves, Qlayers collects real-time data on the health of the *Slash100* system. This close monitoring allows for predictive maintenance and logistic optimization.

THE GRAVITON

As a premium service, the controlled environment allows Qlayers to apply and certify innovative functional coatings. As a first step, Qlayers developed a non-proprietary printing method (the *Graviton*) in 2016, to create a drag-reducing ‘sharkskin’ microstructure in standard coatings. Applying this microstructure on large structures such as wind turbines, airplanes, ships and high-speed trains reduces friction with the air or water with 3-8%. This translates directly into more energy generation of wind turbines and lower fuel use and reduction in CO2 emissions of ships and airplanes. Qlayers realized a proof-of-concept of the *Graviton* by demonstrating its sharkskin coating on the hydrofoil of the TU Delft Solar Boat Team. Now, Qlayers is the only company that can easily print new functional microstructures and therefore the *Graviton* will be patented this summer.

ENVIRONMENTAL BENEFITS

The locally protected environment of Qlayers coating system reduces the amount of paint wasted and toxics released in the environment. Furthermore, applying ‘sharkskin’ microstructures on large structures such as wind turbines, airplanes, ships and high-speed trains reduces friction with the air or water with 3-8%. This translates directly into more energy generation of wind turbines and lower fuel use and reduction in CO₂ emissions of ships and airplanes. For container ships a reduction a drag reduction of 5% translates into fuel savings of 7,5 ton per day per ship (150 ton total use *0,05 = 7,5 ton saved). 7,5 ton fuel reduction in turn translates into a CO₂ reduction of 21,95 ton per ship, which means more than 8.000 CO₂ emission reduction per ship per year (7,5 ton = 8.474 litre diesel, 8.474*2,6319 = 22303 kg CO₂ reduction = 21,95 ton CO₂ reduction). For aircraft a 3-8% drag reduction can translate into 3-8 percent CO₂ emission. The CO₂ emission for one KLM aircraft for 1 year would then be between 1.600 and 4.400 tonnes (Total CO₂ emissions/number of aircraft = 55.368 ton CO₂ emission per aircraft. 55.368*0.03 = 1.600 and 55.368*0.08 = 4.400 tonnes). For wind turbines Qlayers coating can increase the energy efficiency with 4 to 6%. With a 4% increase in efficiency, the Annual Energy Production (AEP) per year would be 144.000 kWh higher, with 6% 264.000 kWh (total energy production per year * increase).

APPENDIX E: ENVIRONMENTAL ANALYSES FOR QLAYERS

1. TARGET MARKET AND CUSTOMERS

CUSTOMERS

The beachhead market for Qlayers is storage tank maintenance, as there is an urgent need for coating application in a locally protected environment such that spray painting used for the maintenance of these tanks. The first customer of Qlayers is already active in this industry and has customers lining up worldwide for his service. The first growth market for Qlayers will be offshore wind turbines, where safety and painting speed need to be increased significantly. The ideal long-term growth market for Qlayers, is the steadily growing, predictable aircraft sector. Invalidated beachhead markets include competition sailing, rowing boats, Formula 1 and high-speed trains. Potential growth markets are cargo ships and high-speed trains. Potential high-profile markets for publicity are competition sailing and art.

MARKET OUTLOOK AND POTENTIAL

Qlayers will start by penetrating the Dutch coating industry, with the ambition to enter the international market. In table 24 and 25, size and growth rate of the most important market segments are described in the Netherlands and worldwide, respectively.

TABLE 23: WORLDWIDE MARKET POTENTIAL OF COATING LARGE STRUCTURES IN DIFFERENT MARKET SEGMENTS

Market segment	Total surface area (m ²)	Current pricing of coating (€/m ²)	TAM (€)	Annual Market Growth
Oil Storage Tank	250 M	4	1 000 M	0.4% ¹⁵
Wind Turbine (Offshore)	10 M	75-250 ¹⁶	750 M	11% ¹⁷
Aircraft	24 M	40	960 M	3% ¹⁸

TABLE 24: MARKET POTENTIAL IN THE NETHERLANDS, INCLUDING NUMBER OF ASSIGNMENTS (TANKS, TURBINES OR AIRCRAFTS)

Industry Segments	Number of assignments (2017)	Total surface area (m ²)	Current pricing of maintenance (€/m ²)	TAM (€)
Oil Storage Tank	481 ¹⁹	500 K	4	2 000 K
Wind Turbine (Offshore)	410 ²⁰	550 K	75-250	41 250 K
Aircraft	203	750 K	40	30 000 K

TARGET MARKET SELECTION

OIL STORAGE TANK INDUSTRY

Due to the low, but stabilizing oil price, the number of oil storage tanks is expected to increase in the upcoming years. The companies maintaining these storage tanks are demanding coating maintenance that can be done in mildly windy conditions and on location. Often, a spray painting process cannot be used due to risk of damage to its surroundings. This forces the maintenance companies to use brushes and rollers, or to encapsulate the entire storage tank in a protective tent. Fixed oil storage tanks are painted every 5 years. On average, 15 people can paint a single tank in 5 days by hand. When the coating is sprayed, 10 – 50% of the paint is being released into the environment. Toxic paint solvents released to the environment can cause health issues for workers, even in small concentrations. Also, as environmental safety regulations must be met, disposal costs are significant. The current inefficient, labour intensive process is disliked by workers, making the step towards automation only a matter of time (Global Wind Energy Council, 2016).

¹⁵ Based on a market research of Global Market Insights (2016), that states that the oil storage market size was over 1,400 million cubic meters in 2015 with forecast to grow over 4% from 2016 to 2025

¹⁶ The coating costs are five to ten times as much during offshore maintenance compared to the cost during production and increase to more than €1000/m² (There has been validated that coating costs even increase up to €13.000/m²), between 40 and 60 times the cost of doing the job in the paint shop, which are around €15-25/m² (Hempel A/S, 2012).

¹⁷ Projected growth rate of global cumulative installed wind power capacity from 2016 to 2021 is expected to be around 11% on average annually (Global Wind Energy Council, 2016)

¹⁸ Based on current number of aircrafts in the world (23.600) and an expected growth rate of 3% up to 2037 (Boeing, 2017)

¹⁹ Taking into account all storage tanks at the Vesta Terminal, Terneuzen Terminal, Zenith Amsterdam Terminal, Odfjell Terminals in Rotterdam and the MOT terminal.

²⁰ https://en.wikipedia.org/wiki/List_of_offshore_wind_farms_in_the_Netherlands

WIND ENERGY INDUSTRY

The sector with the most potential to help to achieve national (Dutch) and international climate targets on the short-term, is offshore wind energy (CBS, 2017). Therefore, it is estimated that the amount of offshore wind turbines will increase rapidly the upcoming years (ABN Ambro, 2015). In 2016, the number of wind turbines, on land and offshore, grew over 26% worldwide (WindEurope, 2017). Turbine blades need regular coating maintenance to keep their aerodynamic shape and structural integrity. In a situation with badly maintained blades, erosion and defects can reduce the annual energy production with 4-8%. New technology for inspection and repair can significantly reduce turbine downtime. As an example, when corrosion protection fails prematurely, the coating cost can increase to more than €1000/m², between 40 and 60 times the cost of doing the same job in the paint shop (Hempel A/S, 2012). In personal conversations with potential customers, the cost could run up as high as €10.000/m² for off-shore wind turbine blade tips in very specific cases. Quality control during coating and worker safety are the most important factors for the immense price of maintenance, due to difficult accessibility of the turbines. Workers have to hang from ropes for yearly inspections, cleaning and painting, so they can only operate in good weather and have to receive safety trainings frequently.

AIRCRAFT INDUSTRY

The two leading aircraft manufactures, Airbus and Boeing, predict that the amount of passenger aircraft above 100 seats and freighters above 10 tonnes will approximately double by 2036. This means between 34.900 and 41.030 new aircraft are expected to be build (Airbus, 2017; Boeing, 2017). Hence, they will have to speed-up the production process. The most important short-term need is the application of coatings in a fast and efficient manner outside specialised painting facilities. Unfortunately, the adoption of automation is slow, due to the large capital investment requirements and strict quality demands. A possible risk for Qlayers would be that international firms would deliver cheaper manual work and transportation. Yet, these processes often are already priced very competitively.

On the longer term, environmental regulations are being strengthened, forcing manufacturers and operators to reduce aircraft fuel consumption. In 2009 the International Air Transport Association (IATA) set the goal to improve the fuel efficiency by 1.5% annually up to 2050. Another goal is capping net emissions with carbon-neutral growth from 2020 and cutting net emissions in half by 2050 compared to 2005 (IATA, 2010). Functional coatings, like self-healing, self-cleaning, drag-reducing and anti-icing coatings could potentially reduce fuel consumption, CO₂ emissions, as well as reducing dirty de-icing, cleaning and maintenance methods. A study by Boeing (2013) showed that one of the most effective means to reduce the drag is to maintain a clean surface. Certification is the main issue holding back innovative coatings, as specific coating parameters need to be guaranteed always.

2. COMPETITIVE ADVANTAGE

SLASH100

The *Slash100* will be a print head for the application of coatings in a locally protected environment. At this moment there are a myriad of coating solutions, of which spray painting is one of the most versatile and fastest methods. This means that the competition is enormous. However, there hasn't been much innovation in coating application in the last decades. In short, all coating companies face the same problems which can be minimized/avoided using the *Slash100*. The problems with state-of-the-art automated spray systems are, mainly:

- Overspray: The flow of the paint vapor and where it lands is strongly dependent on the turbulence of the air in the vicinity of the spray head. This results in an uneven paint layer thickness with additional weight and material cost. This problem can be omitted by controlling the air and paint droplet flow;
- Transfer efficiency: Most conventional automated spray painting systems can have a transfer efficiency of up to 70%. Controlling the local airflow, this can potentially be increased to over 90% (Talbert, 2007);
- Painting facility cost: Paint booths require the entire volume of air inside them to be heated to a stable temperature of 21°C and filtered during the painting process (Talbert, 2007). By recirculating the air only in the print head, a lot less energy and machinery is required decreasing operational costs.

The savings in cost and time of the *Slash100* are strongly case dependent. Table 26 gives a qualitative comparison of how the manual spray painting state-of-the-art automated spray paint systems would compare to the *Slash100* on certain predefined criteria.²¹

TABLE 25: COMPARISON COMPETITIVE STATE-OF-THE-ART AUTOMATED SPRAY PAINT SYSTEMS

	System simplicity	Paint quality	Safety	Operational cost	Painting Efficiency	Cost	System flexibility	Functional coating application	Application speed
Manual spray painting	+++	-	-	-	-	+++	+++	-	+
Automated spray paint systems	+	+	+	++	++	++	++	-	+++
<i>Slash100</i>	-	+++	+++	+++	+++	+	+	++	++

GRAVITON

The *Graviton* applies functional coatings, for which the competitive landscape looks completely different. The first functional coating will focus on is a drag-reducing sharkskin. Although lots of research has been done in

²¹ These criteria are: Simplicity of system (How difficult is the system to use?), Paint quality (How good is the quality and uniformity of the paint thickness), Safety (Do employees have to wear protective equipment?), Operational cost (How expensive is it to operate?), Painting efficiency (How much paint has to be consumed to paint a given area?), Cost (How expensive is the equipment?), Flexibility of the system (How difficult is it to use the system on different shapes?), Application speed (How fast can it be applied?)

this field, there is barely competition. The main competitor is the German institute Fraunhofer IFAM, which uses templating to produce these microstructures. Also, the TU Delft faculty of 3mE sells Drag Reduction Riblet Films. Table 27 gives a qualitative comparison of how the competitive technologies would compare to the *Graviton*. At this moment the biggest weaknesses of the Qlayers printing head is still conceptual. Currently Qlayers is in the process of building the first full-scale prototype. The main barriers to enter the market is that most markets are conservative. The initial cost of the *Graviton* is relatively high, so they are only willing to buy the system when they see the first full-scale prototype in action. The printing of the microstructures is proven and at this point the effectiveness of the structures is being investigated.

TABLE 26: COMPARISON OF APPLICATION METHODS FOR THE SHARKSKIN MICROSTRUCTURE

	Simplicity of application	Structure quality	Operational cost	Cost	Maintenance of layer	Flexibility of system	Application speed
Fraunhofer rolling process	+	+	+	-	+	-	+++
3M Riblet film	-	++	-	+++	-	-	+
Templating	--	-	-	+	+	+	-
The <i>Graviton</i>	+	+	+	-	+	++	++

