Business Models Dynamics for Dutch Technology-Based Startups

A Proposed Framework to Overcome Critical Junctures

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

MASTER OF SCIENCE

in **Management of Technology**

Faculty of Technology, Policy and Management

by

Ghassan Kharbeet

Student number 4939263

To be defended in public on 22nd November 2022

Graduation Committee

Chairperson	Dr. V.E. (Victor) Scholten	Delft Center for Entrepreneurship
First supervisor	Dr. H.K. (Hanieh) Khodaei	Delft Center for Entrepreneurship
Second supervisor	Dr. S. (Saba) Hinrichs-Krapels	Multi-Actor System

Executive Summary

Technology-based startups entail creating and developing sustainable value by capitalizing and commercializing new technologies, which accelerates the growth of the startups and promotes economic sustainability. Unlike new technology developed in commercial firms, technology-based startups go through a process of transformation from a non-commercial to a commercial environment. In this process, they may lack knowledge, network, or resources and face different critical junctures (Vohora et al., 2004). The literature review on the stages of development of technology-based startups resulted in a model that explains different stages of development, from the initial idea through sustainability and global scaleup (Degroof & Robert, 2004; Clarysse & Moray, 2004; Ndonzuau et al., 2002; Rasmussen, 2011; Vohora et al., 2004). Between every two stages, there is a barrier or a critical juncture that the entrepreneur must overcome to survive the startup. This stage-based model has been defined by Vohora et al. (2004) and is used for this study. According to this model, the startup goes through five phases: research, opportunity framing, preorganization, reorientation, and sustainable returns. In order to survive and scaleup, the startup faces junctures known as opportunity recognition, entrepreneurial commitment, credibility, and sustainability. In recent years, emerging startups have been confronted with difficult changes in their business environments. The life spans of the business models are drastically shortened by technological advancements and shifting patterns of client demand. Companies must continuously examine their established routines and procedures if they want to survive and grow in such unsettling environments. Therefore, in order to succeed, the technology-based startup may require market testing and business model adaptation.

Research in business model dynamics and entrepreneurship indicates that the core elements of a business model develop in early stages as well as later stages in order to keep their consistency (Khodaei & Ortt, 2019). Accurately identifying the external environmental factors that demand business model adjustments and dynamics, as well as the internal company are important (Demil & lecocq, 2010) and is critical as a starting point for overcoming the growth stages obstacles. The baseline of the dynamic sustainable business model framework used in this study is based on the dynamic business model framework developed by Kamp et al. (2021) and the sustainable business model canvas developed by Bocken et al. (2018). Building a dynamic framework incorporates three aspects of business models: completeness, interrelationships, and changes over time, according to Meslin (2019), Kamp et al. (2021), and Xu (2022). These three factors are based on standards used by Khodaei & Ortt (2019) to gauge the degree of dynamism in their business model framework. By combining insights from the literature, this paper presents a comprehensive framework that conceptualizes business model dynamics. The framework includes different origins of business model change and different types of business model change as well as the growth stages and junctures. Following the conceptual

framework's construction, the effectiveness of the framework is evaluated using explorative case studies of six Dutch technology-based startups.

The results showed in the early stages, the changes in the business models are often forced and caused by external factors. This is because startups have limited access to resources in the early stages compared to mature startups that have developed partnerships, network and financial resources. Additionally, the startups changed their business models often in the credibility juncture, and they need more than just technological capability to gain credibility; they also need to access capital, resources, partnerships, and customers. The findings also show that external factors were common in the startup's early stages, but as it evolves, more internal factors are considered, and the startup has more freedom to make strategic decisions, particularly in credibility and sustainability junctures. Efficiency opportunity and a supportive financial system are the external factors that happened most frequently at the credibility and sustainability junctures, while resource availability is the internal factor that emerged in the entrepreneurial commitment and credibility junctures. Value creation changed the most in all cases, including key resources, activities and partner. The framework showed that the changes in business model can be made to open up opportunities and avoid challenges, which accelerate the development process of technology-based startups and navigate junctures. Startups with lower market, managerial and entrepreneurial knowledge changed their business model frequently in a response to challenges, like resource constraints, while startups that were able to acquire knowledge were able to grow faster, access resources, and seize opportunities effectively. Finally, first movers to a specific market confronted technological challenges, and changed their business model more often than other startups.

This thesis contributes mainly to the business model and university entrepreneurship literature with the identification of drivers and themes related to the process of business model change, and the introduction of the notion of business model dynamic.

Table of Contents

1. Introduction 9

1.1 Technology-Based Startups 9

1.2 Business Model 10

1.3 Business Model Innovation 11

1.4 Business Models Dynamics 11

1.5 Problem Statement 12

1.6 Research Objective 13

1.7 Relevance of The Research 14

1.7.1 Academic Relevance 14

1.7.2 MOT Relevance 15

1.7.3 Practical Contributions 15

1.8 Research Questions 15

1.9 Research Design and Method 16

1.10 Thesis Structure 18

2. Literature Review 19

Introduction 19

2.1 Technology-Based Startups and The Entrepreneurial Process 20

2.1.1 Growth Phases and Critical Junctures 21

2.1.2 Factors Related to Critical Junctures 26

Business Models 35

2.2 Business Models: A Static View 35

2.2.1 Business Model Definitions 36

2.2.2 Business Model Elements 37

2.3 Business Model: A Dynamic View 39

2.3.1 Business Model Change 39

2.3.2 Business Model Innovation 40

2.3.3 Business Model Dynamics 41

2.3.4 Sustainable Business Model 42

2.4 The Role of Business Model Dynamics in The Success of Technology-Based Startups 44

2.4.1 Business Models in New Technology-Based Startups 44

2.4.2 Business Model Dynamics: The Entrepreneurial Context 45

2.4.3 Business Models Innovation and Startup Performance 48

2.5 Business Model Elements and Critical Junctures 49

2.6 Chapter Summary 51

3. Conceptual Framework 52

3.1 Completeness 53

3.2 Interrelationships of Business Model Components 56

3.3 Changes Over Time 60

4. Methodology 62

4.1 Data Collection 62

4.2 Interview Guide 64

5. Case Studies **67**
MO4 ..... **67**
SolarWorks **73**
The Ocean Cleanup **78**
Noria Sustainable Innovators **85**
AguroTech **89**
Mimic **93**
6. Cross-Case Analysis **97**
6.1 Internal and External Factors in The Case Studies **97**
6.2 Changes in Business Models in The Case Studies **99**
6.3 Interrelationships Between Business Model Elements **107**
6.4 The Role of Business Model Dynamics in Navigating Critical Junctures **108**
6.5 The Role of Decision-Making in The Technology-Based Startup Development Process **115**
7. Conclusion, Discussion, and Recommendation **116**
7.1 Conclusion **116**
7.2 Discussion **121**
7.3 Practical Implications **123**
7.3.1 For Entrepreneurs 123
7.3.2 For Incubators 123
7.4 Theoretical Contribution **124**
7.5 Recommendations for Future Research **124**
7.6 Limitations of The Study **125**
7.7 Framework Development **125**
Bibliography **127**
Appendix 1 ..... **146**
Appendix 2 ..... **149**
Appendix 3 ..... **151**

List of Tables

Table 1.1 Research Approach.....17

Table 2.1 Keywords and Selection Criteria.....20

Table 2.2 Internal and External Factors for Scaleup.....31

Table 2.3 Factors Related to Specific Critical Junctures.....35

Table 2.7 Relationships Between Critical Junctures and Business Model Elements adopted from (Gabriel & Kirkwood 2016).....51

Table 3.1 Business Model Elements for Technology-Based Startups.....55

Table 3.2 External and Internal Factors Affecting Business Model Elements.....56

Table 3.3 Types of Relationships.....57

Table 3.4 Relationships Between Business Model Elements.....60

Table 4.1 The Main Steps in The Data Collection Process.....63

Table 4.2 List of Cases.....63

Table 4.3 Interview Questions.....66

Table 5.1 Causes and Effects of Changes to MO4 Business Model.....72

Table 5.2 Causes and Effects of Changes to SolarWorks Business Model.....77

Table 5.3 Causes and Effects of Changes to The Ocean Cleanup Business Model.....84

Table 5.4 Causes and Effects of Changes to Noria Sustainable Innovators Business Model.....88

Table 5.5 Causes and Effects of Changes to AguroTech Business Model.....92

Table 5.6 Causes and Effects of Changes to MIMIC Business Model.....95

Table 6.1 Internal and External Factors in The Case Studies.....99

Table 6.2 Changes in The Business Models in The Case Studies.....105

Table 2.4 Business Model Definitions.....148

Table 2.5 Business Model Elements.....150

Table 2.6 Business Model Innovation Definitions adapted from (Geissdoerfer et al., 2018).....152

List of Figures

Figure 2.1 The Phases and Critical Junctures in Technology-Based Startups (Vohora et al., 2004) 22

Figure 2.2 Challenges and Key Support Regarding Critical Junctures (Khodaei et al., 2020) 27

Figure 2.3 Barriers During Scaleup Stage (IRIS Group, 2019) 33

Figure 2.4 The Business Model Canvas (Osterwalder & Pigneur, 2010) 38

Figure 2.5 Types of Business Model Innovation (Geissdoerfer et al., 2018) 41

Figure 3.1 Business Model Dynamics Framework (Kamp et al., 2021) 52

Figure 3.2 Sustainable Business Model Canvas (Bocken et al., 2018) 54

Figure 3.3 Proposed Business Model Dynamics Framework to Overcome Critical Junctures 61

Figure 5.1 Growth Stages & Critical Junctures MO4 72

Figure 5.2 Framework Representation of Changes to MO4 Business Model 73

Figure 5.3 Growth Stages & Critical Junctures SolarWorks 78

Figure 5.4 Framework Representation of Changes to SolarWorks Business Model 78

Figure 5.5 Growth Stages & Critical Junctures The Ocean Cleanup 84

Figure 5.6 Framework Representation of Changes to The Ocean Cleanup Business Model 85

Figure 5.7 Growth Stages & Critical Junctures Noria Sustainable Innovators 88

Figure 5.8 Framework Representation of Changes to Noria Sustainable Innovators Business Model 89

Figure 5.9 Growth Stages & Critical Junctures AguroTech 92

Figure 5.10 Framework Representation of Changes to AguroTech Business Model 93

Figure 5.11 Growth Stages & Critical Junctures MIMIC 96

Figure 5.12 Framework Representation of Changes to MIMIC Business Model 96

Figure 6.1 Interrelationships between business model elements 108

Figure 6.2 Business Models Changes to Navigate Critical Junctures 109

Figure 6.3 External and Internal Factors 110

Figure 7.1 Business Model Development Stage 126

Abbreviation

BMs	Business models
BMI	Business model innovation
BMC	Business model canvas
SBMC	Sustainable business model canvas
CC	Choice-Choice
CF	Choice-Forced
FC	Forced-Choice
FF	Forced-Forced
OP	Opportunity recognition
CM	Entrepreneurial Commitment
CR	Credibility
SU	Sustainability
VP	Value Proposition
VCR	Value Creation
VD	Value Delivery
VCA	Value Capture
NTB	New Technology Based

1. Introduction

1.1 Technology-Based Startups

Building a successful business is difficult; many new startups fail to enter the market or are unable to turn a profit (Komi et al., 2015). Hence, there is a lot of research on business survival (Audretsch & Mahmood, 1995; Cefis & Marsili, 2004; Mas-Verd et al., 2015). According to a study of the startup survival rate in the Netherlands that have been conducted by Audretsch et al. (2020), only 85% of manufacturing firms lasted two years and just 45% survived a decade. Only businesses with ten or more employees were included in the data utilized for their analysis. Since many companies employ fewer than ten people, the actual figure is probably significantly lower. To be successful, a startup must overcome many obstacles. Finding adequate financial investments, human resources, or support systems, for instance, can be challenging (Salamzadeh & Kawamorita, 2015). Additionally, it is uncertain if there is enough interest in the novel idea and if the team is qualified to run a business (Audretsch & Keilbach, 2004). Furthermore, new initiatives face greater levels of uncertainty in the product's development, marketing, and sales than established businesses (Audretsch & Keilbach, 2004). Funding is the main issue for startups (43%), according to Komi et al. (2015), followed by networking and business development (21% and 19% respectively).

Lack of economic viability is another cause of failure. Economic viability refers to a venture's potential to make a profit while keeping the business idea in mind (Burgelman, 1985). This means the business must have a thorough understanding of the costs associated with manufacturing, distribution, maintenance, and other expenses, as well as a sales price that is competitive with the market and covers the associated expenses. Demand, supply, and institutional pressures are the three factors that determine economic viability (Shaffer, 2009). Demand factors are influenced by the market that the company serves. Since startups frequently operate in emerging markets with unproven demand, it can be challenging to forecast demand factors. The resources (finance, manpower, and technology) required to produce the target profit are considered supply forces. The final factor is institutional factors and dealing with them requires a broad network and previous business establishment experience. Rules and regulations are represented by institutional forces; while they have an impact on economic viability, startups are unable to change them. Although a thorough understanding of supply and demand variables is necessary, community involvement in the institutional component is frequently a crucial differentiator (Shaffer, 2009).

Startups are essential to the creation and application of innovations as well as a driver for economic growth (Anokhin & Wincent, 2012; Cusumano, 2013; Song et al., 2008; Stam, 2008), despite the fact that these uncertainties and a lack of economic viability can make it challenging for new businesses to compete with the established ones. According to Audretsch & Keilbach (2004) and

Eveleens et al. (2017), startups make use of information that would not otherwise be explored. These businesses explore the potential of emerging technologies with the goal of utilizing them to benefit both users and society. Technology innovation leads to less knowledge spillovers, which is advantageous for the economy (Stam, 2008).

However, there are significant costs and dangers associated with starting and growing a business. Therefore, during this process, companies frequently look for assistance and support. This can include financial assistance, but it can also include expertise, experience, and networking to aid startups in developing their businesses. Many businesses that were simply startups two decades ago have grown quickly to become some of the most powerful and lucrative businesses in the world today. This accomplishment was attained using creative business models that benefited emerging digital technologies (Baden-Fuller & Haefliger, 2013; Massa et al., 2017).

The chance to analyze how technology-based startups' business models change when entrepreneurs seek to commercialize their research outputs has been identified in the literature. As the startups expand, their commercial requirements for additional resources and information change. As a result, their networks are being forced to evolve in response to their ever-changing business demands. technology-based startups networks evolve as their relational and structural characteristics change, allowing firms to adapt and align their networks to gather vital resources for survival (Hite & Hesterly, 2001).

1.2 Business Model

The term "business model" has been defined by several scholars, but definitions are not always in line with each other. Some try to define concrete components of a business model (Johnson et al., 2008), whilst others focus more on a holistic, abstract definition (Chesbrough & Rosenbloom, 2002), which increases the relevance of business models for science and management (Zott et al., 2011). However, many scholars define a business model as a framework, a description, an architecture, or a network that outlines how a company conducts business and generates profit. It is a blueprint for how a company's operations should be carried out (Osterwalder et al., 2005). A business model, according to Osterwalder & Pigneur (2010), outlines the core idea of how organizations generate, deliver, and collect value. Morris et al. (2005) state that a good business model representation "must be reasonably simple, logical, measurable, comprehensive, and operationally meaningful". Researchers wanted to emphasize Teece's description, which states that for a company to carry on its business, it must establish organized ways of conducting day-to-day activities, major processes, and overall activities, all of which have the goal of providing value to customers while also generating profits for the company. The

methods by which a company "delivers value to consumers and turns money into profits" is referred to as a business model (Teece, 2010).

1.3 Business Model Innovation

According to Foss and Saebi (2017), "the idea that managers might actively innovate their business model was first openly discussed in 2003 by Mitchell and Coles." Business model innovation is a new method of creating and capturing value that was attained by changing one or more elements of the existing business model (Chesbrough, 2010; Frankenberger et al., 2013). Innovation in business models was described as being separate from innovation in products or processes. Product innovation entails bringing a new product to market, whereas process innovation includes improving the efficiency of a specific process (Zott & Amit, 2008). However, business model innovation implies a systemic change in the firm's approach to their customer value proposition as well as how they created and captured value (Zott & Amit, 2008).

According to research by Kesting & Günzel-Jensen (2015), Velu (2015), and Wirtz et al. (2016), business models have been linked to performance and enhanced the chances of entrepreneurial success. Innovation in business models has been acknowledged as a source of competitive advantage for entrepreneurial startups (Gassmann et al., 2013; Teece, 2010; Trimi & Berbegal-Mirabent, 2012). Designing a business model effectively requires understanding how to capture the value of innovation (Chesbrough, 2010). A solid business model must be combined with technological innovation to assure startup success (Gassmann et al., 2013; Teece, 2010).

1.4 Business Models Dynamics

By navigating the critical junctures that affect technology-based startup development, the business models of these startups may change over time. This allows the introduction of the concept of business model dynamics which is considered a critical enabler in attaining competitive performance gains in a rapidly changing environment (Desyllas & Sako, 2012). A business model can be created, extended, revised, and terminated in four stages (Cavalcante et al., 2011). Firms must assess the need for extension and revision, and if required, the termination of specific business models, in order to maintain a competitive advantage based on their business model (Cavalcante et al., 2011). Dynamism in this context can be defined as an organization’s capacity to identify the need to move beyond the initial establishment of a business model to its extension, change, and eventual termination (Cavalcante et al., 2011). After identifying these requirements, businesses should use their resources to modify their business models. As a result, a business model that goes through these stages is considered to be dynamic (Cavalcante et al., 2011). They argue that companies tend to avoid major business model

revisions, since these changes usually question managers' mental models and firms' existing processes. The authors also discuss individual agency as a driving force for business model dynamics.

Khodaei & Ortt (2019) have formulated four criteria that reflect dynamics in business model framework:

- Completeness: involving the internal company and external environmental aspects, while business model adaptation is driven by external factors, business model innovation can be influenced by both external and internal factors.
- Interrelationships: between business model components as well as environmental aspects.
- Interrelationships over time: the capability to adapt and modify interrelationships over time to understand business model evolution, especially for academic spin-offs where there is market uncertainty, network expansion, and a long phase of diffusion.
- Framework changes: adaptation of the changes over time.

However, a business model that is actually dynamic should not score high on all criteria, but rather focus on a balance and an optimum level on the four criteria (Khodaei & Ortt, 2019).

Making business models dynamic is difficult since it is usual for companies to become used to a business model that has proved effective over time. It is possible that this contributes to organizations' aversion to change (Cavalcante et al., 2011). There are, however, motives for businesses to make their business models flexible and adaptable to market demands and changes, while the nature and dynamic capabilities of the company have a big impact on these motives (Khodaei & Ortt, 2019). Increased profitability, increased market share, outwitting opponents, gaining platform leadership, and maybe rendering competitors irrelevant are just a few examples. Kim and Mauborgne (2005) claimed in a paper about the influence of a winning business model that firms should not only win in competition but also make their competitors irrelevant. This may be accomplished by focusing on value innovation. Therefore, the benefit of having an adaptable business model that can adjust to the requirements of the external market based on the firm's dynamic capacities might be immeasurable for a firm. As a result, it is probable that dynamic business models thrive on businesses' dynamic capacities, because business models, according to Casadesus-Masanell & Ricart (2010), are at the core of competitiveness and so must draw managers' attention to maintain a competitive edge.

1.5 Problem Statement

According to Vohora et al., (2004), between every two stages of the growth stages that have been identified for startups, there is a critical juncture. These stages are known as research; opportunity framing; preorganization; reorientation; and sustainable returns (Vohora et al., 2004). These critical junctures that influence the startup growth are identified between every two stages respectively:

opportunity recognition, entrepreneurial commitment, credibility, and sustainability (Vohora et al., 2004). In order to pass from one stage to another, the startup must overcome the relevant juncture, and hence the business model may change accordingly to help overcome these barriers. Since they are of university origins and they are lacking business experience, they might have difficulties in changing their business models at the right time and right manner. If the business remains static over time, it may not be able to generate value.

In environments characterized by high technical and market newness, business model design is critical, and these high levels of uncertainty, due to a limited knowledge and expertise base and limited access to resources while trying to bring a novel product to the market, cause more business model changes (Andries & Debackere, 2007; Chesbrough & Rosembloom, 2002). Technology ventures in fast-moving, rapidly changing environments (Loch et al., 2007) can have such high levels of uncertainty. Technology-based startups are common, and their "path to commercially distributing products and services is (…) very rough and uncertain" (Fini et al., 2009). They develop from an irregular, iterative, non-linear, and complicated process involving several players at different levels (Rasmussen, 2011). Startups confront additional obstacles when developing business models since they typically lack commercial, managerial, and entrepreneurial skills compared to other new technology-based companies (Bower, 2003). As a result, these firms may require more market testing and business model adaptations than conventional entrepreneurial enterprises in order to succeed (Clarysse et al., 2011), making them an attractive setting in which to study business model change. Choosing the proper initial business model configuration (Chesbrough & Rosenbloom, 2002) or design (Zott & Amit, 2007) and managing its adaptation over time (Andries & Debackere, 2007) may have a big influence on results. According to Morris et al. (2005), the aspects of a business model are highly interdependent, with changes in one having an impact on the others. However, the dynamics of this system of business model elements, as well as the forces driving its development and studies on the evolution and interactions of business model elements through time are poorly understood (Chesbrough & Rosembloom, 2002; George & Bock, 2011; Morris et al., 2005).

1.6 Research Objective

As indicated in the problem statement, the business model dynamics can be beneficial for emerging startups. Acknowledging information gaps on the interrelationships between business models components and critical junctures for technology startups, the aim of the research is:

- Review and understand the barriers affecting the development of technology-based startups and their business models.

- Review and assess research and theoretical perspectives relevant to the study of the process of technology-based startups business model change.
- Analyze and understand the changes in business models components, and the interrelationships between the components and startups critical junctures.
- Establish a comprehensive framework that represents these changes and interrelationships

The goal of this research is to learn more about how technology startups modify their business models and how it affects their success to overcome challenges. To begin, this study goes beyond the static perspective of standard "snapshot" studies on business models by using a timeline strategy. Second, the case-study method provides for a more detailed understanding of the mechanisms and processes through which business models develop and affect company performance. Third, this research builds on prior work on business model change and company performance, including the expansion to the context of startups, based on research recommendations. Finally, this study goes beyond traditional single-level techniques by using a multilevel approach that looks at the entire business model (aggregate level) as well as its component aspects (disaggregate level). As a consequence, the study's findings should have practical implications for academics studying entrepreneurship, strategic management, and general management, as well as for academic entrepreneurs, institutions, and policymakers.

1.7 Relevance of The Research

From two perspectives, this study will add to the business model and startups development studies:

1.7.1 Academic Relevance

This thesis contributes to the business model literature by focusing on the importance of business model dynamics (Khodaei & Ortt, 2019; Kamp et al., 2021) (e.g., the frequency of business model change, aggregate and by element), during the growth stages of technology-based startups in order to overcome the critical junctures (Vohora et al., 2004; Khodaei et al., 2020) the startups need to navigate during the development process. In addition, this thesis contributes to the specific field of university entrepreneurship with a discussion of the business model triggers (e.g., technology and business environment dynamics, market change) on business model change and startup performance. Even though some reasons for startups' failure are listed in the literature, it is not described how other startups' business models overcame the obstacles in the development process by for example adapting to trends and competition in the industry. Therefore, this study contributes to the role of business model dynamics in technology-based startups.

1.7.2 MOT Relevance

This research is closely related to the master Management of Technology (MOT) program since it considers important topics covered in the MOT program, such as business model innovation/dynamics and its role in the development process of the technology-based company. The foundation of MOT rests on the idea that there is a rising demand for engineers who are knowledgeable and skilled in both technology and management. Strategic management, general management, and e-business have traditionally been the focus of business model studies (Osterwalder et al., 2005; Shafer et al., 2005). This discussion has been broadened to include entrepreneurship (Zott et al., 2011). Business models are significant in entrepreneurship for a number of reasons, including: (1) the performance of entrepreneurial firms is strongly conditioned by their business models (Zott & Amit, 2007); (2) new ventures in turbulent environments must change their business models several times in order to succeed (Loch et al., 2007); and (3) business model design and change is particularly important to new technology-based firms (Andries & Debackere, 2007; Chesbrough & Rosenbloom, 2002)

1.7.3 Practical Contributions

This study shows the diversity and complexity of issues related to the process of business model change in technology-based startups. By mapping the differences and similarities in technology-based startups' business model changes during the growth stages of development. Additionally, by understanding the interrelationship between business models and critical junctures, the dynamics of business models would have important practical implications for startup entrepreneurs, universities, policymakers, facilitators (e.g., incubators) and business model educators. For example, this research assists them to have a better understanding of business model changes as well as the external triggers that influence the business model changes during the start-up growth stages.

1.8 Research Questions

Inspired by the research gap above, this thesis asks the following research question:

RQ: *How can business model dynamics help Dutch Technology-based startups overcome growth critical junctures?*

To better answer this question, a set of sub-questions are identified.

Sub-Research Questions

The following are the sub-research questions, of which the main research question is composed. Addressing these questions will help to answer the general research question and to fulfill the research objective. Considering the main focus of this thesis on business models dynamics for startups, before

answering the main research question, there is a need to understand what the barriers are affecting startups development, and how their business models change over time. Hence, the following sub-research questions are formulated:

Sub Q1: *What are the critical junctures that Dutch startups face during their development process?*

Sub Q2: *What are the business model dynamics?*

Sub Q3: *What is the role of business model dynamics in assisting the development process of technology-based startups?*

Sub Q4: *How can we develop a dynamic business model framework to capture business model dynamics and to foster the development process of technology-based startups?*

1.9 Research Design and Method

An inductive, multiple-case studies design is used to investigate the business model change in technology-based startups, according to the nature of the research questions, and the exploratory character of the study. Furthermore, because the goal of the study is to look at how business models developed over time, a cross-case analysis design is appropriate. The focus of this research is on the company level of analysis. The business model is the unit of analysis (and its constituting elements). The study focuses on how each business model element develops over time, primarily from the perspective of the founders (collected from the interviews). Other perspectives gathered from different data sources (e.g., internal documents, newspapers) are triangulated with this viewpoint. This study tries to capture the causes behind these changes, as well as the subsequent outcomes, such as company performance.

Technology-based startups serve as the research setting. They typically have more uncertainty, time constraints, and motivation than established companies, implying that they will make more business model changes in the future (Gersick, 1994). At the research stage, technology-based startups have less market knowledge and expertise than corporate startups (Clarysse et al., 2011), as well as less business experience (Costa et al., 2004). More adaptations are induced by this limited knowledge, which might be rephrased as increased uncertainty (Conceicao et al., 2012).

The empirical data of the study are restricted to one country (the Netherlands), and different technology-intensive industry sectors. Limiting the scope to a single country serves to control for the country- specific influences, such as policy and local practices toward startups. The inclusion of

different technology-intensive industries facilitates cross-industry comparisons and broader generalizability of results.

Research Approach

A structured research approach with two primary phases is followed to answer the research questions and achieve the study objective: Firstly: a thorough literature review to identify relevant articles and studies related to the research topic, as well as knowledge gaps. Secondly, an extensive review of the information available and an interview with different technology-based startups founders to understand the link between the barriers (critical junctures) and the changes in the business models components. Table 1.1 presents an overview of the research approach and designated output for each of the sub-questions.

#	Research Question	Research Approach	Output
1	What are the critical junctures that Dutch technology-based startups face during their development process?	Literature review	Illustrate the growth critical junctures and factors related to each juncture
2	What is the business model dynamics?	Literature review	Understand how business model components change during the technology-based startups development
3	What is the role of business model dynamics in assisting the development process of technology-based startups?	Literature, Interviews	Understand the dynamics of business model components during the development of the technology-based startups and growth critical junctures.
4	How can we develop a dynamic business model framework to capture business model dynamics and to foster the development process of technology-based startups?	Literature, Interviews	Establish a link between the critical juncture and changes in business model.

Table 1.1 Research Approach

1.10 Thesis Structure

The paper is structured as follows: Chapter 2 covers a thorough literature review of the concepts. The conceptual framework that is created to capture the changes in business models of technology-based startups is presented in Chapter 3. The study's methodology is described in Chapter 4. In Chapter 5, case studies will be covered, then cross-case analysis. The last chapter will provide conclusions, discussions, and recommendations.

2. Literature Review

Introduction

This section evaluates existing literature on business models and technology startups, providing context for this study and assisting in the identification of appropriate operationalizations of the main constructs in the research questions. It is based on strategic management and entrepreneurial literature, as well as management literature more broadly. Business model literature is both extensive and scattered, embracing a wide range of fields and topics. To avoid overwhelming the reader with irrelevant information for the sake of this study, this review only contains literature that is directly related to the research questions. Because the business model literature is so fragmented, a structured approach is required to offer a clear viewpoint and to highlight current limitations.

The first section reviews the growth stages of technology startups, introduced by (Vohora et al., 2004) and how the progression between stages is facilitated by "critical junctures" in terms of resources and capabilities needed to move to the next stage. When studying the business model literature to answer the study's research questions, it became evident that one stream looks at "business models as snapshots in time" (De Reuver et al., 2009), while another looks at how business models change (e.g., business model evolution, adaptation). As a result, this assessment is separated into two sections: a "static" perspective of business models (section 2.1) and a "dynamic" view of business models (section 2.2). Both of these points of view contribute significantly to the literature, yet they both have limitations. Business model definitions and constituent elements are frequently more detailed in 'static' investigations. They are also significant historically, as they were the first studies on business model research to appear. These studies, however, do not use study approaches that capture the dynamics of business models and hence fail to explain how they change.

The 'dynamic' studies, on the other hand, offer some insight into how business models change over time. The relationship with firm performance is, nevertheless, understudied. Furthermore, they assess change at the level of the business model element rather than the complete business model. Therefore, by presenting existing information that feeds the study's research topics, this review aims to combine the complimentary insights of both approaches. Sections 4.2 and 4.5 explore literature on business models at the intersection of entrepreneurship and technology startups, the growth stages, and critical junctures, as this study examines business model change in an entrepreneurial setting.

Having defined the main topic of interest, the research started by trying to map out the selection criteria and keywords; secondly, the research continued by looking up in the primary research browsers to collect the main publications which discuss the research topic. Finally, with the categorized and sorted articles, this chapter developed a critical analysis of the literature.

The keywords were combined in the web research tools to find related articles and publications that were pertinent to the topic. This review used internet tools provided by TU Delft, such as Web of Science, Scopus, and Google Scholar, to look for relevant papers in the literature. The combinations used were coherent with the fields of studies relevant to the research topic and were divided into four different categories: searches related to business model, searches related to business model dynamics, search related to business model in technology-based startups context and search related to startup growth stages. Table 2.1 summarizes the combinations used for each category.

Keywords: Business model; business model innovation; technology-based startups; business model dynamics; critical junctures; barriers; sustainable business model; entrepreneurship.

Categories	Combinations
Business model	("Business model" OR "Business model components" OR Business model definitions")
Business model dynamics	("Business model dynamics" OR "Business model innovation" OR "Business model change" OR "Dynamic business model" OR "Business model evolution" OR "Business model adaptation" OR "Business model renewal" OR "Sustainable business model")
Business model in technology-based startups	("Technology-based startups" OR "Entrepreneurship" OR "Technology startups") AND ("Business model" OR "Business model dynamics" OR "Business model innovation" OR "Business model change")
Startup growth stages.	("Technology-based startups" OR "Entrepreneurship" OR "Technology startups") AND ("Growth stages") AND ("Critical junctures" OR "Barriers")

Table 2.1 Keywords and Selection Criteria

The article research revealed more significant synonyms or related keywords that were not previously considered; therefore, the initial keyword list was not as extensive as it is provided in this thesis. In fact, keywords were found using three separate criteria: words relevant to the research statement, words related to the topic, such as synonyms or more comprehensive terms, and lastly, a list of keywords was completed with the vocabulary found during the article research stage.

2.1 Technology-Based Startups and The Entrepreneurial Process

Startups are newly formed businesses that are launched by one or more entrepreneurs. It is a firm that offers a one-of-a-kind product or service to the market (Kane, 2010). Startups are often small businesses that are originally funded and run by founders or an individual (Leach & Melicher, 2018). Startups, according to Kane (2010), are critical for job creation and employment development in a

nation's economy. However, the failure rate of startups was around 20% in the first year with a 50% within 5 years, as of 2021 (Bryant, 2022). A new business can be organized by following the phases of the entrepreneurial process (Leach & Melicher, 2018)

2.1.1 Growth Phases and Critical Junctures

The process of technology-based startup formation highlights organizational features within each stage of growth and offers adjustments that entrepreneurs must make in their behavior and practices in order to advance to the next level (Miller & Friesen, 1984, Smith et al., 1985). The progression between phases is facilitated by "critical junctures" in terms of resources and competences needed to move to the next stage. Because there is no consensus on the stages of development of technology-based startups, there is no theoretical framework to explain their evolution. Some authors try to explain the development process and have discovered three (Degroof & Robert, 2004; Clarysse & Moray, 2004) or four (Ndonzuau et al., 2002; Rasmussen, 2011) or five stages in the startup process (Vohora et al., 2004). For the purpose of this research, the framework proposed by (Vohora et al., 2004) will be used to study the growth stages of technology startups.

Vohora et al (2004) identify five key stages in the growth of technology startups: 1) Research; 2) Opportunity framing; 3) Pre-organization; 4) Reorientation; and 5) Sustainable returns. They also examine the transition from one stage to the next through critical junctures, which they define as "a complex problem that occurs at a point along a new high-tech venture's expansion path that prevents it from completing the transaction from one development phase to the next". Vohora and his colleagues also claim that startup development is a non-linear process, and Druilhe & Garney (2004) agree with them. This theory is one of the most recent, but unlike others, it does not focus solely on the growth phase. It pays attention to the passage from one stage to the next, which is a crucial point: knowing the phases is not sufficient to comprehend the complicated process of growth; understanding how to develop while accumulating new ability and resources is required. In figure 2.1, the phases and critical junctures are displayed in a diagram. The model is based on the stage-based model and resource-based view.

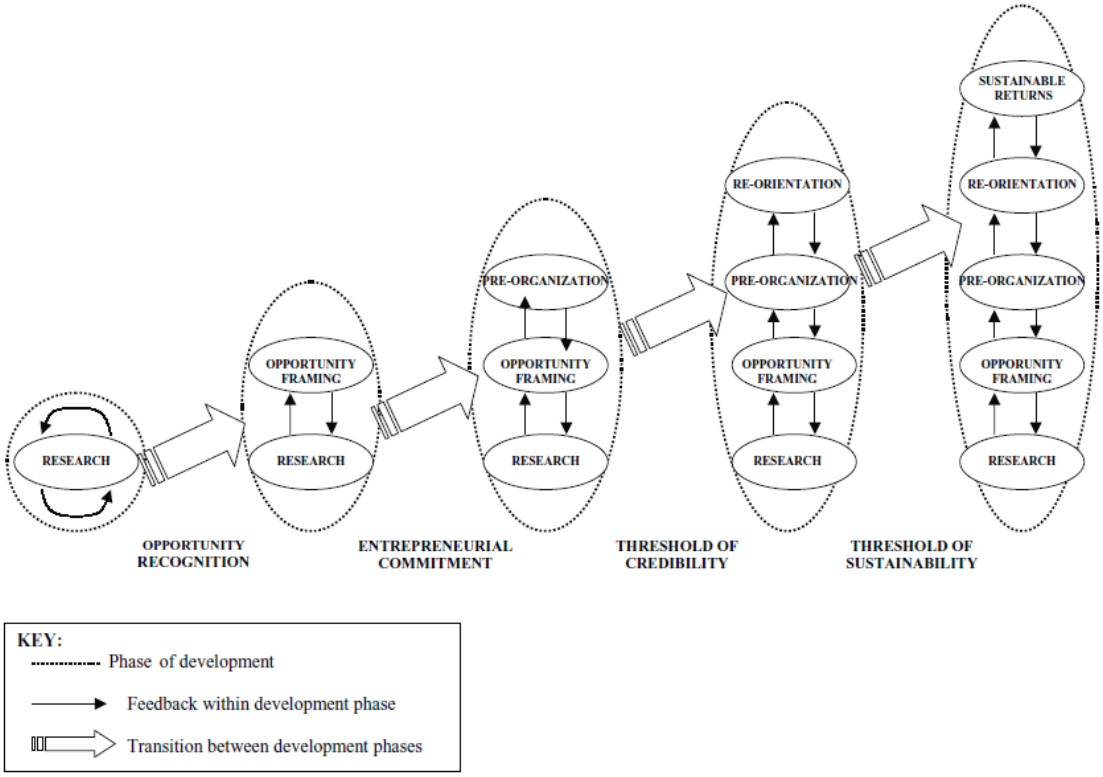

Figure 2.1 The Phases and Critical Junctures in Technology-Based Startups (Vohora et al., 2004)

Research Phase

The research phase is the initial step in the development process. Before deciding to form a startup, the procedure is frequently geared towards developing academic knowledge and licensing innovations to established businesses. The research phase begins with the discovery of a new technology and ends with the creation of intellectual property. This stage might take several years to complete (Vohora et al. 2004). The main goal of the academics participating, according to Vohora et al. (2004), is to improve academic research and publishing of their work towards a specific scientific community before the opportunity to commercialize is recognized. Potential founders should be able to recognize an idea and evaluate its economic value. The idea refers to the founders' new technology or the specific knowledge that can exploit. Commercial understanding is required for this sort of study, which academics lack. The first critical juncture, 'opportunity recognition,' occurs when a possible commercialization opportunity has been discovered.

Critical juncture: opportunity recognition

The critical juncture of 'opportunity recognition' defines the challenges that come from going from the research phase to the opportunity framing phase for a startup. Opportunity recognition is defined by Ardichvili & Cardozo (2000) as "recognition that leads to the formation of viable new businesses".

When academic actors find a commercial concept, the ability to transfer specific knowledge into a business project is not one of their capabilities. The idea is that a lack of market understanding and an unreasonable expectation of return owing to lack of market experience are linked to a readiness to commercialize specific knowledge. Because team members must comprehend each role inside the company and define the firm's strategic orientation, the "opportunity recognition" constitutes the first barrier in the formation of a startup. This factor can be combined with followed critical juncture since they both refer to a competence that the academic team lacks.

Opportunity framing phase

During this step, academics and other partners will assess if the identified opportunity has sufficient underlying value to proceed with commercialization. Technology transfer is a means of assisting in the formation of the startups (Hague & Oakley, 2000). Its responsibilities have been described as facilitating technological diffusion from university research to industry (Siegel et al., 2003), managing and enhancing the value of the university's intellectual property (Meseri & Maital, 2001), and assisting researchers in disseminating research results for the public good (Carlsson & Fridh, 2002). Before forming a startup, academic players must study the market, consumer needs, and the best strategy to commercialize the technology.

Due to a lack of business skills, evaluating the development of commercial value is one of the challenges. People who lack economic knowledge and expertise are unable to capitalize on market opportunities and optimize the profits from intellectual property commercialization. A strong business plan is used in commercial development to specify the important elements (investments, operational expenses, and revenues) as well as how the results will be utilized. The critical juncture entrepreneurial commitment must be overcome following the opportunity framing phase.

Critical juncture: entrepreneurial commitment

Entrepreneurial commitment is necessary in the process of applying academic knowledge to commercial transactions in the creation of the new venture (Vohora et al.,2004). The issue arises from the need to develop the startup, which is exacerbated by the team's lack of entrepreneurial skills. According to Vohora et al. (2004), there are four key reasons of the lack of entrepreneurial capabilities:

- The network is limited to academic actors, resulting in a scarcity of successful entrepreneurial role models with commercial and financial expertise.
- The academic team suffer from a lack of prior business experience in the commercialization of intellectual property together with a lack of faith in their own abilities to cope in a commercial environment.

- Academic actors face challenges in establishing an entrepreneurial structure and delegating responsibility. This is because academics have many years of scientific training but no or little commercial and entrepreneurship skills.
- Due to a lack of social capital, inadequate rewards and incentives, and the difficulty to cede control of their firm to anyone else, identifying, accessing, and acquiring an external entrepreneur with competent skills is a difficult process.

When the company find a committed entrepreneur, by hiring an external consultant, or internally by following training in economic environment, the venture moves to the next phase of development.

Pre-organization phase

During this phase, the founders put and develop strategic plans. Based on the scenarios investigated by Vohora et al. (2004), these plans seek to identify the available resources and skills, as well as the future technologies, resources, and capacity required for development. The purpose is to determine if current resources and knowledge are sufficient to support future growth. When commercial proposals are offered, academic players must assess the projects' long-term sustainability for the new venture. Each model requires resources, capabilities, knowledge, research time, and the ability to leverage technology. A good project is necessary to establish essential factors such as investments, operating costs, revenues, and the method through which the results will be exploited. The founders must identify a better plan that meets the prior criteria throughout this phase. This requires a high level of entrepreneurial experience, human capital, and access to expert networks.

Critical juncture: credibility

Credibility refers to an entrepreneur's capacity to obtain access to and acquire the resources needed to launch a company, and there are several challenges to overcome in order to achieve this, according to (Vohora et al. 2004). The first step is to raise funds in order to obtain adequate resources and move from "pre-organization" to productive activities. Following the acquisition of capital, the next challenge is to identify necessary resources and determine when adequate financial resources are available. Credibility is a critical juncture because it restricts access to financial and human capital, lowering the possibilities of attracting new investors, customers and suppliers when the company fail to create a distinctive identity who value the products and services offer. Furthermore, credibility aids the new ventures in attracting more clients, appearing credible, and creating a professional and quality perception among customers.

External financing, key customers, and collaboration partnerships with existing firms are all vital. These components indicate the "building blocks" necessary to establish significant market credibility (customer, financial intermediaries, and other resources providers). However, some startups

remain embedded within the university and fail to become an independent entity, and customers and financial investors may be suspicious of the university's non-commercial cultures, which affect the startup's credibility. The firm will continue to the next phase of development, the re-orientation phase, after it has secured the requisite financial resources.

Re-orientation phase

Based on the business plan and strategy created in the previous phase, the academic players decide to launch the firm. To begin commercial operations, the academic team must get the resources indicated during the reorganization process, although purchasing them may be difficult at first owing to a lack of funds. In this phase, entrepreneurial teams face the obstacles of continually discovering, obtaining, and integrating resources, and then re-configuring them (Teece et al., 1997). There are tangible (financial and material resources) and intangible (human capital) resources in a firm; in the case of the latter, the growth of a new enterprise cannot thrive without managerial experience (know-how) and excellent social networks (Mustar, 1997). The company needs to acquire resources and skilled personnel, as well as information from interactions with customers, suppliers, competitors and protentional investors to generate productive activities. Therefore, the most important aspect is to gather the necessary resources and incorporate them into the new business. The company must identify its target clients in order to meet their needs, enter the market, and get access to future resources. At the same time, the entrepreneurial team is constantly acquiring, integrating, and re-configuring resources. The critical juncture sustainable returns is the last obstacle before moving to the next phase.

Critical juncture: sustainability

Sustainability is a critical juncture between the re-orientation and sustainable returns stages. Revenues from clients for services or products offered, as well as payments from collaborative investment agreements from current or new investors, are all examples of sustainability. This condition arises only if the startup provides appropriate capital, personnel, and physical resources and capacities to the client. The challenge now is to sustain the return over time while constantly re-configuring existing resources, capabilities, social capital, and professional skills with information, knowledge, and resources. Existing resource weaknesses, insufficient capabilities, and social liabilities inherited from early development decisions and commitments that may be difficult to resolve now (Vohora et al., 2004), should be re-configured into resource strengths, distinct capabilities, and social capital that will allow the startup to generate returns. If this is achieved, the team will be able to create value for customers.

Sustainable returns phase

In this final stage, the company have its own identity and becomes self-sufficiency. By gaining sufficient return to sustain productive activities, the aim is on achieving sustainable growth and credibility outside of the academic context. According to Nair and Blomquist (2019), most startups fail to exit the startup phase because they lack a scalable business model. A business model, according to Casadesus-Masanell and Ricart (2010), explains the firm's logic, or how it runs and creates value for its stakeholders. Startups can focus their efforts on organizational obstacles related to growth by using a good business model (Nair & Blomquist, 2019), which increases their chances of success (Carucci, 2016).

Zott et al. (2011) state that research on business models, innovation, and technology management have shown that technological innovation is critical for firms, but it may not be enough to ensure success. That is why customer choice, transaction costs, heterogeneity among consumers and producers, and competition are all fundamental elements of market economies (Teece, 2010). According to Chesbrough (2010), companies use their business models to commercialize innovative ideas and technology. The complimentary nature of the business model and the technology used, as well as how it may all be commercialized, are defined by the business model choice (Baden- Fuller & Haefliger, 2013). These concerns emphasize the need of business models for a technological startup.

2.1.2 Factors Related to Critical Junctures

To begin with, Khodaei et al. (2020) discussed the challenges associated with the first three critical junctures and the key support that could help to navigate these junctures. According to their research paper, the most challenges and key support illustrated in the figure 2.2 below:

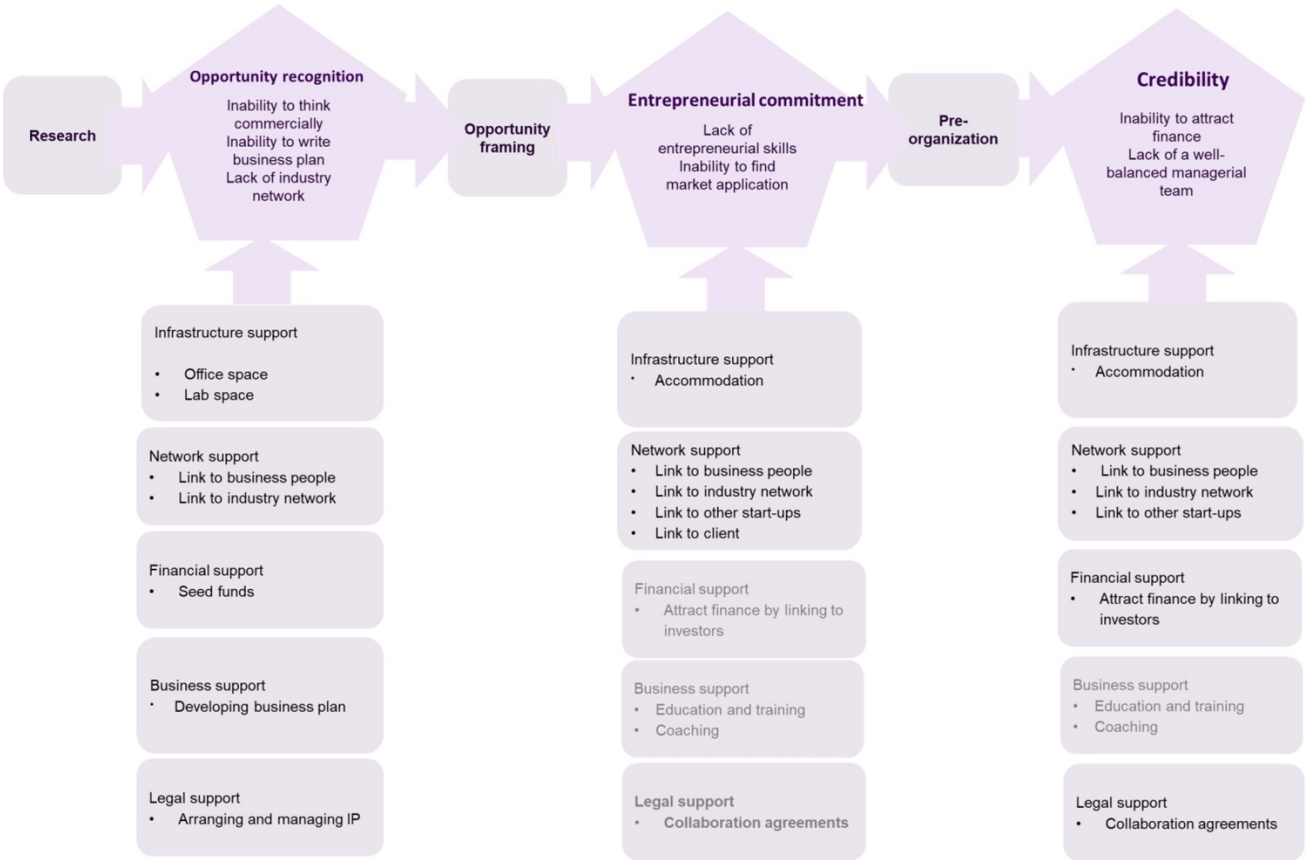

Figure 2.2 Challenges and Key Support Regarding Critical Junctures (Khodaei et al., 2020)

The paper discussed the most challenges that have been mentioned by interviewers and according to Khodaei et al., (2020), the inability to write a business plan, think commercially and lack of industry network were mentioned as frequent challenges during the first critical juncture of opportunity recognition. Lack of entrepreneurial skills and capability, the inability to find market applications, and the absence of a role model were the main challenges in the second juncture of entrepreneurial commitment (Khodaei et al., 2020). Finally, the inability to attract finance from investors, lack of legitimacy and lack of a well-balanced managerial team were the main challenges during the credibility juncture (Khodaei et al., 2020).

However, the paper also mentioned the key support that technology-based startups could get to navigate the above junctures. Founders interviewed mentioned that incubators or other facilitators can support emerging startups to overcome the first critical juncture by providing accommodation where the startups could prototype their products, link to business and industry network that can attract seed funds and investors, and other supports to write the business plan and legal advice to protect intellectual property (Khodaei et al., 2020). The network support will facilitate knowledge transfer and experience sharing, and this will help to navigate the critical juncture of entrepreneurial commitment (Khodaei et

al., 2020). Having strong network support and connections with other startups, external financiers, investors, and potential customers is one of the factors to navigate the credibility juncture (Khodaei et al., 2020). The network will help provide access to resources and get financial support while accommodations and collaboration agreements enhance the startup's credibility and its access to external resources (Khodaei et al., 2020).

After discussing the most important factors and challenges affecting three critical junctures according to the latest research have been done on emerging technology startups, the following will discuss each critical juncture in more detail to find out other factors. The factors will be grouped in table 2.3 to be linked later to business model components.

Opportunity Recognition

(Ardichvili & Cardozo, 2000; Ardichvili et al., 2003) wrote a number of significant publications on the process of entrepreneurship opportunity recognition. He was one of the first scholars to look at a variety of elements that influence the success of new business ventures, and he established a model and theory of opportunity recognition. Ardichvili and Cardozo (2000) studied 20 successful entrepreneurs who had annual revenues ranging from $2 million to $200 million. As a result of the findings, a methodology for recognizing opportunities was developed. Prior knowledge of markets and consumer problems, entrepreneurial alertness, and social networks are all factors in the model that contribute to effective opportunity recognition. Ardichvili et al. (2003) published a theory of opportunity identification and development three years later, building on existing models of opportunity recognition to better explain specific factors and causalities. High levels of entrepreneurial alertness, according to the theory of opportunity recognition, contribute to the effective identification of new venture opportunities. High levels of entrepreneurial creativity and optimism, a convergence of specific interest and industry knowledge, and an extended social network are all associated with alertness.

Prior knowledge of markets, prior knowledge of ways to serve markets, and prior knowledge of customer problems are the three key elements of prior knowledge that influence opportunity recognition (Ronstadt, 1988). This knowledge comes from two sources: special interest knowledge and industrial knowledge (Sigrist, 1999). The venture needs to define the industry or market (sector) it aims to enter (van Gelderen et al., 2006). As well as the market size, scope, competition intensity, risks, and share must all be determined (Cusumano, 2013; van Gelderen et al., 2006; Hall & Hofer, 1993; Mallick & Schroeder, 2005; Song et al., 2007). In addition, the venture should collect market feedback and assess market attractiveness (Hall & Hofer, 1993). It is critical for a new venture to understand market growth and potential to scale. The profitability of each client, the cost of gaining new consumers, and the repeat purchase of current customers all influence market growth (Ries, 2011; Song et al., 2007).

Startups often operate in unexplored markets. As a result, making accurate predictions about market features can be challenging. Throughout the product development process, the product idea should be tested with potential consumers to reduce the chance of making a mistake (Kerr et al., 2014).
Porter (2008) outlined five factors that may be used to examine competitiveness in a market where a firm wants to compete. Competition awareness is critical for both new ventures and incumbents. This can be caused by new entrants or substitutes, but it should also consider competition among existing competitors. The venture should also be aware of suppliers' and buyers' bargaining power since this will affect pricing.

Social network could be defined as s person's network that is made up of both strong and weak ties (Granovetter, 1973). Close friends and relatives make up strong ties, whereas casual acquaintances compensate weak ties. Strong ties often give a wealth of information that allows the entrepreneur to have a deeper understanding of the opportunity. Weak ties act as a "bridge" to knowledge that an entrepreneur would not be able to get from close friends in their strong tie network. Individuals with an extended network see more opportunities, and the quality of their network has a good influence on other factors like alertness and creativity (Hills et al., 1997).

Entrepreneurship has long been seen to be aided by social networking (Aldrich & Zimmer, 1986; Burt, 1992). The importance of the social network approach to analyzing the entrepreneurial process, which focuses on interactions between entrepreneurs and other actors, has provided significant value. Entrepreneurs may use their social networks to find opportunities such as new business opportunities (Elfring & Hulsink, 2003; Shane & Venkataraman, 2000). Networks can allow access to a wide variety of resources (Garnsey, 1998), which are sometimes restricted to a small known group of people (Starr & MacMillan, 1990). Financial capital, a skilled team, market information, and tacit knowledge are examples of these resources (Kaplan, 1996; Stuart & Sorenson, 2005).

Other models, such as the pattern recognition framework (Baron, 2006), the entrepreneurial information processing framework (Vaghely & Julien, 2010), and the integrated model of entrepreneurial opportunity recognition (Riquelme, 2013), have since been published, demonstrating the topic's continued interest and importance in the literature. These theories are based on a range of psychological perspectives and assumptions regarding whether opportunities are discovered or created. Furthermore, some models place an emphasis on the individual and the importance of personality traits, while others focus on external factors and social dynamics. To summarize, all studies show that prior knowledge and social network can affect opportunity recognition, which are the factors needed to comprehend the link between these critical junctures and business model elements, aside from entrepreneurial personal attributes.

Entrepreneurial Commitment

According to Meyer and Herscovitch (2001), commitment is the "power" that holds a person to a certain objective. According to Gollwitzer and Brandstätter (1997), a strong commitment to the goal is necessary for the development of an implementation intention, therefore the concepts of commitment and goal intention may be connected. However, the critical juncture entrepreneurial commitment has been defined previously and is more related to the skills and capability of the team members, as well as knowledge and expertise in business technology (Khodaei et al., 2020). According to Vohora et al. (2004), the issue arises from the need to develop the startup, which is exacerbated by the team's lack of entrepreneurial skills in applying academic knowledge to commercial transactions. These could be due to the network that is limited to academic actors, a lack of prior knowledge and business expertise in commercialization of intellectual property, a lack of capabilities and structure to delegate responsibilities among team members, and a lack of resources and inabilities to acquire external partners. Therefore, the selection of the team members is the first step in developing a high-performance team culture (Kichuk & Wiesner, 1997). Prior to making financial investments, team members must devote a significant amount of information, time, and energy. The capacity of the first leadership team to continue to address new problems as the firm evolves, according to Boeker and Wiltbank (2005), is critical to the success of the new venture.

Credibility

The value of credibility in the context of starting a new firm is debated by Birley and Norburn (1985). The owner (founder) is said to be a new business's greatest strength, especially in the beginning. He understands product/market fit, vision, strategy, etc. Firms would struggle to accelerate their activities if they lacked the necessary knowledge (Birley & Norburn, 1985). Furthermore, in order to be successful, an entrepreneur must acquire all of the resources necessary to construct a feasible and credible plan (Birley & Norburn, 1985). The 'credibility merry-go-round' represents many actors and their relationships. It will be difficult to obtain investments and loans without credibility, as well as to hire professional personnel, sign agreements with suppliers, and acquire premises. Many entrepreneurs are unable to enter the 'merry-go-round circle.' "The only way to break the circle is to establish personal credibility in the eyes of at least one of these groups," say Birley and Norburn (1985). Personal credibility will be supplanted by corporate credibility as the firm grows (Birley & Norburn, 1985).

Later, while researching their study on credibility-driven entrepreneurship, Rehme and Svensson (2011) utilized the research implications of Birley and Norburn (1985). They looked at the topic of credibility and its significance in the context of emerging businesses (startups). Startup firms are said to gain credibility through a variety of activities, including social, technological, economic, and operational activities (Rehme & Svensson, 2011). Having a skilled, well-known team, collaborating

with a prominent investor, publicly demonstrating financial capital, etc., may all help to increase the credibility of a firm or venture (Rehme & Svensson, 2011). A new company's ability to stay in the market depends on its ability to establish credibility. Furthermore, it has been observed that having a variety of relationships prior to launching a startup might be crucial in overcoming a major challenge, such as securing the first sale or obtaining the first successful reference (Ostgaard & Birley, 1996). Young businesses sometimes struggle to obtain enough information to conduct a thorough marketing research (Ostgaard & Birley, 1996). According to Rehme and Svensson (2011), startups must establish their credibility "by providing some proof of concept, proof of market or customer acceptance, plus proof of the commitment of their stakeholders". For new firms, successfully dealing with clients is critical to get these proofs. Entrepreneurs must build and construct viable and effective business plans to achieve the credibility desired (Birley & Norburn, 1985). To underline the significance of credibility for the first sale and first customer, the 'merry-go-round' framework was used and adjusted (Rehme & Svensson, 2011).

External funds, relationships with customers, suppliers, and external partners as well as investors will increase the credibility of the new venture and provide access to necessary resources required for productive activities. Also, team members as indicated in (Khodaet et al., 2020) research is critical factor to increase credibility along with infrastructure.

Sustainability

The main difference between a scale-up, and the regular developing business is how they grow. "Scaleup is achieved by growing revenue without incurring excessive costs," as opposed to growth that occurs linearly by adding additional resources (Whatman, 2021). The scaleup stage is one of the stages in the lifecycle of a startup from creation to exit. The key aspects of successful scale-up businesses have been the subject of several studies. Internal and external factors can be classified as growth drivers (IRIS Group, 2019; Zhao et al., 2019). In table 2.2 below the two categories are presented. Internal factors contribute to the company's success and are decisions that may be led and made deliberately. External factors, on the other hand, are not only dependent on internal decisions, but they can also be influenced.

Internal Factors	**External Factors**
• Founders and owners • Product-market-fit • Firm operation and growth strategies • Human resources management • R&D capabilities	• Geographical factors • Capital and investments • Infrastructure • Institutions and government regulations

Table 2.2 Internal and External Factors for Scaleup

Internal factors: indicate that founders play a crucial role in developing their business and securing its progression to the next stage (IRIS Group, 2019). Companies led by growth-oriented entrepreneurs will expand faster and have a better chance of surviving (Dencker & Gruber, 2015). Marmer et al. (2011) assert, on the other hand, that a founder's prior knowledge or experience has little bearing on scaling success. Founders with prior experience are more willing to take risks, have built a valuable network, and recruit more effectively (Dencker & Gruber, 2015). Finding the right product-market fit is essential for success, but it does not ensure constant growth. Therefore, startups must develop their ability to "ability to keep track market trends and meet the changing needs of existing and new customers by constantly developing their products, services and business model" (IRIS Group, 2019). People represent the bottleneck of high growth rate (Bjerg, 2019; Salamzadeh & Kesim, 2015). A skilled team, according to Zhao et al., (2019), is vital for rapidly growing firms. Scaleup and high growth are driven by firm strategy, innovation, and growth capabilities (Zhao et al., 2019). R&D capabilities have also been identified as a key driver of rapid expansion (Zhao et al., 2019).

When it comes to ***External factors,*** having access to capital at all stages of growth is crucial. Investors provide more than just funds; they also supply managerial skills, industry knowledge, and access to their professional networks. According to Long (2019), companies that use both "formal finance (financing capital sourced from banks and other formal financial intermediaries)" and "informal finance (capital sourced from friends, family, relatives, or private moneylenders)" are more likely to grow and perform better than their counterparts (Zhao et al., 2019). Location and working environment can affect the growth rate positively, and top-performing companies have the most high-performing work environments (Termaat et al., 2014). External environment, such as geographical factors, also have an influence on development potential, according to (Zhao et al., 2019), who state that scale-ups exist in places with larger average establishment sizes, more educational attainment, and more natural amentias. Different infrastructure that facilitates prototype testing stimulates research and development, increasing the likelihood of successful growth (Zhao et al., 2019). Institutions such as universities, government, and cities, according to Cohen (2006), play a critical role in ecosystem development.

Challenges for scaleup

Startups face a range of barriers throughout the scaling phase. IRIS Group (2019) separates the scaling stage into two phases: 'growing to scale' (10 to 50 employees) and 'expansion' (50 to 250 employees) (see figure 2.3).

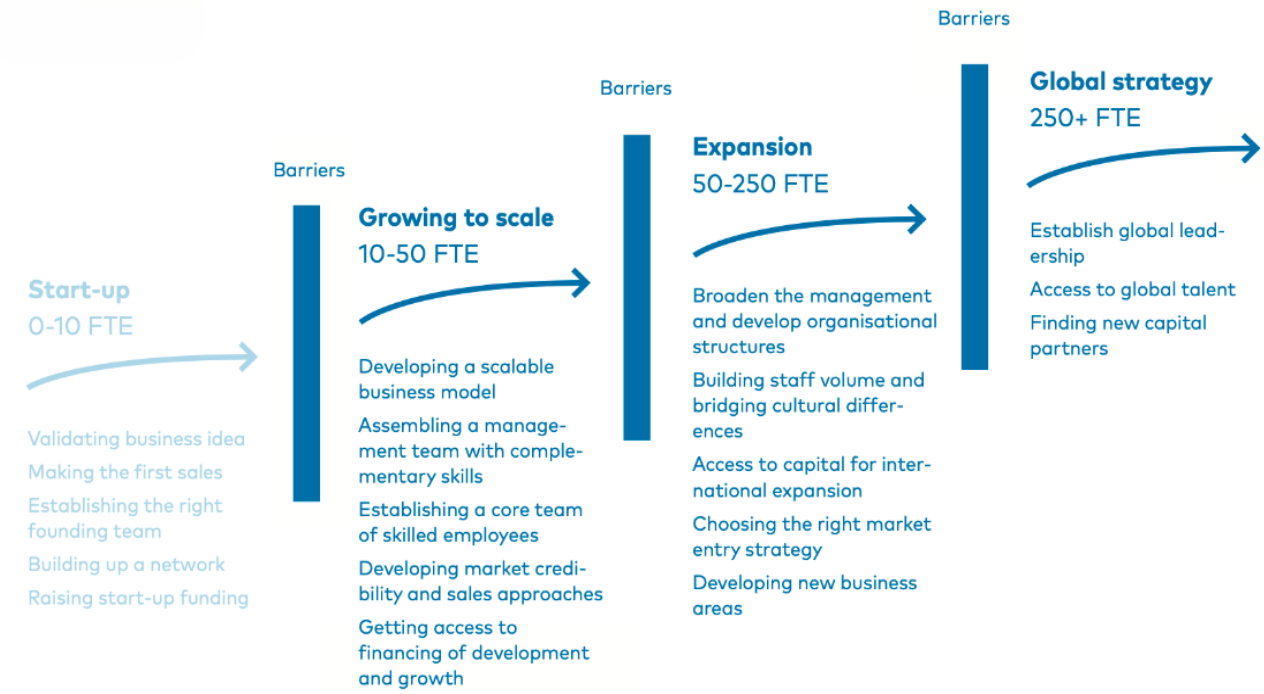

Figure 2.3 Barriers During Scaleup Stage (IRIS Group, 2019)

The inability to obtain capital is a major barrier. Product development, recruiting, sales activity, and organizational development all require continuing investments. Furthermore, raising fundraising rounds is simply one aspect of a company's capacity to fund itself. Building a scalable business model and establishing market credibility are the primary goals of the expansion phase. Internationalization and commercial development are two further issues that need to be addressed.

Critical Juncture	Factors
Opportunity Recognition	**Lack of market Knowledge:** • **Market changes** (Ardichvili et al., 2003; Vohora et al., 2004) • **Landscape changes** (Ardichvili et al., 2003; Vohora et al., 2004) • **Customer problems** (Ardichvili et al., 2003; Vohora et al., 2004) • **Inability to write a Business Plan** (Khodaei et al., 2020) • **Competitors** (Ardichvili et al., 2003) **Lack of industry network:**

	• **To attract investors and financial capital** (Ardichvili et al., 2003; Vohora et al., 2004, Khodaei et al., 2020) **Supportive policy** (Khodaei et al., 2020) **Infrastructure** (Khodaei et al., 2020)
Entrepreneurial Commitment	**Lack of skills and capabilities** (Vohora et al., 2004, Khodaei et al., 2020) **Lack of network** (Vohora et al., 2004, Khodaei et al., 2020) **Lack of surrogate entrepreneur** (Vohora et al., 2004, Khodaei et al., 2020) **Infrastructure** (Khodaei et al., 2020) **Inability to find market application** (Khodaei et al., 2020)
Credibility	**Network:** • **Potential investors** (Khodaei et al., 2020; Birley & Norburn, 1985; Vohora et al., 2004) • **Suppliers** (Birley & Norburn, 1985) • **External partners** (Birley & Norburn, 1985; Khodaei et al., 2020) **Resources** (Birley & Norburn, 1985; Rehme & Svensson, 2011) **Customer relationships** (Birley & Norburn, 1985) **Supportive Policy** (Khodaei et al., 2020) **Infrastructure** (Khodaei et al., 2020) **Skilled Team** (Birley & Norburn, 1985; Khodaei et al., 2020) **Collaboration Partnerships** (Vohora et al., 2004) **Social, technological, economic, and operational activities** (Rehme & Svensson, 2011)
Sustainability	**Knowledge:** • **Product-Market fit** (Bjerg, 2019) • **Market Changes** **Capital and Investments** (Long ,2019; Zhao et al., 2019; (Bjerg, 2019)

	Skilled team (Bjerg, 2019) **Resources** (Bjerg, 2019) **Capabilities** (Zhao et al., 2019) **Infrastructure** (Termaat et al., 2014; Zhao et al., 2019) **Supportive Policy** (Zhao et al., 2019)

Table 2.3 Factors Related to Specific Critical Junctures

Business Models

Business technology, according to Chesbrough (2010), has no objective value on its own. Unless technologies are commercialized through viable business models, their economic value will be lost. In certain circumstances, an invention may effectively exploit a business model that is already familiar to the company, while in others, the company may have a model that makes use of the technology through licensing. However, potentially innovative technology may lack a clear commercial strategy (Chesbrough, 2010). Managers in these situations must broaden their horizons to develop a viable business model that will allow them to reap the benefits of the technology. Without the application of an appropriate business model, technologies will provide less value to the firm than the technology's true potential (Chesbrough, 2010).

2.2 Business Models: A Static View

According to Osterwalder et al. (2005), the term "business model" was first used in a scholarly publication in 1957 (Bellman et al., 1957) and in the title and abstract of a paper in 1960 (Jones, 1960). However, it was the introduction of the Internet in the mid-1990s, as well as the dotcom boom, that sparked interest in "business models." "A firm did not require a plan, particular skill, or even clients – all it needed was a Web-based business model that promised wild profits in some distant, ill-defined future," writes Magretta (2002). The value and power of business models is based on their wide variety of possible applications. It may be utilized as a communication and motivation anchor, as well as a planning and testing tool (Magretta, 2002; Shafer et al., 2005). According to Osterwalder et al. (2005), business models are useful for understanding, communicating, analyzing, managing, simulating, and patenting a firm's business logic.

Chesbrough & Rosenbloom (2002) used data from Xerox Corporation's technological spin-offs to show that while traditional business models may not be effective, they can be very rewarding when commercialized with the correct strategy. They claim that discovery-oriented research frequently results in "spillover" innovations that are difficult to commercialize. In appropriating value from those technologies, the business model architecture is crucial. Chesbrough (2007) emphasizes in his work that a superior business model typically will often prevail over a better concept or technology. “A mediocre

technology explored within a good business model may be more valuable than a great technology exploited via a mediocre business model", according (Chesbrough, 2010).

Business model research is especially important, according to Zott and Amit (2008), since it influences organizations' ability to create and capture value, and so may be a source of competitive advantage. "The formation, growth potential, and success of new organizational forms is typically linked to the development of novel business models, especially in turbulent sectors," George & Bock (2011), and this construct is crucial for understanding value creation. The importance of this construct is demonstrated by the strong link between firm performance and survival.

2.2.1 Business Model Definitions

The literature on business models is still in its infancy and is widely spread (Zott et al., 2011). Despite the term's popularity, scholars have yet to agree on a definition. As a result, there is a broad range of meanings for the concept (George & Bock, 2011). Furthermore, many scholars investigate the concept without providing precise definitions (Bankvall et al., 2017). According to Zott et al. (2011), more than a third (37%) of the 103 business model publications examined do not define the concept, assuming its meaning; fewer than half (44%) explicitly define or conceptualize it; and the remaining publications (19%) refer to the work of other scholars when defining the concept. Existing definitions only partially overlap, resulting in a variety of interpretations surrounding an apparently "nebulous" concept. This ambiguity encourages divergence rather than convergence of viewpoints, and it stymies long-term study on business models (Zott et al., 2011). Baden-Fuller & Mangematin (2013); George & Bock (2011) and Klang et al. (2010) are only a few examples of extensive reviews on the topic of business models.

Table 2.4 in Appendix 1 contains a list of definitions from highly cited works as well as more contemporary articles (2009 and on). Google Scholar, Web of Science, and ABI/Inform were used to find the number of citations for the papers. This table was based on the work of George & Bock (2011), Morris et al., (2006a), Morris et al., (2006b), and Zott et al. (2011), with some additional definitions and the inclusion of article titles and citation indexes. According to the Google Scholar citation database, the three most cited publications using the phrase "business models" in the title are those by Amit & Zott (2001), Chesbrough & Rosenbloom (2002), and Timmers (1998). The most recent publications on this list of highly cited articles are by Osterwalder et al. (2005), Morris et al. (2005), and Shafer et al. (2005), with Osterwalder et al. (2005) having the most citations according to Google Scholar.

The second section of table 2.4 contains a list of definitions from more recent papers, which are distinguished by a large number of citations. These latter definitions are mostly based on reviews of older definitions. They stress that the business model reflects the "rationale" (Osterwalder & Pigneur, 2010) or "logic" (Teece, 2010) of how an organization produces money, and that it is made up of a series of managerial decisions and their outcomes (Casadesus-Masanell & Ricart, 2011). They propose that the business model focuses on "value creation" (Osterwalder & Pigneur, 2010; Zott et al., 2011), "value delivery" (Teece, 2010; Osterwalder & Pigneur, 2010), and "value capture" (Osterwalder & Pigneur, 2010).

Despite the fact that organizations frequently invest heavily and have mechanisms in place to explore new ideas and technologies, they frequently lack the capacity to reinvent the business models through which these inputs will pass (Chesbrough, 2010). This has consequences because the same idea or technology will produce two entirely different economic results if it is introduced to the market via two different business models (Chesbrough, 2010). Furthermore, companies with unique, effective, and efficient business models, according to Teece (2010), are more likely to generate larger profits. The primary goal of a business model is to take advantage of potential business opportunities by providing value for all parties involved (Zott & Amit, 2010). In other words, the company and its partners must meet consumers' requirements and produce customer surplus while producing sufficient profit.

2.2.2 Business Model Elements

Authors discussing the concept of "business model" frequently address the various "elements" (Zott et al., 2011; Osterwalder et al., 2005), "components" (Morris et al., 2005), or "building blocks" that make it up (Osterwalder & Pigneur, 2010). Table 2.5 in Appendix 2 lists the business model elements presented by each author, as well as the total number of elements ("Nr").
This table is based on the same works as table 2.4 for the sake of uniformity. This enables for a comparison of data from both tables to provide an overall picture of the authors, publication year and title, business model definitions, reference indexes, and descriptions of business model parts and their corresponding numbers. A quick glance at table 2.5 indicates a significant difference in the number of business model elements and their descriptions. This finding clearly demonstrates that the lack of agreement on "business model" definitions extends to the elements that make up the model, both numerically and conceptually.

Some authors (e.g., Osterwalder et al., 2005) have sought to develop a reference model, or a common language in the field of business models that may be shared by communities of practice or scholars. However, with a few exceptions, the current stream of articles either evaluates prior business model representations or offers alternatives, demonstrating the existing lack of agreement on a reference

model. To be helpful, a business model representation "must be reasonably simple, logical, measurable, comprehensive, and operationally meaningful," according to the authors (Morris et al., 2005).

The framework of Osterwalder & Pigneur, (2010), is one such representation that is closely matched with this description. This framework consists of nine elements:

1. Customer Segments (CS): are the various groups of individuals or organizations that a firm intends to reach and service.
2. Value Propositions (VP): are a collection of products and services that add value to a certain customer segment.
3. Channels (CH): outlines how a firm connects with and reaches out to its Customer Segments in order to deliver a Value Proposition.
4. Customer Relationships (CR): are the types of relationships that a business makes with various customer segments.
5. Revenue Streams (RS): each Customer Segment generates cash for the company (costs must be subtracted from revenues to create earnings)
6. Key Resources (KR): describes the most critical assets necessary to make a business model operate.
7. Key Activities (KA): the most critical things a firm must perform to make its business model succeed.
8. Key Partnerships (KP): the network of suppliers and partners that support the business model.
9. Cost Structure (CS): describes all expenditures spent to operate a business model.

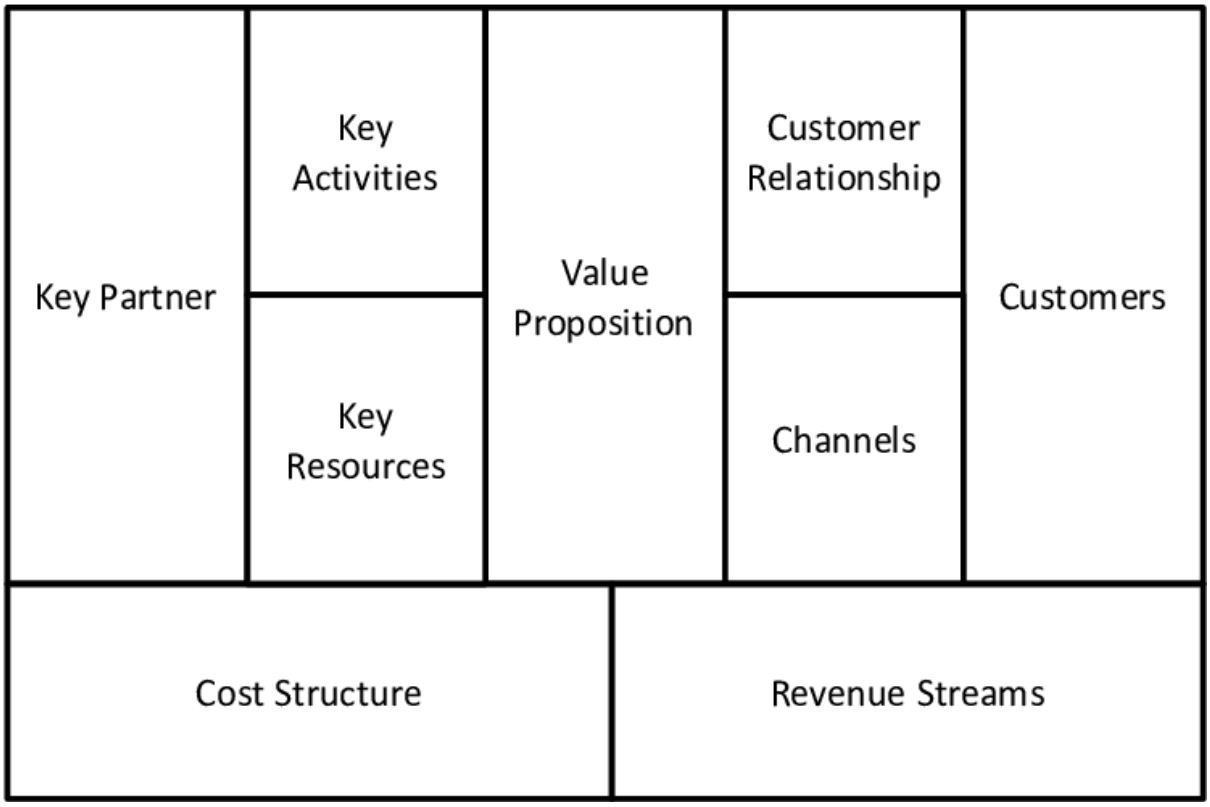

Figure 2.4 The Business Model Canvas (Osterwalder & Pigneur, 2010)

As stated above, there have been several alternative business model frameworks with various components provided. Many of these components are designed to be employed in large, well-established businesses. When evaluating dynamics, increasing the number of components increases both completeness and complexity (Khodaei & Ortt, 2019).

2.3 Business Model: A Dynamic View

A survey of the literature that takes a "static" perspective on business models was offered in the previous section. This section covers the literature using a more "dynamic" viewpoint to the study of business models, which is motivated by the nature of the research questions, that rely on the requirement to understand the process of business model change over time.

2.3.1 Business Model Change

Business model change is one of several terms used in the literature to reflect a more dynamic approach to business models (e.g., Linder & Cantrell, 2000), business model evolution (e.g., Demil & Lecocq, 2010), business model adaptation (e.g., Andries & Debackere, 2006, 2007), development (e.g., Andries et al., 2013), business model innovation (e.g., Chesbrough, 2010), business model renewal (e.g., Doz & Kosonen, 2010), business model reinvention (e.g., Voelpel et al., 2004), business model dynamics (e.g., De Reuver et al., 2009), dynamic business models (e.g., Mason & Leek, 2008). "Most studies [still] look at business models as snapshots in time" (De Reuver et al., 2009), despite the fact that "most firms' business models are under continual pressure to change" according to Linder and Cantrell (2000b). Linder & Cantrell (2000b) were among the first to introduce the concept "changing business models" or "change model." They conclude that: 1) developing a sound business model is important, 2) business models wear out, and 3) leading companies don't just adjust their business models incrementally – they master change models, based on interviews with 70 company executives and analysts and additional secondary research. Additionally, according to the authors, successful companies have mastered the capacity to change their business model efficiently at a rate that fits market dynamics.

In another study, Linder & Cantrell (2000a) conducted an interview with leaders from 40 organizations to see how they are changing their business models more quickly. They came to the conclusion that a small group of leading companies (13%) had figured out how to change their business models considerably more quickly. The best strategy to change company models quickly and fluidly is to cultivate a diverse set of options (Linder & Cantrell, 2000). This may be accomplished by either purchasing companies and learning from them, or by purposefully experimenting. Once a company has a variety of business model possibilities, it must master the art of timing, or making the correct decision

at the appropriate moment. The next stage, armed with numerous business models and the skill of timing, is to move between them without changing the organizational structure. This ability "requires naming the mindsets, providing broad goals and incentives, and practicing role flexibility" according to the authors (Linder & Cantrell, 2000a).

Pateli & Giaglis (2005) noted the lack of a structured method to changing a firm's business model based on a systematic synthesis of existing literature. Some researchers have proposed business model change methodologies (Auer & Follack, 2002; Petrovicet al., 2001; Pramataris et al., 2001), however they have presented a relatively rigid linear series of phases. This method may produce good results in generally stable industry environments, but not in a more turbulent or complicated context. "A progressive process allows organizations to construct various scenarios for BM evolution or extension," Pateli and Giaglis (2005) suggest. The methodology combines scenario-based planning (to create possible future scenarios) with a revolutionary contingency strategy (to select among possibilities). Despite criticizing the linearity of existing "stepwise" business model change approaches, the authors end up proposing a linear series of stages.

According to Cavalcante et al. (2011), there are four forms of business model change: 1) creation, 2) extension, 3) revision, and 4) termination. They suggest that firms avoid large business model revisions because such changes tend to challenge managers' mental models and established processes. Individual agency is also discussed as a driving element for business model dynamics by the authors (Cavalcante et al., 2011).

2.3.2 Business Model Innovation

In terms of business model innovation, the dynamic approach is used since it depicts the evolution of business models through time, implying that business models may be used as a concept or approach to promote company changes through product or business model innovations (Demil & Lecocq, 2010). Business model innovation is a subset of business model research, and some writers consider it an implicit element of their consideration. Table 2.6 in Appendix 3 provides a summary of several business model innovation definitions. The concept is being researched to better understand and assist the analysis and planning of business model transformations. The capacity to innovate business models on a regular basis and successfully may boost a firm's resilience to change and provide a long-term competitive advantage (Mitchell & Coles, 2003).

Geissdoerfer et al. (2018) concluded that business model innovation is the process of changes in the entire business model or its components as a response to the changes in the firm’s environment, or to promote innovation and variety. Figure 2.5 distinguishes four generic configurations of business model innovation based on Geissdoerfer et al. (2018) work.

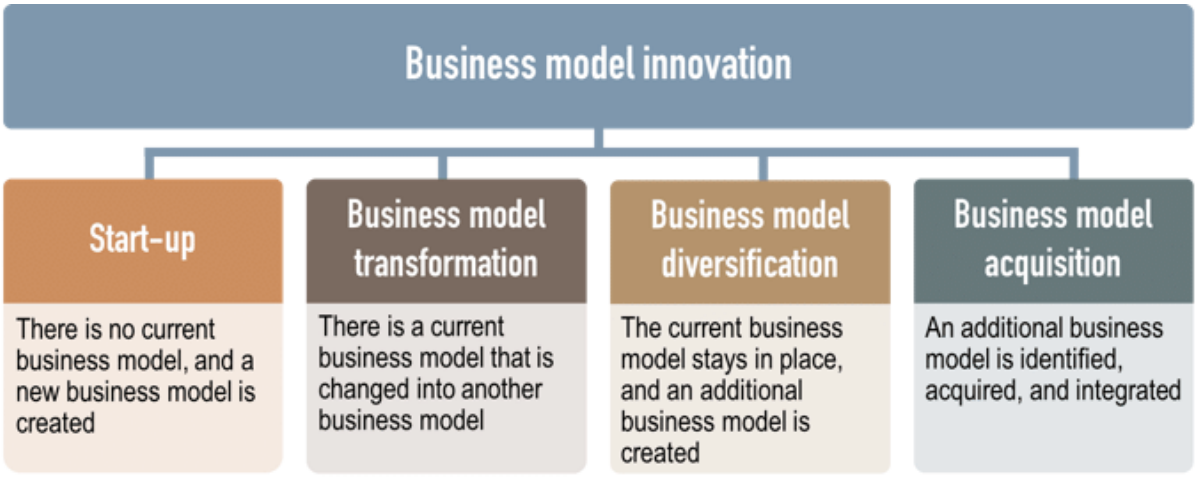

Figure 2.5 Types of Business Model Innovation (Geissdoerfer et al., 2018)

Researchers who have studied the subject have acknowledged that businesses must go through the process of continuous business model innovation due to disruptive technologies (Chesbrough, 2010; Heij et al. 2014; Geissdoerfer et al., 2018), dynamic consumer needs (Ostarwalder & Pigneur, 2010; Martins et al., 2015), and shifting market conditions (Kamprath & Van den Broek, 2015) that are continuously reshaping a business environment (Geissdoerfer et al., 2018).

2.3.3 Business Model Dynamics

The terms "business model dynamics" or "dynamic business model(s)" haven't been used by many authors in management to describe how business models evolve over time. Khodaei & Ortt (2019), Cavalcante et al. (2011), De Reuver et al. (2009), Mason & Leek (2008), and Schweizer (2005) are some of the notable exceptions. Thiagarajan et al. (2002); Weigand et al. (1997) have used the term "dynamic business model(s)" in the context of Information Systems, particularly when discussing Business Process Modeling. This is not a relevant subject of knowledge for this investigation; hence it will not be addressed.

"The competitive environment changes either due to internal (desire for more revenues or firm expansion) or external (competence-destroying technology) forces," according to Schweizer (2005). Therefore, "companies may find themselves having to adjust and adapt their business models in order to stay competitive." As a result, the dynamic perspective of business models must be considered" (Schweizer, 2005). The reasoning is too narrowly focused on the specifics of an accepted typology, ignoring individual modifications in business model components.

Mason & Leek (2008) investigate how "inter-firm knowledge transmission is engaged in the creation of dynamic business models" in a longitudinal study of three firms (the focal firm and two suppliers). Dynamic business concepts were conceived by them as:
"*Preconceived organizational and network structures built through the development of interdependent operational and administrative routines that evolve through problem solving activities*" (Mason & Leek, 2008).

According to this concept, business models as a whole develop in an unanticipated manner as a result of inter-firm learning and information transfer (e.g., focal firms and suppliers). However, this research is too narrowly focused on establishing a supply network, and it fails to explain how the various aspects of the business model evolve. De Reuver et al. (2009) investigated "which sorts of external factors are the most powerful in driving business models to change." They looked at 45 business model dynamics case studies from diverse sectors. The most important drivers are technology and market-related forces, with regulation playing a modest influence. They conclude:
"For start-ups, the effect of technological and market-related drivers is strongest in the early stages of a new business model, while the effects are moderate over time for established, large companies"

Their research is based on case studies from business schools. There are some limitations to this data. To begin with, many of the teaching situations may be based on retrospective statements rather than interviews conducted at various times. Second, these instructional case studies concentrated on the overall business model rather than the many components of the business model and how they changed over time. Third, they are not discussing the same business model framework, which limits cross-case comparisons. Finally, teaching cases are created for the aim of teaching and have a different level of rigor than research case studies (Yin, 2009).

2.3.4 Sustainable Business Model

Creating value for the environment and society is a focus of sustainable business models, which go beyond the standard business model concept of capturing economic value (Bocken et al., 2013; Schaltegger et al., 2016). Thus, sustainable business models gain a competitive advantage by enhancing the environment and the society in which they operate (Bocken et al., 2013, Bocken et al., 2014). However, the firm's ability to capture economic value must still be considered for it to be long-term viable (Bocken et al., 2013). The creation of a sustainable business case is made possible by the fact that economic success is crucial and should follow from operating sustainably (Schaltegger et al., 2011). Furthermore, Schaltegger et al. (2016) contend that sustainable business models cannot be developed if they merely generate value for customers. Instead, it must add value to the environment and the network of stakeholders inside the company, in addition to consumers and shareholders.

The following illustrate how a firm's value proposition, creation, delivery, and capture may result in value on all levels. Many studies have attempted to identify the characteristics of these components, but the connections between them are still lacking in the literature (Bocken et al., 2014; Schaltegger & Wagner, 2011). This makes it difficult to construct precise definitions. Even academic research on sustainable business models has increased the need to understand the relationship between value proposition, creation, delivery, and capture when a firm incorporates sustainability into its business model (Bocken et al., 2014; Schaltegger & Wagner, 2011). This must be considered as the next sections seek to develop a comprehensive perspective of the definition.

Sustainable Value Proposition

The value proposition of a firm is the value that its product or service offers to the consumer (Osterwalder et al., 2014; Teece, 2010), and it is regarded as the basis of any business model (Maurya, 2012). A value proposition highlights the benefits that a consumer may expect from a product or service that will affect customers and all stakeholders directly or indirectly (Osterwalder et al., 2014)

A sustainable value proposition is a product or service that generates economic advantages while reducing environmental and societal depletion (Boons & Ludeke-Freund, 2013). Companies with true sustainability goals have a value proposition that emphasizes delivering social and environmental benefits to their stakeholders (Bocken et al. 2014). Bocken et al. (2015) and Pedersen et al. (2018) state that with sustainable business models, the value propositions go beyond the usual product, service, and process concerns and instead engage the triple bottom line logic as articulated by Elkington (Elkington, 1997).

Chou et al. (2015) also outlines two critical factors that must be linked for a firm to have a sustainability-led value proposition. First, the firm's mission must represent the main business value and strategy. Next, the company's social responsibility should be indicated in the sustainability vision (Chou et al., 2015). Chou et al. (2015) also suggest that in order to be achieved, sustainability must be integrated into a company's value proposition. Boons and Lüdeke-Freund (2013) add to the sustainable value proposition by stating that it should deliver measurable ecological or social value in addition to economic value. Another possible benefit of including the social and environmental aspects into the value proposition is a reduction in a company's negative effect (Bocken et al., 2014; Upward & Jones, 2016).

Sustainable Value Creation

The value proposition creates a company's value. The resources, activities, and partnerships that a firm uses to achieve its value propositions are referred to as value creation (Osterwalder et al., 2014; Aagaard, 2018). To deliver sustainable results, value creation must be sustainable in itself

(Aagaard, 2018). According to Lepak et al. (2007), Sustainable value creation should include the person, society, and all others impacted by the firm. If sustainability is a component of value creation, value delivery and capture can elicit aspects of sustainability (Moratis et al., 2018).

Sustainable Value Delivery

The distribution channels, suppliers, technology, and product features are all examples of value delivery (Osterwalder & Pigneur, 2010). Value delivery offers the utmost value delivered by the service to the client. According to Bocken et al. (2014), in a sustainable business model, value delivery must provide social and environmental benefits through its channels and partners. Sustainable value delivery is not defined as a concept but rather stated as having or including aspects of sustainability when the value creation itself is sustainable and produces sustainable results (Moratis et al., 2018).

Sustainable Value Capture

A business model's value capture outlines the cost structure and revenue model (Osterwalder & Pigneur, 2010). It is the value captured for customers (Teece, 2010; Bocken & Short, 2016). Value capture is further defined as how a company generates revenue by providing goods, services, or information to customers and users (Teece, 2010). Some scholars incorporate the social and environmental levels of value capture to a greater extent (Lepak et al., 2007, Moratis et al., 2018) Similar to sustainable value delivery, sustainable value capture is only possible if value creation is also sustainable (Moratis et al., 2018).

2.4 The Role of Business Model Dynamics in The Success of Technology-Based Startups

2.4.1 Business Models in New Technology-Based Startups

The importance of the business model in technology-based startups is investigated by Chesbrough & Rosenbloom (2002). A successful business model, according to them, connects technology with the achievement of economic value. "Established firms as well as startups take technology to market through a venture defined by a certain business model," they say, implying that the business model serves as a bridge between technology and market (Chesbrough & Rosenbloom, 2002). Furthermore, they emphasize the significance of determining the best business model for capturing the technology's value. Failure to establish the appropriate business model will result in the company capturing less value from technology.

Willemstein et al. (2007) investigated the dynamics of business models in Dutch biotechnology enterprises, concentrating on the business models at their beginning and the subsequent adjustments. The authors discovered a prevalence of solo product and hybrid product business models at founding, particularly between 2005 and 2007. After a company is founded, it is common for business models to become increasingly hybridized. The reasons for these shifts appear to be a combination of management's ambition to develop products and the potential for out-licensing through product development; and "the reasons for not starting with product development from the beginning are a lack of up-to-date technology, a need for short-term revenues to finance R&D expenses, or simply not having the ambition to develop products." (Williamstein et al., 2007). Therefore, most product development companies rely on short-term revenue generators including out-licensing and selling research products.

"Defining an appropriate business model from the beginning is challenging, and adaptation to the original business model is consequently vital for success," suggest Andries & Debackere (2007). Due to substantial technological and market uncertainty, especially in new technology-based startups, the set of all potential business models is rarely predictable in advance. The same authors have previously explored the link between uncertainty and business model adaptation in new technology-based ventures (NTBVs) (Andries & Debackere, 2006). As the entrepreneur gets expertise with products, markets, suppliers, employees, and other crucial variables, these high levels of uncertainty and risk demand the need to change the business model (Andries & Debackere, 2007). Though previous study indicated that adaptability is a need for survival, their findings show that this is not the case. The authors discovered that the influence of adaptation on performance is largely dependent on the industry in which a new technology-based startup operates and whether it is an independent company or a division of a larger corporation.

2.4.2 Business Model Dynamics: The Entrepreneurial Context

Traditional business model representations are intended to provide a static view of how a firm operates and creates value (Spiegel et al., 2016; Cosenz & Noto, 2018). This is an issue for entrepreneurs because it inhibits them from conceptualizing the complexities, uncertainties, and unpredictability of business. These competitive dynamics have an impact on the company model's viability (Baden- Fuller & Haefliger, 2013). Companies must adopt flexible and rapidly changing business models to succeed in today's technology-intensive sectors with constant and rapid changes (Nyström & Mustonen, 2017). To adapt to external discontinuities and disruptions, business models must be continually changed (Achtenhagen et al., 2013; Saebi et al., 2017).

Recent advances in business model research have revealed that companies' business models must evolve over time in order to achieve long-term value creation (Achtenhagen et al., 2013; Foss &

Saebi, 2015). In the literature, it is commonly accepted that dynamic business models are critical to success (DaSilva & Trkman, 2014; Foss & Saebi, 2015). As a result, academics are progressively shifting from a static to a dynamic perspective on business models (Saebi et al., 2017). According to Foss and Saebi (2015), in the context of entrepreneurial and emerging startup firms, business models have recently received increasing attention. Different concepts and terrors have been used to explain the change in the business models, according to Saebi et al. (2017).

Saebi et al. (2017) identified two main study streams on business model change in their review of the literature. Changes in business models are described by one group of scholars as adaptation that occurs over time in existing models and is frequently triggered by external factors (Saebi et al., 2017). Other studies on innovation, on the other hand, assume that there is a need to develop innovation and innovative business models. The main distinction is that, while innovation is a potential consequence, business model adaptation does not need it. Furthermore, although business model adaptation is driven by external factors, business model innovation can be influenced by both internal and external forces (Saebi et al., 2017).

Business model adaptation and innovation are motivated by different factors (Saebi et at., 2017). When a startup adapts a business model, it is driven by a desire to conform to the environment with disruptive innovations, whereas business model innovation is motivated by a desire to reshape the environment with disruptive innovations. Even when the business model is aimed toward disruptive innovations, Morris et al. (2005) and Teece (2018) underline the significance of creating coherence across the business model components. When the business model evolves, it is critical to consider alignment and coherence to ensure that the components are still mutually reinforcing (Teece, 2018).

According to Achtenhagen et al. (2013), three aspects are required to achieve business model change over time: strategic actions, critical capabilities, and specific activities. Sustained value development may be achieved through conceptualizing activities that combine organic growth and strategic acquisitions, simultaneously search for expansion in several strategic dimensions, and focus on quality and cost optimization (Achtenhagen et al., 2013). These strategic activities are supported by many critical capabilities. Capabilities like experimenting with and exploiting new business opportunities, balancing resource use, and creating coherence between a strong organizational culture, active leadership, and employee commitment are vital. The complementarities between these capacities and strategic activities assist each other. These capabilities are context-dependent and vary for each company, as they are formed through a variety of activities.

As previously stated, there is ample evidence that managers should ensure that the business model evolves over time to ensure success in a changing business environment. The business model is

built by the focal company's management, according to Zott & Amit (2013). Managers, however, have little power to adapt the business model, according to Demil & Lecocq (2010), since emergent changes are unintended and partially beyond their control. The business model innovation process is hampered by the complexity and uncertainty of the change process, as well as many interconnected elements of the business model (Foss & Saebi, 2015).

Companies are more likely to modify their business model in response to perceived risks than in response to expected opportunities, according to Saebi et al. (2017). Furthermore, a strategic focus on market development rather than defending the company's current market position supports business model adaptation more efficiently. Saebi et al. (2017) identified three key reasons for business model adaptation in a literature review. The need to adapt to external stakeholders, changes in the competitive market, and opportunities given by new technology are among the recognized drivers. To respond and adapt, the company must be able to receive and interpret signals from the business environment, as well as modify the business model as needed (Nyström & Mustonen, 2017).

Prior research has emphasized the challenges of managing the adaptation process (Saebi et al., 2017). The ability to develop leadership and organizational capacities, as well as the company's willingness to experiment, have been proven to be critical for business model adaptation. Additionally, the existing business model might limit change since companies want to keep the essential components of their current business model (Chesbrough & Rosenbloom, 2002). This implies that business model change is path dependent (Saebi et al., 2017). However, because there is no pre-existing business model for startup enterprises, an entirely new one may be developed (Chesbrough & Rosenbloom, 2002). Thus, in startup ventures, business model innovation is a defining process. Experiments and responses to their outcomes are common in early-stage ventures when it comes to business model innovation (Chesbrough, 2010). The fundamental objective of business model dynamics for entrepreneurial startups is to tap into new partners and their complementary assets to develop a distinctive value proposition (Bohnsack et at., 2014).

Business model dynamics occurs through the interactions of individuals in social groups, inside the organization, and throughout the larger business network, according to the literature on business models (Mason & Spring, 2011). However, when the business model changes, the organizational process must adapt as well (Chesbrough, 2010). Firms do not change their business model unless there are sufficient incentives to do so due to organizational inertia and the uncertainty that comes with change (Saebi et al., 2017).

2.4.3 Business Models Innovation and Startup Performance

Several researchers argue that business models are important (Chesbrough, 2007; Magretta, 2002), and that the proper business model may be more rewarding (Chesbrough & Rosenbloom, 2002). Such arguments strongly imply that business models and company's performance are linked. Despite this, few large-scale systematic empirical research has looked into this connection (Malone et al., 2006).

Linder & Cantrell (2001) examined the success of business models in the consulting industry by looking at the 1000 largest companies in the United States and gathering generic financial and market data to put them in performance quartiles. A review of the business model environment revealed that there are no "silver bullets," or unique company ideas that guarantee financial success. Pohle and Chapman (2006) conducted interviews with 765 business and public sector officials. They discovered that CEOs consider business model innovation to be a source of long-term competitive advantage. According to the authors' examination of financial performance, organizations with higher operating margins were twice as likely as their lower-performing rivals to prioritize business model innovation.

Other studies have attempted to investigate the relationship between business models and performance, but they are overly focused on a single industry, such as mobile services (e.g., De Reuver & Haaker, 2009; Methlie & Pedersen, 2007). Other studies investigate firm performance using more complicated models that combine the business model with other variables, making it more difficult to separate its influence (e.g., Koo et al., 2007)

Through a survival analysis of a sample of new technology based (NTB) businesses, Andries & Debackere (2007) explored the link between business model adaptation and company performance. They revealed that NTB businesses that adjust their business models have a better chance of surviving than those that do not. Furthermore, in less mature, capital-intensive, and high-velocity industries, business model adaptation is more favorable.

Zott & Amit (2007) evaluated the influence of business model design on entrepreneurial company performance using a data set of 190 entrepreneurial ventures that were publicly traded on U.S. and European stock markets. In conclusion, they discovered that entrepreneurial company performance is influenced by business model design. Their research reveals that the more unique an entrepreneurial firm's business model is, the better the firm performs. This positive relationship is also "remarkably persistent through time, even under different environmental regimes," according to their findings (Zott & Amit, 2007). Entrepreneurs' attempts to develop both efficiency- and novelty-centered company models, however, may be detrimental, according to the authors. Zott & Amit (2008) investigate the match between a firm's product market strategy and its business model, as well as the consequences for

the focal firm's performance, in following research. On the perceived performance of organizations, they discovered substantial interaction effects of the business model construct with product market strategies. They discovered a positive relationship between firm performance and novelty-centered business models — when combined with product market strategies that stress differentiation, cost leadership, or early market entry. Zott et al. (2011) give a summary of the literature studying the link between business models and company performance in a review of the business model concept. Their perspectives on this relationship are consistent with the previous discussion.

2.5 Business Model Elements and Critical Junctures

As stated in the literature, dynamics of business model aim to exploit capabilities and resources to adapt to the changing environment and seizing new opportunities. Changing components over time during the development of new technology startups is a process of experiments and reactions to their outcome (Chesbrough, 2010). For early-stage ventures, the main objective of the dynamics of business model is to tap into new partners and their complementary assets to create a unique value proposition (Bohnsack et al., 2014). Business model literature consistently acknowledges that interactions between people in social groups, within firms, and in the wider business network lead to business model dynamics (Mason & Spring, 2011). Also, as the startups are functioning in a constantly changing environment, the capability to modify the business model is crucial and can predict future performance of the company (Teece, 2018).

Factors related to critical junctures that have been identified in the previous section are also related to business model elements. Gabriel & Kirkwood (2016) provide an example of the relationships between these factors and business model elements in the context of renewable energy.

According to Gabriel & Kirkwood (2016), consultants consider their knowledge and business skills as a value proposition that can be leveraged on networks in the renewable energy industry, and therefore provide advice to customers, while also understanding the market. They claimed that entrepreneurs could utilize their networks for physical installation of systems, attract funding and get governance support. Therefore, the network is related to key partners and key activities in the value creation category. The authors explained that entrepreneurs use knowledge and experience to run their business, provide advice to customers and get funds (Gabriel & Kirkwood, 2016). Other factors like infrastructure (e.g., office space), skilled team and financial investors are found to be related to key resources in value creation, while direct and indirect relationships with customer affect customer relationships element. In table 2.7 below, the factors related to critical junctures and business model elements in renewable energy context.

Category	Elements	Factors (Critical junctures)	The relationship between key factors in overcoming specific critical junctures
VP	Value proposition	Knowledge/advice	Entrepreneur's knowledge and business skills help overcoming opportunity recognition and entrepreneurial commitment junctures.
VCR	Key Partners	• Networks • Other Entrepreneurs: knowledge & skills	Networks and knowledge help in overcoming opportunity recognition and entrepreneurial commitment to attract investors and government support, and later scale up.
VCR	Key Resources	Knowledge & skills	Entrepreneur's knowledge and skills are factors related to opportunity recognition, entrepreneurial commitment, and product development to scale up.
		Infrastructure (e.g., office space)	Infrastructure is important in the opportunity recognition, to gain credibility and scale up.
		Financial investors	Financial investors are related to credibility, and sustainability.
		Subcontracting & casual staff	Human resources like external surrogate and skilled team are factors in the entrepreneurial commitment, credibility, and sustainability
VCR	Key Activities	Networking Project development	Utilizing network to attract skilled technicians is a factor related to credibility and sustainability.
VCA	Cost structure	Cost of hiring & relating human capital	The cost of hiring skilled team is a factor related to entrepreneurial commitment, credibility, and sustainability
VCA	Revenue Streams	Advice/knowledge transfer	This is related to credibility and sustainability junctures as knowledge or advice to generate sales
VD	Customer Relationships	Direct and indirect relationships with customers	Customer relationship is a factor related to credibility, when the startup starts selling

			products, and to sustainability to understand customers and develop product-market fit.

Table 2.7 Relationships Between Critical Junctures and Business Model Elements adopted from (Gabriel & Kirkwood 2016)

2.6 Chapter Summary

In this chapter, an extensive literature review has been conducted on growth stages and critical junctures of technology-based startups, as well as business model. The findings serve as basis to the sub-research questions 1, 2 and 3. First, the critical junctures have studied thoroughly to investigate all factors related, and what are the key supports that could help to navigate these junctures. During the development processes, startups may struggle to overcome obstacles that lays at the interface of two subsequent phases. These junctures are defined as 1) opportunity recognition, 2) entrepreneurial commitment. 3) credibility, and 4) sustainability. Second, a structure literature review on business model has been conducted. A "static" view of business models and a "dynamic" perspective are each given their own section in the review. Although each of these viewpoints has its flaws, they both offer significant contributions to the literature. Business model definitions and the components that make it up are often covered in more detail in the "static" studies. Since these were the earliest studies on business model research to appear, they are also significant historically. These studies, however, do not use research methodologies that capture the dynamism of business models, and as a result, they are unable to explain how they change. However, "dynamic" studies shed some light on how business models evolve over time. In increasingly fast-moving environments that are characterized by high technological and market uncertainty, business model changes are more likely to occur. Choosing the right business model configuration or design, and managing its adaptations overtime, has a critical impact on technology-based startups performance.

3. Conceptual Framework

The aim of conceptual framework is to capture the dynamics of business model into a comprehensive framework. Such framework should represent criteria as explained by Khodaei and Ortt (2019) including completeness, interrelationships, and changes over time. Meslin (2019), developed a business model dynamics framework for renewable energy cases, following criteria by Khodaei and Ortt (2019). The framework consists of three main categories: Value Proposition, Value Network, and Cost and Revenue stream, which combined several elements from the literature into the conceptual model. The framework followed the criterion of completeness by capturing environmental factors that influence business model elements. The factors are classified into external, internal, and thereat or opportunity. The second criterion was to look at the interrelationships among business model components by studying literature related to renewable energy sectors and looking at examples that explain how each element affect another one. These interrelationships are classified into forced changes or strategic choice. These classifications reflect the freedom the entrepreneur has when making a change to the business model elements. Then, Meslin (2019) looked at the sequence of changes by capturing the primary and secondary changes.

In a later study, Kamp et al. (2021) developed a framework based on Meslin (2019) by further proposing six considerations to develop such a framework. These considerations are exemplified in Figure 3.1. Recently, a new framework is developed by Xu (2022) which proposed sustainable business model dynamics. In figure3.1, an external origin, forced change in Value Proposition (VP) leads to a secondary, forced change in Value Network (VN).

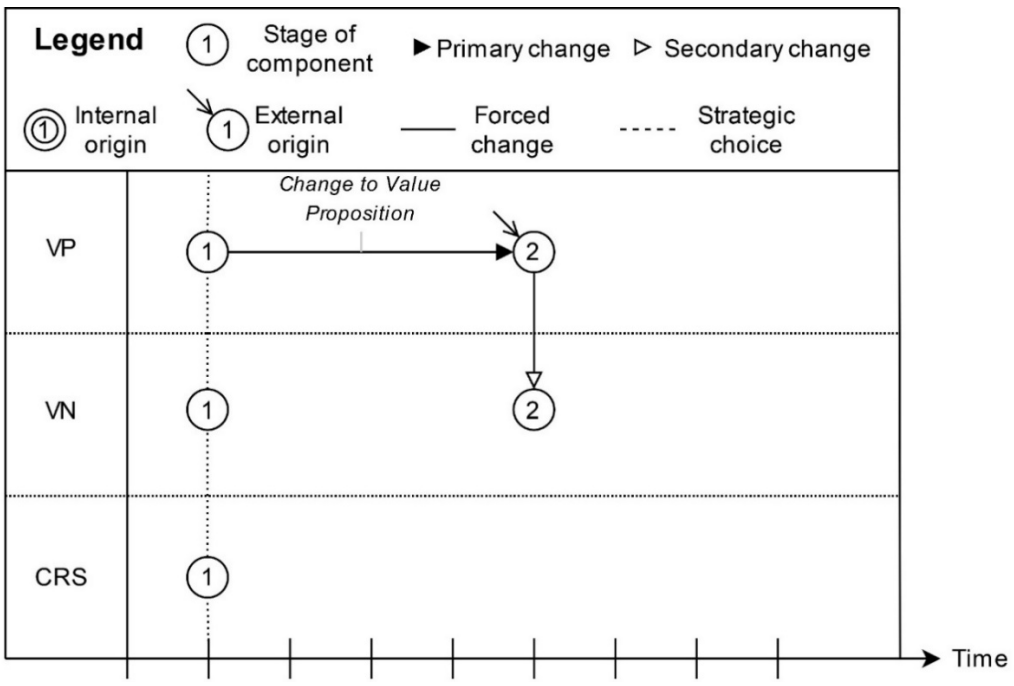

Figure 3.1 Business Model Dynamics Framework (Kamp et al., 2021)

Based on the previous work of Meslin (2019), Kamp et al. (2021), and Xu (2022), a new dynamic business model framework that combined sustainable aspects is presented. The framework is developed by using a sustainable business model canvas (SBMC) by Brcken et al. (2018). Four main categories are presented: Value Proposition (VP), Value Creation (VCR), Value Capture (VCA), and Value Delivery (VD). The framework must represent the six considerations (Kamp et al., 2021). These considerations are updated as follows for the new proposed framework as follows:

- The business model is subdivided into four main components: the value proposition, the value creation value delivery and value capture, of sustainable business model.
- The origin of change can lie inside or outside the company.
- The initial change in the business model refers to one particular business model element.
- Business model consistency mostly requires follow-up changes in one or more other business model elements.
- The initial changes are called primary changes and the possible follow-up changes are Business model changes can be either forced changes or strategic choices.
- The timeline of the growth stages of the start-ups
- The growth stages are included in the framework
- Critical junctures are identified in the framework

As stated above, the criteria to develop a framework will be detailed in the next sections.

3.1 Completeness

There is an optimal level of completeness since a business model is a feasible simplification (Khodaei & Ortt, 2019). Hence, the business model components must represent the entrepreneur's internal and external environment, and the interrelationships between the elements that must be less complicated (Khodaei & Ortt, 2019). The external and internal factors that could affect business model components in technology-based startups are identified and categorized in table 3.2. However, the components of business model have been grouped into four categories in order to keep a simple representation of the main categories. The business model canvas presented by (Osterwalder & Pigneur, 2010) will be modified and the components will be organized into four primary categories based on the framework proposed by (Bocken et al., 2018). This framework is building on Richardson (2008) who argued that his framework “reflect the logic of strategic thinking about value” (Richardson, 2008).

According to Bocken et al. (2018), a business model consists of four components: value proposition, value creation, value delivery, and value capture (Figure 3.2). Value proposition refers to the product or service that is provided to generate economic benefits, as well as mitigating depletion in

the environment and society. Value creation is argued to be the foundation of a business model, in which it most often includes key activities, resources and capabilities, and key stakeholders. Value capture is concerned with the cost structure and revenue streams benefits that a company gets from customers, as well as the value that is acquired by suppliers. Finally, value delivery refers to the value delivered to customers and consists of distribution channels, customer segments and customer relationships.

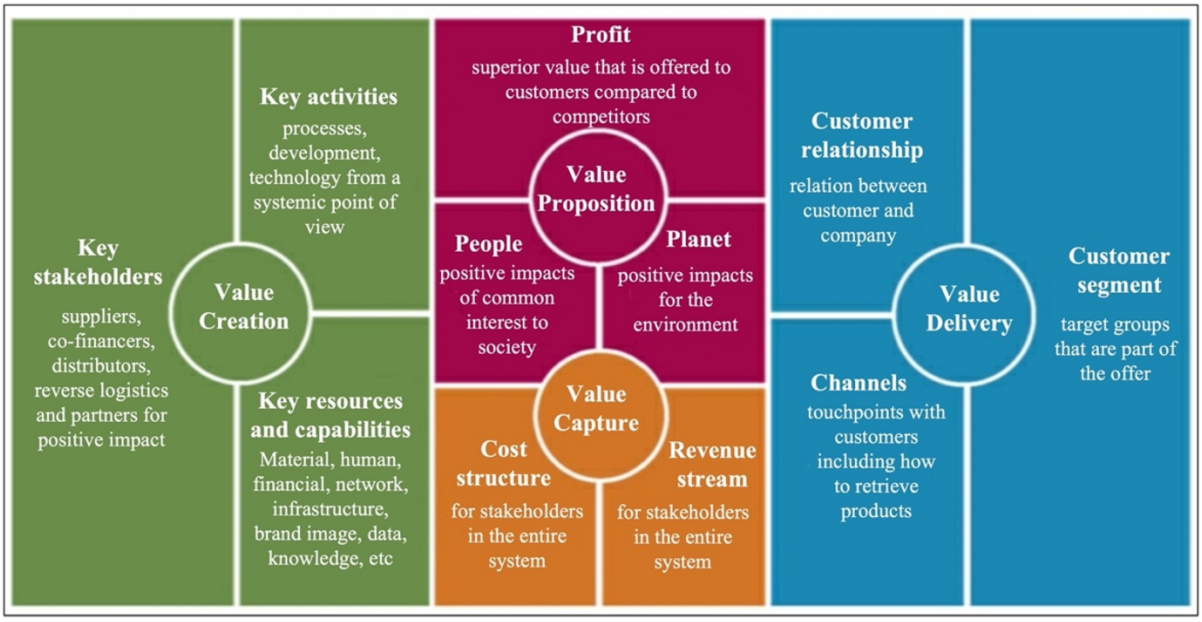

Figure 3.2 Sustainable Business Model Canvas (Bocken et al., 2018)

To achieve completeness, the sustainable business model canvas must entail all business model elements to a business. Metelskaia et al. (2018) present examples of startups seeking AI solutions, and Gabriel and Kirkwood (2016) provide examples of renewable energy startups. These examples are depicted in the table 3.1.

Elements	Sub-components	Example
VP	Value proposition	• Technology & system design (Gabriel & Kirkwood, 2016). • Optimization, customization, automation, cost reduction (Metelskaia et al., 2018).
VCR	Key Activities	• System integration, project development (Gabriel & Kirkwood, 2016). • R&D, Engineering, Software development ((Metelskaia et al., 2018).
VCR	Key Stakeholders	• Networks (Gabriel & Kirkwood, 2016).

		• Investors, University & Research institutions, Developers (Metelskaia et al., 2018).
VCR	Key Resources	• Financial investors, staff (Gabriel & Kirkwood, 2016). • Human Resources, Product/Technology, Intellectual Property (Metelskaia et al., 2018).
VD	Customer Segments	• End users, governments, commercial entities (Gabriel & Kirkwood, 2016). • Business customers, end users, government (Metelskaia et al., 2018).
VD	Customer Relationships	• Direct and indirect relationship with customers, Varied advertising: word to mouth, company website (Gabriel & Kirkwood, 2016). • Customized service, personal assistance (Metelskaia et al., 2018).
VD	Channels	• Direct sales to end-users (Gabriel & Kirkwood, 2016). • Websites, social networks, distributors (Metelskaia et al., 2018).
VCA	Revenue streams	• Product and system sales, advice/knowledge transfer (Gabriel & Kirkwood, 2016). • Startup investment, Subscription fee (Metelskaia et al., 2018).
VCA	Cost structure	• Overheads/ operating expenses, hiring and retaining human capital (Gabriel & Kirkwood, 2016). • Human resources, R&D, product development hardware and software costs (Metelskaia et al., 2018).

Table 3.1 Business Model Elements for Technology-Based Startups

Completeness also looks at internal and external factors influencing the business model components (Khodaei & Ortt, 2019). The internal factors that occur within the company itself and depend on its dynamic capabilities to, for example, develop something new or expand new sales regions (Teece, 2018). Zott and Amit (2013) underline the need of adopting a more systemic approach in order to understand the interdependencies between a firm's business model and the surrounding business ecosystem. Indeed, the business model connects the company to its external business environment, consumers, competitors, and society (Teece, 2010). The relationship between the business model and its business context is dynamic, and as a result, business models require constant evaluation and subsequent change to remain competitive (Ahokangas & Myllykoski, 2014). According to Zott and

Amit (2013), in rapidly changing environments, a firm's performance appears to be heavily reliant on the fit between its business model and the surrounding business ecosystem. In the table below (3.2) some factors that influence business model components.

Effect	Factors
External drivers	• **Market Forces** Chesbrough (2010), De Reuver et al. (2009), Pucihar et al. (2019), Hamwia & Lizarralde (2017) • **Technology forces** Chesbrough (2010), De Reuver et al. (2009), Johnson et al. (2008) • **Customer Preferences** Chesbrough (2010), Johnson et al. (2008), Hamwia & Lizarralde, (2017) • **Regulation** Chesbrough (2010), De Reuver et al. (2009) • **Supportive Financial System** Hamwia & Lizarralde, (2017) • **Social Acceptance** Stigka et al. (2014) • **Environment (social or environmental sustainability factors)** Giesen et al. (2010)
External Barriers	• **Volatile Environment** Saebi (2015) • **Constraining Financial System** Hamwia & Lizarralde (2017) • **Regulation** Karakaya et al. (2016), Leisen et al. (2019) • **Competition** Horváth & Szabó (2018), Saebi (2015) • **Social Acceptance** Stigka et al. (2014)
Internal Drivers	• **Product/service innovation** Giesen et al. (2010) • **Decision-Making responsibility** Chesbrough (2010) • **Role of individual (Entrepreneur)** Cavalcante et al. (2011) • **Resource availability (financial resources, skills& capabilities)** Giesen et al. (2010)
Internal Barriers	• **Production Issues** Horváth & Szabó (2018) • **Decision Bias** Teece (2007) • **Lack of resource availability** Giesen et al. (2010)

Table 3.2 External and Internal Factors Affecting Business Model Elements

3.2 Interrelationships of Business Model Components

Effective business model innovations have to utilize their core capabilities and maintain design consistency both internally and externally (Giesen et al., 2010; Teece, 2010). Demil and Lecocq (2010) examine the interconnections between the business model components using the RCOV (Resources,

Competences, Organization, Value) framework, which was influenced by a Penrosian perspective of the firm. When modifying the BM, they emphasize the need for dynamic consistency in preserving firm performance. However, due to the high complexity of applying relationships to the business model components, the interrelationships between the four components: Value Proposition, Value Capture, Value Creation, and Value Delivery, as proposed by (Bocken et al.,2018) will be used in this study. Therefore, in order to build a conceptual framework, the interrelationships between these four elements must be addressed to understand the dynamics of the components. The interaction between the main component means the change in one component would have an effect or a change in another component to remain dynamic consistency.

Additionally, based on (Kamp et al., 2021) framework, four types of relationships have been identified based on the reason for the change. In this case, the change could be:

- Forced Change labeled as "F": These kinds of changes are unintended and may result from either the environment, but also may be caused by unplanned decisions or by the dynamics of how the business model functions (Demil & Lecocq, 2010).
- Strategic Choice labeled as "C": is the result of the decisions regarding one or more components (Demil & Lecocq, 2010).

The initial change could be a forced change followed by a forced secondary change. This type of relationship is labeled as "FF". A relationship of type "FC" implies that the initial change is forced one, while the second change is a choice decision. If the primary change occurs due to a strategic decision and the second change is also strategic, the relationship will be "CC". Finally, a relationship of type "CF" means that the primary change is a strategic decision while the second change is a forced one.

Type of relationships	**Statement**
CC	The primary strategic change leads to a secondary strategic change
CF	The primary strategic change leads to a secondary forced change
FF	The primary forced change leads to a secondary forced change
FC	The primary forced change leads to a secondary strategic change

Table 3.3 Types of Relationships

Table 3.4 provides some examples of the relationships between business model components. Some of these examples have been found in the literature, and some are adopted from Kamp et al. (2021) and Meslin (2019).

Relationships	Examples	Type
VP		
VP ⟶ VCR	A study of the storage energy market shows that key partners have a major change for small-scale energy storage applications as new partnerships arise, while key resources have changed for all cases (Hamelink & Opdenakker, 2019)	FF
	"Changing the value proposition to adopt more sustainability will lead to developing, enabling, and leveraging certain capabilities within the firm that would eventually lead to improving the firm performance" (Ilyasa & Osiyevskyy, 2021).	FF / CF
	"A change in value proposition towards adopting more sustainability in the form of the introduction of new products for disadvantaged communities might require firms to adapt to the supply chain, production, and distribution channels simultaneously" (Ilyasa & Osiyevskyy, 2021).	CC/CF/FF
VP ⟶ VD	"A sustainable value proposition increases customer willingness to pay and also differentiates the products and services to attract customers" (Ilyasa & Osiyevskyy, 2021).	FF
	Firms explore new and underserved markets such as marginalized communities that offer new opportunities to introduce innovative and sustainable value propositions (Ilyasa & Osiyevskyy, 2021).	CF/CC
	"The Dutch green energy provider Greenchoice developed a program to offer customers a fixed electricity price for the next twenty years through the installation of a PV system" (Richter, 2013)	CC
VP ⟶ VCA	"A sustainable value proposition enhances the financial success of a firm by offering new value product-service systems such as house-, car-, or bike-sharing" (Ilyasa & Osiyevskyy, 2021).	CF/FF
	Technology advancements that allowed wind turbine manufacturers to considerably expand wind tower heights and blade lengths are primarily responsible for cost reductions for wind turbines (Glenk et al., 2021)	CF
VCR		

VCR ⟶ VP	Networks and partnerships lead to a change in the value proposition towards more sustainability (Rossignoli & Lionzo, 2018)	CC/ CF/FC/FF
	Other cases provide insights into how the entrepreneurs' value capture function goes beyond profit by consciously considering waste reduction and community development or the integration of fair resources into the value creation (Gregori & Holzmann, 2020)	CF
VCR ⟶ VCA	Applying AI technologies accelerate innovation and development of new solutions that render a new revenue stream (Åström et al., 2022).	FF
	Software startups reported that the joint involvement of experienced freelancers in the startup activities led to reduce development costs (Gupta et al., 2020).	CF
VCR ⟶ VD	Software startups reported that the joint involvement of experienced freelancers in the startup activities enhanced customer relationships and customer satisfaction and helped the startups to grow faster in the market (Gupta et al., 2020).	CF
	Smart grid deployment will impact customers-suppliers relationship, by giving customers more bargaining power over suppliers (Shomalia & Pinkse, 2016)	CF/FF
VD		
VD ⟶ VP	Customers collaboration with companies that use digital technology to communicate with customers allowed them to develop customized solutions (Chen et al., 2021).	CC/CF
	The role of consumers in value network would be strong if they are a co-provider of electricity that use, for example, distributed energy, such as solar panel and could change the firm value proposition. (Shomalia & Pinkse, 2016)	CF/FF
VD ⟶ VCA	Customers are less inclined to pay extra costs for sustainable products or services (Matzembacher et al., 2020).	FF
VD ⟶ VCR	Customers' participation in supplying data about their consumption and storage capacity will support machine learning and data analysis for smart grids (Mostafa et al., 2022)	CF
VCA		

VCA ⟶ VP	Decreasing revenues can be tackled by different strategies, such as introducing innovations (Karakaya et al., 2016)	FC
	A distinct value proposition for various customer segments will result from various cost and revenue distributions inside the company and among end users (Kulatilaka et al., 2014)	CF
VCA ⟶ VCR	Lower cost will increase the participations of private investment in public-private partnerships projects in renewable energies (Fleta-Asín & Muñoz, 2021)	FF
VCA ⟶ VD	The increased revenue will allow for increased the value of the service (Brogan et al., 2020)	CC/FC
	Long-term customer attraction may be achieved by rewarding loyal customers with a particular incentive or by developing trustful relationships (Chen et al., 2020)	CF

Table 3.4 Relationships Between Business Model Elements

3.3 Changes Over Time

Consistency looks at the sequences of changes, primary and secondary changes that occur in the business model components (Khodaei & Ortt, 2019). When one element of the business model tends to change, it leads to a change in one or more elements to achieve consistency (Kranich & Wald, 2017). For example, a change in value creation could influence the change in value capture by changing the revenue streams or cost structure (Kranich & Wald, 2017).

Figure 3.3 shows how the dynamic framework works when a change in one component leads to a change in another one. Based on the new framework, there are four components: Value Proposition (VP), Value Creation (VCR), Value Delivery (VD), and Value Capture (VCA). The numbers represent the growth stages of technology-based startups: Research (1); Opportunity framing (2); pre-organization (3); Reorientation (4); and Sustainable returns (5). These critical junctures that influence the startup growth are identified between every two stages, and on the same timeline as growth stages to show when and how these changes affected the critical junctures. The framework identifies these junctures as (J1) opportunity recognition, (J2) entrepreneurial commitment, (J3) credibility, and (J4) sustainability. The proposed framework shows the internal and external origin changes that trigger the comping to do an initial or primary change in one component and it can cause a secondary change in one or more components. These changes could be forced or strategic choice. For example, figure 3.3 shows that an external trigger induce a forced change in value proposition (VP), and a follow-up change in value creation (VCR). Another example of an internal trigger influencing value capture (VCA).

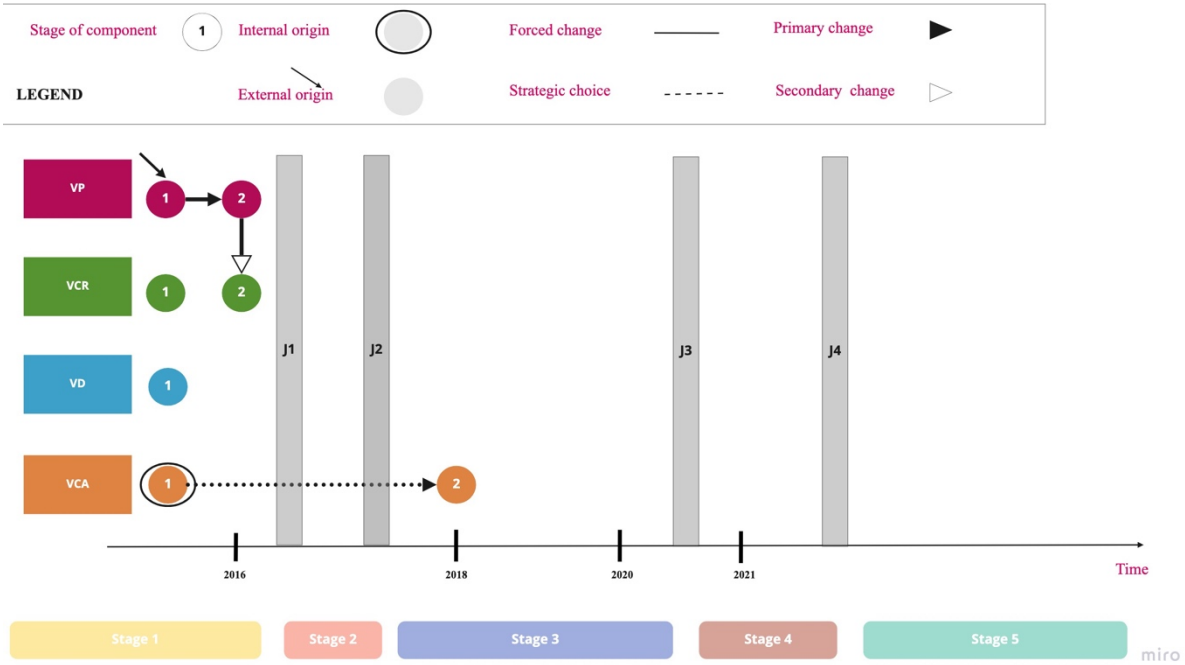

Figure 3.3 Proposed Business Model Dynamics Framework to Overcome Critical Junctures

4. Methodology

The aim of this chapter is to describe and justify the research methodology adopted to explore business model change in technology-based startups, and to investigate the relationships of critical junctures and business model components. This chapter details the research setting chosen for this thesis, followed by the rational for the case selection, the data collection process of the interviews and main case studies. The last sub-research question is addressed in this chapter and the following chapters.: *How can we develop a dynamic business model framework to capture business model dynamics and to foster the development process of technology-based startups?*

Technology-based startups in the Netherlands were used as the research setting to control for policy and practice relating to startup activities. The startups are a suitable environment for studying business model change because they combine uncertainty, time constraints, and drive (Gersick, 1994). Due to the lack of commercial knowledge on their original founding teams (Costa et al., 2004), earlier decisions often need to be corrected (Conceição et al., 2012). Therefore, this environment is appealing for the goals of this study. A common question when dealing with multiple-case design has to do with the number of cases considered necessary or sufficient for the study. The technology-based startups had to follow specific criteria, which limited their availability. They had to be: 1) originated fin the Netherlands, 2) in the early stage of development, 3) willing to participate in the study, and 4) able to provide access to rich data.

4.1 Data Collection

According to Yin (2009), there are six types of sources that could be used while gathering evidence for exploratory case studies: documents, archival records, interviews, direct observation, participant observation, and physical artifacts. The goal of collecting data is to logically explore the subject and therefore three methods of data collection used, including interviews, documents and archival records to achieve triangulation. The main steps in the data collection process are presented in the table 4.1.

Steps	**Description**
Initial investigation	Internet search and website reading
Case selection	Define criteria and select main cases accordingly Determine potential case informants.
Contact	E-mail sent to potential case informants Meeting with case informants

Documentation and archival data collecting	Extensive and thorough collection of written documents and/or other media: - Internal sources (such as business plans, presentations, and internal reports); - External sources (press articles, company websites)
Interviews	Focused on various dimensions of startup evolution, barriers, milestones, and business model elements.

Table 4.1 The Main Steps in The Data Collection Process

Table 4.2 lists the cases that were contacted and interviewed for the aim of this study. In total, twenty technology-based startups have been contacted. The response rate was too low in the beginning. Follow-up emails were sent to increase the number of cases, but due to time constraints, seven case studies responded and six cases were chosen for this study. One case was excluded because the startup is not yet in the critical juncture of credibility, which is insufficient to show the changes in the business model. The technology-based startups were selected from different sectors. However, all of them are taking variety of approaches to innovating the sustainability industry.

Startups	**Industry**	**Specific domain**	**Main informants**	**Founded**
MO4	Offshore	Data analysis and forecasting	Co-founder	2017
SolarWorks	Energy	Solar Systems	Chief Operating Officer	2007
The Ocean Cleanup	Clean Tech	Innovation solutions	Head of business development	2013
Noria Sustainable Innovators	Clean Tech	Innovation solutions	Co-founder	2016
AguroTech	Agriculture	Software and hardware solutions	Co-founder	2020
MIMIC	Manufacturing	Innovative product design	Co-founder Currently: Product Engineering Lead at Mimic	2018

Table 4.2 List of Cases

As a point of departure, archival data from internal resources, such as business plans, websites, presentation, and from external resources such as media articles were collected and studied. The respondents were informed by emails about the purpose of the research, the objective, and the main research question. Some requested a brief of the type of the questions in advance. The main case study consisted of six semi-structured interviews.

Typically, the co-founders served as the primary sources of information. Still, the chief operating officer (CEO) of SolarWorks and the head of business development for the Ocean Cleanup were the participants in the interviews. The interview process started on June 1st, 2022 and ended on June 24th, 2022. The interviewees were asked for their permission ahead of the interview, and during the interview, to record and use the data collected to develop sustainable business model frameworks. The interviews' transcriptions served as the primary source of information that allowed a deeper immersion into the data gathered. The interview duration was around 45 minutes, depending on the informant's willingness to dedicate more time and thus provide more detailed information. While conducting the interviews, I recognized that some entrepreneurs are not familiar with the concept of business model dynamics or cortical junctures. Therefore, I referred on many occasions to the changes in the business model, and the obstacles the startup faces during the development process.

4.2 Interview Guide

The interview guide has three main parts (see Table 4.3), the first part discusses the growth stages of the technology-based startups. The second part shows the theoretical critical junctures and the main causes of these barriers. Finally, business model elements, what have been changed, and when.

Question Scope		**Framework related aspects**	
Growth stages	• What process you went through from idea to sustainability? • What were your main milestones? • What junctures (barriers) you faced with and how you passed them?	• Timeline • Completeness • Growth stages • Critical junctures	
	Opportunity recognition • Lack of prior knowledge on markets and industries • Inability to think commercially	• Completeness • Timeline • Changes over time • Growth stages • Critical junctures	VP, KA, KP, KR
	Entrepreneurial commitment • Lack of entrepreneurial capabilities	• Completeness • Timeline • Changes over time	VP, KA, KP, KR

Critical junctures	• Inability to make use of network contacts to get things done	• Growth stages • Critical junctures	
	Credibility • Inability to attract finance from investors • Inability to form a well-balanced managerial and scientific team • Inability to provide sufficient long-term options for commercialization	• Completeness • Timeline • Changes over time • Growth stages • Critical junctures	VP, VCR, VD, VCA
	Sustainability • Inability to establish a stable position in product/market segments • Inability to make strategic decisions under pervasive uncertainty	• Completeness • Timeline • Changes over time • Growth stages • Critical junctures	VP, VCR, VD, VCA
Value Proposition	• What value/benefits do you offer to each type of customers? • Did it change? What changed? When? How? Why? Who inspired your decision?	• Completeness • Changes over time • Interrelationships • Timeline • Critical junctures	VP, VCR, VCA, VD
	• How do you keep track of changes in customer preferences/needs? How do you adapt to those changes?	• Changes over time • Critical junctures • Growth stages	
Value Creation	• Who are the most important partners in your business network? • What are the most important resources to make your business model work? • What are the most important activities that your company does?	• Completeness • Interrelationships • Critical junctures • Growth stages	KP, KR, KA
	• Did they change? What changed? When? How? Why? Who inspired your decision?	• Completeness • Changes over time • Interrelationships • Timeline • Critical junctures • Growth stages	VP, VCR, VCA, VD
Value Delivery	• Who are your customers?	• Completeness	CS, CR

	• Through which channels are you communicating, selling and distributing your products/services to your customer segments? • How do your current distribution channels increase customer value? Are there possibilities of improvements for example from customer feedback	• Completeness • Critical junctures • Growth stages • Interrelationships • Timeline	CS, CR, CH
	• Did they change? What changed? When? How? Why? Who inspired your decision?	• Completeness • Changes over time • Timeline • Interrelationships • Critical junctures • Growth stages	VP, VCR, VCA, VD
Value Capture	• What and how is each of your customer segments paying for your products/services? • What are the most important costs in your business? • What are your sources of funding?	• Completeness • Timeline • Critical junctures • Growth stages	VD, VCA, VP, VCR
	• Did it change? What changed? When? How? Why? Who inspired your decision?	• Completeness • Changes over time • Timeline • Interrelationships • Critical junctures • Growth stages	VD, VCA, VP, VCR

Table 4.3 Interview Questions

5. Case Studies

Different startups have been contacted to do a semi-structured interview. The selection of the startups was based on their maturity and whether they are as close as possible to the sustainable returns phase. However, due to time limitation and the response rate of the companies that have been reached, six startups were interviewed and five of them are almost between reorientation and sustainable returns phases, while one of them is still in preorganization phase.

MO4

MO4 startup is a service that measures and visualizes the performance of offshore operations. The company was founded in February **2018** and the main goal was to provide accurate forecasting and maintain cost reductions. The initial idea started when the Founder Mark Paalvast, who studied marine engineering at TU Delft, was working as a consultant and writing reports for clients that would do offshore installation work. Companies plan their offshore activities based on medium-term wave and wind forecasts (7-8 days). The reports were about 100 pages, full of engineering language simulations. The crew must make sure that they can do operations in wave heights up to two meters. However, this method is too simple and offers little information, and a company incorporates a large safety margin. Mark found that digitalization and smart use of data can give more accurate forecasting. He started working on the first algorithm using MATLAB software.

In **2017**, Mark wrote the first successful algorithm. Because of customer demands, he changed the value proposition offered by other companies to a new service offering that helps them to work efficiently **VP 1>2**. The new idea drew the attention of other engineers, who tested the algorithm and provided comments.

> *"I was stuck in the technology bubble, and I thought that I understood everything."* **(MO4, Co-founder)**

The co-founder still lacks market knowledge and marketing skills to access the market, but the idea attracted another co-founder with knowledge of technology business, they collaborated with clients to develop the technology further and to understand the market and they were able to write a business plan and test the prototype in late **2017. VCR 1>2.** The critical juncture of opportunity recognition is recognized by acquiring the required knowledge about the market.

The first prototype was not scalable software, but rather one that suited tailored needs. The new technology may be used to attract investors and customers by developing and creating networks.

"We were not building a scalable software, but one that would suit very tailored needs, that was a lack of entrepreneurial capabilities." **(MO4, Co-founder)**

Therefore, they needed an accelerator that can connect them to the industry network to attract investors and customers. In **2018**, they contacted Buccaneer in Delft which functions as a mediator and catalyst and has an extensive industry network **VCR 2>3.** This opened a channel to connect with companies and clients in the offshore sector **VD 1>2**. The founders used the conferences to talk about their new software for potential customers and according to the interviewee:

"The conferences are important channels we use to connect with clients because then we can explain the benefits from a technical point of view." **(MO4, Co-founder)**

The team was able to tackle the critical juncture of entrepreneurial commitment by connecting with the industry network through Buccaneer and using conferences to communicate with customers and investors.

MO4 lacked financial and human resources, and they were critical in finding an investor who has a background as an entrepreneur and can connect MO4 with several companies. In **2019,** MO4 received the Offshore Wind Innovation Award 2019 (Ocean Energy Resources, 2019). The jury looked at the innovativeness, financial and commercial feasibility of the software, and the startup was able to attract an investor and recruit developer **VCR 3>4** who assisted the startup in achieving technological advancements by making it more commercially viable **VP 2>3.** However, selling high-tech products requires proper training for employees who are going to work in the startup and that was a barrier because it takes time and effort.

"The biggest barrier, in the beginning, was training and explaining to customers how to utilize the innovation. Working with the client in the first year required an effort to appreciate the product and use it to its maximum capacity while making user experiences as smooth as possible." **(MO4, Co-founder)**

Therefore, MO4 hired a sales manager **VCR 4>5** who helped in the commercialization area and relationships with customers **VD 2>3**. Accordingly, there was a lobbying effort between MO4 and Equinor, an oil company that wants to build a wind farm and there was a lot of technical discussion between the two parties. The startup was able to sell its first software service in **2019**.

"The pitfall of a technology developed only by technical people is that they only focus on the technical aspects and fail to understand the business implications. Therefore, we wanted to hire

a more balanced team and have a commercial manager who can help us be more commercial." **(MO4, Co-founder)**

In late **2019**, there was much uncertainty in the market and a lack of financial resources due to the global pandemic, therefore the startup got government aid and carried out joint industrial projects with Equinor, Subsea 7, and other companies **VCA 1>2.** In the offshore sector, there are many rules and guidelines for big companies that are, for example, building wind farms.

"When we operate in the offshore industry, the activities must meet specified criteria based on the marine warranty affair". **(MO4, Co-founder)**

To understand these rules and guidelines in the offshore sector, MO4 joined a consortium in **2020** to do a joint project that aims to improve the efficiency of offshore wind farm installation and maintenance vessels **VCR 5>6**. The Offshore Operational Advisory System OOAS is a joint industry project that includes MO4 and many other companies (Acta Marine, 2020). The project runs from 2020 until the end of 2022. MO4 was able to define its resources, attract investors and carry out joint industrial projects. Human resources and a well-balanced team also helped the startup to pass the critical juncture of credibility.

MO4 developed the solutions to establish more customers and it was able to introduce its solutions on its website **VD 3>4** when technological advancements enabled it to reach a wider range of consumers. The startup offered a subscription option **VCA 2>3** and at the time it had two types of customers: vessel owners and charter customers. The value MO4 offers to clients varies. So those who charter the vessel may utilize it more efficiently because they may not require it for 20 days but only 18 days. As a result, they can develop their wind farms faster and safer. The vessel owner who has a contract has a superior risk assessment for what they do. They are less likely to run out of contract, and they work in a more objective manner, which greatly aids communication.

BMO utilizes a fundamental comprehension of maritime operations as the creators of the CTV transfer score system and the Argus SOV operations analytics platform to transform data into useful insights (Know-how- MO4, n.d.). In **2021**, MO4 wanted to understand the realized performance of vessels to provide a full picture for clients. Therefore, MO4 takes over BMO (Know-how- MO4, n.d.) **VCR 6>7.** BMO developed the CTV transfer score system and the Argus SOV operations analytics platform to transform data into useful insights. This acquisition empowered MO4 to be more recognized in the market and use web-based technology that helped to enhance the user interface and experience. MO4 was able to advance its technology further by offering four types of services: MO4 Diagnostics,

MO4 Forecasting, MO4 Analytic, and MO4 Pro **VP 3>4**. The startup has a stable return and regular clients and 80% of the revenues are from selling services.

> "*We found it very difficult to grow organically and make strategic decisions, we were struggling to allocate our resources to quick pitches*". **(MO4, Co-founder)**

In Mar **2021,** MO4 teams up with Damen (Know-how- MO4, n.d.), to harvest the operational data via Damen Triton to feed MO4's analysis **VCR 7>8.** In May **2022**, MO4 secured a 10-year contract with North Star for its new propriety digital twin and artificial intelligence (AI) decision support software package (Know-how- MO4, n.d.) **VCA 3>4.** North Star wants to optimize its service and deliver sustainable solutions. To scaleup, MO4 has now two agents in China and India, and attended International Maritime Contractor Association Conference to extend its networks and channels **VCR 8>9.** MO4 was able to achieve the sustainable returns stage by partnering with high-tech companies to advance the technology and provide new offerings.

Origin	**Cause**	**Primary Change**	**Follow-up effects**	**Critical Juncture**	**Factor related**
Customer Preferences	Writing a new algorithm using MATLAB software that can give an accurate forecasting	**VP 1→2** New method based on smart use of data	**VCR 1→2** The co-founders were able to write the business plan	Opportunity Recognition	Lack of market knowledge and marketing skills to access the market
Resource availability	The startup approached Buccaneer to connect to industry network	**VCR 2→3** Buccaneer functions as a mediator and catalyst.	**VD 1→2** Conferences to communicate with investors and customers	Entrepreneurial Commitment	Lack of entrepreneurial capabilities and industry network
Technology forces	The jury of Offshore Wind Innovation Award 2019 looked at innovativeness, financial and commercial	**VCR 3→4** New investor and developer joined the startup	**VP 2→3** The technology became commercially viable.	Credibility	Lack of the financial and human resources

	feasibility of the new technology				
Employees capabilities	A new sales manager assisted the startup in the commercialization area	**VCR 4 → 5** Lobbying effort between MO4 and Equinor	**VD 2 → 3** Enhance relationships with customers and sell the first product	Credibility	Approaching skilled employees
Global pandemic	The startup received government aid to cope with the financial crisis.	**VCA 1 → 2** Government aid and joint industrial projects with Equinor, Subsea 7, and other companies	-	Credibility	Lack of financial resources and market uncertainty due to the global pandemic
Efficiency opportunity	A new joint project OOAS to improve the efficiency of offshore wind farm installation and maintenance vessels	**VCR 5 → 6** New activities to deliver a system which gives planning advice in several stages of operation	-	Credibility	Understanding rules and guidelines in the offshore industry
Technology development	Develop solutions for two customer segments	**VD 3 → 4** Selling the products through the website to two customer segments	**VCA 2 → 3** Subscription fees	Sustainability	Achieving a product-market fit and establishing customers

Efficiency opportunity	Use the data of the realized performance of the vessels through the BMO technology	**VCR 6 → 7** MO4 acquire BMO	**VP 3 → 4** Developing new four offerings	Sustainability	Become a one-stop-shop requires access to data and technology available in another startup
Efficiency opportunity	Utilize Damen Triton platform to gather operational data that will feed MO4's analysis.	**VCR 7 → 8** Strategic alliances with Damen	-	Sustainability	Technology advancement relies on technologies owned by high-tech startups
Scaleup	10 years contract with North Star	**VCA 3 → 4** New investment to optimize the services.	-	Sustainability	Increase the firm overseas activities
Scaleup	New agents in China and India	**VCR 8 → 9** New partners for expansion	-	Sustainability	Challenges to find overseas markets

Table 5.1 Causes and Effects of Changes to MO4 Business Model

Growth Stages & Critical Junctures:

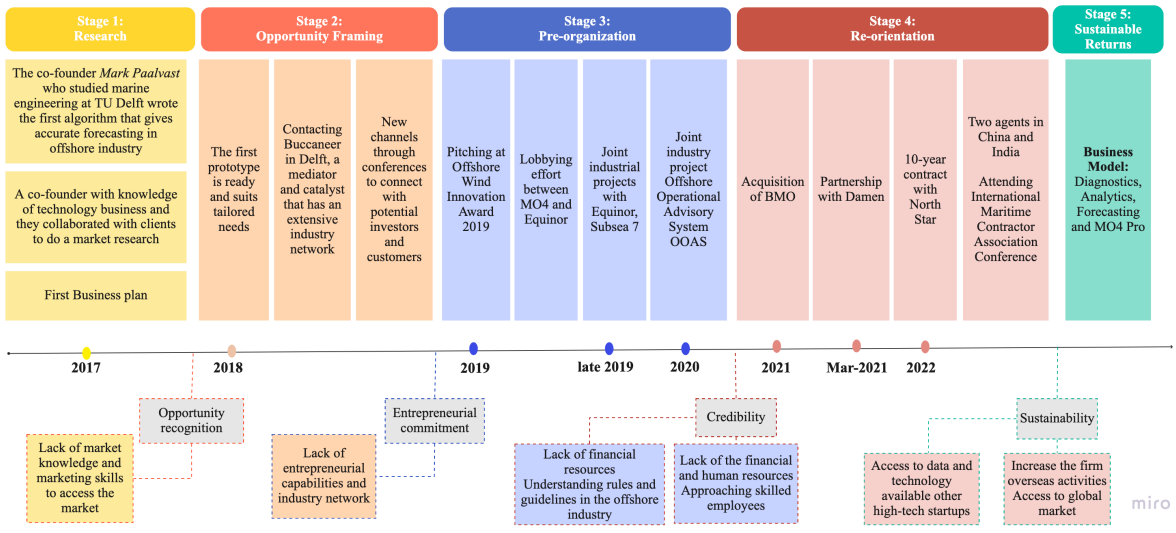

Figure 5.1 Growth Stages & Critical Junctures MO4

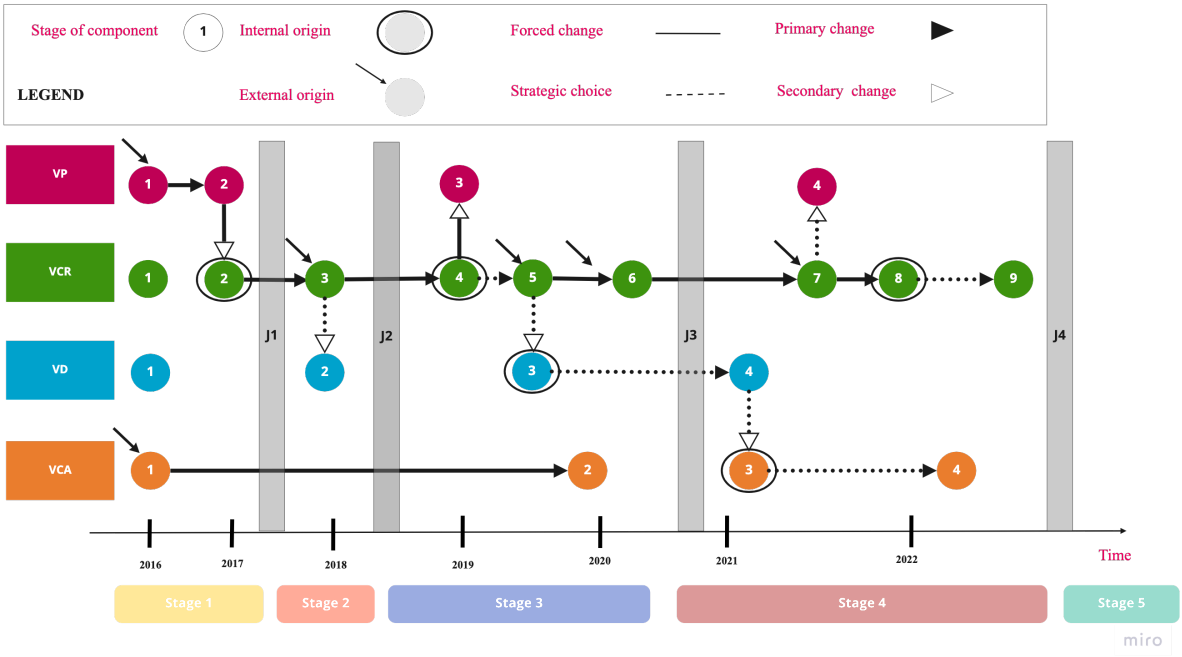

Figure 5.2 Framework Representation of Changes to MO4 Business Model

SolarWorks

Since starting its operations in Southern Africa in 2009, SolarWorks has grown into a market leader in the off-grid solar sector, offering smaller products through distributors and large-scale energy services in Mozambique and Malawi. The initial idea started by *Bernard Hulshof* who studied industrial design engineering at TU Delft. In **2007**, *Bernard* was looking for a graduation project and traveled to Madagascar for a half-year field study to design a prototype of the solar system, basically by asking people what they need in the product. The design of a small lamp that ran on a solar panel resulted from field research **VP 1>2**. The prototype was simple and not commercially viable. However, *Bernard* met *Arnoud de Vroomen* who spent a year in documenting innovations and entrepreneurship in Africa. Arnoud came from a commercial position at several companies, including Unilever, and identified a market potential to establish a business. The team was able to pass the first critical juncture of opportunity recognition and think commercially by acquiring entrepreneurial skills, establishing relationships with locals to understand their needs.

The founders used their own financial resources to start the business. The challenge was to find a market application for their technology and design a durable, reliable, and affordable product. Therefore, they met locals asking what features that are most important to them and their budget range. The team was able to design an innovative power box that can power lights and charge phones **VP 2>3**. They were also able to connect wholesalers and retailers in southern Africa before starting production in late **2008. VD 1>2.** The critical juncture of entrepreneurial commitment is passed by finding a market application for their new idea.

"Finding commercial investors has always been a struggle. They are often unfamiliar with our market and sort of products; thus, they are generally quite reluctant to invest in our type of business." **(SolarWorks, Chief Operating Officer)**

SolarWorks was founded in **2009** when the team set up a sale office in Johannesburg. There was a lack of capital and resources, therefore the startup formed a strategic cooperation with Lemnis Lighting Launch in South Africa in **2010 VCR 1>2.** The R&D and head office moved to Yes!Delft in **2011.** It was necessary to assure technological advancement to achieve market credibility and attract financing. The Delft university assisted the startup to address matters of energy use and battery size, they worked together with PhD Nishant Narayan and prof. Nick van de Giesen. To be able to better predict the available battery capacity based on solar irradiation forecasts, SolarWorks installed several weather stations in Mozambique (TU Delft, n.d.). **VCR 2>3.** In **2013** the startup received debt investment for working capital **VCA 1>2** and there were three products **VP 3>4** covering three consumer segments were on the market in seven countries **VD 2>3.** In **2014** the funds came from equity finance for investment and additional working capital. SolarWorks was able to raise funds and offer products in the market by utilizing its resources and make its own identity.

"*I suppose that money is always a major obstacle. If we were still engaged in product development, it would be difficult to acquire sufficient funding for investments".* **(SolarWorks, Chief Operating Officer)**

In **2015**, SolarWorks wanted to change its business model to more innovative one. There was an increased market competition and the startup approached Persistent, Africa's Climate Venture Builder, seeking assistance to evolve into a Pay-As-You-Go company. By utilizing a Pay-As-You-Go payment platform that is integrated with mobile money providers, systems for homes are made more affordable **VCR 3>4**.

"The legal frameworks are nonexistent, and in a country like Mozambique, which is a massive country but poor infrastructure, it is highly expensive to transport people and goods around. As a result, there are several operational challenges on a daily basis". **(SolarWorks, Chief Operating Officer)**

The collaboration with Persistent is supported by Shell Foundation. The partners assisted SolarWorks to build a local team and launched it in Mozambique in late **2016**. As the expanding company struggled to keep up its accounting systems, Persistent offered one of its finance experts, GET.invest Finance Catalyst, to join SolarWorks and advised the firm in dealing with legal and tax

issues (GET.invest, n.d.). Catalyst, through Persistent, helped build a solid IT infrastructure. This collaboration ensured that SolarWorks had adequate capital to thrive and convinced existing shareholders to invest more capital. Small, medium, and large sized business **VD 2>3** can purchase systems based on their needs **VP 4>5** in combination with a loan from a local bank. The startup decided to switch from manufacturing its own product in favor of lower cost, and higher-quality products from third parties while retaining the unique SolarWorks design **VCA 2>3**. It also wanted to engage with end customers instead of selling through wholesalers and retailers.

> *"Because we were the first, we are the market leaders in Mozambique. Since Malawi is a country that many people frequently ignore, we have been the ones who have been active the longest. So, there are not many companies there that do what we do."* **(SolarWorks, Chief Operating Officer)**

In **2018,** SolarWorks concluded a strategic investment of $2 million from EDP Renováveis SA to boost the international expansion and increase access to sustainable energy (SolarWorks, n.d.) **VCA 3>4**. The firm expanded its business from Mozambique to Malawi and recruited over 170 employees **VCR 4>5.** In **2019,** SunFunder completed a $2 million multi-currency financing facility for SolarWorks in Mozambique with MFX Solutions (SunFunder, 2019). SunFunder solves the financing bottleneck for off-grid and weak-grid solar. To accelerate its expansion in Mozambique, SolarWorks and ElectricFI agreed to a $4 million debt arrangement in **2019. VCA 4>5.** In **2022,** US Agency for International Development (USAID) provided a grant to six Africa-focused renewable energy developers **VCA 5>6**. SolarWorks used the grant to install 3KWh photovoltaic systems **VCR 5>6** in healthcare centers in Malwai **VD 3>4.** SolarWorks was able to overcome the critical juncture of sustainability.

Origin	Cause	Primary Change	Follow-up effects	Critical Juncture	Factor related
Social needs of local community	A graduation project based on people requirements.	**VP 1→2** A small lamp that ran on a solar panel	-	Opportunity Recognition	Lack of market knowledge
Customer preferences	Design a product within customers budget that can	**VP 2→3** Design an innovative power box	**VD 1→2** Open channels to communicate with	Entrepreneurial Commitment	Market application for the new solar systems

	power lights and charge phones		wholesalers and retailers		
Supportive financial system	Access to financial resources and extend the network	**VCR 1 → 2** Strategic cooperation with Lemnis Lighting Launch	-	Credibility	Inability to attract finance
Efficiency opportunity	Address matters of energy use and battery size	**VCR 2 →3** Partnership with TU Delft to develop the technology. New R&D office at Yes!Delft		Credibility	Technological challenges
Resource availability	Access to financial resources	**VCA 1 → 2** Requesting debt to develop new products that cover three customer segments	**VP 3→4** Three products in the market **VD 2→3** New customer segments	Credibility	Received debt investment for working capital
Market competition	Change the business model	**VCR 3 →4** Collaboration with Persistent and GET.invest Finance Catalyst	**VP 4 →5** New systems with different capacity **VD 3→4** New customer segments including households and businesses **VCA 2→3** New payment methods	Sustainability	Developing a scalable business model in response to increased competition. Legal frameworks and poor infrastructure

Sustainability opportunity	Increase access to sustainable energy	**VCA 3 → 4** A strategic investment from EDP Renováveis	**VCR 4 → 5** Expanded the business and recruit employees	Sustainability	Access to capital, investment, and human resources. Developing new business areas
Scaleup	Additional funds to accelerate expansion in Mozambique,	**VCA 4 → 5** Debt investment from SunFunder and ElectricFI		Sustainability	Lack of funds to scaleup. Debt investment for working capital and increase expansion
Supportive financial system	Access to capital and investment	**VCA 5 → 6** Grant from US Agency for International Development	**VCR 5 → 6** Install 3KWh photovoltaic systems **VD 4 → 5** New customer segments including healthcare centers in Malwai	Sustainability	Increase the firm activities and developing new business areas

Table 5.2 Causes and Effects of Changes to SolarWorks Business Model

Growth Stages & Critical Junctures:

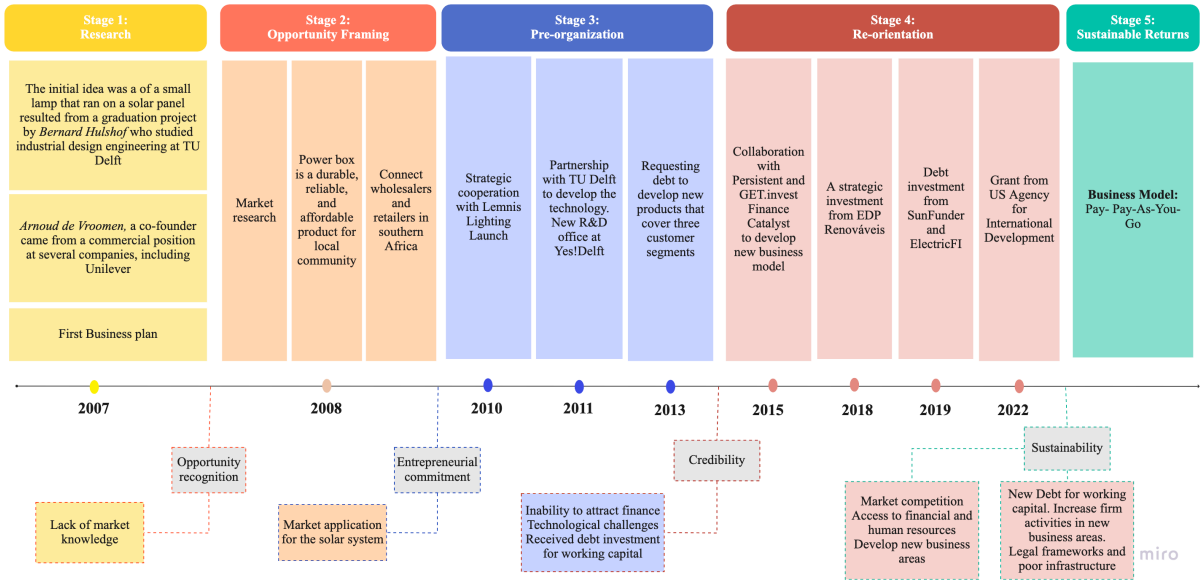

Figure 5.3 Growth Stages & Critical Junctures SolarWorks

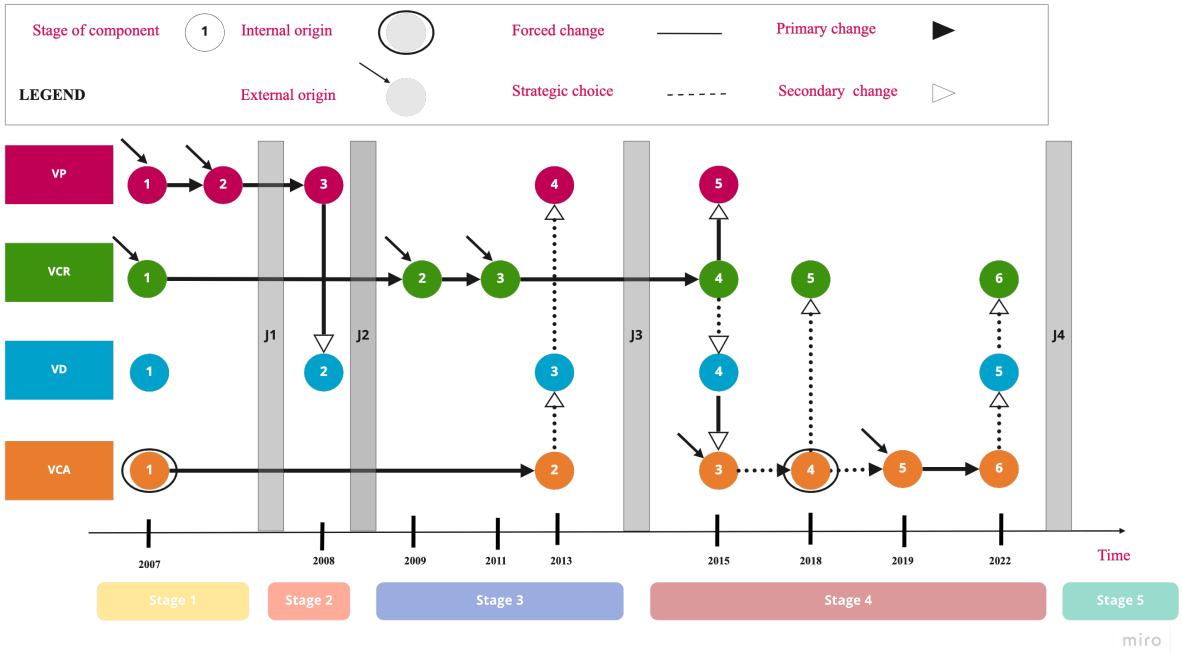

Figure 5.4 Framework Representation of Changes to SolarWorks Business Model

The Ocean Cleanup

Ocean Cleanup is a non-profit organization developing and scaling technologies to rid the oceans of plastic. Their value proposition is to clean the world's oceans from plastic using their own technology. The initial idea started when the founder Boyan Slat noticed that there is more plastic than fish when he was in Greece, and after one year of experimenting with ideas and simple tests, he came up with the idea to develop a passive concentration system. He suggested using the ocean currents to

his advantage by letting them be the driving force behind catching and concentrating the plastic **VP 1>2.** In **2012,** Boyan was invited to present his initial idea at a TEDx conference, but his idea did not gain traction. He lacked the network and funds. However, in **2013,** the video was picked up by several news sites and spread to people. This allowed Ocean Cleanup to raise $ 90.000 through crowdfunding (The Ocean Cleanup, n.d.-a) **VCA 1>2** and recruit an initial team **VCR 1>2.**

In order to remove significant quantities of plastic pollution from the main accumulation zone in the Great Pacific Garbage Patch, a voluntary team of close to 100 scientists and engineers published research in **2014** that suggested the Ocean Cleanup Array is a possible and viable method (The Ocean Cleanup, n.d.-a). The study assessed possible negative environmental effects and legal consequences and served as the basis for further engineering and research **VCR 2>3**. This allowed to bring the knowledge required to start a business. ABN AMRO's SEEDS platform was used to conduct a second crowdfunding campaign that started in **2014** and raised over $2 million in 100 days (The Ocean Cleanup, n.d.-a) **VCA 2>3**. The funds received were used to launch a number of expeditions and the engineering process, and the oceanographic data enabled the engineers to design the cleanup system. The critical juncture of opportunity recognition is passed by addressing the matters regarding the value offering and increase R&D activities that allowed to receive seed funds.

> *"We will need to identify what makes people want to work with us. Why would they want to join us, support us, and provide services to us? which we call the network effect. And based on that network effect, we can truly start scaling to solve the top 1000 polluting rivers that we have identified in the world."* **(The Ocean Cleanup, Head of business development)**

In **2015,** the Ocean Cleanup required an accommodation and entrepreneur skills. At this stage, a supervisory board structure has been introduced to oversee the activities of the management team and the team expanded to twenty members worked alongside a team of volunteers. A series of upscaling tests were performed to develop the concept for initial marine deployment. Deltares and MARIN institutes provided the accommodation required to test the models (The Ocean Cleanup, n.d.-b). Different organizations and corporations provided funds and support in this stage, like Adessium foundation and Microsoft (The Ocean Cleanup, n.d.-b). Also, the startup received support from Ocean Elders, a prominent group of ocean experts. These relationships allow expand the industry network and bring the knowledge and experience required to the company **VCR 3>4.** The startup received funds from Adessium Foundation to develop the interceptor (The Ocean Cleanup, n.d.-a) **VCA 3>4.** The critical juncture of entrepreneurial commitment is tackled by acquiring external surrogate who supervised the team activities, that allowed to increase the startup activities and partners and develop its industry network.

In Aug **2015** there was a mega expedition to investigate and understand the plastic pollution problem. By **2016,** the river research team identified plastic emissions into the ocean from the 1,000 most polluted rivers into the ocean (The Ocean Cleanup, n.d.-a). With the support of partners, the startup deployed the first prototype System 001 in the North Sea on a small-scale structure due to technical challenges and increased costs (The Ocean Cleanup, n.d.-a) **VCR 4>5**. In **2017,** The Ocean Cleanup teamed with TME, a Dutch Machine-Building, and engineering company to build the interceptor 1.0 prototype to intercept waste ((The Ocean Cleanup, n.d.-a) **VCR 5>6.**

The Ocean Cleanup North Pacific Foundation was founded under US laws to prepare for the activities involved in cleaning up the North Pacific Garbage Patch. In **2018**, the Ocean Cleanup sought an opportunity to collaborate with universities in Malaysia, Vietnam, Thailand, Germany, Switzerland, France, and the Netherlands to develop the system further (The Ocean Cleanup, n.d.-a). Additionally, the startup recruit interns who contributed to the development of the technology for automatic camera monitoring and measuring. By mid-**2018,** a new design of the interceptor 2.0 addresses the capacity and operational cost (The Ocean Cleanup, n.d.-a). A partnership with Maersk Supply Services to support the Ocean Cleanup in relaunching its upgraded drifting system to the pacific (Maersk, 2019) **VCR 6>7.** The startup's extensive research to gain information and collect data in Indonesia, Thailand, France, the Netherlands, Benin, Germany, Mexico, the Philippines, the Dominican Republic, Jamaica, and Guatemala has also resulted in a better understanding of plastic emissions and their effects on rivers and oceans. In September **2018,** The Ocean Cleanup deployed its first system 001, in the Great Pacific Garbage Patch **VP 2>3.**

The first-generation design had flaws that required modifications from the engineers due to ineffective plastic retention and the structural failure (The Ocean Cleanup, n.d.-a) **VCR 7>8**. A fatigue fracture during the test led to the detachment of an 18-meter part of the system. Based on the knowledge gained from the previous generation, the startup deployed System 001/B in the Great Pacific Garbage Patch in **2019** and successfully caught the first batch of ocean plastic (The Ocean Cleanup, n.d.-a) **VP 3>4**. The startup created lasting items in **2020**, The Ocean Cleanup Sunglasses, out of plastic that was found in Canada's Vancouver Harbour **VP 4>5** and sold through the startup's website **VD 1>2** which allowed for new revenue stream (The Ocean Cleanup, n.d.-a) **VCA 4>5.** However, turning plastic into durable and useful products was a challenge. Long-term exposure to UV radiation and the mechanical impact of the waves have greatly accelerated the degradation of certain plastic that has been circulating in the ocean for decades (The Ocean Cleanup, n.d.-a). The Ocean Clean-up was able to overcome the critical juncture of credibility. The startup provided social and technological achievement by developing and testing the first clean-up system and using the plastic caught to produce recycled products. Because of its strong values, the Ocean clean-up was able to collaborate with universities and partners around the world.

"We develop an alternative business model to allow us to deliver more impact with fewer resources and scaling-based improvement technology and the second purpose is to make sure that we turn dirty rivers into a solid business case" **(The Ocean Cleanup, Head of business development)**

In late **2020**, Konecranes, a world leader in the lifting industry, entered into a new cooperation to produce, install, and repair Interceptors (Konecranes, 2020) **VCR 8>9**. In **2021,** the firm reached proof of technology and launched System 002/ "JENNY", the first large-scale cleanup system (Milestone 2021, n.d.) **VP 5>6**. The new system had a test campaign completed by October **2021**.

"*The major obstacles are the legal frameworks for forming a consortium of companies that want to collaborate with us and access to authorities that can permit us for operational activities."* **(The Ocean Cleanup, Head of business development)**

By the end of **2022**, 15 rivers will have The Ocean Cleanup systems in place, including its solar-powered Interceptor, thanks to a partnership that combines the scale and global network of Coca-Cola with The Ocean cleanup's technology and data-driven solutions (The Coca-Cola company, 2021) **VCR 9>10**. This partnership is effective since **2021** and will last over 18 months. Coca-Cola will be the first implementation partner that will provide significant time. Accessing Coca-Cola's global network across 200 countries will support licensing, waste management, and acquiring funding **VCA 5>6.** However**,** to establish 90% reduction of floating plastic ocean by 2040, the startup will need to deploy hundreds of systems which is still unfeasible. In **2022,** The Ocean Cleanup has secured a global partnership with Kia for seven years (Kia Vision, 2022) **VCR 10>11**. Kia plans to include recycled ocean plastic collected by The Ocean Cleanup into its value chain process. This partnership will provide the non-profit company with funds and corporations for ocean operations **VCA 6>7.**

"Large corporations like Coca-Cola and Kia, who support us in organizing suppliers who collaborate with us in solving the problem, are becoming more and more significant. They have made it easier for us to start operating in countries where we had never before operated." **(The Ocean Cleanup, Head of business development)**

"*We need to prove the efficacy of our technology when funders will step in".* **(The Ocean Cleanup, Head of business development)**

The Ocean Cleanup is now at a critical juncture of Sustainability. Even though there are technical achievements, the startup is currently working on System 03, to scale up further and prove the efficacy of the technology.

> *"We are now working with external advisors and other professional companies to help us in delivering on a sustainable revenue model"* **(The Ocean Cleanup, Head of business development)**

Origin	Cause	Primary Change	Follow-up effects	Critical Juncture	Factor related
Social and environmental awareness	Increased interest in ocean plastic pollution	**VP 1→ 2** New method to clean the ocean	**VCA 1→ 2** Funds through crowdfunding **VCR 1 →2** Recruit an initial team	Opportunity Recognition	Lack of network. Lack of funds.
Social acceptance	A voluntary team of close to 100 scientists and engineers	**VCR 2→ 3** Assessing the effectiveness of the method	**VCA 2 →3** A second crowdfunding	Opportunity Recognition	Lack of market knowledge.
Team management activities	A supervisor to oversee the team management activities	**VCR 3→ 4** Accommodation, team members and partners	**VCA 3 →4** Funds from Adessium Foundation to develop the interceptor.	Entrepreneurial Commitment	Lack of accommodation and entrepreneur skill
Social and environmental awareness	Expeditions to investigate the pollution problem	**VCR 4→ 5** The 1,000 most polluted rivers were identified as sources of plastic emissions into the ocean and deployment of	-	Credibility	Efforts to find the source of the emissions. Technical challenges and increased costs to

		first prototype system 001			develop a large-scale system
Technology development	Develop the first interceptor 1.0	**VCR 5 → 6** Collaboration with TME		Credibility	Proof of technical development to the stakeholders
Production issues	To address problems in the first interceptor, the startup collaborated with universities and partners to develop the interceptor 2.0	**VCR 6 → 7** R&D activities with universities and partnership with Maersk.	**VP 2 → 3** Interceptor 2.0	Credibility	Flaws in the first interceptor and technical challenges to increase the capacity of interceptor 2.0 and change the operational costs
Production issues	System 001 was not effectively retaining plastic.	**VCR 7 → 8** First-generation modification	**VP 3 → 4** System 001/B	Credibility	Flaws in the first system and technical challenges during testing.
Efficiency opportunity	Use ocean plastic to produce recycled glasses	**VP 4 → 5** New value offering	**VD 1 → 2** New channel through website to sell to customers **VCA 4 → 5** new revenues	Credibility	Operational challenges to turn plastics into durable products
Efficiency opportunity	To rapidly address the plastic pollution, the startup is not able to deploy interceptors without partnerships.	**VCR 8 → 9** Collaboration with Konecranes to produce, install and repair interceptors	-	Sustainability	Limited access to resources to address the problem quickly.

Technology development	The startup achieved technology advancement and launched System 002/ "JENNY	**VP 5 → 6** First large-scale clean system	**VCR 9 →10** New activities and partnership with Coca-Cola **VCA 5 → 6** New funds	Sustainability	Limited access to finance and global network. Legal frameworks and permit for operational activities
Sustainability opportunity	Kia plans to include recycled ocean plastic collected by The Ocean Cleanup into its value chain process.	**VCR 10 →11** Global partnership with Kia for seven years	**VCA 6 → 7** New funds	Sustainability	Proof of the efficacy of the technology. Limited access to finance.

Table 5.3 Causes and Effects of Changes to The Ocean Cleanup Business Model

Growth Stages & Critical Junctures:

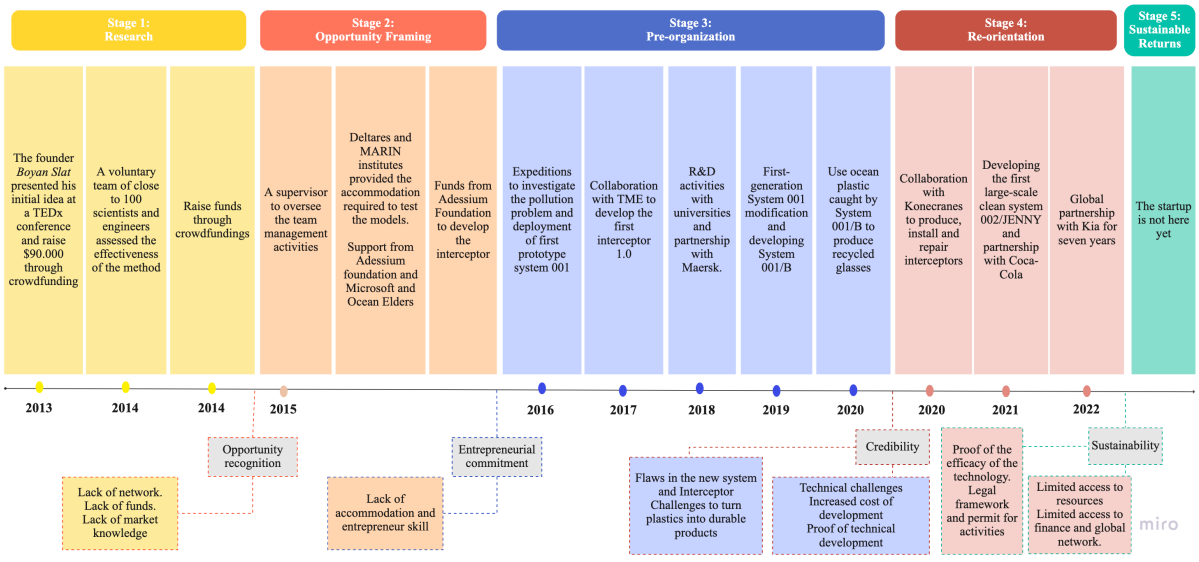

Figure 5.5 Growth Stages & Critical Junctures The Ocean Cleanup

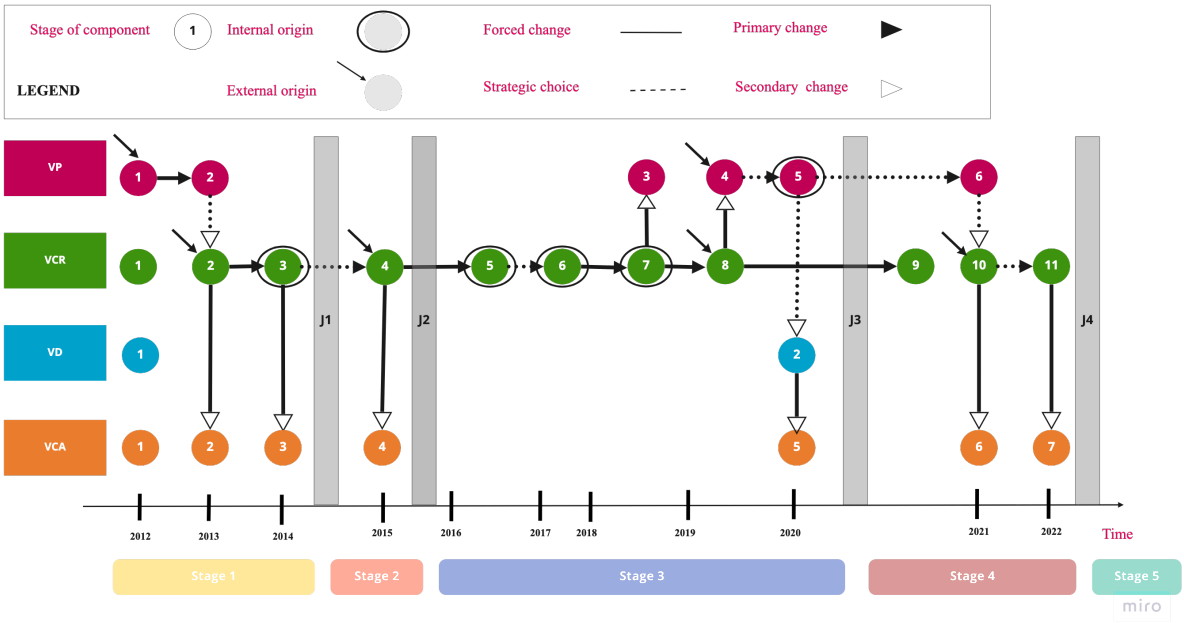

Figure 5.6 Framework Representation of Changes to The Ocean Cleanup Business Model

Noria Sustainable Innovators

Noria Sustainable Innovators is a startup that provides develops techniques to remove plastic from the local water in the Netherlands in a sustainable and affordable manner. It is estimated that every minute one truckload of plastic ends up in the sea, 80% of which comes from rivers. Plastic has the property that it does not decay but gradually breaks down smaller plastic particles. These particles are then eaten by fish, birds, and many other animals. This is major environmental pollution and therefore enough reason to remove the plastic from rivers, preferably close to the source.

The idea started in **2016** by *Rinze de Vries*. During his final year of his study, the Hoogheemraadschap Hollands Noorderkwartier held a competition. They faced a challenging problem: the pumping stations used to pump inland water to the North Sea have trough gates. These trough gates contain 10-centimeter openings for fish to pass through on their way to sea. This, however, implies that plastic can also flow through. The task was thus to find a solution to this problem. Rinze began to consider this problem and developed a solution: a machine that ensures that plastic is eliminated from the water just behind the pumping station **VP 1>2**. The judges selected Rinze's idea as the best, and he won the competition. Noria Sustainable Innovators moved into an office at Yes!Delft, and there Rinze received an advice to find a co-founder with entrepreneur skills to start a business with his idea. Rinze met Arnoud van der Vaart, the co-founder who facilitated the transition into a startup **VCR 1>2.** The first critical juncture of opportunity recognition is passed by acquiring the market knowledge required and entrepreneur skills.

"We developed techniques that can remove plastic from the water in a sustainable and affordable manner. The idea started with the competition that was launched by the Water Board of North Holland." (**Noria, Co-founder)**

The team started working on their prototype and they were in contact with other entrepreneurs as Yes!Delft is a community with workplaces for all kind of startups. The network assisted them at this stage to address their inquiries. The critical juncture of entrepreneurial commitment has been recognized because, according to the interviewee, the company had already sufficient knowledge to run the business, network, accommodation, and supportive policy to do the research.

"We have been in an incubator in the Yes!Delft community, and during the building of the company, we just made the network bigger." **(Noria, Co-founder)**

In **2018,** the startup lacked financial resources. It got the MIT grant and was able develop the first system that can remove plastic **VCA 1>2.** However, it had to change from only removing the plastic to also investigating the problem because they found that the client wants to investigate and analyze the problem.

"Some clients want to know the extent of the issue they are experiencing and following an investigation. We tell them of the issue and provide solutions, however, they are unwilling to spend money to address the problem. Consequently, the complexity of the market is a major obstacle for us". **(Noria, Co-founder)**

Therefore, the company developed the 3R Method: the three phases of this approach are research, removal, and reuse **VP 2>3,** which changed the startup activities to include investigating the source of the problem **VCR 2>3.** The first step is the research, by investigating the problem and providing insights into the sources, the transport, and the locations where the plastic accumulates. The second step is plastic removal. There are two systems that are able to remove the plastic and installing one depends on the research information.

- CanalCleaner can be used in inner-city or in ports where there is less current but a lot of influence from the wind.
- CirCleaner is suitable for use at pumping stations, canals, and rivers. This system is placed at a strategically chosen location where the plastic can be removed by natural forces such as water flow and wind.

The last phase is reuse. Noria provides insights about the amounts and the type of plastic removed and set up campaigns to develop policies to tackle plastic preventively. In **2020**, Noria received another

grant **VCA 2>3.** Noria was able to have its own office, build its own identity and acquire clients and seed funds. The critical juncture of credibility had been overcome.

> *"Since we want to fix the problem and more people want to do the same, we do not perceive competition in our market, which is a positive thing."* **(Noria, Co-founder)**

The startup received a loan in **2021** and carried out various project for Rijkswaterstaat. A Pilot Plastic-free water project in Leeuwarden, on behalf of the municipality of Leeuwarden (Noria, n.d.) **VCA 3>4**. Other projects have been carried out in other cities and the clients were mainly municipalities, provinces, and regulators **VD 1>2.**

> *"Municipalities, water boards, provinces, and regulators are the key clients to whom we provide our services, and the goal of all of them is obviously to achieve plastic-free water. But nowadays, we also engage in extensive surveillance. Consequently, mapping the problem's scale is necessary."* **(Noria, Co-founder)**

> *"We currently operate mainly in the Netherlands, but when our solutions are effective enough, we want to expand".* **(Noria, Co-founder)**

The company is now at a critical juncture of sustainability. They are struggling to scale up internationality due to policies and market complexity. The problem owner, like governments, want to investigate these problems but are reluctant to provide subsidies or financial support.

Origin	Cause	Primary Change	Follow-up effects	Critical Juncture	Factor related
Social and environmental awareness	Increased awareness of the environmental damage caused by plastic pollution	**VP 1 → 2** Offer a solution and won the competition	**VCR 1 → 2** New entrepreneur skills, new office	Opportunity Recognition	Lack of market knowledge and entrepreneur skills
	-	-	-	Entrepreneurial Commitment	

Supportive financial system	The startup received MIT grant	**VCA 1 →2** New funds to carry out development process	-	Credibility	Inability to attract finance
Customer preferences	Change from only removing the plastic to also investigating the problem	**VP 2 →3** New system: 3R Method: research, removal, and reuse	**VCR 2→ 3** New activities to investigate the owner's problems	Credibility	Proof of the efficacy of the technology.
Global pandemic	Grant as part of the financial support to startups	**VCA 2 →3** New financial resources to continue investigating plastic problems	-	Credibility	Inability to access financial resources and customers
Supportive financial system	New funds and connecting with clients	**VCA 3 →4** Carry out various projects	**VD 1 →2** New clients, municipalities	Sustainability	Lack of financial resources.

Table 5.4 Causes and Effects of Changes to Noria Sustainable Innovators Business Model

Growth Stages & Critical Junctures:

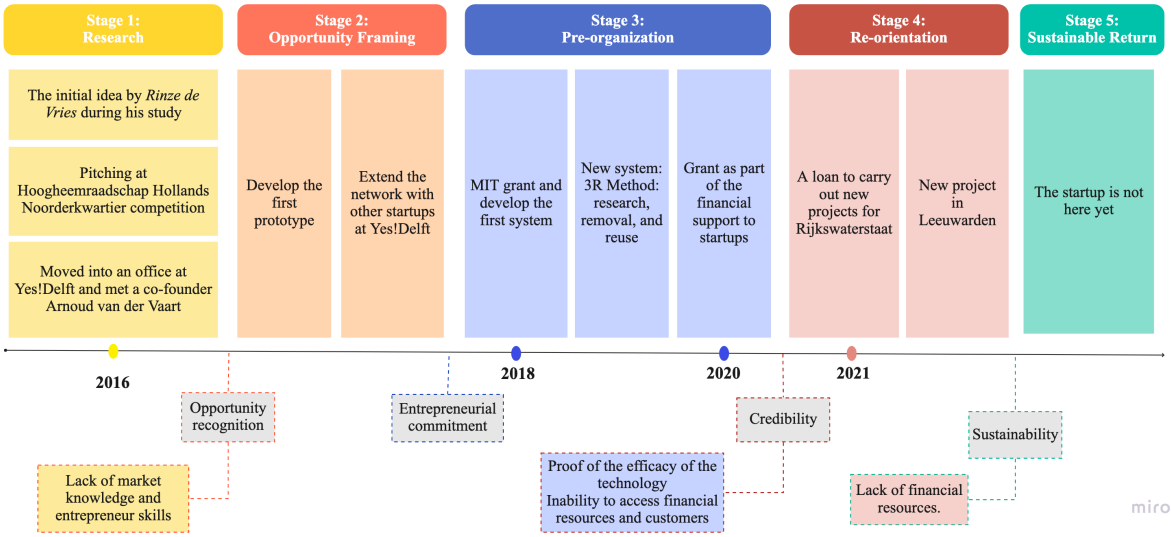

Figure 5.7 Growth Stages & Critical Junctures Noria Sustainable Innovators

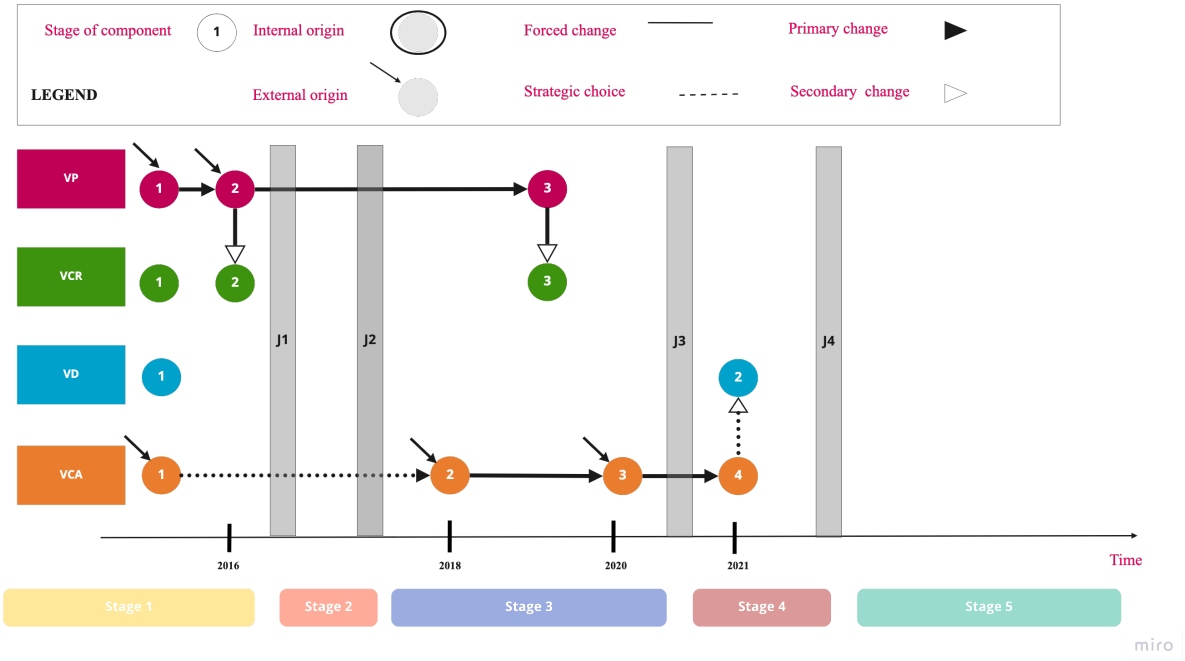

Figure 5.8 Framework Representation of Changes to Noria Sustainable Innovators Business Model

AguroTech

AguroTech is a high-tech company in the agricultural sector that makes data-driven agriculture possible. The startup is founded in **2020** and focuses on developing software and hardware solutions for the agriculture sector, specifically arable farmers with high-yielding crops to increase their productivity and efficiency.

Lilia Planjyan and Joëlle van den Brand, the founders, worked at Kearney, an international management consultancy and advised company on business strategies. However, they wanted to start a business in a sector they have interest in and can add something. The water waste and increasingly frequent long periods of drought threaten crop failure. Because water is becoming an increasingly scarce commodity in the Netherlands, there is an increasing need among farmers for technology that can reduce water consumption in agriculture. Lilia and Joëlle did market research by setting up the podcast Boerenverstand and launched weekly conversations with farmers about their work, live, condition and vision. They have also visited farmers and made interviews to understand what problems they face and how can the technology help them. The team came up with the idea of using technology based on data analysis to increase agricultural productivity and optimize water use **VP 1>2**. They have the market knowledge required and they were able to think commercially. The critical juncture of opportunity recognition is passed by conducting a market research and offer a solution to the farmers.

To understand the agriculture industry better, the team collaborated Wageningen University which has an interest in developing agricultural methods. This collaboration helped the team to get a deep insight into the agriculture sector, types of soils, and water wastage problems **VCR 1>2**. The team was able to establish a network, move to the next stage of growth and overcome the critical juncture of entrepreneurial commitment.

AguroTech was founded as a joint venture with Innoseis Holding, a spin-off of the Nikhef Institute. Innoseis has experience in developing sensors for the oil and gas industry (Kansen voor west 2, n.d.). This knowledge used by AguroTech to create sensors that monitor soil moisture **VCR 2>3.** The technology converts measurable information into clear irrigation recommendations for farmers. The farmer may keep track of where, when, and how much water needs to be used for irrigation on the AguroTech app **VP 2>3.**

> *"The initial technology costs and personnel who are developing are huge barriers currently"* **(AguroTech, Co-founder)**

The startup was able to receive grants and subsidies **VCA 1>2** and by March **2021** the team had their first hardware prototype, which they tested with 60 users over the course of an agricultural season in the Netherlands and Ukraine. The test results showed that the company needs to adapt the technology as each crop is different **VP 3>4.**

> *"I believe that initially, we began by saying that all farmers who grow crops may utilize this product. Then we realized that your technology must be adjusted to quite a few specifics for each crop. As a result, we are currently concentrating more on particular niches or untapped markets and expanding from there."* **(AguroTech, Co-founder)**

In March **2022**, the startup realized its first sale. The client might make an annual subscription payment for the software and a one-time payment for the hardware **VCA 2>3.**

> *"Dutch investors are quite risk averse. Before they invest, they want to see proof of commercial success and a proven product-market fit."* **(AguroTech, Co-founder)**

AguroTech is still in the credibility juncture. Due to the war in Ukraine, the startup decided to stop its business there and focus on testing and selling products in the Netherlands **VCR 3>4.**

Origin	Cause	Primary Change	Follow-up effects	Critical Juncture	Factor related
Social needs of local community	Market research to address the farmers' problems in the Netherlands.	**VP 1 → 2** A new method to develop the agriculture sector	-	Opportunity Recognition	Lack of prior knowledge about agriculture
Resource availability	Wageningen University is interested in the development of agricultural methods.	**VCR 1 → 2** Collaboration with Wageningen University	-	Entrepreneurial Commitment	Lack of network Lack of knowledge about methods used in agriculture
Efficiency opportunity	Collaborating with Innoseis Holding, a spin-off of the Nikhef Institute	**VCR 2 → 3** Use sensors to monitor soil moisture	**VP 2 → 3** The farmer can use app application to keep tracking irrigation process.	Credibility	Technology development required collaboration with partners.
Supportive financial system	Grants and subsidies for working capital.	**VCA 1 → 2** Funds for operational activities	-	Credibility	Inability to attract finance
Production issues	The technology needed to be developed further and focus on crop types	**VP 3 → 4** New solutions	**VCA 2 → 3** New payment methods	Credibility	Technological challenges as the first system needed adaptation
Industry forces	Inability to perform agriculture	**VCR 3 → 4** No activities in Ukraine.	-	Credibility	Limited access to resources

	activities due to the war in Ukraine				
	-	-	-	Sustainability	-

Table 5.5 Causes and Effects of Changes to AguroTech Business Model

Growth Stages & Critical Junctures:

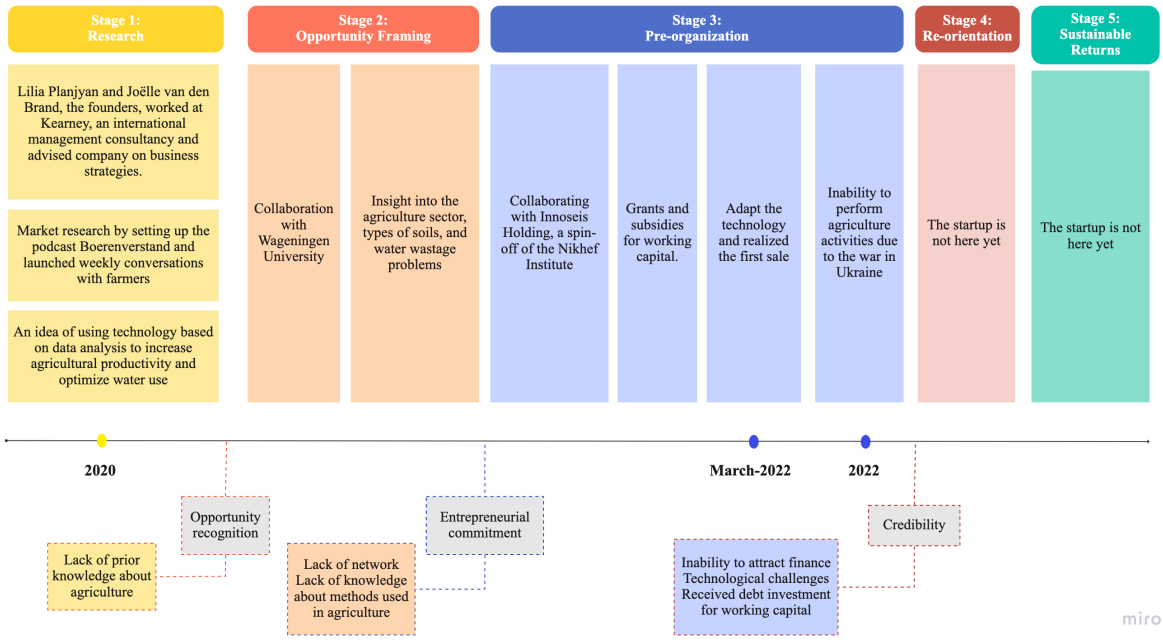

Figure 5.9 Growth Stages & Critical Junctures AguroTech

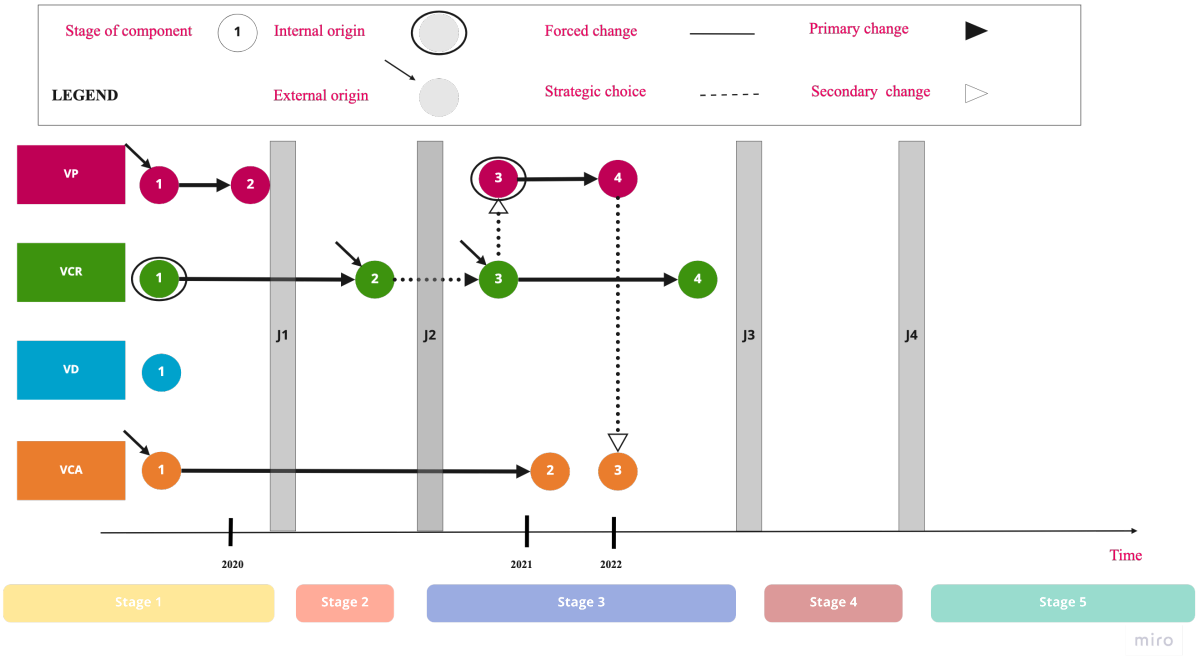

Figure 5.10 Framework Representation of Changes to AguroTech Business Model

Mimic

Mimic is a new startup that is specialized in producing a revolutionary baby bottle that is made of 100% recyclable polypropylene. Mimic is a corporate venture under the Hero Group. The initial idea of Mimic was originated by one of the broad members of Hero Group, Frenkel Tel, to sell milk powder cups. Typically, a family would purchase an entire tin of 800 grams of milk powder for a newborn, and it would scoop the required amount of milk for a bottle-bearing bottle. When the parents give the bottle to the baby, a lot of ailments happen because the baby's swallowed in a lot of false air or the drinking rate is too high or too low. Hero Group is thus investing much in R&D to enhance the composition and quality of milk powder. However, the milk substances and cups have a significant role in the baby's drinking process overall. Therefore, the Mimic idea tries to imitate how breastfeeding actually occurs, and then create a device that could offer the optimum drinking experience to the baby. The innovative cup used by MIMIC bottle moves inward while drinking and that's keep the pressure in the bottle in balance and prevents air from entering. The less air, the fewer colic **VP 1>2.** The technology to create cups has been patented after extensive study and design in **2016**. The main investor was Hero Group as Mimic started as a corporate venture. The difficulty at this stage is to convince the incubator to fund the venture. The idea got the traction required, and seed funds were available as well as network and knowledge. Therefore, the critical juncture of opportunity recognition is passed.

> *"MIMIC is a corporate startup that originates from the Hero Group. We have access to their network and financing since Hero Group is a shareholder."* (**MIMIC, Co-founder)**

One of the team members with a commercial background conducted research to see whether the technology of cups has a good product-market fit in **2018**. To make it simple to modify the parts in response to feedback from the market, a flex design was selected, and the prototype has been made with an injection of aluminum molds at every part on a very small scale. On the marketing side, Mimic collaborated with several parties in Amsterdam that assist startups in finding a product-market fit for new innovative ideas and creating a ghost company to assess customer reactions **VCR 1>2.** The team was able to think commercially and pass the second critical juncture of entrepreneurial commitment**.**

In May **2020,** the startup launched its web shop and started selling its products **VD 1>2**. Due to the global pandemic, there were not many sales in the beginning. Therefore, Mimic began selling products in subscriptions to end customers, and to retail stores in the Netherlands **VCA 1>2**, but they did not get the traction they wanted. Although Mimic attempted to promote the bottle and cups, the product-market fit failed to gain momentum. They initially believed that customers had a problem with the infant milk dosage, but they later realized that the appeal of the cups had not been well received. The interviewee mentioned that a product-market fit was a barrier:

> *"The clients always chose to purchase bottles individually, despite our best efforts to achieve product-market fit for the sale of the bottle with cups."* **(MIMIC, Co-founder)**

> *"It is difficult to make a strategic decision to eliminate one of the products since we have a major stakeholder who is in favor of the cups"* **(MIMIC, Co-founder)**

In **2022**, the startup, in consultation with the incubator, decided to sell each product separately in the Netherlands and Belgium, and they found that the standalone bottle has a lot of traction, while cups are not **VP 2>3**. Therefore, they decided to move forward with bottle development as parents are looking to give a more natural experience to their babies. However, Mimic is under Hero Group, and the strategic decision to kill a product and focus on another must be done in consultation with the main stakeholder. The company did not seek partnerships as they are originated from a large organization. Mimic was able to pass the critical juncture of credibility. They created their own identity, attracted customers, and established relationships with them in the Netherlands and Belgium.

Origin	Cause	Primary Change	Follow-up effects	Critical Juncture	Factor related
Social needs of local community	The transition from breast to bottle feeding is	**VP 1 → 2** A device that could imitate how		Opportunity Recognition	Inability to make decisions separately as the

	frequently accompanied by problems, such as colic or poor latching.	breastfeeding occurs.			founder works under the supervision of the incubator
Social acceptance	Market research to assess customer acceptance	**VCR 1 → 2** Collaboration with different parties in Amsterdam and create a ghost company	-	Entrepreneurial Commitment	Inability to design a product without finding a customer segment to get finance
Resource availability	Open a channel to sell the products	**VD 1 → 2** A web shop to sell baby bottles and cups		Credibility	Struggle to access to customers
Global pandemic	People were reluctant to sell bottles as they can provide breastfeeding during the lockdown.	**VCA 1→ 2** New payment methods	-	Credibility	Inability to attract customers and gain profit
Customer preferences	The benefit of the cups did not resonate	**VP 2 →3** Selling the products separately		Credibility	Inability to make a decision to kill a product
	-	-	-	Sustainability	

Table 5.6 Causes and Effects of Changes to MIMIC Business Model

Growth Stages & Critical Junctures:

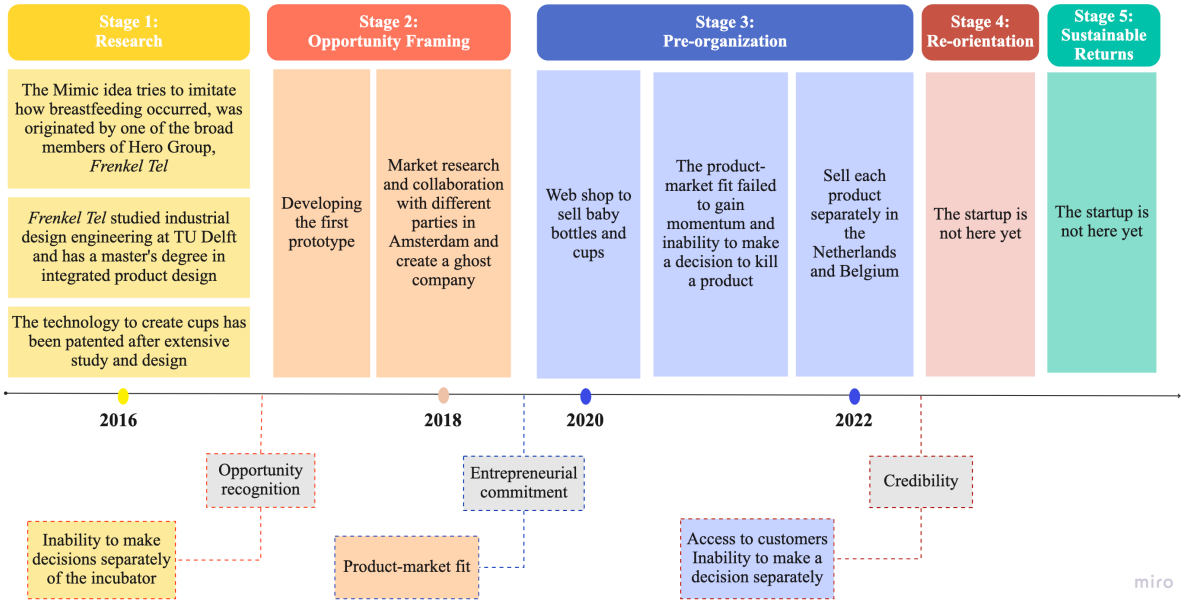

Figure 5.11 Growth Stages & Critical Junctures MIMIC

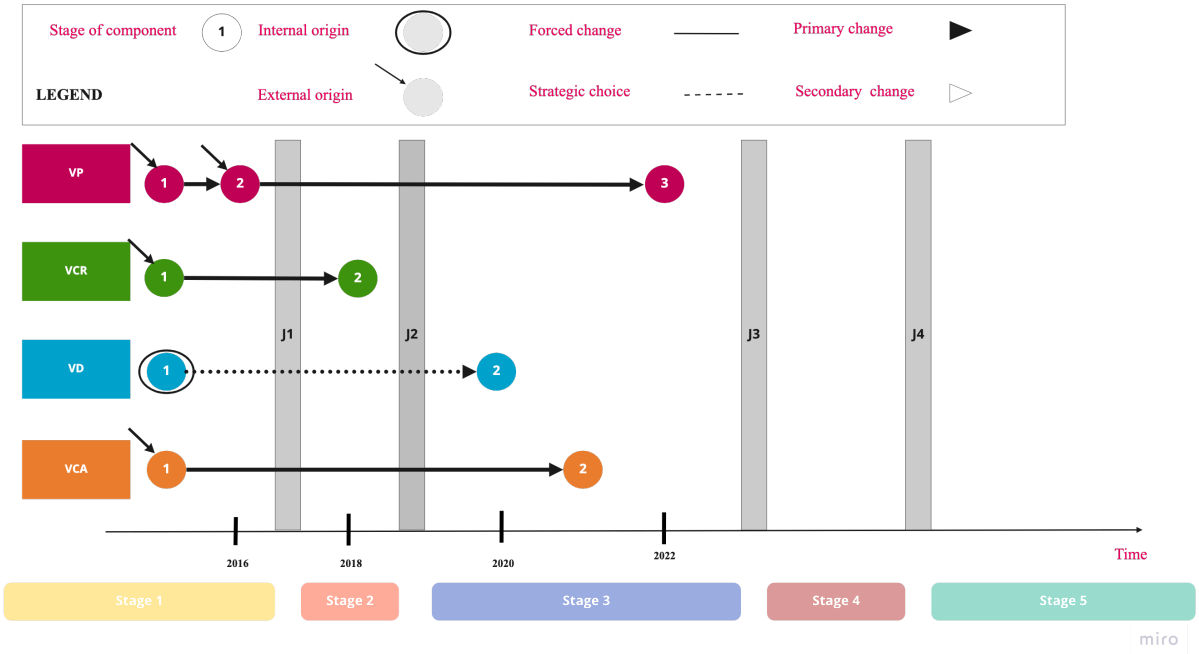

Figure 5.12 Framework Representation of Changes to MIMIC Business Model

6. Cross-Case Analysis

In the previous chapter, each case was thoroughly investigated and explained, utilizing tables and a framework to illustrate the changes in the business model that occurred during the development process. These tables and the framework presented a summary of major business model events.

6.1 Internal and External Factors in The Case Studies

Internal factors indicate the origin of the change is withing the company. "*Resources availability"* refers to the startup ability to leverage its own skills and capabilities and whether the startup deliver economic returns that provide financial resources. This factor has occurred in the entrepreneurial commitment and credibility junctures in and indicated why startups made strategic partnerships, received debt or investors and how the startup utilized human resources, infrastructure, and other resources. An internal factor known as "*technology development*" refers to the advances in technology that may have an impact on particular elements of the business model. The Ocean Cleanup partnership with TME was made possible by the trigger at credibility juncture and allowed for the deployment of the first large-scale clean system and access to the global network by partnering with Coca-Cola. MO4 on the hand was able to access two customer segments and achieving a product-market fit. "*Employees capabilities"* is another internal factor that describes the role and need of professional surrogate to support an activity since the startup lacks the required knowledge and skills. MO4 approached a professional sales manager to market its technology and build relationships with customers. "*Production issues"* refer to the flaws in the startup's technology, products, or service. As for the creation of new technologies, they can include flaws that called for a change of the technology. The Ocean Cleanup was able to address the problems with its first technology and introduce the next generation. AguroTech called for its first technology to adapt to each crop. For "*team management activities"*, the Ocean Cleanup introduced a supervisory board structure to oversee the activities of the management team during the early growth of the startup. Finally, "*scaleup"* describes the internal strategic decision within the startup to make a debt investment to increase its expansion as in the case of SolarWorks, or a strategic investment to support international firms as in the case of MO4 that secured a 10-year contract with North Star.

External factors indicate the origin of the change in the business model was due to external factors. The term "Efficiency opportunity" describes a situation in which there is an opportunity that may be seized by providing products or services to that market or utilize new technologies in combination with existed technologies to perform better in the market. The Ocean Cleanup utilized the ocean plastic that has been collected to produce and sell recyclable glasses. Also, the startup collaborated with Konecranes to rapidly address the plastic pollution and produce interceptors. MO4, on the other hand, was among other startups to collaborate with new and high-tech startups to use the

data available or their technologies to feedback its analytical systems. "*Technology forces"* in the MO4 case explain that the new technology came out to attract an investor and developer by investigating its feasibility by the jury. "*Social acceptance"* is another external factor that describes how people's acceptance of a particular product or service may influence its development. The reaction of the ocean plastic clean assisted the startup to create a voluntary team to assess the idea's viability while MIMIC created a ghost company and did market research to assess people's acceptance of the new products. Regarding "*customer preferences*", the factor has affected the MO4 in the opportunity recognition juncture and was the reason to develop a new offering that suits customer requirements. SolarWorks was able to find a market application and developed the power box based on customer needs. However, the factor was the reason to reconsider the value offering in Noria Sustainable Innovators and MIMIC cases. The "*global pandemic"* impacted the startups' financial situation and had an influence on the global economy. MO4 received government aid while MIMIC had changed its payment method to attract customers who were reluctant to purchase. *"Sustainability opportunity"* describes the startups efforts to increase access to sustainable solutions by making a strategic investment with companies and organizations that share the same values. Kia plans to include recycled ocean plastic collected by The Ocean Cleanup into its value chain process, while the SolarWorks made a strategic investment with EDP Renováveis to increase access to sustainable energy.

In some cases, the first ideas were motivated by the "*social needs of the local community*." For example, the limited access to electricity in Africa was the main reason to develop the graduation project of the solar system and later starting the business. Another example is in the AguroTech case when farmers in the Netherlands addressed the problem of water wastegate and the need for technology in the agriculture industry. "*Market competition"* was the external trigger to change the whole business model in the SolarWorks case and change to a Pay-As-You-Go company. The startup switched from manufacturing its product in favor of lower-cost, and higher-quality products from third parties. A "*supportive financial system"* is an external driver for partnership and access to financial resources, as in the case of SolarWorks, which was able to access capital and investment through strategic collaboration with Lemnis Lighting Launch and it received a grant from the US Agency for International Development. Noria Sustainable Innovators raised funds in the form of an MIT grant and executed a variety of projects to extend its activities. AguroTech also raised funds through grants and subsidies to accomplish technological progress. *"Social and environmental awareness"* impacted the cleantech companies and influenced them to develop solutions. The Ocean Cleanup and Noria Sustainable Innovators' ideas started with the increased interest in ocean plastic pollution. The factor triggered the Ocean Cleanup to launch expeditions to investigate the problem. Finally, "*industry forces"* describe the decisions that are made due to external pressures to adapt to new situations. AguroTech suspended its activities in Ukraine due to the war and its inability to access the agriculture sector there. The case studies' internal and external factors are categorized in Table 6.1.

Origins	Internal/External Factors	Occurrence	Critical juncture
Technology forces	External	1	Credibility
Social acceptance	External	2	Opportunity recognition/ Entrepreneurial Commitment
Customer preferences	External	4	Opportunity recognition/ Entrepreneurial Commitment/ Credibility
Resources availability	Internal	4	Entrepreneurial Commitment /Credibility
Employees capabilities	Internal	1	Credibility
Production issues	Internal	3	Credibility
Global pandemic	External	3	Credibility
Sustainability opportunity	External	2	Sustainability
Social needs of local community	External	3	Opportunity recognition
Market competition	External	1	Sustainability
Supportive financial system	External	5	Sustainability/credibility
Social and environmental awareness	External	3	Opportunity recognition/ Credibility
Team management activities	Internal	1	Entrepreneurial Commitment
Industry forces	External	1	Credibility
Scaleup	Internal	3	Sustainability
Technology development	Internal	3	Credibility/ Sustainability
Efficiency opportunity	External	7	Credibility /Sustainability

Table 6.1 Internal and External Factors in The Case Studies

6.2 Changes in Business Models in The Case Studies

Table 6.2 shows the changes in business models in case studies. These changes are categories based on the origin of change, the cause, interrelationships between components, type of the change and the critical juncture in which the change happened. Critical junctures are represented based on the first letters: **OP** for opportunity recognition, **CM** for entrepreneurial commitment, **CR** for credibility and **SU** for sustainability.

Origin	Cause	Interrelationship	Type	Critical Juncture	Factor related
MO4					

Customer Preferences	Writing a new algorithm using MATLAB software that can give an accurate forecasting	VP → VCR	FF	OP	Lack of market knowledge and marketing skills to access the market
Resource availability	The startup approached Buccaneer in Delft to connect to industry network	VCR →VD	FC	CM	Lack of entrepreneurial capabilities and industry network
Technology forces	The jury of Offshore Wind Innovation Award 2019 looked at innovativeness, financial and commercial feasibility of the new technology	VCR→ VP	FF	CR	Lack of the financial and human resources
Employees capabilities	A new sales manager assisted the startup in the commercialization area	VCR → VD	CC	CR	Approaching skilled employees
Global pandemic	The startup received government aid to cope with the financial crisis	VCA	F	CR	Lack of financial resources and market uncertainty due to the global pandemic
Efficiency opportunity	A new joint project OOAS to improve the efficiency of offshore wind farm installation and maintenance vessels	VCR	F	CR	Understanding rules and guidelines in the offshore industry
Technology development	Develop solutions for two customer segments	VD → VCA	CC	SU	Achieving a product-market fit and establishing customers
Efficiency opportunity	Use the data of the realized performance of the vessels through the BMO technology	VCR → VP	FC	SU	Become a one-stop-shop requires access to data and technology available in another startup
Efficiency opportunity	Utilize Damen Triton platform to gather	VCR	F	SU	Technology advancement relies

	operational data that will feed MO4's analysis.				on technologies owned by high-tech startups
Scaleup	10 years contract with North Star	VCA	C	SU	Increase the firm overseas activities
Scaleup	New agents in China and India	VCR	C	SU	Challenges to find overseas markets
SolarWorks					
Social needs of local community	A graduation project based on people requirements.	VP	F	OP	Lack of market knowledge
Customer preferences	Design a product within customers budget that can power lights and charge phones	VP → VD	FF	CM	Market application for the new solar system
Supportive financial system	Strategic cooperation with Lemnis Lighting Launch, access to financial resources and extend the network	VCR	F	CR	Inability to attract finance
Efficiency opportunity	Address matters of energy use and battery size	VCR	F	CR	Technological challenges
Resource availability	Access to financial resources	VCA → VP/VD	FC\C	CR	Received debt investment for working capital
Market competition	Change the business model	VCR → VP\VD\VCA	FF\C \F	SU	Developing a scalable business model in response to increased competition. Legal frameworks and poor infrastructure
Sustainability opportunity	Increase access to sustainable energy	VCA → VCR	CC	SU	Access to capital, investment, and human resources.

					Developing new business areas
Scaleup	Additional funds to accelerate expansion in Mozambique	VCA	C	SU	Lack of funds to scaleup. Debt investment for working capital and increase expansion
Supportive financial system	Access to capital and investment	VCA → VCR\VD	FC\C	SU	Increase the firm activities and developing new business areas
The Ocean Cleanup					
Social and environmental awareness	Increased interest in ocean plastic pollution	VP → VCA\VCR	FF\C	OP	Lack of network. Lack of funds.
Social acceptance	A voluntary team of close to 100 scientists and engineers	VCR → VCA	FF	OP	Lack of market knowledge.
Team management activities	A supervisor to oversee the team management activities	VCR → VCA	CF	CM	Lack of accommodation and entrepreneur skill
Social and environmental awareness	Expeditions to investigate the pollution problem	VCR	F	CR	Efforts to find the source of the emissions. Technical challenges and increased costs to develop a large-scale system
Technology development	Develop the first interceptor 1.0	VCR	C	CR	Proof of technical development to the stakeholders
Production issues	To address problems in the first interceptor, the startup collaborated with universities and	VCR → VP	FF	CR	Flaws in the first interceptor and technical challenges to increase the capacity of

	partners to develop the interceptor 2.0				interceptor 2.0 and change the operational costs
Production issues	System 001 was not effectively retaining plastic	VCR → VP	FF	CR	Flaws in the first system and technical challenges during testing.
Efficiency opportunity	Use ocean plastic to produce recycled glasses	VP → VD\VCA	CC\F	CR	Operational challenges to turn plastics into durable products
Efficiency opportunity	To rapidly address the plastic pollution, partnership with Konecranes	VCR	F	SU	Limited access to resources to address the problem quickly.
Technology development	The startup achieved technology advancement and launched System 002/ "JENNY	VP → VCR\VCA	CC\F	SU	Limited access to finance and global network. Legal frameworks and permit for operational activities
Sustainability opportunity	Kia plans to include recycled ocean plastic collected by The Ocean Cleanup into its value chain process.	VCR → VCA	CF	SU	Proof of the efficacy of the technology. Limited access to finance.
Noria Sustainable Innovators					
Social and environmental awareness	Increased awareness of the environmental damage caused by plastic pollution	VP → VCR	FF	OP	Lack of market knowledge and entrepreneur skills
Supportive financial system	The startup received MIT grant	VCA	C	CR	Inability to attract finance
Customer preferences	Change from only removing the plastic to also investigating the problem	VP → VCR	FF	CR	Proof of the efficacy of the technology.

Global pandemic	Grant as part of the financial support to startups	VCA	F	CR	Inability to access financial resources and customers
Supportive financial system	New funds allowed the startup to carry out new projects.	VCA → VD	FC	SU	Lack of financial resources.
AguroTech					
Social needs of local community	Market research to address the farmers' problems in the Netherlands. And a new method to develop the agriculture sector	VP	F	OP	Lack of prior knowledge about agriculture
Resource availability	Access to Wageningen University that is interested in the development of agricultural methods.	VCR	F	CM	Lack of network Lack of knowledge about methods used in agriculture
Efficiency opportunity	Collaborating with Innoseis Holding, a spin-off of the Nikhef Institute	VCR →VP	CC	CR	Technology development required collaboration with partners.
Supportive financial system	Grants and subsidies for working capital.	VCA	F	CR	Inability to attract finance
Production issues	The technology needed to be developed further and focus on crop types	VP →VCA	FC	CR	Technological challenges as the first system needed adaptation
Industry forces	Inability to perform agriculture activities due to the war in Ukraine	VCR	F	CR	Limited access to resources
MIMIC					
Social needs of local community	The transition from breast to bottle feeding is frequently accompanied by	VP	F	OP	Inability to make decisions separately as the founder works

	problems, such as colic or poor latching. Therefore, designing a device that could imitate how breastfeeding occurs.				under the supervision of the incubator
Social acceptance	Market research to assess customer acceptance and collaborating with different parties to create a ghost company	VCR	F	CM	Inability to design a product without finding a customer segment to get finance
Resource availability	Open a channel to sell the products through the web shop	VD	C	CR	Struggle to access to customers
Global pandemic	People were reluctant to sell bottles as they can provide breastfeeding during the lockdown.	VCA	F	CR	Inability to attract customers and gain profit
Customer preferences	The benefit of the cups did not resonate, therefore sell the products separately	VP	F	CR	Inability to make a decision to kill a product

Table 6.2 Changes in The Business Models in The Case Studies

Opportunity recognition: the type F and FF is the dominant type at the critical juncture of opportunity recognition. It makes sense as at the research stage, the founder cannot choose but instead must address the social needs of the local community, social and environmental awareness, or customer preferences. For all cases, the change was in the value proposition, and the table reveals that throughout the research stage, researchers seek to seize every opportunity to leverage their idea. At this stage, the market, managerial and entrepreneurial knowledge of the researcher may not be enough to start a business and think commercially about the new idea. Therefore, the researcher offers a new product, solution, knowledge, etc., that appeals to other entrepreneurs who can move the idea to the market.

Entrepreneurial Commitment: the types F, FF, and FC have been noticed in four cases as a response to resource changes, customer preferences, and social acceptance. At this critical juncture, the founders are required to respond quickly and seek assistance to, for example, extend their network. As they lack knowledge, network, funds, etc., they have no choice but forced to make decisions. This

happened when the researchers still lack some knowledge, or they are not able to access the industry network and seek investors. Therefore, the researchers seek to extend their network, through incubators like universities, accelerators, or the entrepreneur network. However, in the case of the Ocean cleanup, the type of change was CF, meaning that the startups decided to assign supervisory team management to more efficient activities. The startup wanted to monitor the entrepreneurial commitment of the team a lack of resources, and because the seed funds are from crowdfunding and must be used efficiently. Additionally, the main element that has been changed at this critical juncture is the value creation for all cases, with one exception in the SolarWorks case when the change was in the value proposition.

Credibility: all types of changes have appeared at this critical juncture, but the types F then FF were the most common changes. The changes were often in the value creation, while the value delivery was the least affected. At this critical juncture, the startups appeared to change their resources including accommodation, human, and financial, and seek partnerships and investors. This is because the startups are still building their identities and developing their technologies. At this stage, it is important for startups to attract investors, partners, and access customer segments, therefore the startups relocate their resources. The table shows that at this stage, the startups examine threats of the startup development more than drivers, such as production issues, and resource constraints. That explains why the changes were mostly forced. The results also reveal that the coping strategies of startups like MO4 and SolarWorks to overcome these threats were better than other startups. However, in the MIMIC case, the startup was a corporate venture and resources were often available, but the startup is seeking credibility through the capacity to make decisions and create its own identity.

Regarding the types of CC, CF and C, these types could be linked to opportunities that startups want to seize like efficiency opportunity, technology development or resource availability. These opportunities work as driving forces for technology-based startups to access data, activities, innovations, partners, etc., while also demonstrating the startup's credibility to stakeholders.

Sustainability: at this stage, the types of CC, CF, and C appeared more frequently in the startups that are already overcome sustainability juncture or are still there. One rationale is that when a startup grows, it has greater freedom to choose partners or opportunities that would benefit its processes. At this stage, value creation and value capture changed often as a response to opportunities to scaleup and navigate the last juncture. Table 6.2 shows that the drivers to change frequently occurred at this stage than at other junctures, while threats of startup development happened less. The startups have identified their resources, accessed customer segments, attracted some partners and investors, and now seek every opportunity to expand and scaleup, and achieve sustainable returns. On the other hand, if there is a threat like in the SolarWorks case, the startup was able to tackle this problem and change the whole business model to adapt to the new market changes. It seems that the coping strategies for SolarWorks

is effective compared to MIMIC and Agurotech cases that are not able to overcome the credibility juncture yet.

6.3 Interrelationships Between Business Model Elements

The interrelationships between the components of the business models in the case studies are depicted in Figure 6.1. The relationships between value creation and value proposition were the strongest, and in all cases, FF and FC are the most prevalent types of changes. This may be explained by the fact that the startups had to modify their business model on many occasions throughout the development process in response to both internal and external forces. Resource constraints (such as financial, human reputation, market knowledge, network, and partners) compelled startups to identify these resources to overcome obstacles and advance to the next stage of growth.

Less often occurring in the case studies and largely mentioned in the value capture relationships were the types of CC and CF. In certain situations, the entrepreneurs obtained grants, debt, or government assistance to help them adjust to the market's volatility in addition to putting forth every effort to get seed funds and carry out projects. In many circumstances, implementing a new payment method for the services is a strategic choice made to draw in new clients. The value delivery as the main change was reported only one time in the MO4 case. The technology development opportunity allowed the startup to introduce its solutions to two customer segments as a strategic choice and receive revenue.

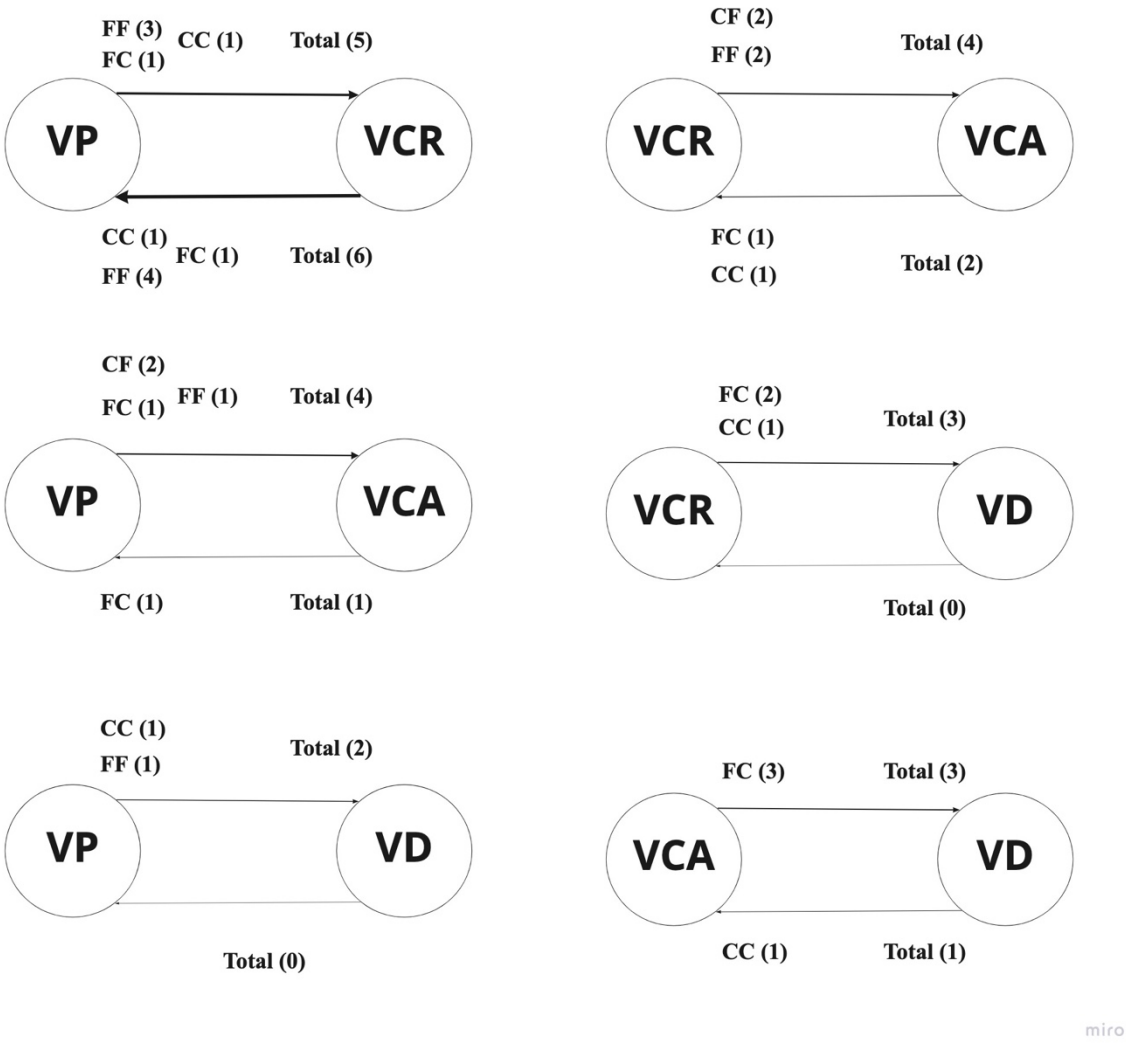

Figure 6.1 Interrelationships between business model elements

6.4 The Role of Business Model Dynamics in Navigating Critical Junctures

Figure 6.2 below shows the changes in the business models for all case studies to navigate the critical junctures. It is interesting to notice the change in the value proposition in the opportunity recognition was always the main change in all cases and the reason to pass the first critical juncture due to different external origins of change. It is also worth mentioning that most startup cases started with founders' funds in the first two critical junctures before they can attract finance in the credibility and sustainability critical junctures. However, the Ocean Cleanup is a non-profit startup, and the seed funds were essential in the beginning to start its business, while MIMIC used the funds available from the incubator.

The value creation changed the most in the credibility and sustainability junctures, and that makes sense as these two junctures required partnerships, new activities, and resources to be able to

navigate them. The value capture changed many times in the credibility and sustainability junctures as well. This is because the investors recognized the technical viability of the products or solutions offered. The changes in the value capture were also due to external forces such as the global pandemic or changing the payment methods for clients and carrying out joint projects. The value delivery was the least to change. SolarWorks, changed the value delivery three times at different stages with each new product it offered to a new customer segment. By looking at the changes in all cases, the diagram shows that the value proposition was the main trigger to passing the opportunity recognition and the value creation was the main influence to overcome the entrepreneurial commitment. Furthermore, the value creation, the value proposition, and the value capture were the main impacts on credibility respectively. Finally, the value creation and the value capture changes helped the startups in the sustainability.

Some internal and external factors also repeatedly appeared during the development process. Efficiency opportunity and a supportive financial system are the external factors that happened most frequently at the credibility and sustainability junctures, according to Figure 6.3 and Table 6.1. This suggests that entrepreneurs at this stage are seeking to seize any opportunity to further their technology advancement and gain access to customers and financial resources. On the other hand, resource availability is the internal factor that emerged in the entrepreneurial commitment and credibility when startups leveraged their skills and capabilities by receiving debt or seeking partnerships, investors or other resources. The findings also show that external factors were common in the startup's early stages, but as it evolves, more internal factors are considered, and the startup has more freedom to make strategic decisions. The next section will go through each critical juncture and discuss the changes that occurred to understand how these changes assisted the startups during the development stages.

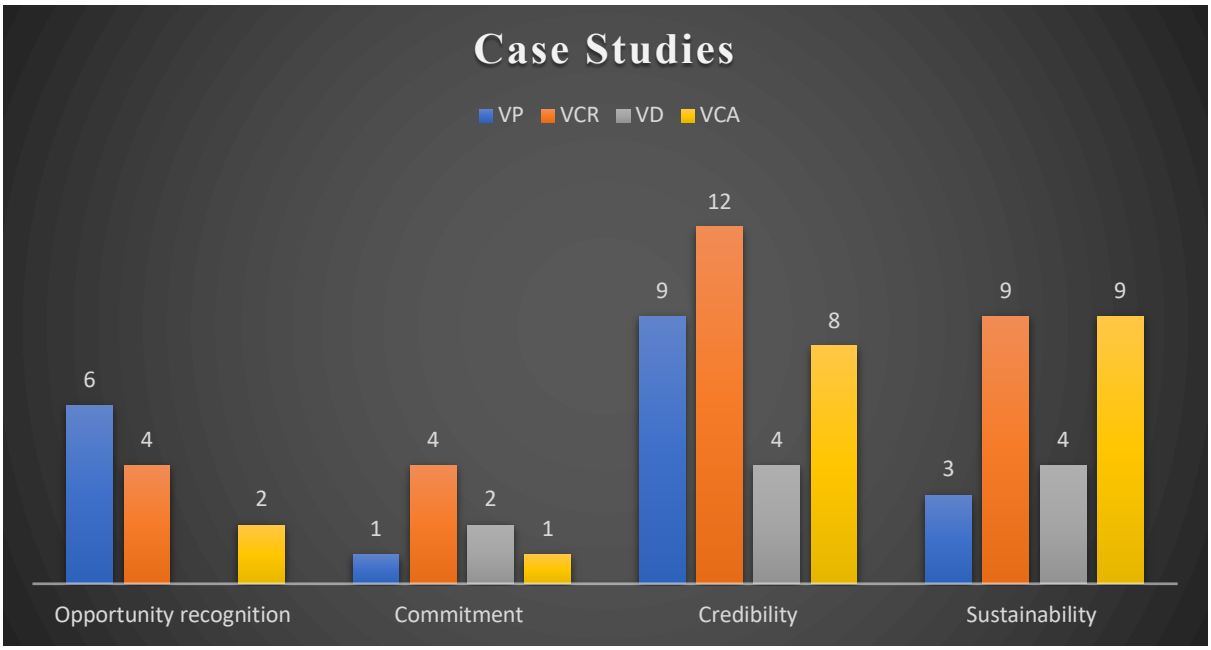

Figure 6.2 Business Models Changes to Navigate Critical Junctures

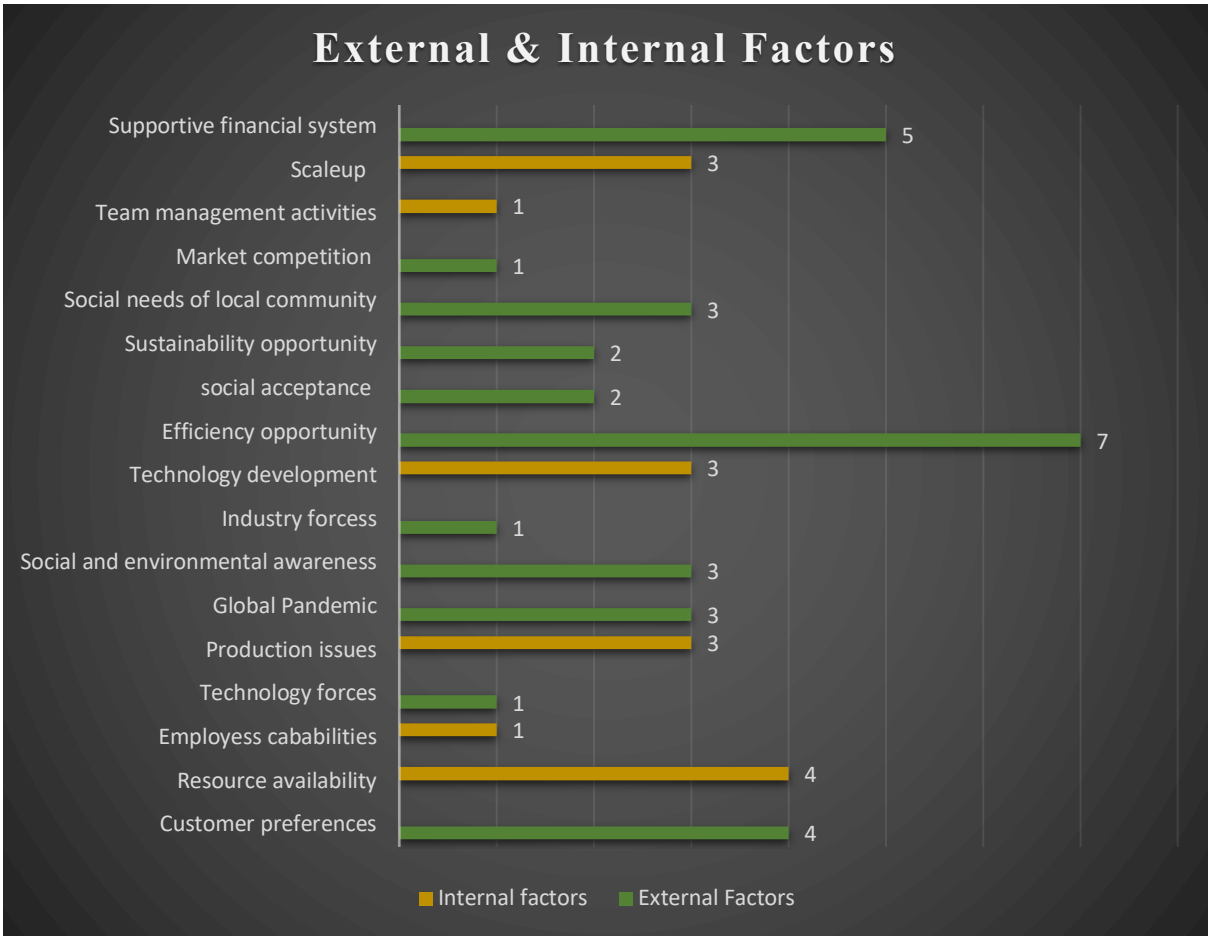

Figure 6.3 External and Internal Factors

Opportunity recognition:

Table 6.1 shows that the change in the opportunity recognition was due to external factors for all cases. When the founders could observe a problem or offer superior technology, the initial idea allowed them to bring the knowledge, network, skills, and funds to think commercially. The founders used their initial idea based in all cases on social or environmental problems, or on customer requirements to receive the traction required from other entrepreneurs, people, or incubators. Looking at the case of MO4, the founder could utilize his new algorithm to catch other engineers' attention, and finally, a co-founder with the required market knowledge wrote the business plan. SolarWorks also provides a similar example, while in the Ocean Cleanup case people increased internets in plastic pollution was the reason to bring the attention and start crowdfunding as seed funds.

Figure 6.2 indicates that the primary changes to pass the first critical juncture of opportunity recognition is to utilize the value proposition to address what the researcher lacks at the first stage. It is worth noting that the Ocean Cleanup used value creation as a primary change in the opportunity

recognition stage. When the idea spread, a volunteer team of 100 scientists and engineers sought to evaluate the approach suggested by the founder, allowing for second crowdfunding. The founder was able to collect seed funds and accelerate the transition to the next stage by verifying the process.

Entrepreneurial Commitment:

Uncertainties associated with using technology in a specific market segment or moving the firm beyond the idea stage necessitate the inventor's full-time and entire entrepreneurial commitment. Therefore, the founders at this stage sought to connect the industry network, seeking an investor, entrepreneurs, or a university that acts as a surrogate with essential skills and expertise. According to the case studies, the founders exploit the external and internal triggers to find out the venture champion that can move the startup into the business.

Figure 6.2 illustrates that value creation, including resources, activities, and stakeholders was the most component that has been used by the cases to navigate the entrepreneurial commitment. The origin of the change is different and could be by changing resources and utilizing partners, such as Buccaneer in the MO4 case, or Wageningen University in the AguroTech case to connect to the industry network and acquire knowledge. MO4 was able to open channels through the conferences to communicate with investors and customers. The change could also be by conducting market research to assess the social acceptance of the product as in the MIMIC case by connecting parties in Amsterdam to create a ghost company which assisted the startup to design the product and attract finance from the incubator. The Ocean Cleanup utilized value creation as well by assigning a supervisor to oversee the team management activities and make a solid entrepreneurial commitment to developing the venture, and later received funds from an investor. Finally, the value proposition was the main change in the case of SolarWorks due to customer demands for a product when addressing locals' requirements assisted the founder to design the power box and find a market application for the technology. Therefore, the main changes in the entrepreneurial commitment critical juncture were in value creation for all cases except for the SolarWorks case where the change was in the value proposition.

Credibility:

Looking at the origins of the changes in the credibility juncture, one can notice that most changes occurred in this juncture, but that is because some startups are still functioning in the credibility and are not yet in the sustainability yet. Additionally, figure 6.2 shows that the changes in the business models occurred mostly in the credibility juncture, while the changes in value creation were the most.

Efficiency opportunity is the external factor that occurred often at this critical juncture. This is because startups at this stage try to seize any opportunity and gain access to the resources needed for

the firm to start operating and earn credibility in the market. A supportive financial system is another external factor that occurred several times through partnerships or receiving grants and subsidies. The value capture changed accordingly to allow access to financial resources through strategic cooperation with other companies, receiving debt to develop technology or products, or subsidies and grants for working capital. The value capture changes a few times as well when the startups received governmental aid or changed their payment methods, as a response to the global pandemic. Other changes in the value capture were follow-ups when the startups were able to receive funds as part of their strategy to respond to production issues, or plastic waste by becoming efficient.

Value creation has mostly changed due to the external factor of efficiency opportunity. The startups seek to be more efficient at this stage regarding their technologies to provide proof of technological achievement. This could be done by partnerships with universities, other high-tech startups, or corporations to address matters in the technology itself, as in the SolarWorks case through collaborating with TU Delft, or to produce products required quickly to address environmental problems as in the Ocean Cleanup and AguroTech cases. SolarWorks changed it value creation to cooperate with Lemnis Lighting Launch and access to financial resources as a response to the external factor of supportive financial system. Other opportunities to overcome the credibility juncture is when the technology forces allowed MO4 to be recognized and seek skilled employees, and the later capabilities assisted the startup in collaborating with an established organization. To understand the guidelines and rules in the offshore industry, MO4 was able to join a consortium to deliver a system as part of a joint project and use its resources efficiently. The Ocean Cleanup changed its value creation four times to navigate the credibility juncture. First, by launching expeditions to discover the source of pollution, then developing the first interceptor, and finally as a response to production issues in the technologies by collaborating with universities and Maersk and launching a new system. The Ocean Cleanup was able to overcome the technical challenges and access R&D activities with different parties. Furthermore, MIMIC acknowledges that social acceptance of the products will secure access to the funds, and therefore it started market research to assess customer acceptance.

The value proposition experienced several changes during the credibility stage, although most changes were reactionary. Starting with the Ocean Cleanup, the firm was able to provide a new value proposition by exploiting the plastic ocean to create recycled items because of the efficiency opportunity. By solving the operational difficulties, the new value proposition helped the firm establish credibility and gain recognition for its efforts to clean up the ocean. Based on consumer demands, MIMIC modified the product offering and began selling it separately. The modification gave MIMIC the freedom to choose without consulting the incubator. AguroTech, on the other hand, modified its value proposition to offer a new solution that is more sophisticated and resolves the technical issues

with the prior solutions. Finally, in response to client requests, Noria Sustainable Innovators presented a new product and solution that is more effective in removing plastic from rivers.

At this point, the value delivery needed the least changes. MIMIC altered its resource allocation and established a sales channel for its products. Other adjustments in the value delivery were made as a result of follow-ups, such as SolarWorks that seized the chance to build a relationship with customers when a qualified employee joined the company or when the startup completely changed its business model in favor of lower costs, compete in the market, and reach new customer segments. As in the case of the Ocean Cleanup, a change might also occur when a business offers a new value proposition to efficiently utilize waste and produce new goods, or when access to funding enables the startup to build a client base.

We can see from the changes in the value proposition, creation, delivery, and capture that the startups benefited from the external and internal factors that influenced the changes. Startups must have access to funding, resources, collaborations, and clients in addition to demonstrating their technological prowess in order to get credibility.

Sustainability:

The critical juncture of sustainability is about the inability to reconfigure existing resources, humans and knowledge with new resources and information. Four startups among six cases that have been studied were able to achieve the sustainability juncture or functioning in the sustainable returns phase. MO4 and SolarWorks are high-performance startups, and now they are scaling up internationally. At this stage, the external and internal factors, according to table 6.1 are mostly different than those of previous junctures. This is because the startups are now mature enough to reconfigure the existing resources and knowledge with new ones. Efficiency opportunity and scaleup record the most external and internal factors that occurred. The internal factor of scaleup, originated twice in the MO4 case and once in the SolarWorks, while the external factor efficiency opportunity appeared two times in the MO4 case and once in the Ocean Cleanup. At the sustainability juncture, the value capture and value creation recorded the most changes, and that makes sense as the startup at this stage focuses on achieving sustainable returns and creating value from the appropriate resources, capabilities, and social capital

Regarding value creation, startups sought opportunities to be more efficient through using new knowledge, technologies, and information available. Therefore, they attempted to exploit these resources from other high-tech startups, or partnerships with established organizations to promote access to their global network as well. An example, MO4 acquired BMO to get access to its valuable data and partnered with Damen to use its platform and gather data that feeds MO4 analysis. The startup

is scaling up and extending its activities to China and India. The Ocean Cleanup also wanted to be more efficient in rapidly addressing plastic pollution and partnered with Konecranes. The market competition could also be a reason to change the startup's business model in favor of lower costs, new activities, and new strategy, as in the SolarWorks case, while the Ocean Cleanup exploit other big organizations' plans to participate positively in the environment and partnered with Kia. However, the value creation could be a secondary change at this critical juncture when a startup received funds and extended its activities, as in the SolarWorks and Noria Sustainable Innovators cases. The change could be due to an opportunity to increase access to sustainable energy, and SolarWorks was able to increase its human resources, investments, and business areas. On the other hand, the Ocean Cleanup launched its large-scale system to collect the plastic ocean, as a step to get access to more revenue in the future.

The value capture changed the most at this stage. SolarWorks changed this component three times as a primary change and once as a follow-up change. According to table 6.2, the startup secured access to capital investment and human resources by exploiting opportunities to increase its sustainability and scaleup, and boost revenues through expanding activities and business areas when a supportive financial system is received. MO4 also signed a 10-year contract to increase its activities overseas when the opportunity to scaleup allowed the company to sustain sustainable returns, while Noria Sustainable Innovators requested a loan to carry out projects aiming to establish customers and profit. However, the change in the value capture was also a follow-up change. This is when a startup achieved technology development and attracts new partners and funds, as in the Ocean Cleanup case, or offers a new payment method, as in the MO4 case. While SolarWorks had been treated by market competition and because of changing the whole business model, it changed the payment method to allow for more flexibility. Finally, the Ocean Cleanup accessed funds by exploiting the opportunity to partner with Kia.

MO4 increased its customer segments and changed the value delivery primary when it achieved a technology development. The change allowed the startup to function in the sustainability by securing profit and establishing a product-market fit. Other changes in the value delivery were follow-up changes. However, even the secondary changes were sometimes essential as in the SolarWorks case where the startup changed the whole business model and then extended its customer segments, channels and relationships, and when the startup received financial resources. Noria Sustainable Innovators attempted to achieve sustainable returns by carrying out projects to receive additional funds.

The least changeable component was the value proposition. The explanation for it is that the startups have already developed solutions and products in the credibility and wanted to focus on customers and financial resources. The only primary change in this component occurred in the Ocean Cleanup case when the startup harnesses its technology to provide access to finance and a global

network. However, some changes were follow-ups, when MO4 saw a potential to provide extended offerings as a result of efficiency opportunity or changing the business model accompanied by new products as in the SolarWorks case.

6.5 The Role of Decision-Making in The Technology-Based Startup Development Process

The previous results showed that the root cause of changes appears as opportunities the startup can seize or threats of technology-based startup development. The entrepreneur consciously utilizes these opportunities and threats to the startup's advantage. In some cases, the startup lacks a network to connect to the industry and overcome a factor related to a juncture, therefore entrepreneur sought an opportunity to change resources, or partnerships, by approaching a university or accelerator, and then the startup can reach professionals or communities in the field, change the key partners, and navigate the factor related to a juncture.

Table 6.2 illustrates that the type of change was often a forced change, and table 6.1 shows that the origin of change was external in the early stages, while less forced changes and more internal factors in the later stages when the startups have more room to make decisions. In the early stages, startup lack knowledge, resources, etc., and they capitalize on every opportunity or threat to overcome these challenges. During the development process and as the startup matures, the entrepreneur has greater power to make choices and access to funds, networks, and knowledge. The founding teams typically have less business expertise, forcing more changes to decisions made earlier in the process. As the founder acquires market knowledge, or the entrepreneur joins the team, academics with less experience continued their involvement with the company in a support role, reducing their interference in business decisions. This indicates that higher levels of experience (and therefore knowledge) of the management team allow them to minimize uncertainty in their business model decisions. Therefore, higher uncertainty related to knowledge is associated with a higher change in the business model elements. This statement is exemplified by AugroTech and the Ocean Cleanup cases. Because of the uncertainty associated with knowledge in technological development, the startups made several changes to their business model throughout the credibility juncture. Additionally, the results revealed that the performance of the startup depends on entrepreneurs' decisions regarding business model elements. In the MIMIC case, the entrepreneur was unable to make a decision apart from the incubator, and therefore the startup is still at a critical juncture of credibility.

7. Conclusion, Discussion, and Recommendation

7.1 Conclusion

The aim of this thesis is exploring the topic of business model change in the context of technology-based startups. In particular, it sought to explore four research questions: 1) What are the critical junctures that Dutch startups face during their development process? 2) What is the business model dynamics? 3) What is the role of business model dynamics in assisting the development process of technology-based startups? 4) How can we develop a dynamic business model framework to capture business model dynamics and to foster the development process of technology-based startups?

This chapter addresses the four research questions raised by synthesizing the main findings derived from the data analysis. This study includes data collected from 6 technology-based startups in the Netherlands.

Sub-Q1) What are the critical junctures that Dutch startups face during their development process?

The question has been answered thoroughly in the literature review section 2.1.1 Growth Phases and Critical Junctures. According to Vohora et al (2004), critical junctures are defined as "a complex problem that occurs at a point along a new high-tech venture's expansion path that prevents it from completing the transaction from one development phase to the next".

In figure 2.1, the phases and critical junctures are displayed in a diagram. Vohora et al (2004) identify five key stages in the growth of technology-based startups: 1) Research; 2) Opportunity framing; 3) Pre-organization; 4) Reorientation; and 5) Sustainable returns. Between each two phases there is a critical juncture. There are several factors that characterized these junctures and are categorized in table 2.2. In short, the junctures can be defined as:

1. Opportunity recognition: is the problem that arise from moving to the opportunity framing phase and is characterize by inability to transfer specific knowledge into a business project.
2. Entrepreneurial commitment: the problem lays at the interface of opportunity framing phase and pre-organizing phase. The juncture is characterized by the team's lack of entrepreneurial skills that are required to develop the startup.
3. Credibility: there are various obstacles to overcome to establish credibility, which is the ability of an entrepreneur to have access to and acquire the resources required to create a business (Vohora et al. 2004). The problem restrict access to financial and human resources, investors, customers, and suppliers when the startup fails to create a distinctive identity.
4. Sustainability: the critical juncture between the re-orientation phase and sustainable returns phase. The challenge here is to sustain the return over time while constantly re-configuring existing resources, capabilities, social capital, and professional skills with information, knowledge, and resources.

These critical junctures have deeply investigated to explore the factors related, and how they influence the development process of technology-based startups. Section 2.1.2 discussed the main factors associated with each critical juncture and how the startups could overcome them by utilizing resources.

Sub Q2) What are the business model dynamics?

The research literature on business models is extensive and dispersed, including a wide range of disciplines and topics. To avoid overwhelming the reader with information that is unrelated to the goals of this study, this review only includes literature that is directly related to the research topics. Because the business model literature is fragmented, a structured literature review is necessary to offer a clear viewpoint and to point out current shortcomings.

Following the study's research questions, it was evident from an examination of the business model literature that a sizable portion of it investigates "business models as snapshots in time," (De Reuver et al., 2009) while other streams focus on how business models change (e.g., business model evolution, adaptation). Business model dynamics is considered a critical enabler in attaining competitive performance gains in a rapidly changing environment (Desyllas & Sako, 2012). A business model can be created, extended, revised, and terminated in four stages (Cavalcante et al. 2011). Firms must assess the need for extension and revision, and if required, the termination of specific business models, in order to maintain a competitive advantage based on their business model (Cavalcante et al. 2011). Dynamism in this context can be defined as an organization’s capacity to identify the need to move beyond the initial establishment of a business model to its extension, change, and eventual termination (Cavalcante et al. 2011). After identifying these requirements, businesses should use their resources to modify their business models. As a result, a business model that goes through these stages is considered to be dynamic (Cavalcante et al. 2011).

Section 2.2.4 to section 2.2.7 studied business model change, innovation, and dynamics and how the terms have been used differently by researchers. According to the literature, it is important to study the business model change as one of many several terms that reflect a more dynamic approach to business models, and business model innovation that depicts the evolution of business models through time. Business model dynamics can be defined as a process of change in at least one or more components to enable the necessary response by the technology-based startup of external and internal factors. These factors influence the business model dynamics, and the changes result in navigating one or more factors related to the growth critical junctures.

Sub Q3) What is the role of business model dynamics in assisting the development process of technology-based startups?

The influence of business model dynamics on technology-based startups were discussed in the literature and later through case studies. According to section 2.3, the literature looked at the role of business model in the new technology-based startups and many authors explained the importance of defining an appropriate business model from the beginning, even though it is a challenging process, but it connects technology with achievement of economic value Chesbrough & Rosenbloom (2002).

Section 2.3.1, 2.3.2 and 2.3.3 provide ample evidence of the role of business model dynamics on the technology-based startups success and performance. The performance of technology-based startups is significantly impacted by selecting the appropriate initial business model configuration (Chesbrough & Rosenbloom, 2002) or design (Zott & Amit, 2007) and managing its adaption over time. Kaplan et al. (2009) assert that early phases are particularly crucial for business model change. Few empirical research, however, have examined the relationship between performance and business model change (e.g., Malone et al., 2006). According to Andries & Debackere (2007), the industry and company's history both affect how well technology-based startups adapt to change. They contend that adaptability is advantageous in young, fast-paced sectors but detrimental in older, more established ones. Furthermore, compared to independent new technology ventures, new technology business divisions of existing enterprises have greater levels of adaption quality.

However, according to the cases studies, it appears that teams with less management, entrepreneurial, and market knowledge struggle more to establish a viable business model. And this difficulty translates into more business model changes, which seems to be associated with lower performance as the startups are not in the sustainable returns stage yet. Additionally, data reveals that technology-based startups tend to interact early with partners and stakeholders, such as potential customers and industry experts, and perform necessary changes to reach a viable business model and initiate businesses. Startups in the early stages of development referred often to resource constraints, including financial and human resources, market and entrepreneurial knowledge and partners. Therefore, the startups tried to implement coping strategies that trigger a higher number of business model change.

Accordingly, the changes in the business model are triggered by internal and external factors that may form drivers or hindrances to the startup’s performance. The startups that have been successful till now, acknowledge the importance of utilizing these changes and factors to navigate critical junctures. Even though the internal or external factors threatened the development process, the startups were able to change one or more components, and tickle one or more factors related to critical junctures.

The availability of resources, particularly financial and human capital, is one of the factors influencing business model changes.

4) How can we develop a dynamic business model framework to capture business model dynamics and to foster the development process of technology-based startups?

Different business model frameworks have been developed recently, and mostly to capture the changes in the business model of specific industry. However, this thesis aimed to investigate the dynamics of the business model and how to apply these changes in favor of navigating critical junctures during the development process. The conceptual framework has been thoroughly described in the section 5 (Conceptual Framework). Looking at the most comprehensive framework that has been developed recently by Meslin (2019) and later modified Kamp et al. (2021), six considerations introduced to develop such a framework. However, these considerations are updated for the new proposed framework including new considerations; 1) four main components instead of three of sustainable business model, 2) the timeline of the growth stages of the technology-based startups, 3) growth stages are identified in the framework, 4) critical junctures are identified in the framework.

After updating the consideration, the framework looked at the completeness, interrelationships, and changes over time, as explained by Khodaei and Ortt (2019). Starting with completeness, the main categories of business model canvas presented by Osterwalder & Pigneur (2010) are grouped into four main components based on the framework proposed by (Bocken et al., 2018). Then, the external and internal factors that may affect business model components are grouped and categorized in table 3.2. Then, the framework looked at the interrelationships between business model components, and examples of these relationships are collected from the literature and categorized in table 3.4, while the type of these relationships as forced or choice, primary or secondary changes are explained in table 3.3. Finally, the framework looked at the changes over time in order to sustain consistency. The new framework included the critical junctures representations to allow the reader to understand how the changes occurred in each stage to navigate the critical juncture.

RQ: How can business model dynamics help Dutch Technology- based startups overcome growth critical junctures?

The aim of the thesis is to investigate the dynamics of business model in technology-based startups and how the change of a particular component could influence other factors related to the critical junctures. The thesis started with a structured literature review to deeply understand the root cause of critical junctures. In the literature, there are few studies related to the critical juncture and stage-based model. However, the main papers used to investigate the growth stages and junctures are by Vohora et al (2004) and Khodaei et al. (2020). To depict a full picture of the root cause, factors, and

all aspects related to the juncture, the most used models related to each juncture are discussed and the factors are grouped in a table to link them later to the business model.

Following the structured literature review, the business model is from two different views: static and dynamic. The "static" studies often go into greater detail on business model definitions and the components that make it up. They are significant historically as well since they were the first business model research studies to be published. These studies, however, do not use research methodologies that capture business model dynamics, and as a result, they are unable to explain how business models change. The "dynamic" research, on the other hand, shed some light on how business models evolve through time. The thesis attempts to explore the dynamics of business model in the entrepreneurial context as these startups combine uncertainty with low market and business knowledge, thus performing several business model changes to survive.

By developing a conceptual framework with the capability to capture the changes in the business model, timeline, and critical junctures, the internal and external factors influenced the changes in technology-based startups' business models during the growth stages of development, and therefore the critical junctures associated. To illustrate, the framework shows that startups were able to take advantage of these changes in a way that allows them to pass a specific factor related to the critical juncture. Some startups showed abilities to adapt their components to navigate critical junctures more efficiently, compared to other startups. These startups use strategies more efficiently to cope with threats like resource constraints, for example, than other startups. Additionally, the framework depicted changes in some startups more than others. These startups performed poorer in the early stages of development than other startups. This assumption has been noticed when comparing MO4 and SolarWorks which are performing well and are now in the sustainable returns phase, to the Ocean Cleanup and other startups that are still in sustainability and credibility junctures. Well-performed startups received knowledge and resources in the early stages, allowing for more drivers to seize opportunities to expand and scaleup, while startups with poor performance exhibited more barriers that influenced the changes in their business models. Therefore, the framework could be used for future research to deeply investigate the firm's performance and the relationship to business model dynamics.

The framework shows that there are some components change more often than others in some stages of development. For example, to overcome the opportunity recognition, the main change for case studies was the value proposition, while in the credibility the changes mostly occurred in the value creation. Also, the type of changes was always forced and external in the early stages; as the startup matures, it allows for room for internal and strategic choices. Thus, technology-based startups in the research stage seize any opportunity, to introduce their ideas, that appeal to entrepreneurs with market knowledge. In credibility, drivers to change business model components are utilized to access investors,

partners, networks, etc., whereas barriers, like production issues, allow startups to provide proof of economic, technological, and operational activities by adapting the business model efficiently.

The results showed that the framework is able to link the decision-making process to the changes in the business model. Higher levels of experience in the management team allow them to minimize uncertainty in their business model decisions and experience fewer changes in the business model than other startups with low levels of experience. Therefore, the developed framework was able to capture the dynamics of the business model as well as assist the Dutch technology-based startups in their development process to overcome the junctures.

7.2 Discussion

The elements of the business model canvas presented by Osterwalder & Pigneur (2010) are categorized and grouped into four main components based on the framework proposed by Meslin (2019), Kamp et al. (2021), and Xu (2022), which served as the foundation for the business model dynamics developed in the conceptual framework (Bocken et al., 2018). The newly updated considerations included the timeline, growth stages, and critical junctures based on the stage-based model proposed by Vohora et al. (2004).

To validate and refine the framework, some explorative case studies have been conducted. Theoretically, the business model framework is not a complete representation. Some simplifications of the conceptual model were necessary to draw conclusions from the case studies based on the complexity of the dynamics of the business model. The elements are not complete and cannot be generalized for all technology-based startups. These startups come from many industries, and each of them had a unique pattern in identifying resources, strategies, and associated obstacles during the growth phases. By narrowing down the scope, we can be assertive and able to define the elements of a specific industry and the changes in the business model, and therefore the results would be meaningful.

In opportunity recognition juncture, the common factor was lack of market and entrepreneurial knowledge for all startups. In the entrepreneurial commitment, market knowledge and network were the common obstacles, while in the credibility financial resources and technological development were the main challenges. Finally, in sustainability, financial and human resources and developing new business areas caused the main challenges to scaleup. The root cause or origin of changes in business model were mostly because of changes in resources. That is confirmed by Vohora et al. (2004) research about financial, human, infrastructure, knowledge etc., for early-stage startups. Efficiency opportunity is the origin of change that is also occurred many times when startups seek to be more efficient and

access knowledge and network through collaboration or partnerships. Xu (2022), and Meslin (2019) in their thesis found that this origin occurred frequently when firms seek partnership.

The results also showed that in early stages of development, the changes are often forced, while in later stages the startups have more room to make strategic decision. This is explained as when the firms mature, they have access to funds and resources more than in the early stages. Kamp et al., (2021) and Xu, (2022) captured the changes in the business model when the firm is already in sustainable returns stage, therefore this research explains the main changes occurred in the early stages of development. Also, external factors were more responsible for changes in the early stages than internal factors, which were more noticeable at the credibility and sustainability junctures.

Looking at the changes in the business models of case studies, one can notice that value proposition constantly changed in the opportunity recognition juncture to attract knowledge, funds, or network, and to avoid the lack of resources. In the entrepreneurial commitment juncture, value creation changed the most. This indicates that founders sought to connect the industry network, seeking an investor, entrepreneurs, or a university that acts as a surrogate with essential skills and expertise. In credibility, value creation changed more than other components, and changes often happened due to the external factor of efficiency opportunity. In sustainability, the changes were mostly between value creation and value capture, and due to the efficiency opportunity and scaleup factors. These results confirm Kamp et al. (2021) findings that changes in the business model can be made to open up opportunities or avoid threats. For example, in opportunity recognition, the changes were done to open up opportunities to attack knowledge or funds and avoid the lack of resources, while in sustainability to expand the business, achieve technology progress and avoid market competition. In total, value creation changed the most in all critical junctures, while value delivery was the least to change.

Regarding to new technologies in a specific sector, startups showed high levels of changes in business models in the credibility juncture compared to other startups. Startups that are the first movers to a specific market faced technological challenges and were required to provide proof of their credibility. Additionally, startups that achieved sustainable returns performed well compared to other startups and changed their business model often to seize opportunities rather than to avoid barriers. Startups with early access to knowledge and resources were better able to embrace opportunities for expansion and scaleup, while startups with poor performance confronted challenges that influenced the changes in their business models. Higher levels of knowledge of the management team allow them to minimize uncertainty in their business model decisions and perform fewer changes in the business model. This statement needs further investigation for startups in the same industry. Also, the results revealed that the performance of the startup depends on entrepreneurs' decisions regarding business

model elements, which emphasizes the importance of expertise and the need to make decisions independently of an incubator.

7.3 Practical Implications

7.3.1 For Entrepreneurs

This report exhorts entrepreneurs to start careful planning as early as possible, even before establishing their business. Additionally, it is urged that entrepreneurs engage with stakeholders frequently and early to evaluate their assumptions about the viability of their models. Early stakeholder participation in this approach offers helpful feedback for further modifications of the business model. As a result, the initial planned business model consolidates more quickly, and the business model and goals are more stable throughout subsequent phases of startup development. Even while having a sound strategy is important, entrepreneurs should be cautious of contingencies. Entrepreneurs should assess the potential value of any unexpected opportunities and consider adjusting the plan if necessary.

High levels of market knowledge, management expertise, and entrepreneurial knowledge are also emphasized in the study. Entrepreneurs should think about developing or acquiring the necessary knowledge if they do not have it. By employing individuals with complementary abilities, the acquisition may become a reality. These individuals may be incorporated into executive or non-executive roles, such as advisory boards. This consequence highlights the significance of team composition diversity for technological commercialization operations even more.

Entrepreneurs are highly advised to form several partnerships with a variety of actors. Additionally, they need to actively seek out and value cooperation in a variety of activities. This vast network of partnerships makes it easier to get resources, which eases resource shortages. The main partner element undergoes more modifications as a result of this exercise, but performance levels are higher. Finally, the findings of this study may have implications for a larger population of entrepreneurs or managers who are attempting to modify their business models amid conditions of significant market and technological uncertainty.

7.3.2 For Incubators

Incubators should enable access to a variety of networks and encourage the formation of both private and public partnerships with various players to collaborate on a variety of projects (Siegel, 2009). Aspiring academic entrepreneurs should be encouraged by incubators to do strategic planning and business model testing. Interacting with stakeholders like consumers and industry networks should be highly encouraged for entrepreneurs. University programs that aim to develop entrepreneurs should also emphasize the fact that the earlier and more intense the connection, ideally prior to the business

incorporation, the better. This involvement may be made easier by creating a link to a network of prospective stakeholders to supplement the normal scientific networks of academic entrepreneurs and, more broadly, by offering resources to support entrepreneurship in all of its forms (Shah & Pahnke, 2014).

7.4 Theoretical Contribution

The paper establishes a direct link between business model change and critical junctures in the development process of technology-based startups and captures the changes on a comprehensive framework. By pinpointing the growth critical junctures associated with the growth stages of startups, this study adds to the body of literature on business model dynamics, which focuses on the development process of technology-based startups. Additionally, this thesis established novel connections between specific dimensions related to these junctures, such as market knowledge, management expertise, entrepreneurial knowledge, and the frequency of business model change.

The need for a deeper understanding of how business models change at the element level (e.g., value proposition) has been voiced frequently by business model researchers (George & Bock, 2011; Morris et al., 2006). Therefore, this study adds to the body of research on business models by providing more detailed knowledge of how each component of a business model changes over time. Additionally, it establishes relationships between the development of technology-based startups, the dynamics of a business model element, and the growth critical junctures. By suggesting a relationship between business model change and entrepreneurial startup performance, it also makes a theoretical contribution to the literature on business models.

7.5 Recommendations for Future Research

It is recommended to narrow the scope of the study for future investigations of business model dynamics and critical junctures. Focusing on a specific sector or industry would allow the researcher to draw a common business model canvas and establish a strong relationship between business model elements, critical junctures, and firm performance.

In terms of firm performance and business model dynamics, it is recommended to focus on the stability and the number of changes in business models in a specific industry. Higher levels of experience and knowledge are assumed to perform better at removing uncertainty. For future research, longitudinal study and complex dynamics of more elements can enable tracking of the important changes in the business model that allow navigating critical junctures, as well as the relationship between startup performance and business model changes.

7.6 Limitations of The Study

The generalizability of this study's findings to a wider environment is a primary problem that affects any case study research. The study was conducted in the context of technology-based startups in the Netherlands. As mentioned earlier, the context of technology-based startups should be limited to a specific industry to allow for comparable results of the development process and related junctures. Some startups are not yet in the sustainability stage, and therefore the compression for this critical juncture is insufficient.

The interviewees occasionally had a lot of trouble recalling how different components of their business models had changed. And periodically, throughout the course of the interview, they would recall more modifications to the business model that had occurred. I also came to the conclusion that occasionally the respondents were not even aware of certain changes. Additionally, because they viewed it as sensitive and wished to protect their businesses, the interviewees may have sometimes consciously withheld information about the business model change. I was informed of these omissions in some instances, but at other times I would not even be aware that the information was being omitted. Finally, some interviews were short, and interviewees would often rush through the interviews, while some interviewees were willing to dedicate more time and thus might have provided more detailed information.

7.7 Framework Development

Figure 7.1 shows the main steps to develop a business model dynamics framework including the growth stages and critical junctures.

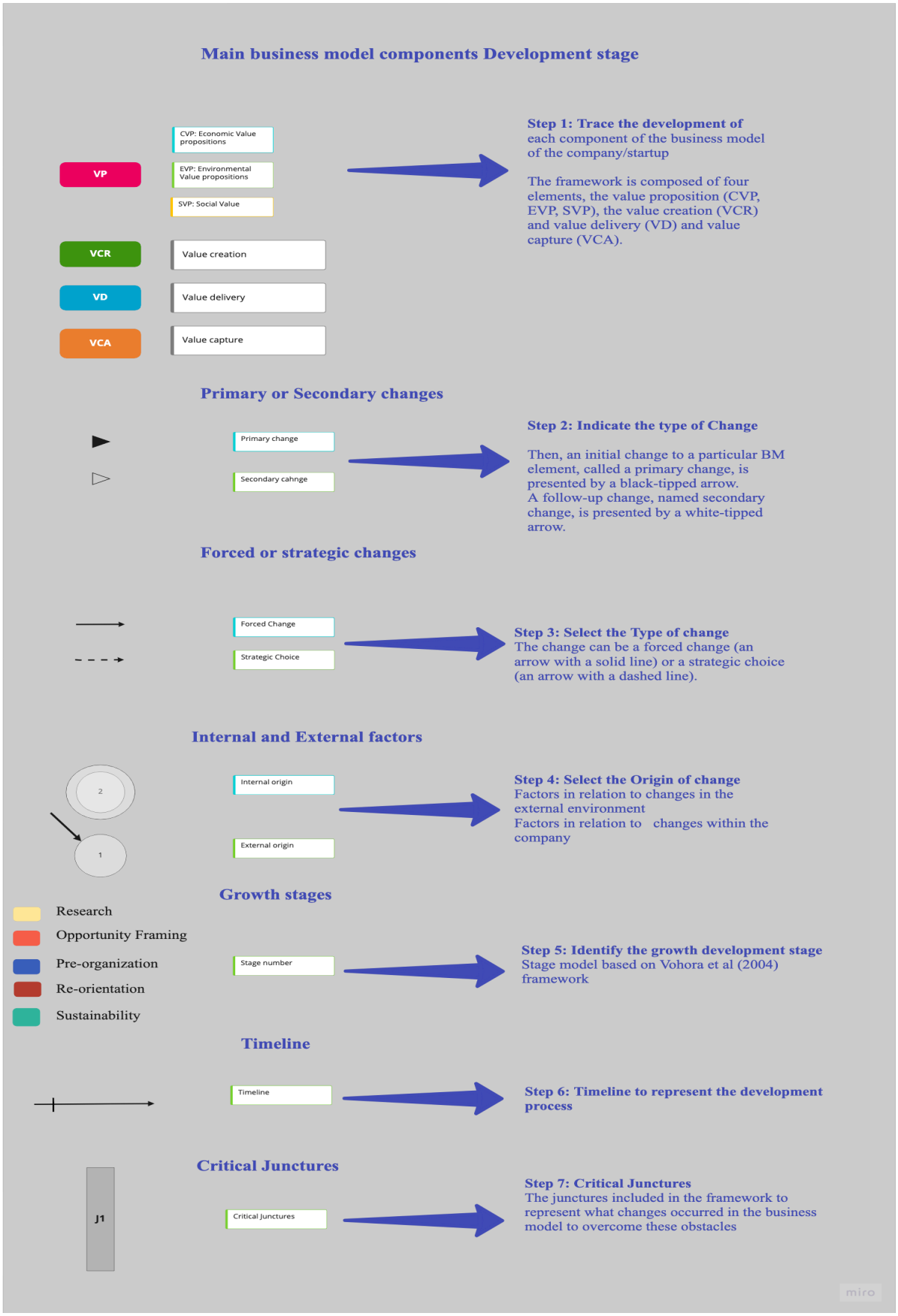

Figure 7.1 Business Model Development Stage

Miro link: https://miro.com/app/board/uXjVO8eEHXI=/?share_link_id=139119056149

Bibliography

1) Aagaard, A. (2018). Sustainable Business Models. *Springer International Publishing Ag.*

2) Achtenhagen, L., Melin, L., & Naldi, L. (2013). Dynamics of Business Models – Strategizing, Critical Capabilities and Activities for Sustained Value Creation. *Long Range Planning*, *46*(6), 427–442. https://doi.org/10.1016/j.lrp.2013.04.002

3) Acta Marine. (2020). Offshore Operational Advisory System. Https://Www.Actamarine.Com/Nieuws/220/Offshore-Operational-Advisory-System.

4) Ahokangas, P., & Myllykoski, J. (2014). The Practice of Creating and Transforming a Business Model. *Journal of Business Models*, *2*, 6–18. https://doi.org/10.5278/ojs.jbm.v2i1.719

5) Aldrich, H., & Zimmer, C. (1986). Entrepreneurship through Social Networks. In D. Sexton, & R. Smilor (Eds.), The Art and Science of Entrepreneurship. *Cambridge, MA: Ballinger Publishing Company.*, 3–23.

6) Amit, R., & Zott, C. (2012). Creating Value Through Business Model Innovation. *MIT Sloan Management Review*, *53*, 41–49.

7) Andries, P., & Debackere, K. (2006). Adaptation in new technology-based ventures: Insights at the company level. *International Journal of Management Reviews*, *8*(2), 91–112. https://doi.org/10.1111/j.1468-2370.2006.00122.x

8) Andries, P., & Debackere, K. (2007). Adaptation and Performance in New Businesses: Understanding the Moderating Effects of Independence and Industry. *Small Business Economics*, *29*(1–2), 81–99. https://doi.org/10.1007/s11187-005-5640-2

9) Andries, P., Debackere, K., & van Looy, B. (2013). Simultaneous Experimentation as a Learning Strategy: Business Model Development Under Uncertainty. *Strategic Entrepreneurship Journal*, *7*(4), 288–310. https://doi.org/10.1002/sej.1170

10) Anokhin, S., & Wincent, J. (2012). Start-up rates and innovation: A cross-country examination. *Journal of International Business Studies*, *43*(1), 41–60. https://EconPapers.repec.org/RePEc:pal:jintbs:v:43:y:2012:i:1:p:41-60

11) Ansoff, I. (1972). Strategies for diversification. *Harvard Business Review*, *35*(5), 113–124. https://doi.org/10.1016/0024-6301(72)90048-9

12) Ardichvili, A., & Cardozo, R. N. (2000). A model of the entrepreneurial opportunity recognition process. *Journal of Enterprising Culture*, *08*(02), 103–119. https://doi.org/10.1142/S0218495800000073

13) Ardichvili, A., Cardozo, R., & Ray, S. (2003). A theory of entrepreneurial opportunity identification and development. *Journal of Business Venturing*, *18*(1), 105–123. https://doi.org/10.1016/S0883-9026(01)00068-4

14) Åström, J., Reim, W., & Parida, V. (2022). Value creation and value capture for AI business model innovation: a three-phase process framework. *Review of Managerial Science*. https://doi.org/10.1007/s11846-022-00521-z

15) Audretsch, D. B., Houweling, P., & Thurik, A. R. (2000). Firm Survival in the Netherlands. *Review of Industrial Organization*, *16*(1), 1–11. https://doi.org/10.1023/A:1007824501527

16) Audretsch, D. B., & Keilbach, M. (2004). Entrepreneurship and regional growth: an evolutionary interpretation. *Journal of Evolutionary Economics*, *14*(5), 605–616. https://doi.org/10.1007/s00191-004-0228-6

17) Audretsch, D., & Mahmood, T. (1995). New Firm Survival: New Results Using a Hazard Function. *The Review of Economics and Statistics*, *77*(1), 97–103. https://EconPapers.repec.org/RePEc:tpr:restat:v:77:y:1995:i:1:p:97-103

18) Auer, C., & Follack, M. (2002). Using Action Research for Gaining Competitive Advantage out of the Internet, s Impact on Existing Business Models. *Bled EConference*.

19) Baden-Fuller, C., & Haefliger, S. (2013). Business Models and Technological Innovation. *Long Range Planning*, *46*(6), 419–426. https://doi.org/10.1016/j.lrp.2013.08.023

20) Bankvall, L., Dubois, A., & Lind, F. (2017). Conceptualizing business models in industrial networks. *Industrial Marketing Management*, *60*, 196–203. https://doi.org/10.1016/j.indmarman.2016.04.006

21) Bellman, R., Clark, C. E., Malcolm, D. G., Craft, C. J., & Ricciardi, F. M. (1957). On the Construction of a Multi-Stage, Multi-Person Business Game. *Operations Research*, *5*(4), 469–503. https://doi.org/10.1287/opre.5.4.469

22) Birley, S., & Norburn, D. (1985). Small vs. Large Companies: The Entrepreneurial Conundrum. *Journal of Business Strategy*, *6*(1), 81–87. https://doi.org/10.1108/eb039103

23) Bocken, N. M. P., Rana, P., & Short, S. W. (2015). Value mapping for sustainable business thinking. *Journal of Industrial and Production Engineering*, *32*(1), 67–81. https://doi.org/10.1080/21681015.2014.1000399

24) Bocken, N. M. P., Schuit, C. S. C., & Kraaijenhagen, C. (2018). Experimenting with a circular business model: Lessons from eight cases. *Environmental Innovation and Societal Transitions*, *28*, 79–95. https://doi.org/10.1016/j.eist.2018.02.001

25) Bocken, N. M. P., & Short, S. W. (2016). Towards a sufficiency-driven business model: Experiences and opportunities. *Environmental Innovation and Societal Transitions*, *18*, 41–61. https://doi.org/10.1016/j.eist.2015.07.010

26) Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, *65*, 42–56. https://doi.org/10.1016/j.jclepro.2013.11.039

27) Bocken, N., Short, S., Rana, P., & Evans, S. (2013). A value mapping tool for sustainable business modelling. *Corporate Governance: The International Journal of Business in Society*, *13*(5), 482–497. https://doi.org/10.1108/CG-06-2013-0078

28) Boeker, W., & Wiltbank, R. (2005). New Venture Evolution and Managerial Capabilities. *Organization Science*, *16*(2), 123–133. https://doi.org/10.1287/orsc.1050.0115

29) Bohnsack, R., Pinkse, J., & Kolk, A. (2014). Business models for sustainable technologies: Exploring business model evolution in the case of electric vehicles. *Research Policy*, *43*(2), 284–300. https://doi.org/10.1016/j.respol.2013.10.014

30) Boons, F., & Lüdeke-Freund, F. (2013). Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. *Journal of Cleaner Production*, *45*, 9–19. https://doi.org/10.1016/j.jclepro.2012.07.007

31) Bower, D. J. (2003). Business model fashion and the academic spinout firm. *R and D Management*, *33*(2), 97–106. https://doi.org/10.1111/1467-9310.00285

32) Brogan, P. V., Best, R., Morrow, J., Duncan, R., & Kubik, M. (2020). Stacking battery energy storage revenues with enhanced service provision. *IET Smart Grid*, *3*(4), 520–529. https://doi.org/10.1049/iet-stg.2018.0255

33) Bryant, S. (2022). How Many Startups Fail and Why? *Investopedia.*

34) Burgelman, R. A. (1985). Managing the new venture division: Research findings and implications for strategic management. *Strategic Management Journal*, *6*(1), 39–54. https://doi.org/10.1002/smj.4250060104

35) Burt, R. S. (1992). Structural Holes: The Social Structure of Competition. *Harvard University Press, Cambridge, MA.* https://doi.org/10.2307/3322456

36) Carlsson, B., & Fridh, A.-C. (2002). Technology transfer in United States universities. *Journal of Evolutionary Economics*, *12*(1–2), 199–232. https://doi.org/10.1007/s00191-002-0105-0

37) Carucci, R. (2016). Midsize Companies Shouldn't Confuse Growth with Scaling. *Harvard Business Review*, *94(4)*, 2–4.

38) Casadesus-Masanell, R., & Ricart, J. E. (2010). Competitiveness: Business Model Reconfiguration for Innovation and Internationalization. *Management Research: Journal of the Iberoamerican Academy of Management*, *8*, 123–149.

39) Casadesus-Masanell, R., & Ricart, J. E. (2011). How to design a winning business model. *Harvard Business Review*, *89(1-2)*, 100–107.

40) Cavalcante, S., Kesting, P., & Ulhøi, J. (2011). Business model dynamics and innovation: (re)establishing the missing linkages. *Management Decision*, *49*(8), 1327–1342. https://doi.org/10.1108/00251741111163142

41) Cefis, E., & Marsili, O. (2005). A matter of life and death: innovation and firm survival. *Industrial and Corporate Change*, *14*(6), 1167–1192. https://EconPapers.repec.org/RePEc:oup:indcch:v:14:y:2005:i:6:p:1167-1192

42) Chen, S., Chen, H. H., & Shen, T. (2020). Suitable business models for innovation in different levels of the smart grid energy industry. *Environmental Progress & Sustainable Energy*, *39*(1), 13275. https://doi.org/10.1002/ep.13275

43) Chen, Y., Visnjic, I., Parida, V., & Zhang, Z. (2021). On the road to digital servitization – The (dis)continuous interplay between business model and digital technology. *International Journal of Operations & Production Management*, *41*(5), 694–722. https://doi.org/10.1108/IJOPM-08-2020-0544

44) Chesbrough, H. (2007). Business model innovation: it's not just about technology anymore. *Strategy & Leadership*, *35*(6), 12–17. https://doi.org/10.1108/10878570710833714

45) Chesbrough, H. (2010). Business Model Innovation: Opportunities and Barriers. *Long Range Planning*, *43*(2–3), 354–363. https://doi.org/10.1016/j.lrp.2009.07.010

46) Chesbrough, H., & Rosenbloom, R. S. (2002). The Role of the Business Model in Capturing Value from Innovation: Evidence from Xerox Corporation's Technology Spin-Off Companies. *Industrial and Corporate Change*, *11*, 529–555.

47) Chou, C.-J., Chen, C.-W., & Conley, C. (2015). Creating Sustainable Value Through Service Offerings. *Research-Technology Management*, *58*, 48–55.

48) Clarysse, B., & Moray, N. (2004). A process study of entrepreneurial team formation: the case of a research-based spin-off. *Journal of Business Venturing*, *19*(1), 55–79. https://doi.org/10.1016/S0883-9026(02)00113-1

49) Clarysse, B., Wright, M., & van de Velde, E. (2011). Entrepreneurial Origin, Technological Knowledge, and the Growth of Spin-Off Companies. *Journal of Management Studies*, *48*(6), 1420–1442. https://doi.org/10.1111/j.1467-6486.2010.00991.x

50) Cohen, B. (2006). Sustainable valley entrepreneurial ecosystems. *Business Strategy and the Environment*, *15*(1), 1–14. https://doi.org/10.1002/bse.428

51) Conceição, O., Fontes, M., & Calapez, T. (2012). The commercialisation decisions of research-based spin-off: Targeting the market for technologies. *Technovation*, *32*(1), 43–56. https://doi.org/10.1016/j.technovation.2011.07.009

52) Cosenz, F., & Noto, G. (2018). A dynamic business modelling approach to design and experiment new business venture strategies. *Long Range Planning*, *51*(1), 127–140. https://doi.org/10.1016/j.lrp.2017.07.001

53) Costa, C., Fontes, M., & Heitor, M. v. (2004). A methodological approach to the marketing process in the biotechnology-based companies. *Industrial Marketing Management*, *33*(5), 403–418. https://doi.org/10.1016/j.indmarman.2003.08.016

54) Cusumano, M. A. (2013). Evaluating a startup venture. *Communications of the ACM*, *56*(10), 26–29. https://doi.org/10.1145/2505337

55) DaSilva, C. M., & Trkman, P. (2014). Business Model: What It Is and What It Is Not. *Long Range Planning*, *47*(6), 379–389. https://doi.org/10.1016/j.lrp.2013.08.004

56) De Reuver, M., Bouwman, H., & Maclnnes, I. (2009). Business model dynamics: a case survey. *Journal of Theoretical and Applied Electronic Commerce Research*, *4*(1). https://doi.org/10.4067/S0718-18762009000100002

57) De Reuver, M., & Haaker, T. (2009). Designing viable business models for context-aware mobile services. *Telematics and Informatics*, *26*(3), 240–248. https://doi.org/10.1016/j.tele.2008.11.002

58) Degroof, J.-J., & Roberts, E. B. (2004). Overcoming Weak Entrepreneurial Infrastructures for Academic Spin-Off Ventures. *The Journal of Technology Transfer*, *29*(3/4), 327–352. https://doi.org/10.1023/B:JOTT.0000034126.23592.23

59) Demil, B., & Lecocq, X. (2010). Business Model Evolution: In Search of Dynamic Consistency. *Long Range Planning*, *43*(2–3), 227–246. https://doi.org/10.1016/j.lrp.2010.02.004

60) Dencker, J. C., & Gruber, M. (2015). The effects of opportunities and founder experience on new firm performance. *Strategic Management Journal*, *36*(7), 1035–1052. https://doi.org/10.1002/smj.2269

61) Desyllas, P., & Sako, M. (2013). Profiting from business model innovation: Evidence from Pay-As-You-Drive auto insurance. *Research Policy*, *42*(1), 101–116. https://doi.org/10.1016/j.respol.2012.05.008

62) Doz, Y. L., & Kosonen, M. (2010). Embedding Strategic Agility. *Long Range Planning*, *43*(2–3), 370–382. https://doi.org/10.1016/j.lrp.2009.07.006

63) Druilhe, C., & Garnsey, E. (2004). Do Academic Spin-Outs Differ and Does it Matter? *The Journal of Technology Transfer*, *29*(3/4), 269–285. https://doi.org/10.1023/B:JOTT.0000034123.26133.97

64) Elfring, T., & Hulsink, W. (2003). Networks in Entrepreneurship: The Case of High-technology Firms. *Small Business Economics*, *21*(4), 409–422. https://doi.org/10.1023/A:1026180418357

65) Elkington, J. (1997). The triple bottom line. *Environmental management: Readings and cases, 2*.

66) Eveleens, C. P., van Rijnsoever, F. J., & Niesten, E. M. M. I. (2017). How network-based incubation helps start-up performance: a systematic review against the background of management theories. *The Journal of Technology Transfer*, *42*(3), 676–713. https://doi.org/10.1007/s10961-016-9510-7

67) Fielt, E. (2014). Conceptualising Business Models: Definitions, Frameworks and Classifications.

68) Fini, R., Grimaldi, R., & Sobrero, M. (2009). Factors fostering academics to start up new ventures: an assessment of Italian founders' incentives. *The Journal of Technology Transfer*, *34*(4), 380–402. https://doi.org/10.1007/s10961-008-9093-z

69) Fleta-Asín, J., & Muñoz, F. (2021). Renewable energy public–private partnerships in developing countries: Determinants of private investment. *Sustainable Development*, *29*(4), 653–670. https://doi.org/10.1002/sd.2165

70) Foss, N. J., & Saebi, T. (2015). *Business Model Innovation: The Organizational Dimension*. Oxford University Press.

71) Foss, N. J., & Saebi, T. (2017). Fifteen Years of Research on Business Model Innovation: How Far Have We Come, and Where Should We Go? *Journal of Management*, *43*(1), 200–227. https://doi.org/10.1177/0149206316675927

72) Frankenberger, K., Weiblen, T., Csik, M., & Gassmann, O. (2013). The 4I-framework of business model innovation: a structured view on process phases and challenges. *International Journal of Product Development*, *18*(3/4), 249. https://doi.org/10.1504/IJPD.2013.055012

73) Gabriel, C.-A., & Kirkwood, J. (2016). Business models for model businesses: Lessons from renewable energy entrepreneurs in developing countries. *Energy Policy*, *95*, 336–349. https://doi.org/10.1016/j.enpol.2016.05.006

74) Garnsey, E. (1998). A Theory of the Early Growth of the Firm. *Industrial and Corporate Change*, *7*(3), 523–556. https://doi.org/10.1093/icc/7.3.523

75) Gassmann, O., Frankenberger, K., & Csik, M. (2013). The St. Gallen business model navigator. *Working Paper University of St.Gallen*.

76) Geissdoerfer, M., Bocken, N. M. P., & Hultink, E. J. (2016). Design thinking to enhance the sustainable business modelling process – A workshop based on a value mapping process. *Journal of Cleaner Production*, *135*, 1218–1232. https://doi.org/10.1016/j.jclepro.2016.07.020

77) Geissdoerfer, M., Vladimirova, D., & Evans, S. (2018). Sustainable business model innovation: A review. *Journal of Cleaner Production*, *198*, 401–416. https://doi.org/10.1016/j.jclepro.2018.06.240

78) George, G., & Bock, A. J. (2011). The Business Model in Practice and its Implications for Entrepreneurship Research. *Entrepreneurship Theory and Practice*, *35*(1), 83–111. https://doi.org/10.1111/j.1540-6520.2010.00424.x

79) Gersick, C. J. G. (1994). PACING STRATEGIC CHANGE: THE CASE OF A NEW VENTURE. *Academy of Management Journal*, *37*(1), 9–45. https://doi.org/10.2307/256768

80) GET.invest. (n.d.). Powering up Southern Africa's off-grid homes. Https://Www.Get-Invest.Eu/Story/Powering-up-Southern-Africas-off-Grid-Homes/.

81) Giesen, E., Riddleberger, E., Christner, R., & Bell, R. (2010). When and how to innovate your business model. *Strategy & Leadership*, *38*(4), 17–26. https://doi.org/10.1108/10878571011059700

82) Glenk, G., Meier, R., & Reichelstein, S. (2021). Cost Dynamics of Clean Energy Technologies. *Schmalenbach Journal of Business Research*, *73*(2), 179–206. https://doi.org/10.1007/s41471-021-00114-8

83) Gollwitzer, P. M., & Brandstätter, V. (1997). Implementation intentions and effective goal pursuit. *Journal of Personality and Social Psychology*, *73*(1), 186–199. https://doi.org/10.1037/0022-3514.73.1.186

84) Granovetter, M. S. (1973). The Strength of Weak Ties. *American Journal of Sociology*, *78*(6), 1360–1380. https://doi.org/10.1086/225469

85) Gregori, P., & Holzmann, P. (2020). Digital sustainable entrepreneurship: A business model perspective on embedding digital technologies for social and environmental value creation. *Journal of Cleaner Production*, *272*, 122817. https://doi.org/10.1016/j.jclepro.2020.122817

86) Gupta, V., Fernandez-Crehuet, J. M., Hanne, T., & Telesko, R. (2020). Fostering product innovations in software startups through freelancer supported requirement engineering. *Results in Engineering*, *8*, 100175. https://doi.org/10.1016/j.rineng.2020.100175

87) Hague, D., & Oakley, K. (2000). Spin-offs and Start-ups in UK Universities. *Universities UK*.

88) Hall, J., & Hofer, C. W. (1993). Venture capitalists' decision criteria in new venture evaluation. *Journal of Business Venturing*, *8*(1), 25–42. https://doi.org/10.1016/0883-9026(93)90009-T

89) Hamelink, M., & Opdenakker, R. (2019). How business model innovation affects firm performance in the energy storage market. *Renewable Energy*, *131*, 120–127. https://doi.org/10.1016/j.renene.2018.07.051

90) Hamwi, M., & Lizarralde, I. (2017). A Review of Business Models towards Service-Oriented Electricity Systems. *Procedia CIRP*, *64*, 109–114. https://doi.org/10.1016/j.procir.2017.03.032

91) Hedman, J., & Kalling, T. (2003). The business model concept: theoretical underpinnings and empirical illustrations. *European Journal of Information Systems*, *12*(1), 49–59. https://doi.org/10.1057/palgrave.ejis.3000446

92) Hills, G. E., Lumpkin, G. T., & Singh, R. P. (1997). Opportunity recognition: Perceptions and behaviors of entrepreneurs. *Frontiers of Entrepreneurship Research*, *17(4)*, 168–182.

93) Hite, J. M., & Hesterly, W. S. (2001). The evolution of firm networks: from emergence to early growth of the firm. *Strategic Management Journal*, *22*(3), 275–286. https://doi.org/10.1002/smj.156

94) Heij, C. V., Volberda, H. W., & Van den Bosch, F. A. J. (2014). How does business model innovation influence firm performance: The effect of environmental dynamism. *Academy of Management Proceedings*, 2014(1), 16500. https://doi.org/10.5465/ambpp.2014.234

95) Horváth, D., & Szabó, R. Zs. (2018). Evolution of photovoltaic business models: Overcoming the main barriers of distributed energy deployment. *Renewable and Sustainable Energy Reviews*, *90*, 623–635. https://doi.org/10.1016/j.rser.2018.03.101

96) Ilyas, I. M., & Osiyevskyy, O. (2021). Exploring the impact of sustainable value proposition on firm performance. *European Management Journal*. https://doi.org/10.1016/j.emj.2021.09.009

97) IRIS Group. (2019). Nordic scalers A study of drivers of growth and barriers to scaling of Nordic companies. *Nordic Innovation*.

98) Johnson, M. (2010). Seizing the White Space: Business Model Innovation for Growth and Renewal. *Harvard Business Press, Boston*.

99) Johnson, Mark. W., Christensen, Clayton. M., & Kagermann, H. (2008). Reinventing Your Business Model. *Harvard Business Review*.

100) Jones, Gardner. M. (1960). Educators, Electrons, and Business Models: A Problem in Synthesis. *The Accounting Review*, *35(4)*, 619–626.

101) Kamp, L. M., Meslin, T. A. J., Khodaei, H., & Ortt, J. R. (2021). The Dynamic Business Model Framework—Illustrated with Renewable Energy Company Cases from Indonesia. *Journal of Open Innovation: Technology, Market, and Complexity*, *7*(4), 231. https://doi.org/10.3390/joitmc7040231

102) Kamprath, M & Van den Broek, A. (2015). From Business Models to Business Model Environment - Evaluating and Redesigning Business Models based on their Environment Compatibility.

103) Kane, T. J. (2010). The Importance of Startups in Job Creation and Job Destruction. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1646934

104) Kansen voor west 2. (n.d.). AGUROTECH. Https://Www.Kansenvoorwest2.Nl/En/Projecten/Agurotech/.

105) Kaplan, J. (1996). Startup: A Silicon Valley adventure*. New York: Penguin.*

106) Kaplan, S. N., Sensoy, B. A., & Stromberg, P. (2009). Should Investors Bet on the Jockey or the Horse? Evidence from the Evolution of Firms from Early Business Plans to Public Companies. *The Journal of Finance*, *64*(1), 75–115. https://doi.org/10.1111/j.1540-6261.2008.01429.x

107) Karakaya, E., Nuur, C., & Hidalgo, A. (2016). Business model challenge: Lessons from a local solar company. *Renewable Energy*, *85*, 1026–1035. https://doi.org/10.1016/j.renene.2015.07.069

108) Kerr, W. R., Nanda, R., & Rhodes-Kropf, M. (2014). Entrepreneurship as Experimentation. *Journal of Economic Perspectives*, *28*(3), 25–48. https://doi.org/10.1257/jep.28.3.25

109) Kesting, P., & Günzel-Jensen, F. (2015). SMEs and new ventures need business model sophistication. *Business Horizons*, *58*(3), 285–293. https://doi.org/10.1016/j.bushor.2015.01.002

110) Khodaei, H., & Ortt, R. (2019). Capturing Dynamics in Business Model Frameworks. *Journal of Open Innovation: Technology, Market, and Complexity*, *5*(1), 8. https://doi.org/10.3390/joitmc5010008

111) Khodaei, H., Scholten, V. E., Wubben, E. F. M., & Omta, S. W. F. O. (2022). The Role of Academic Spin-Offs Facilitators in Navigation of the Early Growth Stage Critical Junctures. *IEEE Transactions on Engineering Management*, *69*(4), 1769–1780. https://doi.org/10.1109/TEM.2020.2995361

112) Kia Vision. (2022). Tackling Ocean Plastic with Technology. Https://Www.Kia.Com/Us/En/Kia-Collective/Vision/the-Ocean-Cleanup.

113) Kichuk, S. L., & Wiesner, W. H. (1997). The big five personality factors and team performance: implications for selecting successful product design teams. *Journal of Engineering and Technology Management*, *14*(3–4), 195–221. https://doi.org/10.1016/S0923-4748(97)00010-6

114) Kim, W. C., & Mauborgne, R. (2005). Blue ocean strategy: How to create uncontested market space and make the competition irrelevant. *Harvard Business School Press*.

115) Klang, D., Wallnöfer, M., & Hacklin, F. (2010). The Anatomy of the Business Model: A Syntactical Review and Research Agenda.

116) Know-How - MO4. (n.d.). Mo4.Online. Https://Mo4.Online/Know-How/.

117) Komi, M., Still, K., Wallin, A., & Jaring, P. (2015). Accelerating the innovation process of start-ups - Business incubator and accelerator services in Finland. *In XXVI ISPIM Innovation Conference: Shaping the Frontiers of Innovation Management*, 1–15.

118) Konecranes. (2020). The Ocean Cleanup prepares for series production of Interceptor - partners with Konecranes. Https://Www.Konecranes.Com/Press/Releases/2020/the-Ocean-Cleanup-Prepares-for-Series-Production-of-Interceptor-Partners-with-Konecranes.

119) Koo, C., Song, J., Kim, Y. J., & Nam, K. (2007). Do e-business strategies matter? The antecedents and relationship with firm performance. *Information Systems Frontiers*, *9*(2–3), 283. https://doi.org/10.1007/s10796-006-9008-1

120) Kranich, P., & Wald, A. (2018). Does model consistency in business model innovation matter? A contingency-based approach. *Creativity and Innovation Management*, *27*(2), 209–220. https://doi.org/10.1111/caim.12247

121) Kulatilaka, N., Santiago, L., & Vakili, P. (2014). Reallocating risks and returns to scale up adoption of distributed electricity resources. *Energy Policy*, *69*, 566–574. https://doi.org/10.1016/j.enpol.2014.02.005

122) Labbé, M., & Mazet, T. (2005). Die Geschäftsmodellinnovations-Matrix: Geschäftsmodellinnovationen analysieren und bewerten (Vol. 17). *Der Betrieb.*

123) Leach, J. C., & Melicher, R. W. (n.d.). Entrepreneurial Finance (6th Edition).

124) Leisen, R., Steffen, B., & Weber, C. (2019). Regulatory risk and the resilience of new sustainable business models in the energy sector. *Journal of Cleaner Production*, *219*, 865–878. https://doi.org/10.1016/j.jclepro.2019.01.330

125) Lepak, D. P., Smith, K. G., & Taylor, M. S. (2007). Value Creation and Value Capture: A Multilevel Perspective. *Academy of Management Review*, *32*(1), 180–194. https://doi.org/10.5465/amr.2007.23464011

126) Linder, J., & Cantrell, S. (2000a). Carved in water: Changing business models fluidly. *Accenture Institute for Strategic Change Research Report*, *12*, 1–13.

127) Linder, J., & Cantrell, S. (2000b). Changing Business Models: Surveying the Landscape.

128) Lindgardt, Z., Reeves, M., Stalk, Jr., G., & Deimler, M. (2009). Business Model Innovation: When the Game Gets Tough, Change the Game. *In Own the Future. The Boston Consulting Group, Boston*. https://doi.org/10.1002/9781119204084.ch40

129) Loch, C. H., Solt, M. E., & Bailey, E. M. (2007). Diagnosing Unforeseeable Uncertainty in a New Venture*. *Journal of Product Innovation Management*, *25*(1), 28–46. https://doi.org/10.1111/j.1540-5885.2007.00281.x

130) Long, T. Q. (2019). Becoming a high-growth firm in a developing country: The role of co-funding. *Finance Research Letters*, *29*, 330–335. https://doi.org/10.1016/j.frl.2018.08.018

131) Maersk. (2019). The Ocean Cleanup. Https://Www.Maersk.Com/News/Articles/2019/06/25/Ocean-Cleanup.

132) Magretta, J. (2002). Why business models matter. *Harvard Business Review*, *80(5)*, 86–92.

133) Mahadevan, B. (2000). Business Models for Internet-Based E-Commerce: An Anatomy. *California Management Review*, *42*(4), 55–69. https://doi.org/10.2307/41166053

134) Mallick, D. N., & Schroeder, R. G. (2009). An Integrated Framework for Measuring Product Development Performance in High Technology Industries. *Production and Operations Management*, *14*(2), 142–158. https://doi.org/10.1111/j.1937-5956.2005.tb00015.x

135) Malone, T. W., Weill, P., Lai, R. K., D'Urso, V. T., Herman, G., Apel, T. G., & Woerner, S. (2006). Do Some Business Models Perform Better than Others? *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.920667

136) Marmer, M., Herrmann, B. L., Dogrultan, E., Berman, R., Eesley, C., & Blank, S. (2011). Startup Genome Report Extra on Premature Scaling. *Startup Genome*, 1–59.

137) Martins, L. L., Rindova, V. P., & Greenbaum, B. E. (2015). Unlocking the hidden value of concepts: A cognitive approach to business model innovation. *Strategic Entrepreneurship Journal,* 9(1), 99–117. https://doi.org/10.1002/sej.1191

138) Mason, K. J., & Leek, S. (2008). Learning to Build a Supply Network: An Exploration of Dynamic Business Models. *Journal of Management Studies*, *45*(4), 774–799. https://doi.org/10.1111/j.1467-6486.2008.00769.x

139) Mason, K., & Spring, M. (2011). The sites and practices of business models. *Industrial Marketing Management*, *40*(6), 1032–1041. https://doi.org/10.1016/j.indmarman.2011.06.032

140) Massa, L., Tucci, C. L., & Afuah, A. (2017). A Critical Assessment of Business Model Research. *Academy of Management Annals*, *11*(1), 73–104. https://doi.org/10.5465/annals.2014.0072

141) Mas-Verdú, F., Ribeiro-Soriano, D., & Roig-Tierno, N. (2015). Firm survival: The role of incubators and business characteristics. *Journal of Business Research*, *68*(4), 793–796. https://doi.org/10.1016/j.jbusres.2014.11.030

142) Matzembacher, D. E., Raudsaar, M., Barcellos, M. D. de, & Mets, T. (2020). Business Models' Innovations to Overcome Hybridity-Related Tensions in Sustainable Entrepreneurship. *Sustainability*, *12*(11), 4503. https://doi.org/10.3390/su12114503

143) Maurya, A. (2012). Running Lean: Iterate from Plan A to a Plan That Works. *Sebastopol, CA: O'Reilly.*

144) Meseri, O., & Maital, S. (2001). A Survey Analysis of University-Technology Transfer in Israel: Evaluation of Projects and Determinants of Success. *The Journal of Technology Transfer*, *26*(1/2), 115–125. https://doi.org/10.1023/A:1007844530539

145) Meslin, T. (2019). Dynamics of Business Models: The Case of Rural Renewable Energy Projects in Indonesia. *TU Delft.*

146) Metelskaia, I., Ignatyeva, O., Denef, S., & Samsonowa, T. (2018). A business model template for AI solutions. *Proceedings of the International Conference on Intelligent Science and Technology - ICIST '18*, 35–41. https://doi.org/10.1145/3233740.3233750

147) Methlie, L. B., & Pedersen, P. E. (2007). Business model choices for value creation of mobile services. *Info*, *9*(5), 70–85. https://doi.org/10.1108/14636690710816462

148) Meyer, J. P., & Herscovitch, L. (2001). Commitment in the workplace: toward a general model. *Human Resource Management Review*, *11*(3), 299–326. https://doi.org/10.1016/S1053-4822(00)00053-X

149) Miller, D., & Friesen, P. H. (1984). A Longitudinal Study of the Corporate Life Cycle. *Management Science*, *30*(10), 1161–1183. https://doi.org/10.1287/mnsc.30.10.1161

150) Mitchell, D., & Coles, C. (2003). The ultimate competitive advantage of continuing business model innovation. *Journal of Business Strategy*, *24*(5), 15–21. https://doi.org/10.1108/02756660310504924

151) Mitchell, D. W., & Bruckner Coles, C. (2004). Business model innovation breakthrough moves. *Journal of Business Strategy*, *25*(1), 16–26. https://doi.org/10.1108/02756660410515976

152) Moratis, L., Melissen, F., & Idowu, S. O. (2018). Sustainable Business Models. Principles, Promise, and Practice. *Cham, Switzerland: Springer.*

153) Morris, M., Allen, J., Schindehutte, M., & Avila, R. (2006a). Balanced management control systems as a mechanism for achieving corporate entrepreneurship. *Journal of Managerial Issues*, *18*, 468–493.

154) Morris, M., Schindehutte, M., & Allen, J. (2005). The entrepreneur's business model: toward a unified perspective. *Journal of Business Research*, *58*(6), 726–735. https://doi.org/10.1016/j.jbusres.2003.11.001

155) Morris, M., Schindehutte, M., Richardson, J. E., & Allen, J. (2006b). Is the Business Model a Useful Strategic Concept? Conceptual, Theoretical, and Empirical Insights. *Journal of Small Business Strategy*, *17*, 27–50.

156) Mostafa, N., Ramadan, H. S. M., & Elfarouk, O. (2022). Renewable energy management in smart grids by using big data analytics and machine learning. *Machine Learning with Applications*, *9*, 100363. https://doi.org/10.1016/j.mlwa.2022.100363

157) Mustar, P. (1997). How French academics create hi-tech companies: The conditions for success or failure. *Science and Public Policy*. https://doi.org/10.1093/spp/24.1.37

158) Nair, S., & Blomquist, T. (2019). Failure prevention and management in business incubation: practices towards a scalable business model. *Technology Analysis & Strategic Management*, *31*(3), 266–278. https://doi.org/10.1080/09537325.2018.1495325

159) Ndonzuau, F. N., Pirnay, F., & Surlemont, B. (2002). A stage model of academic spin-off creation. *Technovation*, *22*(5), 281–289. https://doi.org/10.1016/S0166-4972(01)00019-0

160) Noria. (n.d.). Projects – Noria. Https://Www.Noria.Earth/Projects/?Lang=en.

161) Nyström, A.-G., & Mustonen, M. (2017). The dynamic approach to business models. *AMS Review*, *7*(3–4), 123–137. https://doi.org/10.1007/s13162-017-0103-x

162) Ocean Energy Resources. (2019). MO4 wins Offshore Wind Innovation Award. Https://Ocean-Energyresources.Com/2019/12/12/Mo4-Wins-Offshore-Wind-Innovation-Award/#:~:Text=Amsterdam%2Dbased%20MO4%20has%20been.

163) Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. *Wiley, New Jersey*.

164) Osterwalder, A., Pigneur, Y., Bernarda, G., & Smith, A. (2014). Value proposition design: How to create products and services customers want. *John Wiley & Sons.*

165) Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying Business Models: Origins, Present, and Future of the Concept. *Communications of the Association for Information Systems*, *16*. https://doi.org/10.17705/1CAIS.01601

166) Ostgaard, T. A., & Birley, S. (1996). New venture growth and personal networks. *Journal of Business Research*, *36*(1), 37–50. https://doi.org/10.1016/0148-2963(95)00161-1

167) Paradkar, A., Knight, J., & Hansen, P. (2015). Innovation in start-ups: Ideas filling the void or ideas devoid of resources and capabilities? *Technovation*, *41–42*, 1–10. https://doi.org/10.1016/j.technovation.2015.03.004

168) Pateli, A. G., & Giaglis, G. M. (2005). Technology innovation-induced business model change: a contingency approach. *Journal of Organizational Change Management*, *18*(2), 167–183. https://doi.org/10.1108/09534810510589589

169) Pedersen, E. R. G., Gwozdz, W., & Hvass, K. K. (2018). Exploring the Relationship Between Business Model Innovation, Corporate Sustainability, and Organisational Values within the Fashion Industry. *Journal of Business Ethics*, *149*(2), 267–284. https://doi.org/10.1007/s10551-016-3044-7

170) Petrovic, O., Kittl, C., & Teksten, R. D. (2001). Developing Business Models for Ebusiness. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1658505

171) Pohle, G., & Chapman, M. (2006). IBM's global CEO report 2006: business model innovation matters. *Strategy & Leadership*, *34*(5), 34–40. https://doi.org/10.1108/10878570610701531

172) Porter, M. E. (2008). The five competitive forces that shape strategy. *Harvard Business Review*, 25–40.

173) Pramataris, K. C., Papakyriakopoulos, D. A., Lekakos, G., & Mylonopoulos, N. A. (2001). Personalized Interactive TV Advertising: The iMEDIA Business Model. *Electronic Markets*, *11*(1), 17–25. https://doi.org/10.1080/10196780122859

174) Pucihar, A., Lenart, G., Kljajić Borštnar, M., Vidmar, D., & Marolt, M. (2019). Drivers and Outcomes of Business Model Innovation—Micro, Small and Medium-Sized Enterprises Perspective. *Sustainability*, *11*(2), 344. https://doi.org/10.3390/su11020344

175) Rappa, M. A. (2004). The utility business model and the future of computing services. *IBM Systems Journal*, *43*(1), 32–42. https://doi.org/10.1147/sj.431.0032

176) Rasmussen, E. (2011). Understanding academic entrepreneurship: Exploring the emergence of university spin-off ventures using process theories. *International Small Business Journal: Researching Entrepreneurship*, *29*(5), 448–471. https://doi.org/10.1177/0266242610385395

177) Rehme, J., & Svensson, P. (2011). Credibility-Driven Entrepreneurship. *The International Journal of Entrepreneurship and Innovation*, *12*(1), 5–15. https://doi.org/10.5367/ijei.2011.0015

178) Reis, E. (2011). The lean startup. *Crown Business*.

179) Richardson, J. (2008). The business model: an integrative framework for strategy execution. *Strategic Change*, *17*(5–6), 133–144. https://doi.org/10.1002/jsc.821

180) Richter, M. (2013). German utilities and distributed PV: How to overcome barriers to business model innovation. *Renewable Energy*, *55*, 456–466. https://doi.org/10.1016/j.renene.2012.12.052

181) Riquelme, H. E. (2013). In Search of Entrepreneurial Opportunities — An Integrated Model. *Journal of Enterprising Culture*, *21*(03), 249–274. https://doi.org/10.1142/S0218495813500118

182) Romero, D., & Molina, A. (2009). Value Co-creation and Co-innovation: Linking Networked Organisations and Customer Communities (pp. 401–412). https://doi.org/10.1007/978-3-642-04568-4_42

183) Ronstadt, R. (1988). The Corridor Principle. *Journal of Business Venturing*, *3*(1), 31–40. https://doi.org/10.1016/0883-9026(88)90028-6

184) Rossignoli, F., & Lionzo, A. (2018). Network impact on business models for sustainability: Case study in the energy sector. *Journal of Cleaner Production*, *182*, 694–704. https://doi.org/10.1016/j.jclepro.2018.02.015

185) Saebi, T. (2015). Evolution, Adaptation, or Innovation? In *Business Model Innovation* (pp. 145–168). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198701873.003.0008

186) Saebi, T., Lien, L., & Foss, N. J. (2017). What Drives Business Model Adaptation? The Impact of Opportunities, Threats and Strategic Orientation. *Long Range Planning*, *50*(5), 567–581. https://doi.org/10.1016/j.lrp.2016.06.006

187) Salamzadeh, A., & Kawamorita Kesim, H. (2015). Startup Companies: Life Cycle and Challenges. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2628861

188) Schaltegger, S., Hansen, E. G., & Lüdeke-Freund, F. (2016). Business Models for Sustainability. *Organization & Environment*, *29*(1), 3–10. https://doi.org/10.1177/1086026615599806

189) Schaltegger, S., Lüdeke-Freund, F., & Hansen, E. G. (2011). Business Cases for Sustainability and the Role of Business Model Innovation: Developing a Conceptual Framework. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2010506

190) Schaltegger, S., & Wagner, M. (2011). Sustainable entrepreneurship and sustainability innovation: categories and interactions. *Business Strategy and the Environment*, *20*(4), 222–237. https://doi.org/10.1002/bse.682

191) Schweizer, L. (2005). Concept and Evolution of Business Models. *Journal of General Management*, *31*(2), 37–56. https://doi.org/10.1177/030630700503100203

192) Shafer, S. M., Smith, H. J., & Linder, J. C. (2005). The power of business models. *Business Horizons*, *48*(3), 199–207. https://doi.org/10.1016/j.bushor.2004.10.014

193) Shaffer, R. (1990). Building Economically Viable Communities: A Role for Community Developers. *Community Development Society. Journal*, *21*(2), 74–87. https://doi.org/10.1080/15575339009489962

194) Shah, S. K., & Pahnke, E. C. (2014). Parting the ivory curtain: understanding how universities support a diverse set of startups. *The Journal of Technology Transfer*, *39*(5), 780–792. https://doi.org/10.1007/s10961-014-9336-0

195) Shane, S., & Venkataraman, S. (2000). The Promise of Entrepreneurship as a Field of Research. *The Academy of Management Review*, *25*(1), 217–226. https://doi.org/10.2307/259271

196) Shomali, A., & Pinkse, J. (2016). The consequences of smart grids for the business model of electricity firms. *Journal of Cleaner Production*, *112*, 3830–3841. https://doi.org/10.1016/j.jclepro.2015.07.078

197) Siegel, D. (2009). From the Guest Editors: New Developments in Technology Management Education. *Academy of Management Learning & Education*, *8*(3), 321–323. https://doi.org/10.5465/AMLE.2009.44287933

198) Siegel, D. S., Waldman, D., & Link, A. (2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study. *Research Policy*, *32*(1), 27–48. https://doi.org/10.1016/S0048-7333(01)00196-2

199) Sigrist, B. (1999). Entrepreneurial Opportunity Recognition. *Paper Presented at the Annual UIC/AMA Symposium at Marketing/Entrepreneurship Interface, Sofia-Antipolis, France*.

200) Smith, K. G., Mitchell, T. R., & Summer, C. E. (1985). TOP LEVEL MANAGEMENT PRIORITIES IN DIFFERENT STAGES OF THE ORGANIZATIONAL LIFE CYCLE. *Academy of Management Journal*, *28*(4), 799–820. https://doi.org/10.2307/256238

201) SolarWorks. (n.d.). SolarWorks! Receives Investment from EDP to Boost International Expansion. Https://Www.Solar-Works.Co.Za/News/41-Solarworks-Receives-Investment-from-Edp-to-Boost-International-Expansion.

202) Song, M., Podoynitsyna, K., van der Bij, H., & Halman, J. I. M. (2007). Success Factors in New Ventures: A Meta-analysis*. *Journal of Product Innovation Management*, *25*(1), 7–27. https://doi.org/10.1111/j.1540-5885.2007.00280.x

203) Spiegel, O., Abbassi, P., Zylka, M. P., Schlagwein, D., Fischbach, K., & Schoder, D. (2016). Business model development, founders' social capital and the success of early stage internet start-ups: a mixed-method study. *Information Systems Journal*, *26*(5), 421–449. https://doi.org/10.1111/isj.12073

204) Stam, E. (2008). Entrepreneurship and Innovation Policy. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1115262

205) Starr, J. A., & MacMillan, I. C. (1990). Resource Cooptation Via Social Contracting: Resource Acquisition Strategies for New Ventures. *Strategic Management Journal*, *11*(4), 79–92.

206) Stigka, E. K., Paravantis, J. A., & Mihalakakou, G. K. (2014). Social acceptance of renewable energy sources: A review of contingent valuation applications. *Renewable and Sustainable Energy Reviews*, *32*, 100–106. https://doi.org/10.1016/j.rser.2013.12.026

207) Stuart, T. E., & Sorenson, O. (2005). Social Networks and Entrepreneurship. In *Handbook of Entrepreneurship Research* (pp. 233–252). Springer-Verlag. https://doi.org/10.1007/0-387-23622-8_11

208) SunFunder. (2019). SunFunder closes $2m multi-currency debt facility in Mozambique with MFX Solutions for SolarWorks! Https://Www.Sunfunder.Com/Post/Sunfunder-Closes-2m-Multi-Currency-Debt-Facility-in-Mozambique-with-Mfx-Solutions-for-Solarworks.

209) Teece, D. J. (2010). Business Models, Business Strategy and Innovation. *Long Range Planning*, *43*(2–3), 172–194. https://doi.org/10.1016/j.lrp.2009.07.003

210) Teece, D. J. (2018). Business models and dynamic capabilities. *Long Range Planning*, *51*(1), 40–49. https://doi.org/10.1016/j.lrp.2017.06.007

211) Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

212) Termaat, A., van Sprang, H., & Groen, B. (2014). Workspace 2020 - Club, Hub and Co-workspace: business models for optimal FM support for office workers in the future.

213) The Coca-Cola company. (2021). Coca-Cola Signs On as Global Implementation Partner for The Ocean Cleanup's River Project. Https://Www.Coca-Colacompany.Com/News/Ocean-Cleanup-Partnership.

214) The Ocean Cleanup. (n.d.-a). Milestones • the ocean cleanup. *Retrieved from* https://theoceancleanup.com/milestones/

215) The Ocean Cleanup. (n.d.-b). The Ocean Cleanup annual report 2015. Https://Assets.Theoceancleanup.Com/App/Uploads/2019/04/TOC_2015_Annual_Report.Pdf.

216) Thiagarajan, R. K., Srivastava, A. K., Pujari, A. K., & Bulusu, V. K. (2002). BPML: a process modeling language for dynamic business models. *Proceedings Fourth IEEE International Workshop on Advanced Issues of E-Commerce and Web-Based Information Systems (WECWIS 2002)*, 222–224. https://doi.org/10.1109/WECWIS.2002.1021264

217) Timmers, P. (1998). Business Models for Electronic Markets. *Electronic Markets*, *8*(2), 3–8. https://doi.org/10.1080/10196789800000016

218) Trimi, S., & Berbegal-Mirabent, J. (2012). Business model innovation in entrepreneurship. *International Entrepreneurship and Management Journal*, *8*(4), 449–465. https://doi.org/10.1007/s11365-012-0234-3

219) TU Delft. (n.d.). Life-changing solar products in Africa. Https://Www.Tudelft.Nl/Global/Stories/Life-Changing-Solar-Products-in-Africa.

220) Upward, A., & Jones, P. (2016). An Ontology for Strongly Sustainable Business Models. *Organization & Environment*, *29*(1), 97–123. https://doi.org/10.1177/1086026615592933

221) Vaghely, I. P., & Julien, P.-A. (2010). Are opportunities recognized or constructed? *Journal of Business Venturing*, *25*(1), 73–86. https://doi.org/10.1016/j.jbusvent.2008.06.004

222) van Gelderen, M., Thurik, R., & Bosma, N. (2006). Success and Risk Factors in the Pre-Startup Phase. *Small Business Economics*, *26*(4), 319–335. https://doi.org/10.1007/s11187-004-6837-5

223) Velu, C. (2015). Business model innovation and third-party alliance on the survival of new firms. *Technovation*, *35*, 1–11. https://doi.org/10.1016/j.technovation.2014.09.007

224) Venkatraman, M., & Henderson, J. C. (1998). Real Strategies for Virtual Organizing. *Sloan Management Review*, *40*, 33–48.

225) Voelpel †, S. C., Leibold, M., & Tekie, E. B. (2004). The wheel of business model reinvention: how to reshape your business model to leapfrog competitors. *Journal of Change Management*, *4*(3), 259–276. https://doi.org/10.1080/1469701042000212669

226) Vohora, A., Wright, M., & Lockett, A. (2004). Critical junctures in the development of university high-tech spinout companies. *Research Policy*, *33*(1), 147–175. https://doi.org/10.1016/S0048-7333(03)00107-0

227) Weigand, H., Verharen, E., & Dignum, F. (1997). Dynamic business models as a basis for interoperable transaction design. *Information Systems*, *22*(2–3), 139–154. https://doi.org/10.1016/S0306-4379(97)00010-0

228) Whatman, P. (2021, June 8). *Growth vs scaling: What's the difference and why does it matter?* Spend Journal. Https://Blog.Spendesk.Com/En/Growth-vs-Scaling.

229) Willemstein, L., van der Valk, T., & Meeus, M. T. H. (2007). Dynamics in business models: An empirical analysis of medical biotechnology firms in the Netherlands. *Technovation*, *27*(4), 221–232. https://doi.org/10.1016/j.technovation.2006.08.005

230) Wirtz, B. W., Pistoia, A., Ullrich, S., & Göttel, V. (2016). Business Models: Origin, Development and Future Research Perspectives. *Long Range Planning*, *49*(1), 36–54. https://doi.org/10.1016/j.lrp.2015.04.001

231) Xu, X. (2022). Sustainable Business Model Dynamics of Distributed Solar PV Projects in China. *TU Delft*.

232) Yin, R. K. (2009). Case study research: Design and methods. *London: Sage.*

233) Zhao, M., Dalziel, M., Barge, B., & Walker, A. (2019). Characteristics of scale- ups and the impact of scale-up support programmes. A Literature Review. *Nordic Innovation*.

234) Zott, C., & Amit, R. (2007). Business Model Design and the Performance of Entrepreneurial Firms. *Organ. Sci.*, *18*, 181–199.

235) Zott, C., & Amit, R. (2008). The fit between product market strategy and business model: implications for firm performance. *Strategic Management Journal*, *29*(1), 1–26. https://doi.org/10.1002/smj.642

236) Zott, C., & Amit, R. (2010). Business model design: an activity system perspective. *Long Range Planning, 43(2), 216-226.*

237) Zott, C., & Amit, R. (2013). The business model: A theoretically anchored robust construct for strategic analysis. *Strategic Organization*, *11*(4), 403–411. https://doi.org/10.1177/1476127013510466

238) Zott, C., Amit, R., & Massa, L. (2011). The Business Model: Recent Developments and Future Research. *Journal of Management*, *37*(4), 1019–1042. https://doi.org/10.1177/0149206311406265

Appendix 1

Definitions from highly cited articles

Author(s) (Year)	Title	Selected Definitions of Business Models
Amit & Zott (2011)	Value creation in E-Business	Depicts "the content, structure, and governance of transactions designed so as to create value through the exploitation of business
Magretta (2002)	Why Business Models Matter	“They are, at heart, stories—stories that explain how enterprises work” (p. 4).
Mahadevan (2000)	Business Models for Internet-Based E-Commerce	"A unique blend of three streams that are critical to the business. These include the value stream for the business partners and the buyers, the revenue stream, and the logistical stream" (p. 59)
Chesbrough & Rosenbloom (2002)	The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies	"The architecture of the revenue" (p.530); "Provides a coherent framework that takes technological characteristics and potentials as inputs and converts them through customers and markets into economic outputs. (...) A focusing device that mediates between technology development and economic value creation" (p. 532).
Venkatraman & Henderson (1998)	Real strategies for virtual organizing	"A coordinated plan to design strategy along all three vectors (customer interaction, asset sourcing, and knowledge leverage" (p. 46).
Timmers (1998)	Business Models for Electronic Markets	"An architecture for the product, service and information flows, including a description of the various business actors and their roles; A description of the potential benefits for the various business actors; A description of the sources of revenues" (p. 2).

Osterwalder et al. (2005)	Clarifying Business Models: Origins, Present, and Future of the Concept	"A conceptual tool that contains a set of elements and their relationships and allows expressing the business logic of a specific firm. It is a description of the value a company offers to one or several segments of customers and of the architecture of the firm and its network of partners for creating, marketing, and delivering this value and relationship capital, to generate profitable and sustainable revenue streams" (p. 17-18).
Morris et al. (2005)	The entrepreneur's business model: toward a unified perspective	"A concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets" (p. 727).
Rappa (2004)	The utility business model and the future of computing services	"A method of doing business. All business models specify what a company does to create value, how it is situated among upstream and downstream partners in the value chain, and the type of arrangement it has with its customers to generate revenue" (p. 34).
Hedman & Kalling (2003)	The business model concept: theoretical underpinnings and empirical illustrations	"Term often used to describe the key components of a given business" (p. 49).
Shafer et al. (2005)	The power of business models	"A representation of a firm's underlying core logic and strategic choices for creating and capturing value within a network" (p. 202)
Linder & Cantrell (2000)	Changing business models: surveying the landscape	"The organization's core logic for creating value" (p. 1)

Other definitions from more recent articles (2009 -)

Osterwalder & Pigneur (2010)	Business Model Generation	Describes the rationale of how an organization creates, delivers and captures value" (p. 14).
Teece (2010)	Business Models, Business Strategy and Innovation	"A business model articulates the logic, the data, and other evidence that support a value proposition for the customer, and a viable

		structure of revenues and costs for the enterprise delivering that value" (p. 8).
Zott & Amit (2010)	Business Model Design: An Activity System Perspective	"A system of interdependent activities that transcends the focal firm and spans its boundaries" (p. 1).
George & Bock (2011)	The Business Model in Practice and its Implications for Entrepreneurship Research	"The design of organizational structures to enact a commercial opportunity" (p. 99); "A static configuration of organizational elements and activity characteristics" (p. 102); "The organization's configuration enactment of a specific opportunity" (p. 102).
Zott et al. (2011)	The Business Model: Recent Developments and Future Research	"A new unit of analysis, offering a systemic perspective on how to 'do business', encompassing boundary-spanning activities (performed by a focal firm or others), and focusing on value creation as well as on value capture" (p. 1038).
Casadesus-Masanell & Ricart (2011)	How to Design a Winning Business model	"a business model consists of a set of managerial choices and the consequences of those choices" (p. 5)
Amit & Zott (2012)	Creating Value Through Business Model Innovation	"a bundle of specific activities — an activity system — conducted to satisfy the perceived needs of the market, along with the specification of which parties (a company or its partners) conduct which activities, and how these activities are linked to each other." (p. 42)
Baden-Fuller & Haefliger (2013)	Business Models and Technological Innovation	"a system that solves the problem of identifying who is (or are) the customer(s), engaging with their needs, delivering satisfaction, and monetizing the value." (p. 419)
Fielt (2014)	Conceptualizing Business Models: Definitions, Frameworks and Classifications.	“A business model describes the value logic of or organization in terms of how it creates and captures customers value.” (p. 92)
Wirtz et al. (2016)	Business Models: Origin, Development and Future Research Perspectives	Business models are “a simplified and aggregated representation of the relevant activities of a company. It describes how marketable information, products and/or services are generated by means of a company’s value-added component. In addition to the architecture of value creation, strategic as well as customer and market components are taken inter consideration, in order to achieve the superordinate goal of generating, or rather, securing the competitive advantage.” (p. 41)

Table 2.4 Business Model Definitions

Appendix 2

Business model elements.

Author(s) (Year)	Perspectives on Business Model Elements	Nr.
Amit & Zott (2001)	1. Transaction content; 2. Transaction structure; 3. Transaction governance (p. 511).	3
Magretta (2002)	1. Who is the customer?; 2. What does the customer value?; 3. How do we make money in this business?; 4. How can we deliver value to customers?; 5. ...at an appropriate cost? (p. 4).	5
Mahadevan (2000)	1. Value streams; 2. Revenue streams; 3. Logistical streams (p. 67).	3
Chesbrough & Rosenbloom (2002)	1. Value proposition; 2. Market segment; 3. Value chain; 4. Cost structure and profit potential; 5. Value network; 6. Competitive strategy (pp. 533-534)	6
Venkatraman & Henderson (1998)	1. Customer interaction; 2. Asset configuration; 3. Knowledge leverage (p. 34)	3
Timmers (1998)	Value chain' elements: 1. Inbound logistics; 2. Operations; 3. Outbound logistics; 4. Marketing & sales; 5. Service; 6. Technology development; 7. Procurement; 8. Human resource management; 9. Corporate infrastructure (p. 3).	9
Osterwalder et al. (2005)	A. Product (1. Value Proposition); B. Customer Interface (2. Target Customer; 3. Distribution Channel; 4. Relationship); C. Infrastructure Management (5. Value Configuration; 6. Core Competency; 7. Partner Network); D. Financial Aspects (8. Cost Structure; 9. Revenue Model) (p. 18).	9
Morris et al. (2005)	1. How do we create value? (Factors related to the offering); 2. Who do we create value for? (Market factors); 3. What is our source of competence? (Internal capability factors); 4. How do we competitively position ourselves? (Competitive strategy factors); 5. How we make money? (Economic factors); 6. What are our time, scope, and size ambitions? (personal/investor factors) (p. 730)	6

Hedman & Kalling (2003)	1. Customers; 2. Competitors; 3. Offering; 4. Activities and organization; 5. Resources; 6. Supply of factor and production inputs; 7. Longitudinal process component (pp. 52-53).	7
Shafer et al. (2005)	A. Strategic choices (Customer, Value Proposition, Capabilities/Competencies, Revenue/Pricing, Competitors, Output, Strategy, Branding, Differentiation, Mission); B. Value Network (Suppliers, Customer Information, Customer Relationship, Information Flows, Product/Service Flows); C. Create Value (Resources/Assets, Processes/Activities); D. Capture Value (Cost, Financial Aspects, Profit) (p. 202).	20
Linder & Cantrell (2000)	1. Pricing model; 2. Revenue model; 3. Channel model; 4. Commerce process model; 5. Internet-enabled commerce relationship; 6. Organizational form; 7. Value proposition (p. 3).	7

More recent articles (2009-)

Osterwalder & Pigneur (2010)	1. Customer Segments; 2. Value Propositions; 3. Channels; 4. Customer Relationships; 5. Revenue Streams; 6. Key Resources; 7. Key Activities; 8. Key Partnerships; 9. Cost Structure (pp. 16-17).	9
Teece (2010)	1. Technologies and features to be embedded in the product/service; 2. Benefit to customer from consuming/using the product/service; 3. Market segments to be targeted; 4. Revenue streams; 5. Mechanisms to capture value (p. 2).	5
Zott & Amit (2010)	1. Activity system content (refers to the selection of activities); 2. Activity system structure (describes how the activities are linked); 3. Activity system governance (refers to who performs the activities) (p. 5).	3
George & Bock (2011)	1. Resource structure (static architecture of the firm's organization, production technology, and core resources leveraged to serve customers); 2. Transactive structure (organizational configuration that determines key transactions with partners and stakeholders); 3. Value structure (system of rules, expectations, and mechanisms that determine the firm's value creation and capture activities) (p. 99)	3
Casadesus-Masanell & Ricart (2011)	1. Policy choices; 2. Asset choices; 3. Governance choices	3
Amit & Zott (2012)	1. Content; 2. Structure; 3. Governance.	3
Baden-Fuller & Haefliger (2013)	1. Customer identification; 2. Customer engagement; 3. Value delivery; 4. Monetization.	4

Table 2.5 Business Model Elements

Appendix 3

Bunnies model innovation definitions.

Source	Definition
Mitchell and Coles (2004)	"By business model innovation, we mean business model replacements that provide product or service offerings to customers and end users that were not previously available. We also refer to the process of developing these novel replacements as business model innovation. "(p. 17)
Labbé and Mazet (2005)	A business model innovation changes one or more dimensions of a business model (which are perceived by the authors as product-market combination, the architecture of the value creation, and the revenue model) so that a novel configuration of the elements is created and implemented. (p. 897 f.)
Osterwalder et al. (2005)	"Specifying a set of business model elements and building blocks, as well as their relationships to one another […] a business model designer […] can experiment with these blocks and create completely new business models, limited only by imagination and the pieces supplied." (p. 24)
Chesbrough (2007)	Business model innovation is to "advance [the] business model […] from very basic (and not very valuable) models to far more advanced (and more valuable) models." (p.15)
Lindgardt and Reeves (2009)	"Innovation becomes BMI [business model innovation] when two or more elements of a business model are reinvented to deliver value in a new way. […] BMI can provide companies a way to break out of intense competition, under which product or process innovations are easily imitated ". (p. 2)
Romero and Molina (2009)	business models as definers of the value creation priorities in an organisation should be continuously reviewed in response to actual and possible changes in the perceived market conditions and evolve the enterprise strategy as the business environment and customers' needs change." (p. 3)
Chesbrough (2010)	Business model innovation "[1] Articulates the value proposition (i.e., the value created for users by an offering based on technology); [2] Identifies a market segment and specify the revenue generation mechanism (i.e., users to whom technology is useful and for what purpose); [3] Defines the structure of the value chain required to create and distribute the offering and complementary assets needed to support position in the chain; [4] Details the revenue mechanism(s) by which the firm will be paid for the offering; [5] Estimates the cost structure and profit potential (given value proposition and value chain structure); [7] Describes the position of the firm within the value network linking suppliers and customers (incl. identifying potential complementors and competitors); and [8] Formulates the competitive

	strategy by which the innovating firm will gain and hold advantage over rivals." (p. 355, citing Chesbrough and Rosenbloom, 2002)
Johnson (2010)	"[Seizing the white space] calls for the ability to innovate something more core than the core, to innovate the very theory of the business itself. I call that process business model innovation." (p. 13) "business model innovation is an iterative journey "(p. 114)
Geissdoerfer et al. (2016)	"Business model innovation describes either a process of transformation from one business model to another within incumbent companies or after mergers and acquisitions, or the creation of entirely new business models in start-ups." (p. 1220)

Table 2.6 Business Model Innovation Definitions adapted from (Geissdoerfer et al., 2018)