Pivots in Dutch Sustainable Energy-Tech Startups

Investigating External Triggers Causing Pivots in Business Model

Management of Technology - Master

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by

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Acknowledgment

It all started with an aircraft, a tiny wooden aircraft, endlessly spending my days sanding, painting and displaying the work of so-called 'art', with a flight time of mere seconds. That fascination grew me towards something bigger. My engineering studies saw me working hard on aviation projects in parallel to never-ending coursework - the passion kept me strong. While I was fluent with technicalities (not boasting at all, okay maybe slightly), the management of it - planning, marketing, decision making - stuck with me the most. That spark led me to the world of business, had to decipher how these ideas take flight outside the hanger.

Two years ago, with a very deliberate decision, I packed my bags to leave behind the engineering workshop and land in Netherlands to pursue Masters in Management of Technology at TU Delft. Equipped with previous business experience, with love to connect and talk to people, and a huge smile almost always on my face, I was ready. In hindsight, the two years seem slightly blur - and not just because of Dutch weather. I saw myself traveling almost every month, to a new country, understanding culture, wandered more train stations than I can count, and made meeting people both a hobby and professional skill. TU Delft gave me that beautiful space to network with tremendous number of companies and connect with people from all phases of life, and for that I am truly, genuinely grateful.

A special mention to an organization that I now call my home - quite literally - The X TU Delft. Spending over 12 hours almost everyday meant I did pretty much everything within these green and black walls: working, studying, sporting, eating, cooking and yes...even showered (don't ask). It was more than a work place. I felt like Tom Hanks from The Terminal, with X being airport terminal, where people met from all walks of world, came and went, and I somehow managed to get closer to so many of them. Today, I am a part and face of X, with a huge 1.5m*1.5m laughing portrait photo hanging in the main hallway, and I believe I was somehow destined for it. The friends I have made here have turned into a tight-knit family, sharing deadlines, victories, inside-jokes, lot of laughs and occasional existential crisis. X wasn't just a part of my Delft life - it *was* my Delft life. And if there was an award for "Most time spent at X", I would probably earn *summa cum laude*.

On the other hand, shockingly, I did manage to have active life outside X (just too social). Seeing friends turn into family - you all know who you are - we survived a challenging academic degree, sharing wins and losses together in project rooms, drinking caffeine, learning Dutch, well-deserved parties on weekends, and starting strong again every Monday with a jug of coffee. TU Delft has a way to ensure every credit is earned the hard way, intense pace and to-do lists reproducing faster than our doing capabilities. But it has taught me that with right people around, these challenges were nothing but fun.

Without further ado, a huge thanks to my supervisors, Dr. Hanieh Khodaei and Dr. Roland Ortt, for guiding me through this research maze with sheer wisdom, patience and occasional reality checks. I really value the time Hanieh spent with me every other week to find the best possible solution, approach best companies and somehow slightly increasing the scope of project every time we met to help achieve high quality research. Super grateful for Roland's patience with my results, challenging the status quo in every possible way, persuading me to think out-of-box always, and posing questions that made me question reality.

To my close friends - you're the ones who turned Delft into home. My travel buddies, late-night conversations, spontaneous adventures, cooking and sharing meals and inside jokes, from surviving project deadlines to celebrating wins later like kings - you turned into families. Ending with most important appreciation, my lovely family - Mom, Dad, Dada - for being most fun ATC service in the world, guiding my flight from miles away, always with a smile. Thank you for grounding me when I was stressed, cheering on smallest victories, and pretending to understand when I talked about my thesis. Your "are you eating properly?" was the real safety net beneath all my adventures. With that, I land this flight for refueling for my next adventure, awaiting decision for my next destination!

Executive Summary

Sustainable energy new-age ventures are driving the global energy transition towards cleaner and resilient energy systems. While the development of this sector looks positive and successful from the outside, the companies face tremendous impacts within to sustain their competitiveness and survival. The industry lies at the crux of environmental, economical and social constructs given the nature of their business, that involves having focus and consideration for product, people and planet. This involves operating in an ecosystem driven by continual impacts, requirements and changes from all three constructs, and tactically reacting to those pressures. These pressures, also known as, 'triggers', can sprout from both internal and external factors. Internal triggers comprise of impacts arising within the organization. The external triggers on the other hand comprise of events that impact the business from outside, for instance, regulatory reforms, technology evolution, varying market requirements, and pandemic. More often than not being unpredictable, these external triggers significantly effect the development of firm, that can either be perceived as an opportunity or a threat.

To understand the impact of these external triggers, this research examines how Dutch sustainable energy-tech startups and scale-ups perceive the triggers and respond accordingly. With having a particular focus on 'pivots' - i.e., deliberate change in the course of action of business model (Ries, 2011) - an attempt to explore the understanding between trigger and subsequent pivot action has been made. Drawing upon conceptual understanding of dynamic business models, we further probe into cascade of internal changes within business models of companies as a result of these external triggers and pivots.

The central research question this study aims to target is: **How do external triggers instigate pivots in business model elements of Dutch sustainable energy-tech startups and what are corresponding effects on other elements of business model?** To approach the answer, a qualitative multiple-case study approach is followed, where semi-structured interviews with six Dutch sustainable energy tech startups are conducted. This is followed by cross-case analysis using Gioia methodology to unfold patterns and observations. Netherlands is chosen as a geographical choice due to its accelerated development and immense potential in the field, all the while facing major challenges of existing reliance on natural gas, outdated infrastructure, grid congestion and uncertain policies.

The research yields several core findings. External triggers concerning market and regulation pose as a prominent factor in company's development. These effects are majorly observed to be focused on outward facing elements, i.e., Value Proposition and Delivery of the firm, that compels them to evolve their internal resources/strategies, i.e., Value Creation. This is followed by understanding the factors that allow the decision makers to identify external triggers to be opportunity or threat. Triggers are often considered opportunities when they impact the outward facing elements, i.e., VP and VD. However, triggers are perceived as threats when it impacts the company's core functioning and strategy (VC). The cognition facilitates the pivoting action undertaken in response and observing subsequent secondary impact on business model elements. These changes in business models are classified as innovation or adaptation based on nature and intensity of changes. An insightful comparison or perception (opportunity/threat) and nature of BM change (BMI/BMA) reinforces the concept of 'Threat-Rigidity Theory' by Staw et al. (1981) in our study that shows that companies are more prone to undertaking risks in gain potential rather than loss potential. The chronology is backed by a conceptual framework to explain the phenomena of external triggers, its perception and subsequent pivot action.

The research contributes on a theoretical level towards empirical framework linking the external trigger, cognition, pivoting action and identifying the nature of change. It contributes to the nuances of dynamic business models, pivoting theories, and triggers companies face. On a practical scale, the findings provide actionable insights for firms to develop scanning capabilities of their surrounding, by helping predict the potential changes that can be brought on about by the external trigger.

Bhavesh Abhang
Delft, August 2025

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Nomenclature

Abbreviations

Abbreviation	Definition
BM	Business Model
DBM	Dynamic Business Model
SBM	Sustainable Business Model
BMI	Business Model Innovation
BMA	Business Model Adaptation
VP	Value Proposition
VC	Value Creation
VD	Value Delivery
VCA	Value Capture
SBMC	Sustainable Business Model Canvas
SBM	Sustainable Business Model

1

Introduction

The accelerated pace of global climate change and consequent sustainability mandates and challenges has identified necessity of sustainable entrepreneurship. Lying at the forefront of innovation, the entrepreneurs lay emphasis on environmental and social aspects as well in addition to profitability, resulting in developing new products and services that improve overall quality of life in terms of people, profit and planet (Schaltegger, 2013). Inevitably, the ventures and decision makers in this industry are also bombarded with external environment changes at a higher rate due to exponential rate of technology advancement, uncertain climate pathway, changing government policies towards climate support, circularity, production restrictions and so forth (Palzkill and Augenstein, 2017). The markets are quite volatile with many shifting scenarios at high rate and limited time to react (Saebi et al., 2017). Established companies display signs of hesitance towards these changes due to momentum gathered over the years, whereas startups and scaleups, with their lean approach, thrive on their agility to maneuver changing scenarios with aplomb (Schwarz et al., 2021). They innovate, develop, test the product, gain customer feedback and make decisions to pivot at a faster rate, allowing them to solve the needs of the market sooner (Refer Figure 1.1).

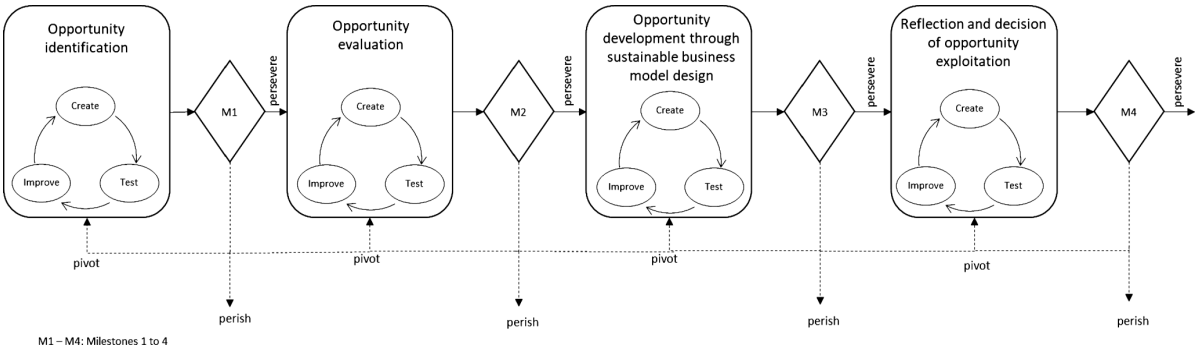

Figure 1.1: Entrepreneurial lean thinking ideology for sustainable innovation (Schwarz et al., 2021)

The Dutch startup ecosystem while being geographically small is densely populated with significant innovation originating as academic or research spin-offs in fields of energy, material science, and sustainability technologies. The environment has seen strong collaboration between universities and industries to develop research-backed solutions, and also robust legislation and policies surrounding sustainability, such as Dutch Climate Agreement(Government of The Netherlands, 2019). However, despite strong legislation and close-knit network between universities and industry, the innovations are found to be more prone to slower and problematic developments (Nejabat and Van Geenhuizen, 2019). According to their study, it was found that while the nation produced high quality of scientific output, the commercialization stays weak due to lack of favorable investment access, low risk-taking mindset, and lacking regulatory firmness. Furthermore, the study by OECD (2015) shows that Dutch startups have

55% survival rate in the initial three years, with most firms shutting in year two, posing as one of the lowest in the region. The output in terms of employment creation is also below average at 2-3% as compared to the average of 6-7% in Europe. A number of challenges such as limited financial access, startup mindset, market acceptance, policy stability need to be tackled to ensure increased performance within startups in Netherlands (Van Praag and Versloot, 2007).

Within broader umbrella of sustainable-tech startups, we focus our research on energy based companies. Energy focused tech operates in close vicinity of complex regulations, technology advancements and market changes. Bohnsack et al. (2014) emphasizes the need for energy based startups to constantly adapt their strategic business models to cope up with changing political and social landscape. Approximately 40% of sustainable energy firms in Netherlands fail to introduce and scale their technology in the market and over 30% introduce at inappropriate time, due to lack of collaborative efforts, market needs and limited access to investments (Geenhuizen et al., 2021). Furthermore, Richter (2013) underscores the reliance of energy based startups on external partnerships to sustainably access resources, infrastructure and technical know-how, helping in successful transition from incumbent technology.

Research has emphasized the relation between success of startup with their dynamic capabilities to maneuver these external changes effectively, showcasing its link to dynamic business models. The dynamic business model refers to a company's ability to tweak, restructure or realign their business model with agility, in response to changes in environment scenario, such as changing customer needs, regulatory changes, and technological advancements (Schaffer et al., 2019). These adaptations allow companies to stay in the game by actively making amends to realign with environmental needs. Exploring the effect of these triggers and how they are perceived by decision makers is crucial to apprehend the reasons for company's failure or successes as described before (Demil and Lecocq, 2010; Trimi and Berbegal-Mirabent, 2012).

Given highly uncertain environment surrounding sustainable energy based firms and low success rate of startups in the Netherlands, the following research delves deeper into how external event impact the business models of these innovative companies, and how companies pivot (change) their course of action to tackle effectively.

1.1. Background Information

1.1.1. Dutch Energy-based Tech Startup Scenario

The Dutch landscape has evolved into a leading platform for the sustainable energy-tech industry, driven by active government policies that facilitate and legislate strong sustainability goals. While the country significantly made use of abundant natural gas available in its territory in the past, the changing climate and planet concerns have boosted innovation of energy generation towards renewable sources. It has also been one of the first European country to eliminate utility of natural gas. As a result, in 2022, sustainable energy production rose by 20% to account for approximately 40% of total electricity production. The top domains contributing towards these changes are wind energy (18%), solar energy (15%), and biomass (7%) (International Trade Administration, 2022).

Recently, in 2024, the Dutch startup ecosystem has climbed to 13th position in the "World's top-performing startups" by Startup Genome (world organization working towards innovation ecosystem development), ranking highly in investments, talent density and scaling entrepreneurship (Startup Genome, 2024). To fast-track renewable energy development, the Dutch government allocated USD 31 billion towards goals of reducing net carbon by levying higher carbon tax and increasing subsidies for higher utility (International Trade Administration, 2024). In addition, the government has introduced multiple policies and frameworks to support development of energy-tech. For instance, policies such as 'Sustainable Energy Transition Incentive Scheme (SDE++)' (RVO, 2025b), 'Energy Act 2024', 'Green Growth Package' (NEA, 2025), provide subsidies for development of renewable technologies and safeguard consumers from variation.

In 2024, Dutch tech ecosystem gained a significant improvement in its venture capital funding, accounting to EUR 3.1 billion, a 47% increase from previous year. However, in parallel, it was also observed that investments in early-stage companies dropped by 20% and domestic investment dunked sharply from 61% to 15%, showcasing the shift in priorities of investors towards international companies and

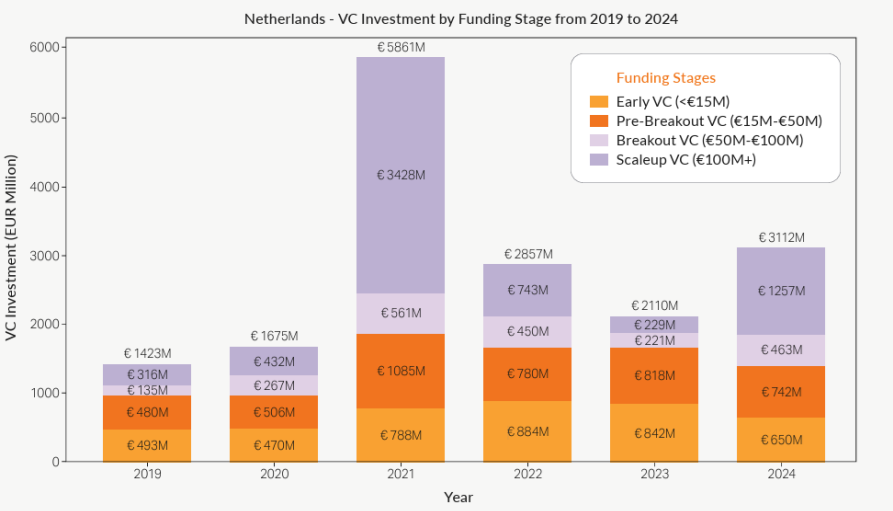

Figure 1.2: VC Funding by stage (Netherlands) from 2019-2024 (Techleap, 2025)

later-stage companies. The conversion rate of startups to scale-ups also lags in The Netherlands (21%) as compared to Europe average (23%). This evidently has significant effect on the overall environment of a tech company, with triggers being reflected in terms of technology advancement, finances, regulations updates and so forth (Techleap, 2025). As can be seen in figure 1.2, the variations in investment have been considerable over the years, resulting in constant external triggers with regards to stability of ecosystem. Consequently, the amount of startups has also been observed to have reduced (Figure 1.3).

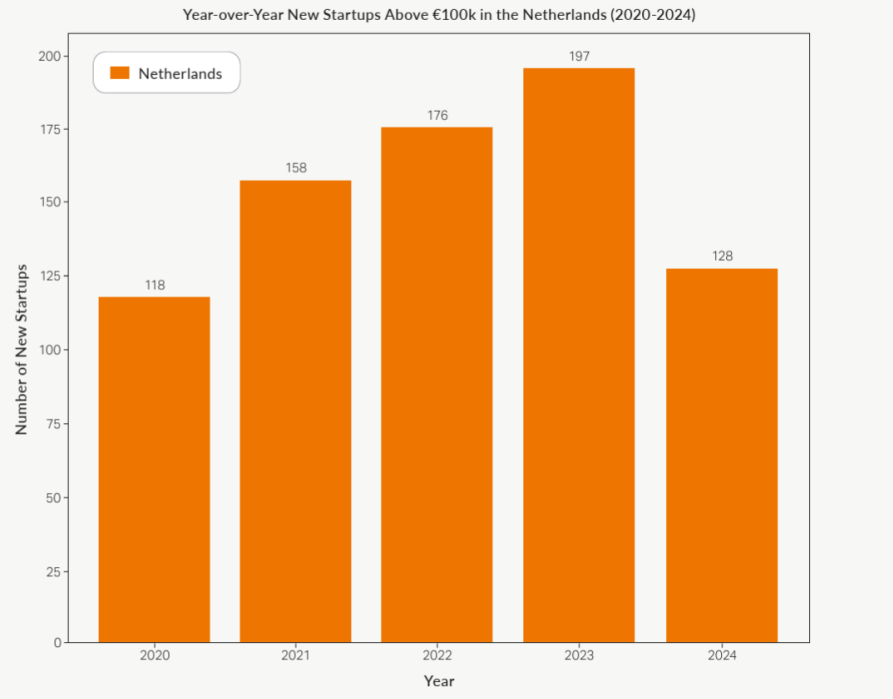

Figure 1.3: New startups in NL (Techleap, 2025)

According to research survey done by Techleap (2025) upon consulting over 600 founders, it has been observed that startups struggle to manage their go-to-market strategy in midst of time consuming investment cycles. They also face hurdles in internationalizing their value offering and scaling to newer markets, while managing the existing business processes and organizations. The startups need to em-

brace fast-paced technological advancements, tackle external pressures with agility, understand volatile customer needs, and strong competition operating in close vicinity given high inter-connectivity of digital world. A deeper understanding of such external factors helps understand the dynamism in developing a technology, helping startups thrive and align industry's sustained progress.

1.1.2. Business Model

The business model concept has observed its forays in multiple industries over the past few decades, acting as crux to understand the development of a firm in context of value creation, capture and delivery (Sjödin et al., 2019; Teece, 2010). It has seen its application spanning across all fields of knowledge, guiding the firms towards their goals and possibilities by providing a thought framework. However, due to its versatility the concept has been defined in multifarious ways in academics, with variations in components, process, and applications (Morris et al., 2005). According to Amit and Zott (2001)(p.493), taking an activity-based view, the model has been defined as "The content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities". Whereas Chesbrough and Rosenbloom (2002) contextualize BM to be "mediating construct between technology and economic value", implying that BM facilitates technology into commercial solutions. Similarly, various perspectives have been laid out in refining the concept.

A business model (referred as BM hereafter) helps companies understand their overall business outlook and plan action for sustained growth. Multiple efforts have been employed on this front where research on various business models have been explored. These models comprise of individual elements, such as product, customers, relationships, revenues etc., that support each other in unique ways helping further develop the business offering. These BM elements have also been explored from various angles in the literature in terms of economic, social and entrepreneurial focus. According to a renowned concept developed by Osterwalder et al. (2010a), known as 'Business Model Canvas (BMC)', the business model comprise of nine main elements, i.e, 'Customer Segments', 'Value Propositions', 'Channels', 'Customer Relationships', 'Revenue Streams', 'Key Resources', 'Key Activities', 'Key Partnerships', and 'Cost Structure'. The model has been the holy grail for well over two decades, acting as a base for furthering the research on BM. However, the study on business models in recent past has taken a more dynamic route. Scholars have acknowledged the necessity to not view BM as a static medium but instead a dynamic process, filled with constant iterations to tackle the changes and capture the nuances in a company's environment better (Cavalcante et al., 2011; Teece, 2018; Schaffer et al., 2019). To study this dynamic phenomena, the complex and traditionally vast BMC makes it challenging to investigate the interlinks and relationships between its various elements.

Hence, to support the clause, multifarious iterations have been made by researchers to make it concise and cater uniquely for each situation. This comprises of altering individual elements of the model, framework they lie in, and also exploring their inter-relations. Multiple frameworks have been explored (refer Section 3.3.3) and for this research, we utilize the 'Sustainable Business Model Canvas' developed by Bocken (2015), given its conciseness and incorporation of 'social' and 'environmental' ideologies, along with 'economic' component in the model. The model has categorized BMC under 4 segments, i.e., 'Value Proposition (VP)', 'Value Creation (VC)', 'Value Delivery (VD)' and 'Value Capture (VCA)'. And since the study focuses on sustainable energy based companies, the integration of sustainability principles, stakeholder inclusion and profitability, align well with the nature of startups. Further information on process of choosing the business model framework can be found in Section 3.3.3.

1.1.3. Dynamic Business Model

Research shows that business models are not fixed - they are dynamic and made up of connected parts that can shift and adapt (Schaffer et al., 2019; Teece, 2018). This flexibility helps companies respond to changing market demands, new technologies, and evolving regulations, making it easier to stay competitive and meet customer needs. This conceptual understanding of BM, takes into account, the origin and type of changes, such as whether they are forced or strategic, primary or secondary, intensity of impact, net effect on business's outlook that helps ensure consistency and adaptability (Kamp et al., 2021). It highlights the need for companies to stay flexible and adaptable, using networks and partnerships to share resources and navigate challenges more smoothly (Nyström and Mustonen, 2017). High-tech industries especially gain from dynamic models, as they have to keep up with fast-

changing technologies and markets that help them manage complex relationships evolving over time and in different context (Khodaei and Ortt, 2019). They further allow companies to mix and match elements like pricing and revenue sharing to drive innovation and handle uncertainty at a fast pace and facilitate knowledge sharing between firms, posing key to building efficient supply networks (Rugnon et al., 2010). Overall, dynamic models provide companies a flexible way to create value, stay competitive and relevant, and adjust quickly to shifts in the market and business environment, facilitating relevance and resilience in constantly changing scenarios (Achtenhagen et al., 2013).

Within the context of sustainability, the DBM is considered essential for companies that must adapt to changing environmental, social and economic challenges to accomplish long-term sustainability targets. This dynamism involves changes brought about by outside and inside forces, whose effects build up on the 'triple bottom line', i.e., 'social', 'environmental' and 'economic' dimensions (Effendi et al., 2024). By aiding in building capability for pivoting or changing their course of action, DBM acts crucial for new-age ventures.

Sustainable Energy startups and scaleups function in environments bound by fluctuating environmental concerns, political instability, unclear regulations, emerging technologies, volatile investor confidence and so forth. This results in firms compelled to constantly track their business model and make subsequent changes to align their offering and opeartions with external environment. Incorporating DBM allows navigating and adapting to these challenges and optimizing the value offering and strategies for a better fit.

1.1.4. Business Model Archetypes in Sustainable energy based firms

Sustainable energy technologies are capital and time-intensive, require considerable infrastructural support resulting in crucial need for companies to transform their approach and innovate newer business models to stay competitive (Kolk and van den Buuse, 2012). They need to explicitly account for major commercialization challenges such environmental policies (e.g., subsidies, carbon taxation), investment capital for substantial infrastructural and technology development, and resistance from reigning energy providers. These challenges can be effectively targeted by reconfiguring business models of startups and addressing the pain points (Refer Figure 1.4) (Wüstenhagen and Boehnke, 2017).

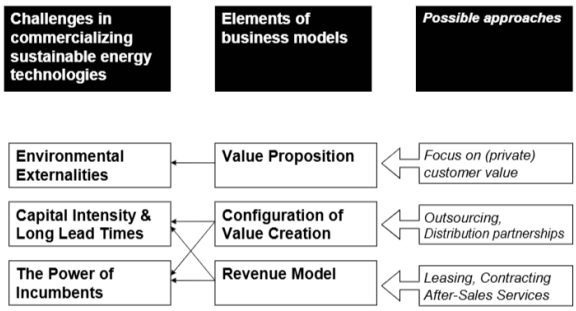

Figure 1.4: Reconfiguration of Energy Business Model to tackle commercialization challenges (Wüstenhagen and Boehnke, 2017)

Development of startups in the sector face critical setbacks in alluring the investors due to unsteady regulations and unclear customer base formation, resulting in most companies relying on public grants, incentives, subsidies and constrained support from industry incumbents (Singh et al., 2022). Strong competition and monopoly of existing giant companies, such as power generation and distribution/-transmission companies, make it super difficult for startups to venture into the field and provide value. As a result, a trend has been observed wherein entrants are targeting the end-side of value chain, i.e., approaching the consumers directly by providing energy-as-a-service (EaaS) [Refer Figure 1.5]. This comprise of service providers installing and managing energy systems, and consumers pay subscription fees based on guaranteed energy savings under a performance contract. Similarly, multiple innovative forms of service offering have been developed such as 'Battery-as-a-service', 'Microgrid-as-a-service', and 'Peer-2-peer Trading-as-a-service' (Singh et al., 2022). This flexibility, high scalability, and poten-

tial to swivel into the value chain attracts angel investors and venture capitalists into capital intensive technology development (Singh et al., 2022; Shaya Afrin et al., 2024). Companies are increasingly targeting 'Power Purchase Agreements (PPAs)' to ensure long-term contract with consumers for continual revenue cycle and collaborating with local communities via means of co-ownership to actively participate in decision making and have skin-in-the-game in transition towards resilient energy ecosystem (Shaya Afrin et al., 2024).

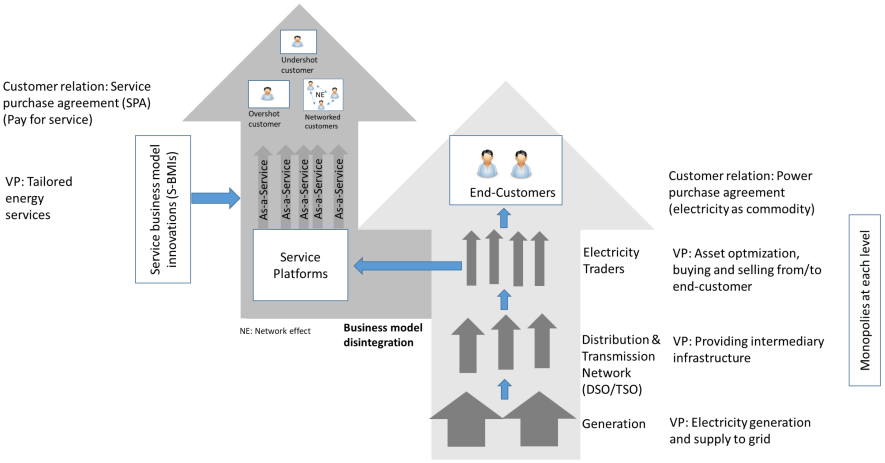

Figure 1.5: Value Chain in Energy Sector (Singh et al., 2022)

Throughout literature several innovative business model archetypes in sustainable energy industry have been discerned. For instance, 'Product-Service Systems (PSS)' is a model where firms provide renewable energy from sources such as solar, as a service rather than selling physical product. By reducing the liability for customers, this increases the tendency to adopt and boosts the firm's revenue with continual service. Another archetype, the 'Platform-Based Model' provides user with decentralized energy on demand and smart utility using Machine learning, IoT and blockchain technology, acting as a foundation for peer-to-peer energy trading and real-time energy tracking (Kufeoglu et al., 2019). Companies are finding ways to evolve their business models with changing scenarios to stay in the game, and this involves pivoting to a high extent.

1.1.5. External Trigger

Dynamic situations constantly bombard on firms, creating setbacks and events that compel them to strategically adapt, also often termed as 'Triggers', that have the potential to surface internally or externally or both. These triggers can drive companies to challenge the status quo and enforce innovation to survive, equilibrate and maintain competition (Bashir et al., 2021). For instance, changes in sustainable policies can compel companies to alter their products or processes. By tackling these triggers strategically, organizations can mitigate risk and maintain competitive advantage. Hence, a deeper understanding on the effects of external triggers on certain sections of BM is crucial to understand future potential. In an attempt to accommodate this dynamic behavior of triggers in an organizations functioning, Khodaei and Ortt (2019) have incorporated instantaneous changes in Business Model (BM). The model represents the location and identification of triggers causing systemic changes, which is further amplified in other elements of a BM. The triggers can be categorized as 'external' (events outside the jurisdiction of firm) or 'internal' triggers (events inside firm's jurisdiction) which have tendency to cause pivots. External triggers can include factors such as change in government regulations, environmental policies, socio-economic developments, changes in customer needs, disruption in global market due to pandemic etc. These triggers are imposed on an organization rather than budding from within, and often dictate systemic response - i.e., examining broader system rather than isolated sections - to react effectively (Stern et al., 1979).

In context of Sustainable energy-based industry, companies in their path to develop greener technologies face impacts on multiple fronts. As identified by Pysmenna and Trypolska (2020), firms prominently

face high initial cost given their infrastructural needs and uncertain carbon pricing mechanism keeps subsidies debatable. Lack of consistency in supportive policies has also deterred the innovation capabilities, acting as a major external trigger. In addition, The Netherland is also facing huge grid congestion due to inability of existing grid infrastructure to accommodate varying load from renewable source of energy, directly impacting the prices, market acceptance, regulatory limitations, customer requirements and investments (de Winkel et al., 2025). This constant dynamism inter-playing in sustainable startup ecosystem hence solicits the need for understanding the effects of triggers surmounting to changes in business model.

1.1.6. Pivots in Busness Model

Business Model Pivots are strategic shifts experienced by a company by differentiating how a firm creates, delivers or captures value, as deemed necessary to ensure competitiveness and organization's survival. They play a crucial role in aiding companies navigate changing environmental conditions, achieve a better product-market fit, and provide a way for them to explore new opportunities. According to Kirtley and O'Mahony (2023), a pivot is defined as "change in a firm's strategy that reorients the firm's strategic direction through a reallocation or restructuring of activities, resources, and attention". The concept of pivots is significantly pronounced in the entrepreneurial sector where startups face uncertain environments (Townsend et al., 2018), with choice to chase multiple opportunities without fully comprehending the worth of alternate strategies (Gans et al., 2019). They are not just about changing firm's product/service, but also have tendency to change the operations, customer outlook, finances, revenue and so forth. Research on pivots observes both external factors - changing customer needs, market requirements, regulatory changes - and internal factors - product development, leadership changes, operations - to be significant contributors to pivots (Bajwa et al., 2017a; Allen et al., 2024). Global shocks such as COVID-19 also have a deep-seated impact on functioning of companies, forcing them to rethink their value offering, exploring new markets and customers, employing digital technology and shifting their customer relationship patterns (Adamek and Meixnerova, 2020). These changes are multi-dimensional requiring synchronized changes in overall business components that have tendency to reshape firm's identity. Effective pivots are distinguished by thoughtful foresight, organizational agility, and a deliberate focus on long-term resilience.

Startups are known for their agility to swiftly adapt to changing scenarios, factors both internal and external to the company. These changes can stem as innovative strategies employed to figure out novel ways to pursuing an action or adaptive steps taken to neutralize the effects on the company. Upon studying 15 Portuguese startups to understand impact of pivots, Fernandes and Afonso (2018) found that startups that promptly responded to fickleness in their environment, managed to survive and grow better, and that changes one section of business model ultimately influenced change in other sections, signifying the dynamic effects of pivots. Literature shows that ventures that show tendency to pivot multiple times benefit by limiting the uncertainty and achieving a better product-market fit (Zott and Amit, 2008; Sosna et al., 2010).

The concept is gaining traction in academics, however research has scarcely explored as to when firms choose pivoting their processes (Kirtley and O'Mahony, 2023). Sustainable energy companies face external triggers from all three arenas, i.e., economical, environmental and social circle. With changing climate situation across globe, the firms need to make decisions under high uncertainty with regards to product needs, feasibility, and changing regulations. Furthermore, the industry functions on high capital investment, long product development cycle and stern regulatory restrictions. Hence, for the research, pivots made by sustainable energy company when interacted with an external trigger are explored. Due to increasing complexity, no differentiation is made between intensity of pivot.

1.2. Problem Statement

Sustainable energy technology startups function in dynamic environments abundant with rapid changes, fickle customer needs and competition, that demands continual business reconfiguration for sustained viability. Changes in regulations such as new environmental laws, GHG pricing mechanism, can either promote new market opportunities or quickly make green products obsolete (Denoo et al., 2022). Similarly, technological advancement such as digitalization, green technology, smart devices, or global

pandemic such as COVID-19, climate change, act as prominent external triggers that compel the startups to be agile with their business models to ensure survival. As conceptualized by Ries (2011), a 'pivot' or a change, is deliberate effort by company to create fundamental changes to their business models to adapt to these changes effectively. When an external trigger impacts the business model, changes are made within to realign the outdated value offering with evolving market requirements (Fernandes and Afonso, 2018; Comberg et al., 2014). These changes are more pronounced in sustainable tech venture since they proactively focus on economic, environmental and social concerns, implying that changes in one sector enforces changes in other. In addition, these triggers are perceived either as opportunity or threat by entrepreneurs, and during this process of connecting the dots, they recognize the need to act to pivot (Baron and Ensley, 2006; Bucherer et al., 2012). This categorization of perception of a trigger acts as a critical driver influencing adaptation of business model (Saebi et al., 2017).

As found in research, the business model is not static, but dynamic, with interconnected components actively regulating each other (Khodaei and Ortt, 2019). However, this cascading effect of external triggers causing pivots or changes in the way a firm functions is lacking research in academics, especially in sustainable startup context (Motjolopane and Ruhode, 2021). Hence, this thesis aims to explore how external triggers are identified as opportunity or threat, create changes in business models and set knock-off changes in 'Value Proposition', 'Value Creation', 'Value Delivery', or 'Value Capture'. To summarize in a brief:

The research focuses on studying the pivots caused by external triggers in business models of new-age sustainable energy-tech startups by understanding the snowball effects on different elements of BM.

1.3. Research Gap

The transition pathway from using fossil fuels for energy needs to sustainable forms of resources such as wind and sun has been a critical journey for this generation. Impending climate change and global disruptions are compelling users to formulate new technologies to tackle the problems and harness energy from abundantly available resources. This metamorphosis is associated with questioning the utility, efficiency and applicability of existing infrastructure that have been supporting conventional resources, and making efforts towards developing the supporting systems and infrastructure to acclimate new technology. This involves delving deeper not only into the infrastructural and technological advancements, but also crucially requires thinking from a systems viewpoint, taking into account the needs and preferences of stakeholders, corresponding policy development for easy implimentation, regulations to limit disruptions, and development of new-age ventures resilient to these changing scenarios.

While, over the decades, considerable advancements in technology by ventures have transpired, bringing the industry a step closer to reaching its goals, a series of gaps have been observed in the research when it comes to understanding how startups/scaleups or SMEs navigate this complex business environment (Schaper, 2002). A major part of this involves understanding how companies behave, adapt, and change to changing external triggers they are exposed to. A detailed literature study observes following three gaps, this research intends to contribute to.

First, knowledge gap has been observed concerning the perception of external trigger in sustainable energy firms. While there are frameworks available with regards to general entrepreneurship perceiving triggers, the application of these frameworks in context of sustainable energy entrepreneurship is scarcely understood (Bucherer et al., 2012; Baron, 2006). Similarly, there lies a void as to how energy startups categorize impact of regulations, technology, market needs and climate as an opportunity or a threat (Lee et al., 2025). This has significant implication, given how these startups, predominantly function at the intersection of policies, economics, environmental and social causes due to their high capital and infrastructural investment requirements and wide-scale impact. The following research aims to identify what broad triggers impact companies in this industry, and what factors aid them to distinguish between opportunity or threat.

Second, limited understanding of cascading impact of one BM element on another is found in literature. This observation of when a trigger impacts the business model and subsequent pivoting action takes place, requires further exploration to better understand the nature of BM (Rhoads, 2015; Fernandes and Afonso, 2018). Khodaei and Ortt (2019) have developed a dynamic framework that investigates

the interconnectedness characteristics of business models. Building on this general understanding, the research aims to observe the relation between elements from sustainable energy perspective, where the 'triple-bottom-line' factors - i.e., 'economic', 'environmental' and 'social' - vulnerably impact the business model of new-age companies.

Third, literature on pivoting action of firms in response to an external triggers has been seen to be scarce (Motjolopane and Ruhode, 2021; Morgan et al., 2020). Pivot actions undergone by companies to ensure survival has been studied widely, that has allowed furthering the research in terms of understanding dynamic nature of business model (Ries, 2011). However, generic frameworks such as 'Build-Measure-Learn' loop by Ries (2011), that emphasize the pivot actions, falls short of addressing the factors causing those pivots. Motjolopane and Ruhode (2021), further highlights the scarcity of research on the factors driving these pivots, emphasizing the need to understand the triggers that lead to changes in business model.

1.4. Research Objective and Scope

Building on the above problem statement, the objective of the research is to explore the influence of external triggers causing pivots within sustainable-tech startups business model. In addition, the aim is to understand the ramification of these triggers resulting in echoed effects in other parts of Business Model (BM). The motivation stems from the need to understand in detail how new-age green tech companies adapt to external stimuli and proactively restructure their BM to ensure survival, stay competitive, and maintain relevance in changing environment. To achieve these objectives, the study shall focus on:

- Identifying the external triggers that result in persuading sustainable-tech startups to make pivots in Business Model and what factors allow decision makers to perceive it as opportunity or threat. This consists of classifying the external triggers that prominently affect the firms, into categories, that is bound by geographical specificity, i.e., Dutch energy landscape. The general triggers will be obtained through literature review, and analysis will be conducted to achieve triggers specific to Dutch sustainable energy industry.
- Exploring the primary influence of an external trigger on certain business model element of startups. This involves mapping the frequency with which BM element is impacted by certain external trigger category.
- Investigate the nature of pivoting actions undertaken by the firm in face of triggers, and identify the nature of BM change undergone, i.e., innovation or adaptation.
- Observing how changes in certain BM element impact other elements of BM. This systemic behavior helps to understand how startups synchronize their changes across BM to avoid misalignment and ensure resilience.
- Provide suggestions to the startups management team to strategically monitor and evaluate strategies to cope with inevitable pivots. This involves evaluating triggers, monitoring activities and make informed changes in course of business.

The research aims to advance the academic understanding of dynamic business models in sustainable energy-tech firms, equipping entrepreneurs with strategic tools to help them understand the impact of various external triggers on their business model, and subsequent pivots undergone. The research focuses on startups, scale-ups and academic spin-offs in Dutch energy landscape to constrain variations in regulations, infrastructure and institutional frameworks.

1.5. Research Question & Sub-Question

Based on the problem statement and objective of research, following main research question and subsequent sub-question that can help answer the research question has been formulated:

Research Question: *How do external triggers instigate pivots in business model elements of Dutch sustainable energy-tech startups and what are corresponding effects on other elements of business model?*

1. **How do startups evaluate the external trigger to be an opportunity or a threat?**

We identify the key external events and drivers impacting the companies and how they are perceived as opportunity or threat. This contributes to insights of entrepreneurial cognition and decision making process. Distinguishing the two, help leaders allocate resources strategically and increase resilience in face of triggers.

2. **Which section of Business Model (i.e., 'Value Proposition', 'Value Creation', 'Value Delivery' and 'Value Capture') does the external trigger primarily impact and what is the pivot effect?**

   This helps to understand how business model elements behave upon impact. It enhances the clarity of moldable nature of BM elements and explore the influence of external triggers on elements to cause corresponding pivots. This can help entrepreneurs critically reflect on reinforcing their BM components accordingly, and develop their capability to predict changes in BM.

3. **How do these pivots in one section of Business Model impact other elements of Business Model?**

   This helps to assess the change effect on wider business models, by exploring the concept of interconnectedness and interdependent nature of BM elements. It can aid entrepreneurs equip for cascading changes in their business model, and reinforcing their business processes to accommodate changes to increase effectiveness.

1.6. Relevance of Research

1.6.1. Academic Relevance

The thesis contributes to business model literature by explicating the impact of external events on the business model of startups. This study explores the key components of a business model - 'Value Proposition', 'Value Creation', 'Value Delivery', and 'Value Capture' - and examines how changes in one area influence the others across the model. As emphasized by Teece (2007), the dynamic ability of firm to restructure internal and external competencies with changing external environment is crucial for survival. It necessitates continual adaption and innovation, and understanding the rationale behind making a change is crucial to understand dynamics. The thesis also contributes to the field of entrepreneurship by exploring different types of triggers acting on a company, causing effects on company's performance (Foss and Saebi, 2018). The thesis is closely related to Masters in Management of Technology as it explores important topics of business model elements, innovation and dynamics and its significance in developing innovation and sustaining a business. The discussion pays a close attention to entrepreneurship by focusing effects on sustainable energy based startups and scaleups. The ability of these firms to perceive these external changes as opportunity or threat, also influences the type of business model changes.

1.6.2. Practical Relevance

The concepts holds practical significance to a great extent for entrepreneurs, investors, and policy makers. Entrepreneurs function in ecosystems influenced by rapid technological changes, regulations and customer needs. Understanding the consequences of these external triggers causing pivots (change) in business model has practical relevance that can allow the decision makers to make informed decisions. The knowledge can help entrepreneurs provide insight into recognition and response to these recurring triggers, ascertain them as opportunity or a threat, anticipate the extent of changes and potential challenges surrounding it. Furthermore, incubators, accelerators and startup development organizations can utilize the information to tailor their advisory services and programs accordingly. By understanding the common triggers, their influence and common pivots undergone, they can help equip and navigate the future startups better.

1.7. Methodology

Addressing the research question, a detailed methodology will be employed to reach conclusions. This involves literature review, data collection using interviews with sustainable energy based companies and public data archival records, and further data analysis using thematic analysis to draw patterns.

An inductive, multi-case study approach is utilized to understand the impact of external triggers on the business model of sustainable energy-based tech startups and scale-ups and how pivots are introduced in company's functioning to adapt those changes better. The aim of the study is to explore type of

external triggers and corresponding changes implemented by companies in this sector, hence a cross-case analysis is appropriate for observing pattern of events. The study focuses on industry-level analysis by interviewing individual company's officials about their experiences. Data from other publicly available sources such as company websites, white papers, company blogs, news articles are used to triangulate the data.

Sustainable-energy based companies serve as research setting, given the high uncertainty, time sensitiveness, climate change, regulation changes and restriction to new market expansions. The companies are restricted to The Netherlands to limit the country-specific factors such as regulation variation, technology availability, reliance on external commodities (energy, electricity, water), local environment and so forth. However, companies from different domains such as nuclear, battery, wind energy etc. have been considered to generalize the results to a specific industry, i.e., energy-tech.

Approach

An exploratory approach is used using literature survey, interviewing participants and public archives. The following table 1.1 presents an overview of research approach for each sub-question.

Table 1.1: Research Approach

Sr. No	Research Question	Research Approach
1	How do startups evaluate the external trigger to be an opportunity or a threat?	Literature Review, Interviews
2	Which section of Business Model (i.e., 'Value Proposition', 'Value Creation', 'Value Delivery', 'Value Capture') does the external trigger primarily impact and what is the pivot effect?	Literature Review, Interviews
3	How do these pivots in one section of Business Model impact other elements of Business Model?	Literature review, Interviews

1.8. Organization of Thesis

The paper is structured as follows:

- Chapter 2: Methodology adopted for analysis.
- Chapter 3: Literature Review of relevant concepts.
- Chapter 4: Conceptual Framework developed for answering the research question.
- Chapter 5: Case Studies of companies interviewed.
- Chapter 6: Cross-Case Analysis between all companies interviewed to find a pattern.
- Chapter 7: Discussions, Conclusion and Recommendations.

2

Methodology

This chapter delves into the research methodology utilized to explore the pivots in business model caused by external triggers, and its significant effect on individual BM elements. The research focuses on Dutch-based sustainable tech startups in Energy sector that have emerged as a result of innovation from academic spin-offs, research-based study or gap identified in market. The aim is to describe and justify the methodology adopted to explore impact of external triggers on company's business model functioning and understanding nature of subsequent change/pivot as a consequence.

The section begins with explaining the research setting chosen, followed by explanation on case-study and company selection criteria, corresponding data-collection procedure exercised, and finally concluded with data analysis technique applied.

2.1. Research Design

Energy based Sustainable-tech startups established in The Netherlands has been considered as research setting to limit variance in industrial and geographical functioning, regulations, and policies. The study dives into the frequent changes undergone in a company due to external events. Given highly volatile and frequent market changes owing to advanced technology and fast processing time, the startups act as a suitable subject to explore the changes in business model (Günzel and Wilker, 2012).

The research uses qualitative, multiple-case study approach in order to explore pivot effects in BM caused by external triggers in Dutch energy based startups. Qualitative approach allows exploring complex phenomenon unique to every individual subject by providing contextual depth, and nuanced indications (Jameel et al., 2018). It facilitates rich in-depth data collection that encompasses distinctiveness of given procedures, focused data capture, and pattern recognition. According to Yin (2003), a case study is "an empirical inquiry that investigates a contemporary phenomena within real-life context". A multiple case study design allows cross-sectional analysis various cases in parallel, formulating patterns, and differentiating characteristics (Eisenhardt, 1989). The approach involves examining and comparing cases for triggers, reaction and corresponding changes in BM, further helping identify patterns. Furthermore, cross-analysis of multiple cases also helps identify unique outliers in individual cases and coalesce recurring themes (Eisenhardt, 1989).

The theoretical analysis of qualitative data is conducted following Gioia Methodology (Gioia et al., 2013), which helps to explore complex organizational events, taking into account also the context of phenomena. The detailed procedure is outlined in section 2.5. In addition to qualitative analysis, quantitative analysis is also conducted to identify the frequency that allows to observe patterns in the data.

2.2. Sample Strategy

To enhance the focus of data collection by targeting desired data type, 'Purposive Sampling' approach has been considered (Bougie and Sekaran, 2019). To employ this method, the companies chosen for analysis had to satisfy following criterias:

- Startup/Scale-Up company in The Netherlands: Firms must be in early-stage development phase (conceptual design validated, i.e, market need identified), ready-for-market stage or scale up phase with multiple customers. They must originate from The Netherlands.
- Energy Sustainable-Tech Industry: Startups have forays in energy sector, with core business based on advanced technologies, research-backed technologies, and academic spin-offs focused on sustainability.
- Pivot: The BM should face at least 5 pivots during its operations to derive meaningful insights.
- Willing to participate in the study and provide rich data.

Based on above criteria, the Table 2.1 lists the companies that were contacted and interviewed for the study. In total 25 companies were approached via means of LinkedIn, company email address, mutual network connection. With response rate being too slow, telephonic calls were made to get in touch faster, wherein it was realized that due to sensitive data and privacy concerns pertaining to their strategy, most of the company officials were hesitant to provide any information. Following which 6 companies agreed to an interview, with one in-person interview and five online interview over MS Teams platform. The startups and scaleups selected are from varying domains, however, focusing on sustainable energy industry. Due to privacy and protection concerns conveyed by the company officials, the company name and all unique data pertaining to the company has been completely anonymised. This does not impact the quality of research since the focus is not on individual company's unique progress, but understand the general external impacts faced by companies in this industry.

Table 2.1: Startups contacted for case-study

Sr. No	Company	Domain	Founding year	Response	Main informant
1	Company K	Wind Energy	2016	Yes	Marketing Manager
2	Company G	Battery Storage System	2018	Yes	Chief Operating Officer
3	Company N	Bio-Gas	2018	Yes	Marketing Manager
4	Company E	Battery Material	2019	Yes	Program Manager
5	Company B	Energy Storage	2019	Yes	CEO and Commercial Director (2 interviewees)
6	Company T	Nuclear Energy	2018	Yes	Business Development Director

2.3. Data Collection

An overview of complete data collection procedure can be found in Table 2.2. The collection process starts with doing extensive field work over internet and verbal communication to find appropriate companies working in the industry. These companies are further filtered out according to selection criteria (as mentioned in section 2.2) based on their product availability, market accessibility, company goals and potential future development. Next, these companies were further contacted using cold-emails, connecting with decision makers over LinkedIn and approaching mutual network connections.

In parallel, interview scenario and questions were designed according to project goals, publicly-available company documents were accumulated to reinforce the study (interview guide can be found in section 2.4). Upon successful interviews, the transcripts were coalesced and compared with publicly available data to increase the validity and robustness of the data received. Upon completion, relevant information talking about external triggers and consequent pivoting action was isolated in excel file as "quotes" for further analysis.

2.3.1. Interview Data Collection

The primary data collection involved semi-structured interview with company officials having designations ranging as CEO, COO, Commercial Director, Marketing Manager, Program Manager, Business Development Director, and Business Development Manager, which allowed getting various perspectives. Since the data aims to delve deeper into events happening and contextual information surrounding those activities, semi-structured approach was selected which allowed to strike balance between guided inquiry while providing flexibility to create a exploratory inquiry. The queries were aimed at understanding the external triggers and their corresponding impact on various business model elements and understanding the pivoting nature. The questions were open ended that mainly focused on:

- Identifying the type and extent of external trigger.
- Description of company's response in face of these changes.
- Understanding the rationale and logic for change/pivot.
- Learning from the outcomes and pivot decisions.

Each interview lasted between 30-60 minutes and was conducted both in-person and online (Microsoft teams), subject to availability. The interviews were recorded and transcribed on Microsoft Teams under TU Delft account for privacy and protection reasons. Furthermore, given the fragility of the nature of content, all company participants wanted the data to be completely anonymised. The quotes from the participants were further used for coding and analysis.

2.3.2. Publicly Available Data Collection

In addition to interview data from participants, company centric data publicly available was extracted from company websites, white papers, reports, blogs, press releases and articles. The data was studied in detail before the interviews to understand the context and environment the company functions in to allow personalization of questions and also gain a perspective on company's business pathway and goals. It provided insights into the history of activities, background information of companies, market environment they function in, and understand the competition and its intensity. In addition, upon conclusion of interviews, the qualitative data from interview also allowed triangulation which involved cross-verification with publicly available data to enhance the robustness and reliability of data.

Table 2.2: Steps and Description of Data Collection and Analysis Process

Main steps	**Description**
Initial Background Study	• Internet surfing, website study (Understanding the company business), Verbal information gathering.
Company selection	• Cross-verifying company selection for criteria
Connecting with start-ups	• Sending e-mails to companies and follow-up emails • Mutual Network • Connecting with responsible member via LinkedIn • Telephonic inquiries
Information gathering and primary analysis	• Interview design • Collecting important publicly available company documents, i.e., press release, news articles, websites. • Conducting interviews • Consolidating interview transcripts with written documents to make arguments robust
Case Analysis and Report	• Make case description • Analyse the cases using Gioia Methodology • Develop Conceptual framework • Individual Case Analysis • Cross case analysis • Discussion and implications • Conclusions

2.4. Interview Guide

The interview questionnaire comprise of 5 main sections. The first section explores general company and interviewee based information to understand the context both lie in and frame further questions accordingly. The second section explores the value offering of the companies, impact by customers, market and other strategic reasons. The third section explores impact on company by new market and geographical expansion. The fourth section delves into the sustainability policies, government regulations and other governing factors. The fifth section delves inside company's functioning and its resource relations with other partnered companies to understand the implication of external impact on company's functioning. Most of the company officials were able to answer all questions successfully, however for a few questions, we did come across situation wherein they mentioned that they were not the right person for credible data in certain areas. The complete guide can be found below:

Legend: ***TR*** - *Trigger ;* ***BME*** - *Business Model Element ;* ***O/T*** - *Opportunity or Threat ;* ***PV*** - *Pivot ;* *'**Not Act**' - No pivot/change,act*

Table 2.3: Interview guide

Areas	Question	Framework Related Aspects
General	Can you briefly talk about your role and experience at company? Can you also mention any significant milestones?	
Value Offering	Did the company goals and product offering significantly change over the years? If yes, when and why did it change? Was there any technological change?	TR, BME, PV
	Did you view them as an Opportunity for something better or did you take action to mitigate the Threat?	O/T
	With these new changes in product offering, was there any particular section like vendors, finances, customers, partnerships that was directly and more intensely impacted?	BME, PV, O/T
	Can you think of an example when a product change was needed but was not acted upon?	'Not Act', PV
	How do you track changes in customer needs and how do you respond to these changes in customer needs?	TR, BME, PV, O/T
	Has company ever undergone any strategic changes concerning rebranding or repositioning? If yes, what factors influenced these changes? If no, did the firm ever face any options/situations where decision was made to not act?	TR, PV, 'Not Act'
Value Delivery (Market)	Has company explored or entered new markets or industries since starting operations? How are these new market opportunities evaluated?	TR, PV, O/T, BME
	What were the Opportunities or Threats that made you enter new market?	O/T, PV, TR
	Can you think of any example wherein decision was made to act or not-act on those opportunities or threats?	'Not Act', PV, TR
	Does company have operations in multiple countries/regions? If yes, how do these regulations vary across regions and how do they influence company's business operations?	TR, PV, BME, O/T
	Can you mention some steps that decision makers take to seamlessly enter operations in a new country/region? How is business model adapted?	PV, BME, O/T
	With new market, did the value offering/product have to go through lot of change to adapt to new regulations? Did the process involve restructuring partnerships/vendors or new financing schemes?	PV, BME, O/T
Regulations and Policies	Government policies on sustainability and climate are changing owing to multiple factors. Can you explain a bit on how these policies are constantly adapted within company?	TR, PV, BME, O/T
	Have they impacted the cost structure, available resources within firm, the ways customers are willing to pay, or customer segments?	O/T, BME, PV
	Did it ever lead to technological change in your product? Were there any additional resources like new vendors, experts, or partnerships that had to be hired to conform to these policies?	PV, BME, O/T
	Geopolitical tensions in recent years resulted in energy prices increasing drastically. What were the type of challenges and opportunities that COMPANY B realised?	PV, BME, O/T, TR
	What was impacted the most in company's functioning with these external adversities? What steps were taken to tackle the problem?	BME, PV
Company Resources	How important are partnerships and collaboration in your business model?	TR, BME
	Were the partnerships made as an opportunity to explore new areas or were they also made to protect from external threats to companys functioning?	PV, O/T
	Did new partnerships help create new value offerings, new market, new financial protocol, new resources or lead to new vendor types?	TR, BME, PV, O/T

2.5. Data Analysis

The qualitative data - interview transcripts, company blogs, press release - collected shall be thematically analyzed which involves examining data to identify common themes, reading between lines and identifying meaning within the patterns. The process follows certain protocols to ensure the quality of data. Initially, the data received in mode of transcripts are thoroughly read to form an overarching understanding of the events and context they take place in. This helps to analyze the nuances that depend on contextual factors. Next, the data undergoes thematic analysis involving following steps:

- **Open Coding**: This process corresponds to inductive approach to break down the data into certain modules relevant to a line of thought.
- **Axial Coding**: The numerous components are then reassembled to identify meaningful relations and patterns.
- **Selective Coding**: The themes are coalesced together into broader main constructs housing all relevant elements.

This data acts as a base to conduct Cross-Case Analysis involving identification of patterns across various Sustainable-Tech startup cases and variables. This helps identify external triggers startups face, their perception of a trigger, observe corresponding pivoting action, and eventually explore chain reaction on other sections of BM. Further explanation of cross-case analysis can be found in Chapter 6.

Gioia methodology is utilized to code and categorize the data in layers, followed by developing a data structure and building theory (Gioia, 2013). This involves studying the transcripts of interviews to label the information in first-order layer, linking the patterns in second-order layer, and further coalescing them into aggregate dimensions.

2.6. Cross-Case Analysis

2.6.1. Gioia Methodology

The data collected was analyzed using Gioia Methodology - qualitative analysis approach to develop grounded theory using inductive study(Gioia et al., 2013). The method comprise of multi-stage coding process, that allow refining and filtering of raw qualitative data into concise concepts for building knowledge. The process comprises of three main stages, i.e., First-order coding(open-coding), Second-order coding(axial-coding/thematic analysis) and Aggregator Dimension development.

- **First-Order Coding (Open Coding)**

  The interview transcripts were studied and perused to find quotes concerning external trigger impacts on company's functioning and corresponding pivot decisions. These quotes were further ordered in an excel file. The quotes were reviewed and made concise in terms of brief, descriptive statements encapsulating the nature of events. This process involved staying close to interviewee's intention without much intervention to reduce researcher's bias.

  - **Example 1:** *Company K*: "*So also what I learned now from our potential customers and for most of them, the [X capacity] is too small. Like it doesn't impact enough on what they need, so their energy demand is higher than what we can deliver with the [X capacity]. So that's where we at right now, trying to increase the capacity to target their needs.*"

    Description: "Existing product size inadequate according to customer feedback,prompting development of a more suitable technical solution"

    First-Order Code: "Adjusting product capacity to meet customer needs"

  - **Example 2:** *Company K: "We get requests but we specifically pick countries that have the same regulation framework... If we want to go to [geographical region X]... we will have to make changes in product. So yes, we explore the markets especially in [geographical region Y] because they are easy to reach and the laws for us to manufacture our product and to be able to operate is the same as the market in the Netherlands."*

Description: Product and company resources introduced in geographical regions having similar regulatory framework, facilitating product introduction in new markets.

First-order code: Introducing product in regions with aligned regulations.

- **Second-Order Coding (Axial-Coding)**

  The first order code was studied to identify patterns and relationships, and similar codes were grouped together under a single theme. This involves high level of abstraction, trying to find similarities and a roof where the first order codes can lie under. The process is iterative, with themes being continually refined to formulate systematic set of themes.

  Example: "Enhancing product efficiency with tech improvements", "Automating product operations to boost efficiency with technological advancement", "Repositioning company approach with technological advancement of product" etc were grouped under "Technological Advancement" (Trigger) since all the pivots took place due to technical triggers.

- **Aggregate Dimension Development**

  The second order themes were further analyzed to categorize into 'Aggregate Dimensions' which aim to ground theory/typology on different type of pivots that are triggered due to external factors. These dimensions were carefully refined such that all second order themes could be accommodated.

  Example: "Customer feedback and preference adaptation", "New Market Access", "Market saturation or decline", "Marcoeconomic Market Disruptions" were all the triggers associated with the market environment, hence they were categorized as "Market-Driven Triggers".

  Following the development, a structured visual representation of the Gioia analysis - i.e., Gioia Tree - was made to provide a clear concise summary of how raw interview data was coded into categories.

The Gioia Analysis acts as a pathway towards cross-case analysis of interviewed data from sustainable energy based companies.

2.6.2. Frequency Observation and Pattern Recognition

Upon conducting data analysis using Gioia methodology, the data is further explored using quantitative methods. This corresponds to measuring frequency of individual dependent and independent variables. This provides pathway for observing patterns and relation between events, and draw meaningful conclusions. Given the straightforward nature of these analysis, the process is conducted and visualized using MS Excel.

Research Methodology Visualization

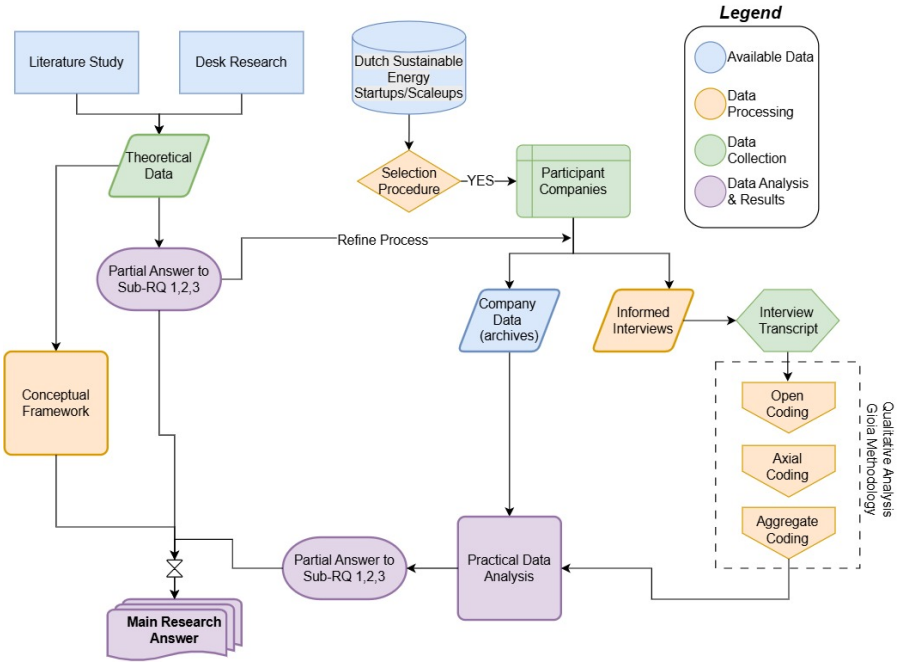

Figure 2.1: Research Methodology Visualization

3

Literature Review

3.1. Sustainable Energy Sector in The Netherlands

The Netherlands through its sheer innovation and entrepreneurial ecosystem is driving a significant progress towards sustainable energy technologies. Focusing on a long term perspective, the government adopted a 'transition' concept about two decades ago, which involved creating certain pathways and conducting experiments towards implementation of sustainable development (Kemp et al., 2007; Verbong and Loorbach, 2012). This 'Transition management approach' conceived by Dutch governance focuses on understanding complex issues from long-term perspective and understanding influence from multiple actors, phases, and levels (Loorbach et al., 2008). The country being previously reliant on non-renewable natural gas has been significantly undergoing transition to renewable energy sources to achieve carbon neutrality with innovation and fostering strong collaborations between academics, industry and government (Verbong and Loorbach, 2012). Frequent climate issues like earthquakes near gas fields of Groningen (Dutch city) has resulted in exponential decline in Natural gas production since 2013 (Holz et al., 2017). Over the years, the nation has observed a rapid growth in green energy, with a jump from 15% in 2017 to 40% (total power generation) in just 5 years (2017-2022) (IEA, 2024).

With aims to achieve net-zero carbon emissions by 2050, the country has implemented multiple fronts to reach the goal via means of government subsidies and regulations, novel technologies and collaborations (IEA, 2023). The National Climate Agreement established in 2019 has facilitated remarkable improvements and fast-track in transitioning to sustainable resources and reduction in greenhouse emission, with significant growth of solar, wind and green-hydrogen generation (Government of the Netherland,

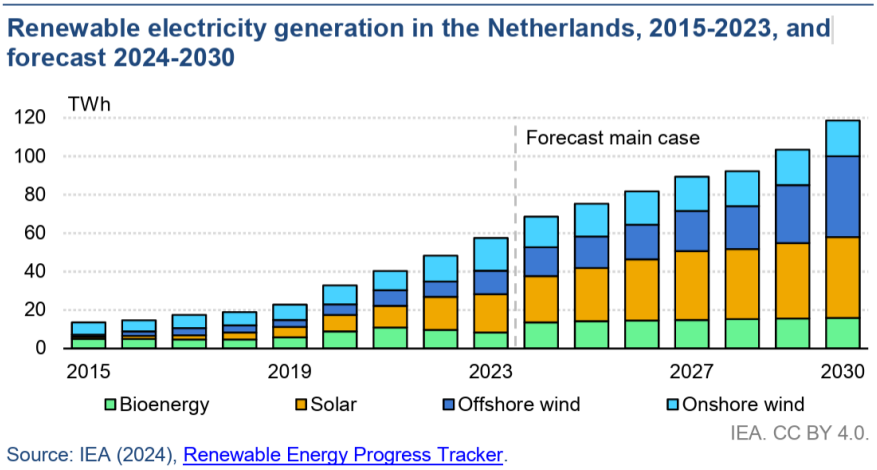

Figure 3.1: Renewable Energy Share (IEA, 2024)

2019). While considerable advancements have been laid out in renewable energy sources, close to 42% of domestic energy production still comes from Natural gas alone, while renewable energy accounts for 22%, implying a large chunk of development yet to be made (refer Figure 3.2) (IEA, 2023).

The Dutch renewable energy landscape is dominated by Wind (59%) and Solar energy (40%), acting as a significant source of energy generation. The nation has been a successful leader in the wind energy industry for decades with its extensive outreach in Offshore North Sea area (van der Loos et al., 2021).

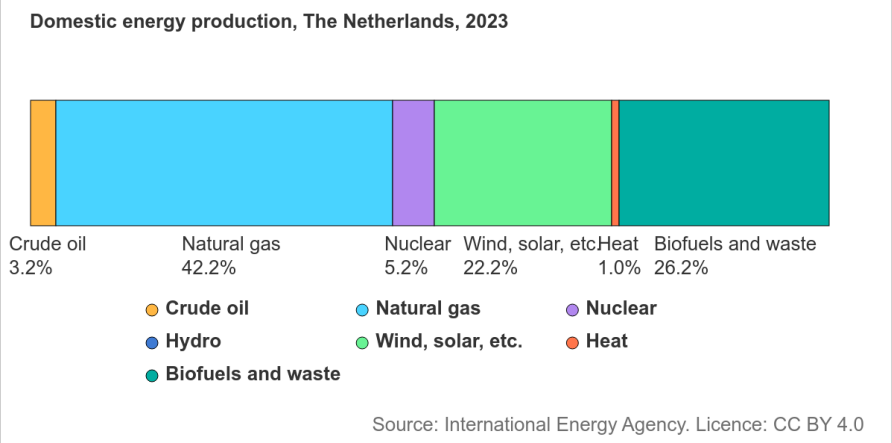

Figure 3.2: Domestic Energy Production, The Netherlands, 2023 (IEA, 2023)

The government has actively taken interest towards achieving sustainability goals for decades - with roots to achieve modern solutions being set in early 2000s, with implementation of 'Transition Management' (Kemp et al., 2007). The key considerations of this line of thought included having long term perspective on short term policies, thinking from multiple perspectives (domains, levels, phases), and learning from experimentation (Kemp and Loorbach, 2006). The Climate Agreement, 2019 had set the framework and targets to control GHG emissions to 49% by 2030 as compared to 1990 levels (Government of the Netherland, 2019). Further validating the quality of measures taken by the nation, study by Environmental Assessment Agency (2024) mentions that Netherland is scarcely in line to achieve 44-52% GHG reduction, with probability of reaching climate goal 2030 extremely unlikely (Environmental Assessment Agency, 2024). Significant delays in deployment of offshore wind-farms, slowdown of hydrogen development and uncertain political landscape have added to the cause.

The government has extensively invested in providing subsidies to foster innovation towards developing sustainable technologies. The 'Top Sector Energy' acts as hotspot for collaboration between industry, government and social institutions, help develop private-public partnerships and platform for knowledge diffusion for a holistic solution(RVO, 2019b). Under their initiative of 'Topconsortia voor Kennis & Innovatie (TKIs)', they support startups and scale-ups by easing access to grants and funding for R&D, organize networking and offer programs focusing on R&D to market-ready solutions. Furthermore, the RVO developed Sustainable Energy Transition Incentive Scheme (SDE+ and SDE++) which aims at granting subsidies to institutions for a period of 12-15 years, that focus on advancing reneweable energy and reduce GHG emissions (RVO, 2025b). With a budget of €8 billion, the program aims to compensate the gap between cost of developing technology and market value. Complementary to the SDE++, 'The Climate Fund' has allocated €35 billion, with most of funds diverted towards developing Nuclear and Hydrogen technology and infrastructure (Central Government - NL, 2024). In addition, the Netherland Enterprise Agency (RVO) also runs in parallel various renewable energy schemes such as 'HER+' (RVO, 2017), 'Demonstration Energy Innovation - DEI+' (RVO, 2025a), and 'Multi-year Mission-driven Innovation Program - MMIP' (RVO, 2019a), that aims to subsidize innovation in renewable energy sector. These programs provide a supportive ecosystem for startups and scale-ups with networking, sharing knowledge, aligning nation's innovation goals, and financial access further reducing time to market.

The National Energy System Plan 2023 was incorporated to support path towards carbon neutral soci-

ety, with adaptations being implemented every 5 years. The emphasis lays on enhancing wind energy capacity, increasing solar energy production and focusing on developing roots of hydrogen technology. Furthermore, to tackle grid congestion, significant investments in digitalization and smart tech, improvements of energy storage system and flexibility in grid operation is being aimed at. To ensure smooth transition to renewable energy sources, the plans to strengthen via means of retraining and bolstering the grid infrastructure has been mentioned (RVO, 2024).

This transition to renewable energy is buttressed by collaborative efforts between the academics, government and industry professionals, each bringing a unique perspective to the table (Etzkowitz and Leydesdorff, 2000). Referred to as 'The Triple Helix', this model facilitates creation of knowledge from diverging perspectives of social and technological value, economy and regulations, ensuring products ready for market with a holistic fit. This forms the basis for 'Mission Oriented Innovation System' as developed by Hekkert et al. (2020) which is defined as "network of agents and set of institutions that contribute to the development and diffusion of innovative solutions with the aim to define, pursue and complete a societal mission." Under Dutch sustainable energy transition context, the agents comprise of ministries which guide innovation and its R&D by forming collaborations with academicians, industry professionals and non-profit organizations (Hekkert et al., 2020). The Dutch Universities such as the Delft University of Technology and Eindhoven University of Technology, stand forefront in the development of innovations and technologies in the field of sustainable energy. Via government backed platforms such as 'Topsector Energie', these institutions collaborate closely with industry and government to create solutions in real-time (RVO, 2019b). Independent research organization such as 'Netherlands Organisation for Applied Scientific Research (TNO)' and Environmental Assessment Agency (PBL, 2025), act as bridge between academic innovation, patents development and their subsequent applications in solving industrial gaps.

The country however faces significant setbacks and challenges in sustainably transitioning to renewable energy. The existing infrastructure is heavily gas-oriented, resulting in complex infrastructural and financial load while transitioning to electrification and sustainable energy. The lower energy prices, consistency and reliability of fossil fuels created a setback from consumers towards acceptance and transitioning to green sources. In addition to this, nation having limited space and high population density (Janssen et al., 2020), physically hinders the development of renewable energy systems like wind-farms, nuclear and hydrogen power plants (Hölsgens, 2016). According to findings by Pinkse and Groot (2015), industry personnel mentioned ambiguous and fickle policies - in terms of grants and tax-mechanisms - to be a major hurdle. The subsidies are bureaucratically convoluted with unclear processing times, resulting in investors losing confidence in their long-term investments. Adding to that, the lack of standardization of non-conventional energy and their framework adds to the confusion for technology developers and their ability to sell to consumers.

One primary hurdle is the grid congestion. The current grids were not designed for novel sustainable energy forms which comprise of decentralized sources with varying supply. This poses problems with rate of expansion of new energy generation methods to slow down due to inefficient transfer of electricity to the users and severe congestion in accommodating new connections. This also has proved to have implications on government based policies such as SDE++ which require the new innovations to have tested grid connection capacity (IEA, 2024). To tackle the problems of grid, notable investments in policies/regulatory frameworks have to be made to accommodate growing user needs of grid infrastructure (IEA, 2025).

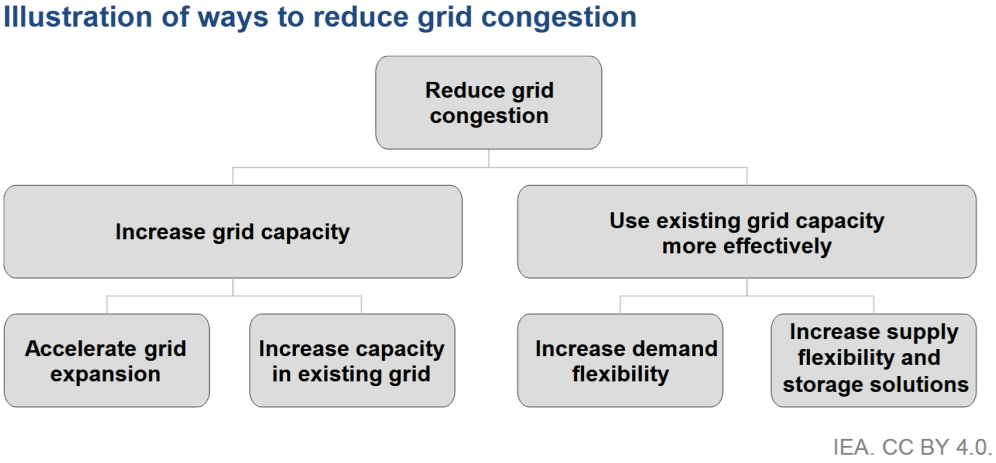

Figure 3.3: Illustration of ways to reduce grid congestion. (IEA, 2025)

3.2. Startups, Scaleups and Academic Spin-offs

The Netherlands is actively pursuing path towards CO2 free emission and energy transition via means of effectual partnership between public and private sectors as explained in section 3.1. These efforts to achieve ambitious targets by 2050 is significantly driven by development of startups, scaleups and academic spin-offs. The agility of these organizations to tackle impending challenges, understanding market situation at root level and catering to those demands play a crucial role in advancing the nation towards green goals (Janssen et al., 2020).

According to Ehrenhard et al. (2017), "Startups are companies that seek to develop and implement a repeatable, scalable and profitable business model to exploit market opportunities". Scaleups are high-growth startups that have had their initial product offering validated in the market, having considerable investment backing, growing team, and formation of network for sustainable growth (Duruflé et al., 2016; Isenberg and Onyemah, 2016). Academic spin-offs are ventures that are conceived from university research and finding commercial value of the research innovation in the market. These bodies are at the forefront of disruptive innovation, providing new technological and commercial solutions supporting effective energy transition. Their flexible and moldable nature drive the creativeness of entrepreneurs to foster technological advancement (Hockerts and Wüstenhagen, 2010). They delve into risky innovations to develop radical products, solving impending market problems, with agility that is hard to find in corporations.

World has been driving its approach towards sustainability, questioning the use of conventional systems, using renewable resources and incorporating values of social concerns. Following the line of thought, entrepreneurs are adopting their innovations towards sustainability, which has eventually given rise to 'Sustainable Entrepreneurship' (Anand et al., 2021). This not only involves developing sustainable products, but also proactively driving the society towards sustainable ecosystem. On lines of sustainable energy, startups and scale-ups have been executing a pivotal role in transitioning towards green energy (Salehi, 2023). However, given the ambiguity of industry due to extensive capital, infrastructural and technological needs, the impact of these firms remains vague.

The companies face significant set-backs in the process of commercializing innovation, such as, change in technology, varying customer/market demand, regulatory challenges, cross-country legalities, financial competition and so on. These changes in environment (i.e., external triggers) compel organizations to constantly tweak their business model to adapt and streamline their business outlook. Entrepreneurs face ethical dilemmas to juggle between economic, environmental and social interests. The complex environment of sustainable energy dominated by large incumbents in energy sector and governments, create a fragile and challenging environment for new ventures. However, currently, not much is known about what really helps sustainable energy startups survive and thrive in the long run (Nejabat, 2025).

3.3. Business Model

The following sections delves deeper into the definition of Business Model and its corresponding elements.

3.3.1. Origin & Definition

Business model and its innovation is the method with which the firms explore and define their value offering, understand value creation mechanism, and visualise their delivery mechanism to provide holistic solutions to stakeholders (Timmers, 1998; Zott et al., 2011; Wirtz et al., 2016; Teece, 2010). The concept of has been explored in the literature for over half of a century now, with the topic being initially referenced by (Bellman et al., 1957; Osterwalder et al., 2010b; Wirtz et al., 2016). Following which the concept has been reiterated, devised, modified and developed in multifarious facets throughout the years, with each uniquely identifying the elements and dynamics of its presence (Wirtz et al., 2016). It has had exponential momentum since the emergence of internet and personal computer (mid-1990s) (Amit and Zott, 2001; Magretta, 2002). However, even after tremendous popularity among the academic circle, there is a lack of consensus in the literature due to divergent goals and interests of academic and industrial circle (Zott et al., 2011). As per review conducted by Shafer et al. (2005), they found twelve definition of the concept, with staggering forty-two different business model components being explored in publications between 1998-2002. While there is significant differences along narrowing down of an accepted definition, the concept has been widely acknowledged to act as a unit of analysis to gauge how to conduct business (Zott et al., 2011). That being said, the definition of Business Model lies somewhat vague and varying throughout literature, however, the construct has been observed to focus over time. The definitions explicated by various academicians ad their corresponding components has been mentioned in 3.1.

To visualize the business model concept, Gassmann et al. (2020) have defined a 'magic triangle', that defines the value offered to customers, who they are, and how revenue is generated 3.4.

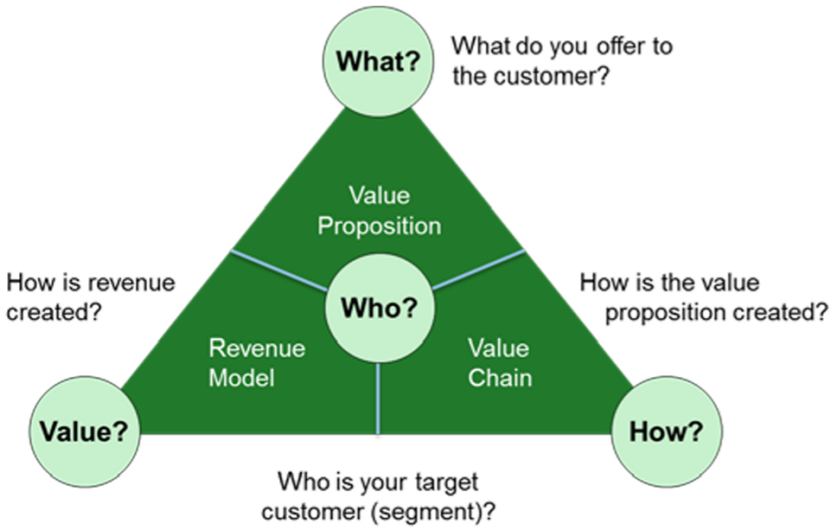

Figure 3.4: 'Magic Triangle' accomodating customers, value offered and revenue creation by Gassmann et al. (2020)

Table 3.1: Selected Business Model Definitions and their Components

Author(s), Year	Definition	Key Components
Slywotzky (1996)	"The totality of how a company selects its customers, defines and differentiates its offerings, determines tasks to perform or outsource, configures resources, goes to market, creates utility, and captures profits."	'Customer selection' 'Value Capture' 'Differentiation & Strategic Control' 'Scope of activities'
Timmers (1998)	"... is 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; and a description of the sources of revenues."	'Value Proposition' 'Value Network' 'Revenues'
Stewart and Zhao (2000)	"..a statement of how a firm will make money and sustain itsprofit stream over time."	'Value Capture' 'Differentiation & Strategic Control' 'Scope & Organization of Value Chain'
Amit and Zott (2001); Zott and Amit (2010)	"The business model depicts the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities." "We conceptualize a firm's business model as a system of interdependent activities that transcends the focal firm and spans its boundaries."	'Transaction Content' 'Transaction Structure' 'Transaction Governance'
Chesbrough and Rosenbloom (2002)	"The business model is the heuristic logic that connects technical potential with the realization of economic value (p. 529)."	'Value Proposition' 'Market Segment' 'Value Chain' 'Revenue Generation' 'Value Network' 'Competitive Strategy'
Magretta (2002)	"Business models are stories that explain how enterprises work with emphasis on how they are different from strategies. The difference is that a business model is a system that is integrated with a strategy in the sense that it is the logic by which the business is sustained, and the strategy is how the business model will be implemented."	'Value Proposition' 'Economic Logic'
Morris et al. (2005)	"A business model is 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."	'Value Proposition' 'Customer Requirements' 'Core Competency' 'Competitive External Positioning' 'Economic Model' 'Operational Factors'
Osterwalder et al. (2010b)	"A business model is a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm. Therefore we must consider which concepts and relationships allow a simplified description and representation of what value is provided to customers, how this is done and with which financial consequences."	'Value Proposition' 'Customer Segments' 'Customer Channel' 'Customer Relationships' 'Key Resources' 'Key Activities' 'Key Partnerships' 'Cost Structure' 'Revenue Stream'
Casadesus-Masanell and Ricart (2010); Teece (2010)	"A business model articulates the logic, the data and other evidence that support a viable proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value (p. 179)."	'Firm Choices' 'Consequences'

3.3.2. Business Model Innovation and Adaptation

Business Model Innovation (BMI)

Over the years, the business model innovation concept among academicians and practitioners has gained significant traction in an attempt to increase the quality of output, cater to ecosystem's needs and efficiency (Chesbrough, 2010; Demil and Lecocq, 2010). As defined by Motjolopane and Ruhode (2021), BMI comprises of "either adapting an existing business model, innovating one or more components of the business model or innovating business model components to create a completely new business model for the company, with both adapted and created business models seeking to enable the company to compete effectively in a changing environment".It captures the process of how organizations make changes to their overall value offering by making adaptive changes to its business model and is considered essential for sustainable value creation (Foss and Saebi, 2017). Innovation in business model can aid firms maneuver rapidly changing market seamlessly via means of novel tools that capture the dynamic processes (Teece, 2018). This may involve making alteration to the existing business models or radicalize the process by developing completely novel solution. According to review by Kraus et al. (2020), the three dimensions of organizational factors, environmental factors and social factors are crucial for successful implementation of BMI [Refer Figure 3.5]. Nevertheless, for reasons similar to business model, the concept of business model innovation has been observed to be highly ambiguous with diverging lines of thoughts and perspectives (Foss and Saebi, 2017; Kraus et al., 2020).

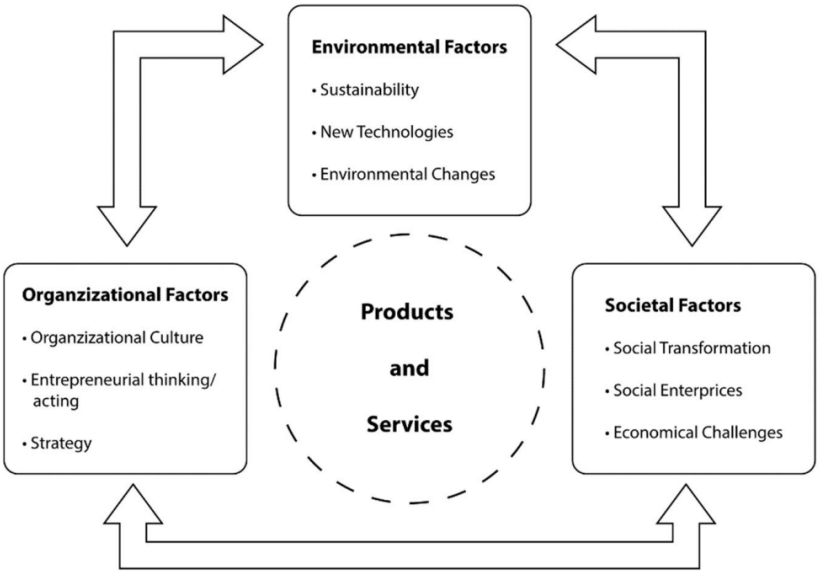

Figure 3.5: Factors influencing BMI (Kraus et al., 2020)

The implementation of innovation in an organization's business model is not as smooth however, with challenges faced in cognitive and resource limitations, posing as a roadblock (Huang and Ichikohji, 2023). With significant investments made in gradually developing the business model, firms understand their current models with deep knowledge of the relationships and linkages between different elements, due to which they tend to become and act more rigid towards required necessary changes (Sund et al., 2021). Furthermore, it is commonplace for organizations to closely follow competitor's chase and focus on profit margins, losing long-term focus and perspective on actively developing business model for sustained growth (Vuori and Huy, 2016). While business model innovation can take an 'evolutionary or revolutionary' role, the process is labyrinthine with organizations having the latitude to experiment with wide spectrum of disruptive changes and gain a competitive advantage (Ramdani et al., 2019). Actively processing business model innovation can create significant new forays for sustainable technologies to create holistic value for the customers, and environment (Bohnsack et al., 2014).

Business Model Adaptation (BMA)

Business model adaptation as defined by Saebi (2015), is "the process by which management actively aligns the internal and/or external system of activities and relations of the business model to a changing environment", which specifically does not have to be innovative, and can be undertaken as a response to opportunity or threat. This involves incremental changes within existing business model, that maintains the fundamental business logic while tweaking components to cater to changing situations. Research by Balboni and Bortoluzzi (2015) on BMA in Italian companies, shows how adapting the model helps to increase startup's tendency to survive in near term and enhance growth over long term perspective. Adjustment allows companies to function effectively under resource constraints while tackling the external pressures to create compatible offerings (Dopfer et al., 2017). The process involves continual search, tactical selection, and restructuring of business model elements to fit better with external environment's needs and requirements (Saebi, 2015; Dopfer et al., 2017). With main intention to align with changing environment, these require business models have "to be tested and retested, adjusted and tuned as the evidence with respect to provisional assumptions becomes clarified" (Teece, 2010). With adaptation, developing a novel product might be a possibility, however is not necessarily a requirement (Saebi, 2015). The need to adjust according to external stakeholder's requirements (Ferreira et al., 2013), alterations in competitive landscape (Reuver et al., 2009) or realizing new market opportunities (Wirtz et al., 2010) are some of the factors that can drive business model adaptation.

The following table 3.2 identifies the difference between Business Model Adaptation and Business Model Innovation, following Saebi (2015)'s method.

Table 3.2: Difference between business model innovation and adaptation, following Saebi (2015)'s approach

	Business Model Innovation	**Business Model Adaptation**
Outcome	Disruptive outcome, novelty	Realign with market better
Scope of effect	Wide effect on BM	Narrow-wide impact on BM
Degree of change	Radical, disruptive	Incremental
Frequency	Sporadic	Regularly
Novelty	High - Mandatory novelty	Low to medium - Possible, but not necessary
Key references	Chesbrough (2010); Amit and Zott (2012); Foss and Saebi (2018)	Saebi et al. (2017); Dopfer et al. (2017)

3.3.3. Business Model Elements and Frameworks

Just as conceptualization of business model, the categorization of 'components' or 'elements' of business model is not set in stone in literature as well, targeting varying perspectives and goals. Multifarious frameworks and models have been developed to incorporate their significance in the ecosystem of conducting business. As stated by Schaffer et al. (2019), a dynamic business model comprises of interconnected elements of value proposition, capture and creation that dynamically work with internal and external triggers resulting in overall unique progression of business model. Various business model frameworks have been developed to help visualize the process and each of these comprise of unique foundation elements selected for individual cases.

According to literature, the most commonly utilized framework in conceptualization of business environment of a company is Osterwalder et al. (2010b)'s Business Model Canvas, which comprises of 9 elements. These include, 'Value Proposition', 'Customer Segments', 'Customer Relationships', 'Distribution Channels', 'Key Partners', 'Key Activities', 'Key Resources', 'Cost Structure', and 'Revenue Structure' [Refer Fig 3.6]. The clear visuals, structured planning and all-round coverage has encouraged its adoption widely. It has been proven to be highly valuable for traditional business entrepreneurs and

early-stage ventures to design their business processes. However, the model is primarily centered on 'Economic value' for companies, with lack of environmental and social impact consideration. In addition, the model takes a traditional approach of static nature of BM while avoiding the dynamic nature of businesses currently function under. Hence, the model with more number of individual elements, make it convoluted to observe and trace changes with multiple moving pieces.

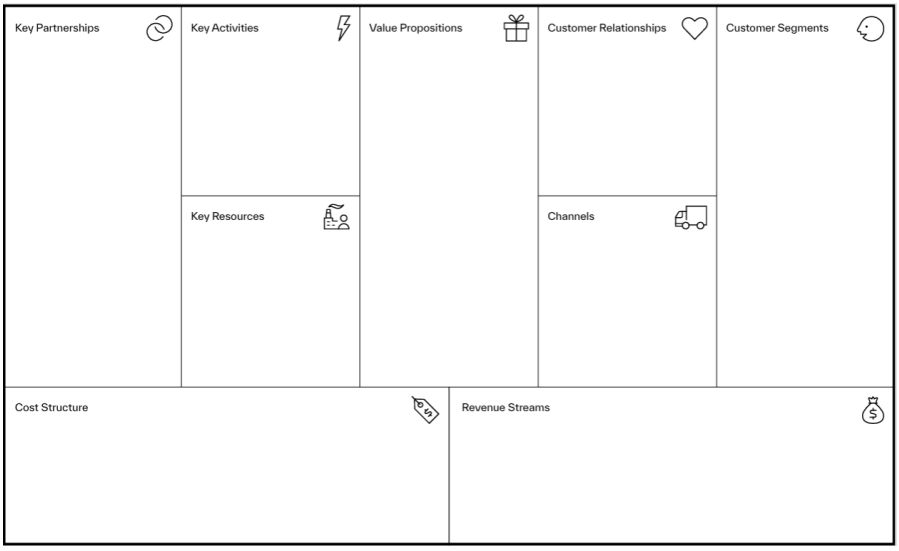

Figure 3.6: Business Model Canvas by Osterwalder et al. (2010b)

To embrace the high-risk high-agility scenario materializing in a startup's vicinity, Maurya (2010) modified the original BMC to The Lean Canvas by swapping the elements of 'Key Partners', 'Key Activities', 'Key Resources' and 'Customer Relationships' to 'Problems', 'Solution','Key Metrics', and 'Unfair Advantage' - allowing optimization for building product required in the market and problem worth solving [Refer Fig 3.7]. It aids rapid experimentation and iteration to achieve better product-market fit, while accentuating the risk. On the contrary, there is an isolated focus on Minimum Viable Product (MVP) ideology and exclusion of environmental and social constructs, with similar lack of interconnectedness between elements. Its insufficiency of sustainability consideration, dynamic interaction between elements and ethical concerns, results in significant drawbacks for its use in sustainable startup situation.

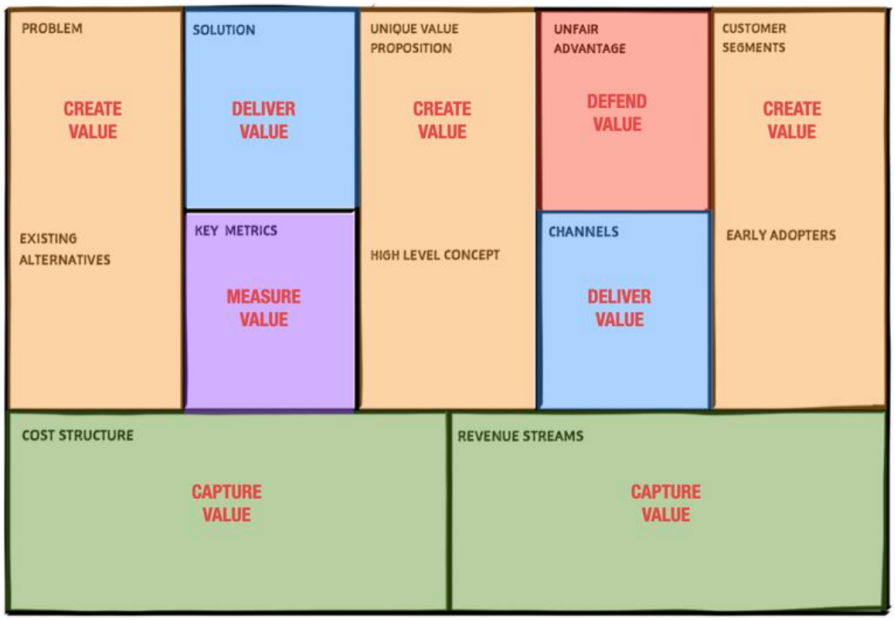

Figure 3.7: The Lean Canvas by Maurya (2010)

With changing business environment, to incorporate the concept of sustainability and targeting the three main values surrounding the concept, i.e., 'Economic', 'Environmental' and 'Social' constructs, Joyce and Paquin (2016), modified the BMC to a 'Triple Layered Business Model Canvas (TLBMC)'. The model uses 'Triple Bottom Line' approach, by understanding the impact of business processes on the stakeholders and the environment. The deep insight into sustainability-oriented concepts results in a comprehensive three-layered framework targeting myriad niche elements. However, tremendous amount of unique individual elements to decipher, makes it intricate for startups to visualize their business models. Separate layers adds to the confusion, obscuring ability to apprehend the dynamic interaction between elements. While the tool is great to understand the background and description in which the sustainable businesses function, i.e., as an evaluative tool, it is, however, complex for analyzing impacts of triggers on business model elements and comprehending cause-effect relationships.

To simplify the framework, Bocken et al. (2018a) developed a 'Sustainable Business Model Canvas (SBMC)', which integrates a dynamic approach to business models while taking into account the concept of sustainability, which makes the framework suitable for this research objective. Drawing inspiration from Osterwalder et al. (2010b)'s BMC, the SBMC distinctly subsumes the 'economic', 'environmental' and 'social' concepts, via means of 'Profit', 'Planet' and 'People' [Refer Figure 3.8]. Not necessarily developing an add-on layer, but is directly embedded in the Value Proposition section, insinuating companies to think from triple line approach - suitable for sustainable companies. Furthermore, the entire framework is sub-divided into four main categories, namely:

- **Value Proposition**: Consists of values that an organization provides to its customer and environment, and signifies the uniqueness of the value offering. Consists of value offering targetted towards 'Profit', 'People' and 'Planet'.
- **Value Creation**: Comprises of key stakeholders (such as suppliers, distributors, logistic partners), key resources (infrastructure, brand image, human capabilities, inventory), and key activities (Internal Processes). They determine how value offering solidifies. Consists of 'Key Stakeholders', 'Key Activities', and 'Key Resources and Capabilities'.
- **Value Delivery**: Comprises of relationships with customers, distribution channels and targetted customer groups. In combination with Value Creation, it describes how the product offering is developed and distributed to its consumers. Comprises of 'Customer Relationships', 'Customer Segments', and 'Channels and customer Touchpoints'.
- **Value Capture**: Comprises of financial information concerning cost borne for the value offering and revenue streams from consumers. Includes 'Cost Structure' and 'Revenue Streams'.

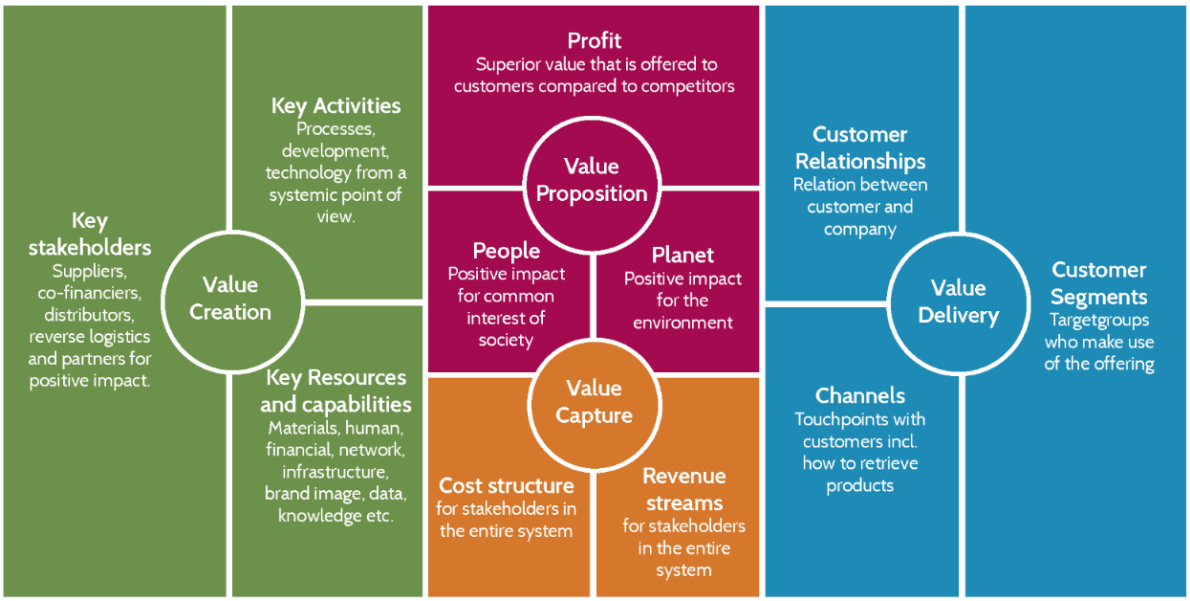

Figure 3.8: Sustainable Business Model Canvas by Bocken et al. (2018b) inspired from Osterwalder et al. (2010a)'s traditional BMC

Table 3.3: Comparison of above mentioned business model frameworks and elements

Framework	Focus	Sustainability Integration	Startup suitability	Perspective	Use Cases
Business Model Canvas (Osterwalder et al., 2010b)	Economic Value	NA	High	Customer centric	Traditional and Early-stage business
Lean Canvas (Maurya, 2010)	Product-market fit	NA	Very High	Customer centric	Startups/Scaleups
TLBMC (Joyce and Paquin, 2016)	Economic, Environment, Social	Yes. Spearate Layers for each	Low	People, Product, Profit	Sustainability Evaluation and reporting
SBMC (Bocken et al., 2018a)	Economic, Environment, Social	Yes	High	People, Product, Profit	Startups/Scaleups in Sustainability sector

The SBMC model uniquely captures stakeholder's concerns while targeting long-term thinking, resulting in helping companies achieve resilience and better alignment with environs of company and global sustainability development goals. By integrating the 'Three pillars of Sustainability' (Purvis et al., 2019), the framework aligns perfectly for sustainable energy based companies, given their exposure to fickle environmental laws, stakeholder concerns and profitability. The conciseness of number of categories in business model makes it appropriate for analyzing pivots made by decision makers upon impact from an external trigger, making the model suitable for high-volatile scenarios. And since the thesis delves into inter-related effects on individual elements of BM, this framework fits the gap.

Hence, upon comparing multiple frameworks [Refer Table 3.3] and studying various elements devised in literature (Refer Table 3.1), for our study we shall utilize the elements from Sustainable Business Model Canvas by Bocken et al. (2018a), given its conciseness of number of components and consideration of sustainable factors appropriate for sustainable energy based firms.

3.3.4. Sustainable Business Models (SBM) used in literature

Companies are increasingly focusing their approach towards sustainable business methods and processes supporting 'Sustainable Development', defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987; Hernández-Chea et al., 2021). Following the philosophy, the definition in terms of organization's business model has transcended to include concepts of sustainable management, social and ethical values. Stubbs and Cocklin (2008) initially formulated the term 'Sustainability Business Model (SBM)' including the above three dimensions. The Business Model for Sustainability as defined by Schaltegger et al. (2016):

"A business model for sustainability helps describing, analyzing, managing, and communicating (i) a companys sustainable value proposition to its customers, and all other stakeholders, (ii) how it creates and delivers this value, (iii) and how it captures economic value while maintaining or regenerating natural, social, and economic capital beyond its organizational boundaries."

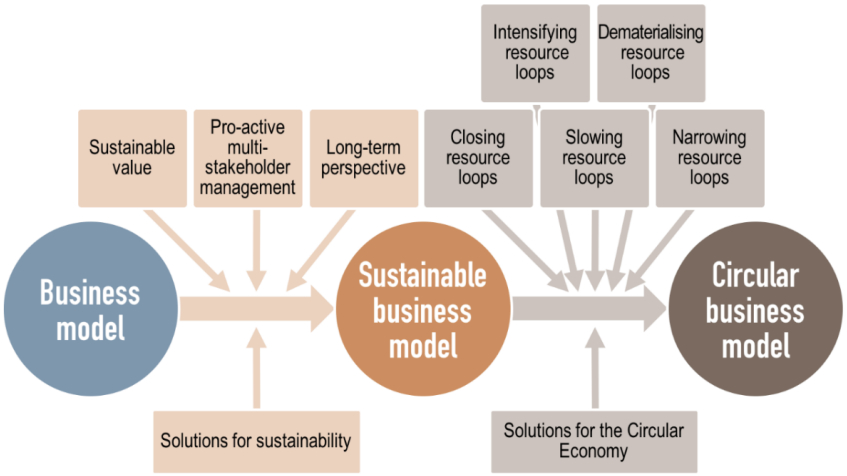

Figure 3.9: Business Model evolution towards sustainable transition (Geissdoerfer et al., 2018a)

Growing literature is focusing on utilizing the sustainable business model towards energy sector, delving deeper into its use, observing how BM elements behave and modification relevant for the industry (Vernay et al., 2020; Bohnsack et al., 2014; Bohnsack and Pinkse, 2017). To advance towards a sustainable future, innovation is required to be implemented at the core of business model with efforts to prioritize welfare of environmental and social circle (Bocken et al., 2014). SBM provides organizations a platform to guide towards sustainable value creation, having long-term outlook, voice broader opinions, innovate resource life-cycle, and consider environmental and social perspectives (Geissdoerfer et al., 2018b; Bocken, 2021a). Hence, in an effort to incorporate values of sustainability, multiple tools like 'Triple-Layer Business Model Canvas (TLBMC)' (Joyce and Paquin, 2016), 'Sustainable Value Analysis' tool (Yang et al., 2014), and 'Value Mapping' tool (Bocken et al., 2013) have been developed. As conceptualized by Hernández-Chea et al. (2021) [Refer Figure 3.10], a sustainable transition requires implementing changes at three levels, i.e., "Strategic long-term level" (create and provide sustainable value offering), "Tactical Medium-term Level" (network and collaboration) and "Operational Short-term Level" (experimentation and sustainable operations). This transition management approach provides a framework incorporating micro-level firm-centric activities and macro-level act towards sustainability (Corcoran et al., 2024; Hernández-Chea et al., 2021).

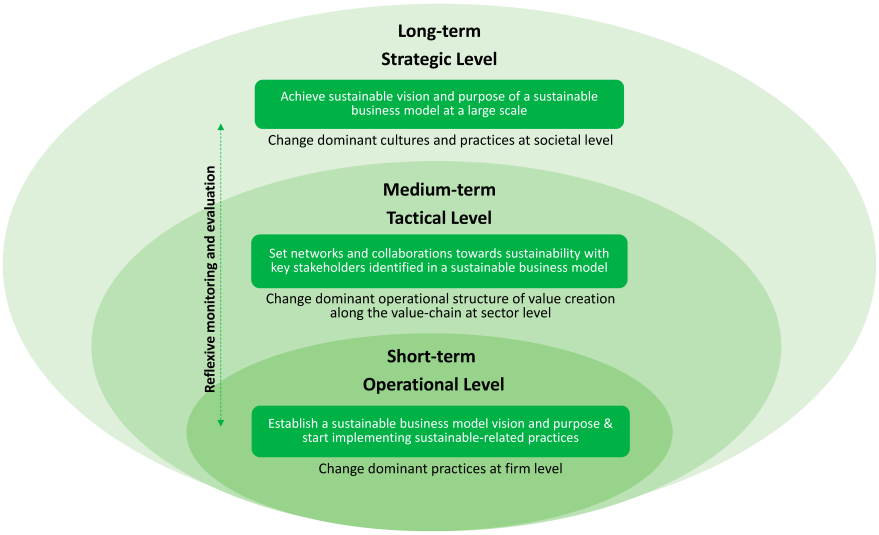

Figure 3.10: Conceptualization of activities for sustainable transition (Hernández-Chea et al., 2021)

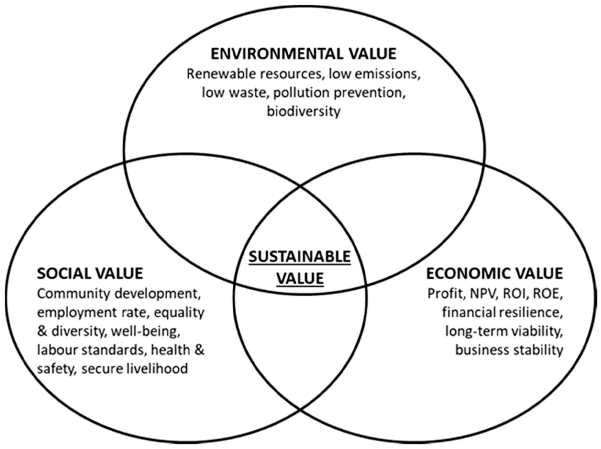

Figure 3.11: Sustainable Value Holistic elements (Evans et al., 2017)

SBM provides holistic view of processes from environmental, economic and social perspective [Refer Fig 3.11], allowing driving the innovation towards sustainability (Stubbs and Cocklin, 2008). This triple line approach takes into account the views of stakeholders from all facets to formulate sustainable strategies and measure performance, showcasing the dissimilitude from the traditional BMC's focus on profit making firm-centric approach (Bocken, 2021a; Ritala et al., 2018). On the other hand, some research have considered perspective of technological, social and organizational constructs (Bocken et al., 2014) [Refer Fig 3.13].

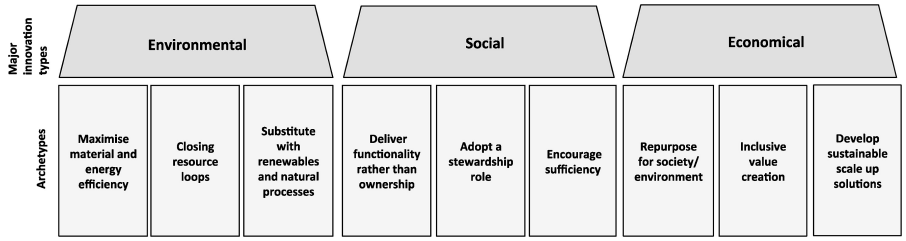

Figure 3.12: Environmental, Economical and Social View on SBM (Ritala et al., 2018)

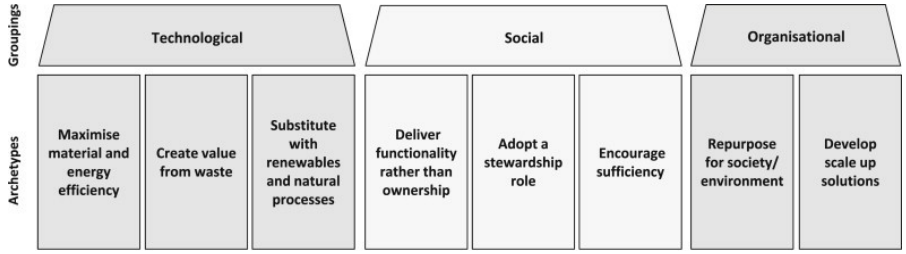

Figure 3.13: Technology, Social and Organizational View on SBM (Bocken et al., 2014)

As mentioned above, certain tools catered towards development of SBM have facilitated the adoption of model among practitioners by aiding in generation of ideas, evaluating processes and sustainability. For instance, the Sustainable Business Model Canvas by Bocken et al. (2018b), modifies the traditional business model canvas developed by Osterwalder et al. (2010a) by incorporating the elements and stakeholder impact of people and planet in value proposition, aiding comprehensive product offering [Refer Fig 3.8].

3.4. Dynamic Business Model

The literature is heaving with diversified perspective, definition and components of business model to better explain and customize to unique business's approach. However, with fast processing time and fickle environment, notion of the concept is moving towards its dynamic nature, understanding its innovation and ability to adapt (Saebi et al., 2017). The concept of dynamic approach to business model was initially developed and presented by Teece et al. (1997), and is defined as "the companys ability to integrate, build, and reconfigure internal and external resources/competencies to deal with and possibly adapt to rapidly changing business environments." (Teece, 2012). According to Saebi et al. (2017), two categories of business model dynamics have been observed, i.e., 'Business Model Adaptation' and 'Business Model Innovation'. BM Adaptation comprises of processes wherein companies realign their business models according to external changing environment, such as different customer needs, new regulations, new stakeholders and so on (Demil and Lecocq, 2010; McGrath, 2010; Saebi et al., 2017). On the other hand, BM Innovation as defined by Santos et al. (2011) "is a reconfiguration of activities in the existing business model of a firm that is new to the product/service market in which the firm competes". This comprises of innovating the business processes to 'disrupt' the market opportunities, and can be impelled by both internal and external factors (Saebi et al., 2017; Bucherer et al., 2012).

A crucial element in advancement of company's business model dynamically involves ability and efficiency of the decision makers to alter and refine the BM (Teece, 2018). This uniqueness makes the process inimitable and providing an opportunity to gain a competitive advantage. Teece (2018) identified three processes in dynamically innovating a business model, i.e., 'sensing' an opportunity by identifying current and future needs, 'seizing' the opportunity by committing resources and strategy and 'transforming' by realigning firm's outlook and structure (Refer Figure 3.14).

Startups/scaleups are exposed to rapid changes implying the need to be agile and swift in their approach to maneuver their business models, signifying importance of dynamic business model to help thrive challenges (Zahra, 2021). As defined by Khodaei and Ortt (2019), dynamic business models are "frameworks that capture relevant changes in the internal and external company aspects, for example, by studying trends or sudden changes in those aspects and by studying how a trend or sudden change in one aspect of the framework can affect another aspect of the framework." The nature of business models cannot be static, and arguments have been made implying that changes are adapted over time with experimentation and feedback loops to foster innovation and ensure survival (McGrath, 2010; Casadesus-Masanell and Ricart, 2010). Cavalcante et al. (2011) has segmented the business model innovation/changes in four categories, namely, i. 'BM Creation', ii. 'BM Extension', iii. 'BM Revision', iv. 'BM Termination'. 'BM Creatio'n comprises of solidification of an initial 'idea' into a business venture ; 'BM Extension' involves expanding the activities/resources of an existing BM to accommodate for changes ; 'BM Revision' involves replacing existing processes into new ones to explore varying ways of continuing business ; 'BM Termination' involves forsaking the existing model which might imply

cessation of an organization (Cavalcante et al., 2011).

For our study, we shall focus on Business Model Innovation and Adaptation and understand the implication of external triggers on business models components of companies and how they align their strategies and goals.

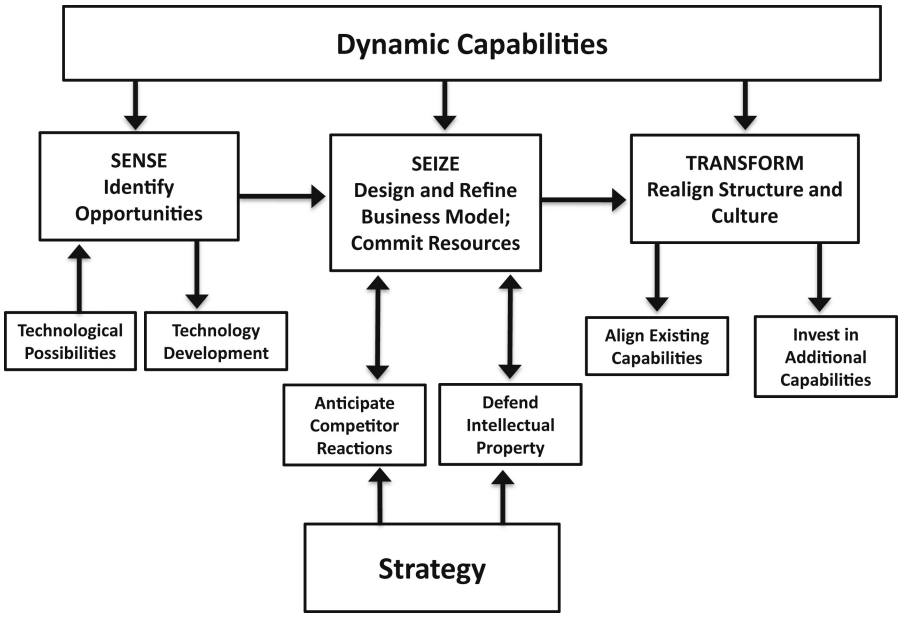

Figure 3.14: Dynamic Capability Schema (Teece, 2018)

3.5. External Triggers

External triggers, as defined by Leroi-Werelds et al. (2021) "are disturbances emitted from the macro-environment that challenge the status quo of one or more market actors and/or the industry in which they are embedded". These are necessarily events originating external to the environment of company, with ability to impact firm's functioning, directly and indirectly.

Leroi-Werelds et al. (2021) has mirrored the concept to be similar to waves implying shift/transfer of pressure from one point to another (in BM context, from environmental factors on to BM Elements). As observed in Figure 3.15, this wave comprises of four characteristics, namely, i. *Period* (time duration of an external trigger), ii. *Frequency* (Number of times the external triggers impacts the business model), iii. *Amplitude* (signifying the intensity of impact on the business model), and iv. *Velocity* (the rate at which external trigger evolves)

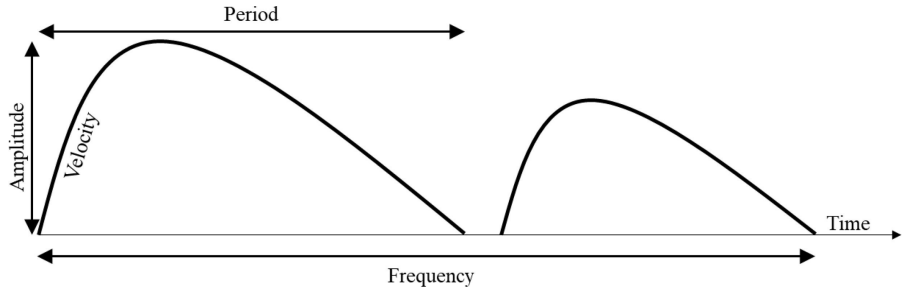

Figure 3.15: Wave Characteristic of External Trigger (Leroi-Werelds et al., 2021)

The external trigger's impact on a firm can be multi-faceted, with the tendency to either make or break the venture. When interacted with one, the firm has to maneuver its course of action to tackle the

problem, which if not done on time or effectively, can lead to unwanted impact on survival. Alternatively, these triggers can help improve the competitiveness of an organization by reacting to imminent external changes to the company allowing to gain a upper hand (Bashir et al., 2021). The nature and characteristic of these external triggers vary depending on context and can be categorized as threat or opportunity by decision makers (Bucherer et al., 2012). For instance, changes in subsidy policy, can directly impact the survival of the firm due to subsidy's tendency to reduce gap between product and its market. Firms need to strategically adapt their operations so as to benefit from subsidy and be agile enough to subsume any challenges in their operations upon changes.

A famous analytical framework evolved as a marketing tool, called PESTEL Analysis, comprise of scanning, understanding and analyzing external macro-environment of an organization that aids in honing strategy of an organization. It helps explore six components, i.e., 'Political', 'Economic', 'Social', 'Technological', 'Environmental', and 'Legal'. (Buye, 2021)

- Political: These refer to the government, regulatory, and policy influence on the business's activities. These might include factors like geopolitical scenario, government stability, trading regulations and so on.
- Economic: These include macro-economic situation surrounding the business such as interest rates, inflation, subsidies, tax structure, bargaining and purchasing power of consumers and vendors, trending financial models and so on.
- Social: These comprise of stakeholder's social trends, choices, lifestyle, cultural behavior, demography, ethnicity.
- Technology: These include the advancement and evolution of technology surrounding the business's activities such as R&D, automation, infrastructure and digitization.
- Environmental: Factors concerning environment such as climate change, carbon footprint, GHG emissions, extreme weather events, activism.
- Legal: These refer to the laws and regulation the business has to function and abide by. These can include, working condition laws, health and safety regulations, permits, licenses, intellectual property.

Sustainable energy-based firms are advancing in environments brimming with these external pressures compelling towards decentralization, servitization, market liberalization, automation and digitization. This is resulting in companies appraising BM innovation or adaptation to deal with changing energy market, technical needs, political scenario and consumer lifestyle (Nieuwenhuis, 2018). Providing examples in terms of PESTEL, 'Political' based packages such as "Fit for 55" and "European Climate Pact" fosters consumer education and inclusion in energy transition (Debourdeau et al., 2023). Economic forces such as funding and investments in green technology impacts the efficiency of energy transition and fluctuations in energy prices for consumers (Chen et al., 2023). Social and cultural forces such as public awareness and drive to adopt green tech vastly affects the rate of expansion. Technological advancements allow businesses to explore application in newer product gaps and markets, requiring constant modification of the product to remain competitive (Shaya Afrin et al., 2024). Environmental factors such as climate change, GHG emissions and extreme weather events impact the product application and future needs (Popescu et al., 2024). Similarly, decentralization and liberalization of market has influenced companies to alter from single product model to providing array of end-to-end solutions (Gitelman and Kozhevnikov, 2023). To tackle these external challenges, businesses innovate their BM outlook and approach to stay competitive.

Similarly, Kotler and Armstrong (2011), in their book 'Principles of Marketing', have delineated major forces acting in company's macroenvironment, i.e., Demographic, Economic, Natural, Technological, Political and Cultural - all of which can influence market conditions and consequently company's strategic outlook. 'Demographic' comprise of unique characteristics of the population and their behavior ; 'Economic' refers to monetary factors such as financial strength, trends, income statistics, growth rate ; 'Natural' comprise of ecological factors such as resource availability or climate change ; 'Technological' involves the advancement in innovations or tech ; 'Political' involve the laws and regulations ; and concluding with 'Cultural' factors such as societal norms, consumer preferences and expectations.

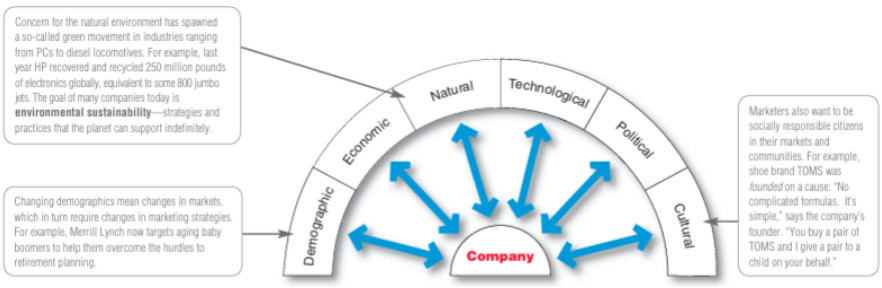

Figure 3.16: Major Forces acting on Company's macroenvironment (Kotler and Armstrong, 2011)

The Macroenvironment model closely aligns with the PESTEL model, with few differences in perspective, where macroenvironment model exhibits marketing and social centric objective. For instance, rather than generalizing 'social' factor, the macroenvironment model alters it to 'demography' and 'culture' to provide a deeper population insight/attitudes. Conversely, macroenvironment model combines both policy-based and legal factors under 'political', whereas, PESTEL divides it into two separate entities. Rest of the elements overlap for both the models. Hence, the models complement and reinforce each other in identifying broad factors companies face in their vicinity.

Both, PESTEL and Macroeconomic Model framework shall be used as a conceptual base to understand the background of external triggers, and further modifications to the framework shall be made depending on company's (research subject) experiences - allowing to capture uniqueness of sustainable energy industry.

3.6. Opportunities and Threats

Understanding the reasoning of how companies evaluate external triggers to be an opportunity or a threat is crucial to examine the decision-making process and recognizing the influence of the impact on elements of Business Model. As defined by Jackson and Dutton (1988), threats are considered as "negative situations in which loss is likely and over which one has relatively little control", while opportunities are considered as "positive situation in which gain is likely and over which one has a fair amount of control". The ability for entrepreneurs to recognize these changes using cognitive functioning and 'connecting the dots' between certain events, helps identify new business arenas, products or services (Baron and Ensley, 2006; Baron, 2006). The process of evaluating a condition as an opportunity or threat comprises of gauging the risks, exploring the need to adapt to the changes, associated benefits and making holistic decision. According to Mary George et al. (2014), the following broad six factors influence how decision makers identify opportunities, i.e., 'Prior Knowledge' (existing knowledge and experience of decision makers), 'Social Capital' (the recognition facilitated by relationships and networks), 'Cognition' (decision maker's ability to perceive and evaluate the situation), 'Environmental conditions' (society events and context surrounding the organization), 'Entrepreneurial Alertness' (ability to recognize and react to those changes), and 'Systematic Search' (searching for knowledge actively).

Threats can be recognized as situations or events that can hinder a project or be a cause of its failure (Sarcina and Canesi, 2023). According to Staw et al. (1981)'s 'Threat-Rigidity Theory', when organizations face threat situations, they tend to damp the information processing abilities by focusing on familiar information and turning blind eye to subtle external cues, resulting in less opportunities or threats being recognized. This also involves resorting to well-established former routines in search of stability, however this might curtail innovation and dynamic ability to tackle the threats (Refer Figure 3.17). Following the concept, research has also observed that decision makers are more risk tolerant in cases of risk being perceived as an opportunity rather than a threat (Aarøen and Selart, 2020) .

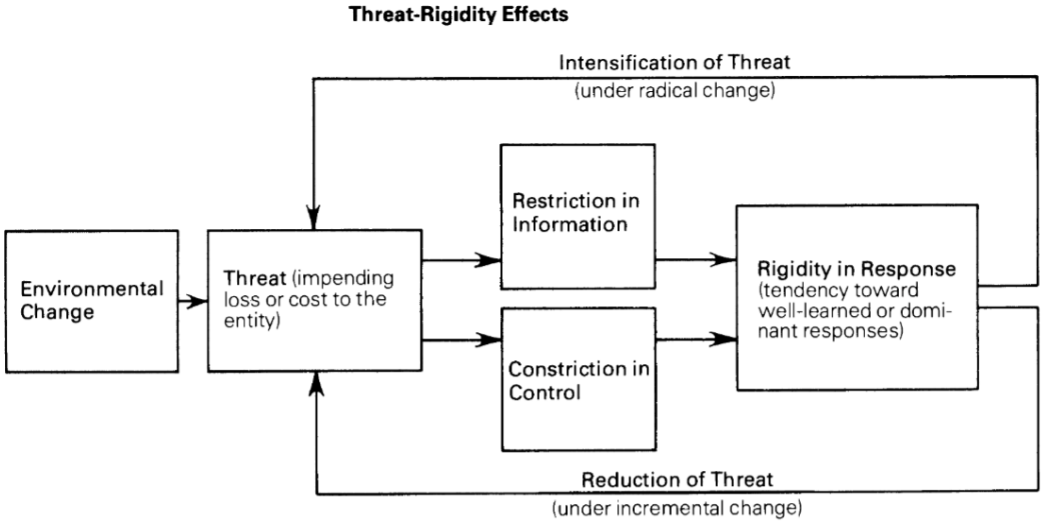

Figure 3.17: Threat-Rigidity Cycle (Staw et al., 1981)

On the other hand, some studies suggest that perceived threat can also be viewed as a driving force for organizations with higher tendency to dynamically adapt their business models (Saebi et al., 2017). Firms following a strategic approach of 'market development', i.e., developing business processes by actively engaging with external triggers, have the tendency to undergo business model adaptations. This enhances the capability and flexibility for firms to tackle threats effectively (Saebi et al., 2017). Gilbert and Bower (2002) suggests that instead of looking at a situation completely as an opportunity or threat, a balance should be struck between the two and allocate resources accordingly to re-frame the situation and circumstances.

The sustainable energy companies lie forefront in this age of transformation, with constant exposure to opportunities and threats in terms of technology, regulations, politics, social and environmental causes. Examining these external impacts as opportunity or threat is crucial to understand the decision making process and provide a broad overview of ramifications on organization's functioning.

3.6.1. Opportunities for Sustainable Energy Startups

The rapid technological advancement in the fields of renewable energy technology, supported by exponential digitalization and automation of services has sped up the application of technology to wide number of arenas, with companies facing significant impact on the way to approach a solution (Shaya Afrin et al., 2024). It facilitates the organization to alter its business models to cater to advancing customer needs, new markets, alternate financial schemes and new partnerships/resources. Constant tracking of data by technological improvements also further enhance energy efficiency, tracking, support circular economy, reduce GHG emissions, and actively bolster the Sustainable Development Goals (SDG) towards a greener future (Rita, Uchenna Attah et al., 2024; Sułek and Borowski, 2024). Adopting new innovative subscription based models such as 'Energy-as-a-service', allow seamlessly combining the traditional energy infrastructure with new renewable green energy technology, ensuring smooth transition to newer methodologies. Access to these models ensure intelligent energy management systems that consider customers as partners and actively considering their feedback in technological development for a better product fit (Sułek and Borowski, 2024). To maximise flexibility, startups are gradually altering their approach to smart-services by unbundling the energy system into segregated features, and offering product via means of platform-based service and digital marketspaces (Singh et al., 2022).

Wide technological transformation with vast digitalization has also significantly increased the scope and size of market, effectively accessing the niche areas at reduced costs and higher efficiency (Faaij and Domac, 2006; Hassan et al., 2024). Consumers are increasingly following green energy and market trends in an effort to support environmental improvements, eventually supporting rise and expansion of green market (Kushwaha GS, 2015). The rise of product awareness among consumers has positively facilitated the adoption of green energy and market practices, providing companies the opportunity to

jump on the bandwagon. A positive correlation has been found between green market and evolution of business opportunities for green entrepreneurial ideas (Lotfi et al., 2018). Furthermore, financial mechanisms such as Green exchange-traded funds (ETFs) are facilitating the expansion of energy market by providing investment opportunities, improving the financial viability of projects (Naqvi et al., 2022). Collaborative initiatives have also developed over the years between consumers, government and startups/businesses. This comprises of co-owning the green energy project, focusing on decentralization of production, increase flexibility, transparency, and enhance security. Access to such community engagements cultivate local engagement and acceptance of concept at grass-root level (Sarcina and Canesi, 2023).

To promote the accessibility and expansion of sustainable energy, governments and cenral organizations are implementing tax incentives, grants, and subsidies to foster collaboration, acceptance and innovation to innovators and consumers. Detailed information on this has been explicated in section 3.1.

3.6.2. Threats for Sustainable Energy Startups

While the environment surrounding the energy-based startups and scaleups are constantly changing, it also implies recurring threats to organization's functioning. For instance, the regulations surrounding the integration of new sources of renewable energy in circulation is still hazy. Constantly changing government regulations in order to achieve the set emission goals, directly impact the functioning of a startup's outlook (Wang et al., 2022). This might involve modification/advancement in the technology of the product, formation of new partnerships, new customer needs or altering the financial planning of existing/new product. Some authors suggest that such nebulous environmental regulations shall inhibit innovation in the initial stages (Wang, 2011; Wang et al., 2022). It has been observed that strict and changing regulations reduces the tendency of businesses to invest in green technologies due to increased expenditures and reduced profit-margins resulting in lack of green technologies being implemented (Yang et al., 2021; Wang et al., 2022; Taghizadeh-Hesary and Yoshino, 2020).

According to Sachs et al. (2019), the investments in renewable energy sector across globe reduced by 3% in 2017, with predictions of further lowering rates, eventually threatening the expansion of green energy technologies. It has been observed that green energy projects are associated with comparatively lower rate of returns corresponding to their fossil fuel counterparts, compounded with higher risk resulting in reduced confidence among investors and banks to further invest in these capital intense projects (Yoshino and Taghizadeh-Hesary, 2018). In addition to continual reduction in prices of innovation due to technological advancements, investors are willing to wait for prices to further lower, eventually causing shortage of investments (Taghizadeh-Hesary and Yoshino, 2020). Research and innovation is being conducted to facilitate the financial accessiblity for these projects via means of instruments such as Non-Banking Financial Institutions (NBFI), Pension funds, insurance companies, community based green funds, tax relief/credit, blockchain, (Sachs et al., 2019; Yoshino and Taghizadeh-Hesary, 2018; 201, 2018).

Tremendous amount of innovation is being conducted in parallel to utilize all possible renewable energy sources such as solar, wind, nuclear, bio-gas, and so on to curb the utility of fossil fuels. However, these sources cannot maintain stable power due to their reliance on natural sources such as sunlight, waves and wind, causing imbalance in energy generation. The power/energy generation from various sources is being concentrated together at the supply grid from where the energy is further distributed. As mentioned in section 3.1, the grid congestion has posed to be a major setback in continual innovation of new energy forms due to inability of existing infrastructure to hold such variable loads. This has further impacted the security and stability of operations, resulting in cautions with regards to efficient integration at the grid. The current grid operations are differentiated between different operator types, causing ambiguous regulations for energy manufacturers to abide by, soliciting need for harmonious rules and regulations to ensure uniformity (Al-Shetwi et al., 2020; Arrinda et al., 2014).

Global pandemic such as COVID-19 and rising geopolitical tension also cause significant setbacks for renewable energy companies in terms of slowed manufacturing, changing customer demand and disrupted supply chain resulting in declining progress (Hosseini, 2020).

3.7. Pivots in Business Model

With fickle business environment, entrepreneurs and decision makers have to adapt to changing situations and adapt their approach in real-time to tackle the problems, adapt to new market and strategically leverage innovation to firm's advantage (Kirtley and O'Mahony, 2023). Also known as 'Pivots', the concept started getting traction in the entrepreneurial sphere with proliferation of agile concepts such as The Lean Methodology (Ries, 2011) and lean startups (Blank, 2013), which consider pivots as "structural course correction" of firm's processes upon feedback. As defined by Kirtley and O'Mahony (2023), a pivot is defined "as a change in a firm's strategy that reorients the firm's strategic direction through a reallocation or restructuring of activities, resources, and attention." While these challenges and opportunities are also available for seasoned organizations, the changes are particularly pronounced for startups and SMEs given high uncertainty of working conditions, financial support, undeveloped market, unknown customer demands and so on (Townsend et al., 2018). Research indicates that pivots are among the most frequent and significant entrepreneurial choices that include unpredictable consequences and irreversible commitments which has potential to disrupt stakeholder partnerships eventually questioning the company's survival (Hampel et al., 2020). However, literature lacks consensus as to what contributes to a pivot, for instance, some theories conclude it's associated with company's ability to comprehend and respond to market demands (Bajwa et al., 2017b), while some state it as reaction to stakeholder expectations (McDonald and Gao, 2019).

Chaparro and Gomes (2021) in their literature survey of 86 pivot-related papers have categorized five perspectives on pivots, namely: a. 'Pivots as a change' (refers to transformation in strategy, idea, product offering, to improve scalability or profitability), b. 'Pivots as a strategic decision (refers to decisions that lead to change in startup's business components and transform under resource constraints), c. 'Pivots as a correction in case of failure' (refers to adjustments made to overcome failed hypothesis, or actions undertaken to trial and test ideas), d. 'Pivots as a process or an event' (refers to actions unfolding over time or sudden shift in events happening in the environment), e. 'Pivots as a state' (refers to the fluidity of events happening within company's context, with complete uncertainty and their ability to adapt to changing context). Taking an environmental perspective, pivots are completely contingent on external environmental factors such as regulations, competition, consumer needs, technological advancement and the capability of the organization to make adaptive changes within the company to accommodate for these factors. They grow out of constant interaction between value offering by company and subsequent market needs, implying corresponding improvements to achieve the product-market fit and learning new information for continual offer iteration (O'Connor and Klebahn, 2011). As visualized by Chaparro and Gomes (2021), Figure 3.18 shows the decision making process of pivot in terms of recognizing, apprehending and piloting the changes.

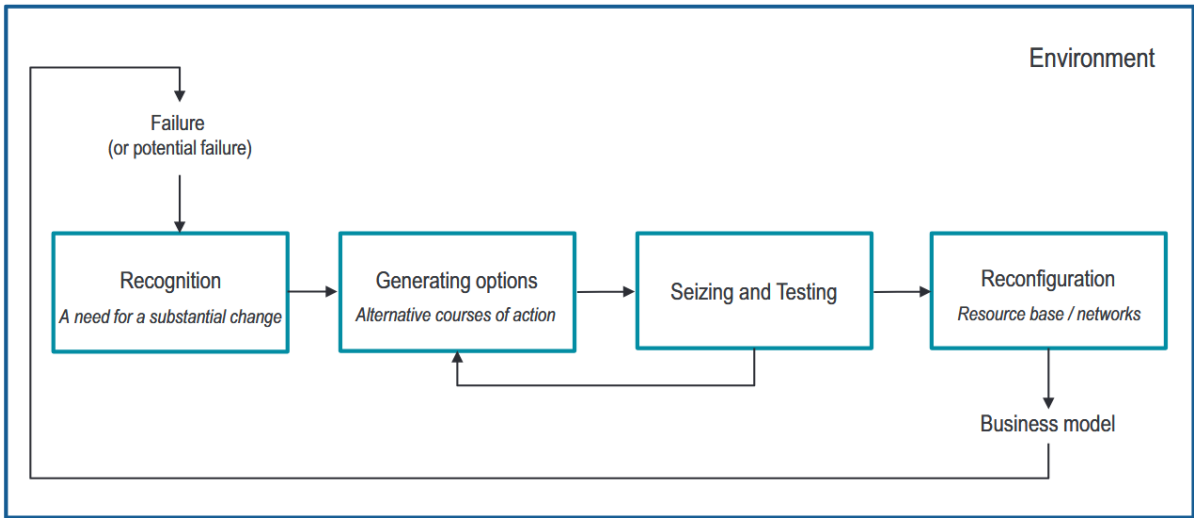

Figure 3.18: The pivot decision making process (Chaparro and Gomes, 2021)

A core concept with respect to pivot is the tendency, ability and willingness of decision makers to

undertake/perform pivots, and growing literature has been examining the cognitive processes (Kirtley and O'Mahony, 2023). This dynamic capability of decision makers to pivot, according to Teece et al. (1997) and Teece (2007), comprise of 'sensing' (i.e., ability to perceive and evaluate an opportunity), 'seizing' (i.e., ability to use organization's resources skillfully to capitalize on that opportunity), and 'transforming' (i.e., capacity of an organization to mold itself and flexibly renew its functioning) (Refer Figure 3.14). Disruption in status quo of business models calls for need of agile leadership skills for appropriate pivots (Doz and Kosonen, 2010). As observed by Kirtley and O'Mahony (2023), decision makers undergo pivots/strategic changes incrementally with unique individual triggers affecting the decision step by step, rather than completely overhauling in one wave. They assimilate new information and make strategic decision gradually to undergo additional actions towards a cause or avoid making changes (exit) [Refer Figure 3.19].

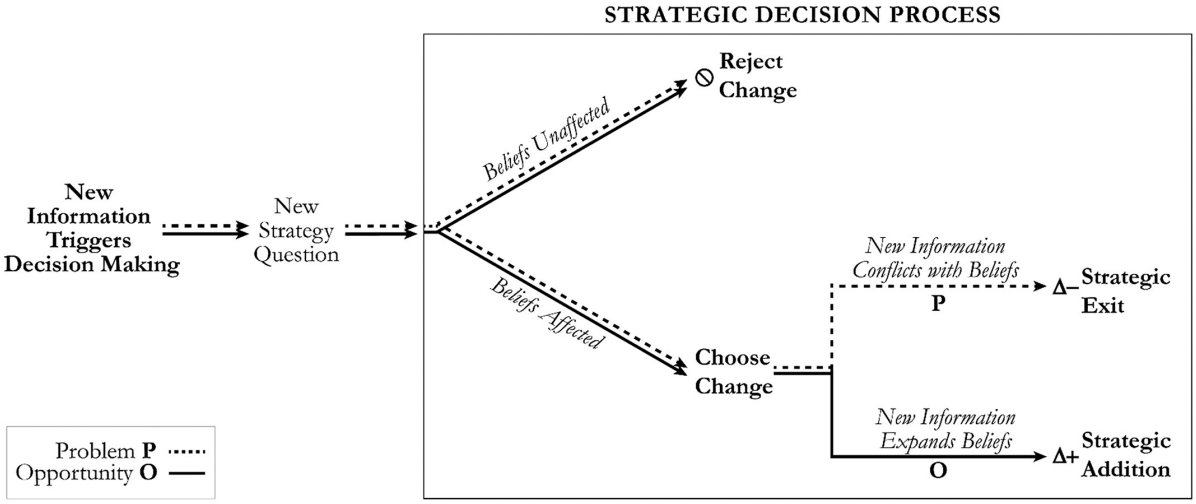

Figure 3.19: Firms strategic decision making progress (Kirtley and O'Mahony, 2023)

4

Conceptual Framework

This chapter focuses on developing conceptual framework to systematically understand how external triggers impact business models of sustainable energy startups/scale-ups, resulting in them pivoting their course of action. This involves discerning how these triggers are perceived (as an opportunity or threat), their primary effect on a certain business model element, pivoting action undertaken in response, observing cascading effect on other business model element and identifying whether the change in course of action is an innovation towards something novel or an adaptation. The initial framework is grounded using established literature concepts and is later refined using empirical data from interviews conducted. As a result, the final improved framework is organized around the three sub-research questions as mentioned in Section 1.5, and qualitative analysis via means of Gioia analysis has been conducted to support main individual sections of the framework. Following, explanation is provided about the model development, and underlying theories and their connections towards solving the research questions.

Perception of trigger as an opportunity or a threat

Entrepreneurs use cognitive ability and organizational situation to constantly monitor and assess external stimuli. These can be identified as 'Opportunity' - e.g., new government policy providing access to subsidies for company's product development - or as 'Threat' - e.g., expensive nature of product hampeing product adoption in market. (Baron, 2006; Bucherer et al., 2012). Research on 'Prospect Theory' (Kahneman and Tversky, 2018) and 'Threat-rigidity Theory'(Staw et al., 1981) suggest that decision makers behave differently to perceived gains or losses. There have been studies based on how decision makers perceive the stimuli. For instance, 'Prospect' and 'Threat-Rigidity' theory imply that decision makers are more skewed towards taking action when they consider the situation to be a threat and are more sensitive towards losses. Similarly, conclusion from an empirical research of 1196 Norwegian companies, conducted by Saebi et al. (2017), states that business model is more likely to change under perception of threats rather than opportunities, and leans highly towards adaptation rather than innovation. Furthermore, 'entrepreneurial alertness' (Tang et al., 2012) and 'Cognitive Perspective' (Baron, 2004) theories, classify perception to be subjective on decision maker's analytical and organizational factors.

Hence, to observe from sustainable energy point of view, an aim is to understand what broad factors allow companies in this sector to identify an external trigger as an opportunity or a threat. When it's observed as opportunity, decision makers may be more open to explore and experiment, for instance, mandatory carbon tax laws might help sustainable energy companies to target wider market possibilities. Whereas, if considered as threat, companies might delve into survival or defensive strategies, for instance, new regulatory laws might force modifications in product to comply with changing laws (Baron and Ensley, 2006). This answer to sub-research question is supported by following conceptual model 1 (Refer 4.1), that further acts as a sub-part of our main conceptual framework.

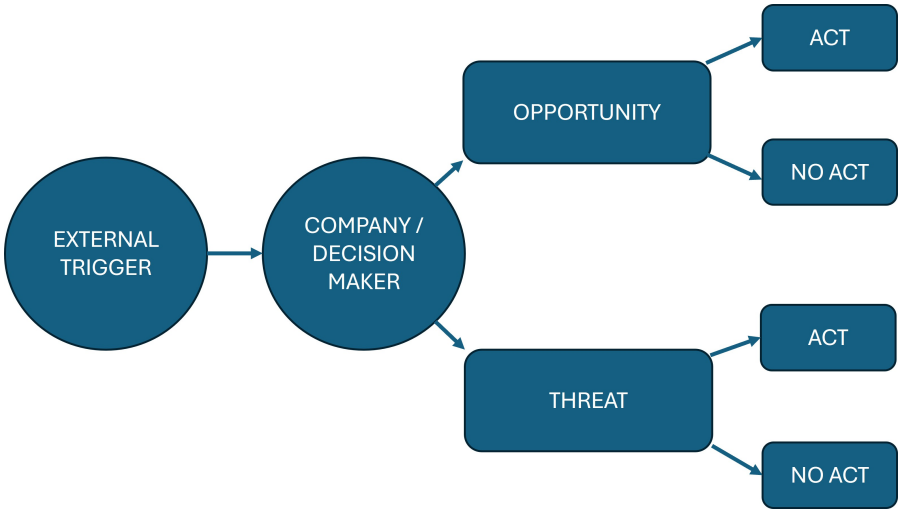

Figure 4.1: Sub-Conceptual Model 1 (*author's interpretation*)

Impact on business model and subsequent pivot action

Once the trigger is observed to be an opportunity or a threat, the firm makes appropriate decision to change its course of action, i.e., act or not-act. This effect of trigger on firm's business model can be categorized into its impact on four elements as described by Bocken (2021b), i.e., Value Proposition (Product or service offering to customers), Value Creation (activities, strategies and resources surrounding the company creating the value), Value Delivery (customers, market approach and their relationships to deliver the value offering), and Value Capture (revenue and cost structure that drives the business). The sustainability model also incorporates the values of environmental and social factors in the value proposition section. The following figure 4.2 visualizes the effect of external trigger on individual BM element, helping further the understanding of sub-research question 2.

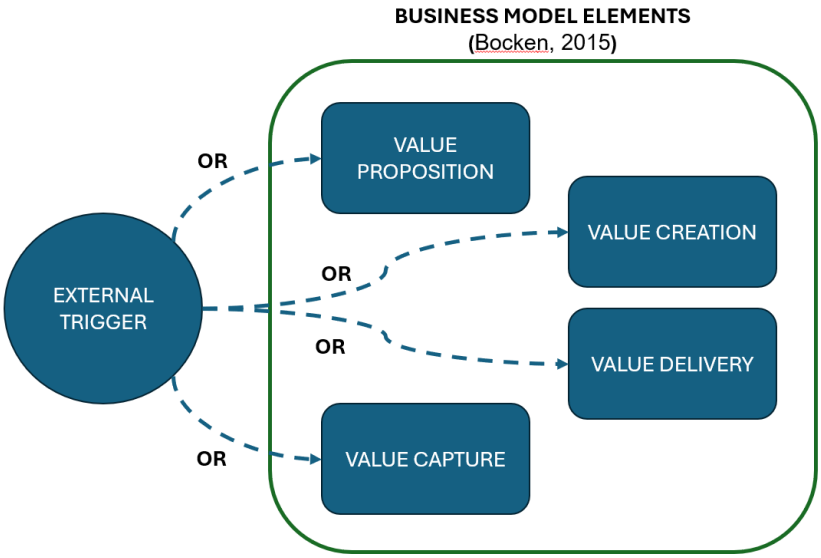

Figure 4.2: Sub-Conceptual Model 2 (*author's interpretation*)

Pivot, as theoretically conceptualized by Ries (2011), is a strategic change undergone by a firm by changing one or more of these business model elements to strategically respond to the identified opportunities or threats. This might involve reallocating, restructuring or realigning the strategies and resources to cater better to the impending needs. For instance, an external trigger might implicate changing com-

ponents of a product, or their strategies, building new infrastructure, cater to new markets, modifying their pricing structure and so forth. They do tend to pivot when new information "conflicts with or expands their beliefs" (Kirtley and O'Mahony, 2023). Hence, in line with sustainable energy firms, we identify the pivoting actions generally undergone by these firms in response to particular triggers using Gioia methodology, and identify the cascading effect on other business model elements when pivots are undergone.

Snowball effect on other elements

The theory of business model dynamics identifies that the nature of BM is systemic, i.e., impact on an element cause ripple effect on other (Teece et al., 1997). Once an element changes, there are subsequent changes in other elements, or deliberate changes have to be made to various elements, to keep the model stable and consistent. These changes can range from minor changes to radical overhaul. A minor impact can lead to pivoting as a means of small adaptation - for instance, regulation mandates using certain color of part - wherein only a few subsequent elements might see an impact. Whereas, an overhaul can be part of radical innovation - for instance, new product developed to cater to a new global environmental challenge - which might require completely changing multiple elements of the business model to be sustainable and consistent. The sub-research question 3 identifies this cascading effect, and ties to the literature on dynamic business models (Teece et al., 1997; Khodaei and Ortt, 2019). [Refer Figure 4.3]. The research focuses only on primary and secondary impact on BM, to limit the scope of study.

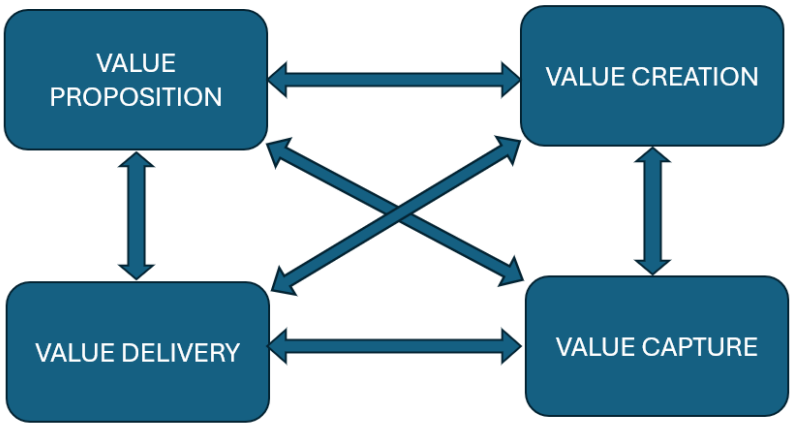

Figure 4.3: Sub-Conceptual Model 3 (*author's interpretation*)

Conceptual Framework

The above conceptual models and corresponding theoretical literature underpinnings allow developing the following conceptual framework (Refer Figure 4.4). The framework is conceptualized for understanding the effect of external triggers on sustainable energy firm's business model and corresponding pivot action undertaken by them to subsume these triggers.

The framework starts with understanding the triggers impacting the firms in this sector. Next, what factors allow these triggers to be perceived by decision makers as opportunity or threat. When a company faces an external trigger, the framework allows observing its impact on certain component of business model, i.e., VP, VC, VCA, or VD. Further, once there is an impact, corresponding pivoting action undertaken by company is understood and categorized using Gioia method. The effect of these pivot enforce changes in subsequent business model elements of the company, i.e., secondary BM element that is changed. There are also possibilities that an external trigger does not enforce the firm to undergo changes, which is categorized as 'No Pivot'. Finally, the pivoting action is identified to be an innovation or an adaptation. For furthering our research, the triggers, pivots and opportunity/threat are analyzed using Gioia methodology by utilizing the interview excerpts. This allows thematically analyzing the constructs relevant to sustainable energy industry and identify patterns.

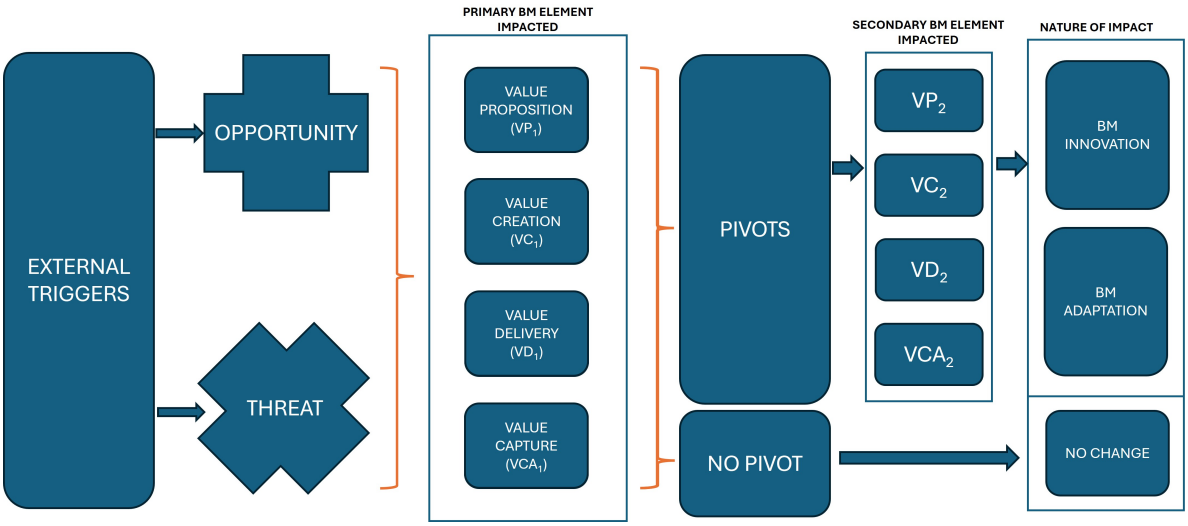

Figure 4.4: Initial Conceptual Framework (*author's interpretation*)

Hence, the framework is grounded on theoretical constructs of, Opportunity-Threat Perception (Baron, 2006; Staw et al., 1981), Dynamic Business Models (Teece et al., 1997), Sustainable business model concept (Bocken, 2021a), interconnected nature of BM elements (Zott and Amit, 2010; Khodaei and Ortt, 2019), and Pivoting theory (Ries, 2011),

5

Case Study

This section delves into the detailed information and results of companies and their interviews.

5.1. Company K

Company K (name anonymized) is an academic spin-off startup in the field of wind energy electricity generation established in The Netherlands. The primary research about the technology began in early part of 1990s, with significant product improvements over the years in terms of patent filing, technology demonstration, and real-life testing in the environment. The company was established in mid-2010s and clouts academic research to foster a novel unique alternative to non-renewable energy production by harnessing power of wind. The product comprises of hardware parts with add-on software capabilities to develop the efficiency of energy generation and tracking. The innovation lies in terms of significantly less raw material used for production, ensuring ease of transportation to remote locations and increased flexibility to construct the technology at places with much less environmental constraints. The company also focuses quite a lot on tackling major technological problems concerned with wind energy, i.e., noise and visual disturbance in environment.

Over the years, the company has developed multiple prototypes and pre-production models to demonstrate their capabilities in terms of power capacity, modularity, varying customer and market needs and scope of application. The portfolio currently comprise of 2 main products, catering to different application needs with an eye to develop a few more. They achieved their primary milestones in terms of product display in 2017, and proving technical and commercial know-how on a market scale in 2018.

In terms of financial capability, the company has been successful in winning government backed grants and angel investments for research purposes and has formed close partnerships and collaborations in multiple countries to help diversify its outreach. These partnerships comprise of outsourcing production nature and collaborating on new technological arenas. Furthermore, to enhance their commercial outreach, the company has also secured multi-million euro funding from impact investors and venture capital funding to further the cause. The product is also backed by government schemes, subsidies, and tax benefits to mobilize the customers towards sustainable energy adaptation. In addition, they have won certifications that allow access and operations in multiple countries without heavy restrictions.

Since its inception, the company has been successful in testing the product in national and international jurisdiction, develop prototypes, launch commercial product with demo products in use in multiple countries across the world. Acknowledgment of the technology by government regulations and international bodies has further accelerated their path towards novel energy generation by providing with technology concept validation and access to multiple markets and geographical locations.

5.1.1. Triggers Experienced and Subsequent Pivot Action

This section explores the interview data (quotes) to identify external triggers and subsequent pivot actions undertaken by companies. Following are some examples of quotes and how they were categorized

as opportunity or threat and their subsequent effect to bring pivots in company. Interview was conducted with the 'Business Development Manager' and all the following excerpts have been extracted from that interview.

Technological limitation (Trigger) resulting in alternate new product development (Pivot)

> *"We worked to a product that could produce [X capacity] as a system and after trying to get there for multiple years, we realized that we couldn't get there in time technologically. So we decided and developed another product of [X capacity]."*

Description: A new alternate product developed due to delay in launching original product (due to lack of technological advancement)

Observation: The technological trigger was observed to be a **threat**, that impacted the **Value Proposition** of the company primarily requiring changes in product offering. The development of new product (pivot) was prominently undertaken to reach market faster and validate technology, i.e., **Value Delivery. (VP -> VD)**

Customer Feedback (Trigger) resulting in Product Modification (Pivot)

> *"So also what I learned now from our potential customers and for most of them, the [X capacity] is too small. Like it doesn't impact enough on what they need, so their energy demand is higher than what we can deliver with the [X capacity]. So that's where we at right now, trying to increase the capacity to target their needs"*

Description: Existing product size inadequate according to customer feedback,prompting development of a more suitable technical solution

Observation: The customer feedback trigger was observed to be a **threat**, that impacted the **Value Proposition** of the company primarily requiring technological modifications in product offering. The change in product prominently impacted the company resources to develop new technology i.e., **Value Creation. (VP -> VC)**

Supportive government regulation (Trigger) allowing New Market Expansion (Pivot)

> *"We get requests but we specifically pick countries that have the same regulation framework... If we want to go to [geographical region X]... we will have to make changes in product. So yes, we explore the markets especially in [geographical region Y] because they are easy to reach and the laws for us to manufacture our product and to be able to operate is the same as the market in the Netherlands."*

Description: Product and company resources introduced in geographical regions having similar regulatory framework, facilitating product introduction in new markets.

Observation: Favorable government regulations in a geographical region acts as an **Opportunity**, allowing company to expand its target market, i.e., **Value Delivery (VD)**. This results in expansion of company resources to new regions, i.e., **Value Creation (VC) (VD->VC)**.

Customer feedback (trigger) prompting diversification of Revenue Model (Pivot)

> *"(Rental model) we did the market segmentation, and upon asking potential clients we found that the most promising market wanted that, i.e., The energy-as-a-service model....So that is why we are trying to get the rental phase to work, which is still a small adaptation, but a smaller gap than going for a purchase."*

Description: Adopted a revenue model to match customer preferences, ensuring market fit and enabling future growth opportunities.

Observation: Feedback from customer segments about their purchasing preference promotes company to explore and diversify its revenue model. This acts as an **Opportunity** for company to cater better to the market, with trigger primarily impacting the **Value Capture (VCA)** and corresponding effect on its Customer segments, i.e., **Value Delivery (VD) (VCA->VD)**.

Technological limitation (Trigger) requires adjustment to company risk strategies (Pivot)

> *"(Hybrid Power Plant): We believed that If we need to bump up reliability, or if we need to be independent of only [natural resource X], then we still need to be aware that there are other competitive alternatives....Then we need to be aware that we can maybe make a hybrid plant where we combine the few things that that I just mentioned and offer that as a total solution, and that's what we are aiming to offer with this plant."*

Description: Exploring hybrid solutions while prioritizing core technology to enhance reliability and mitigate risk.

Observation: Company faces imminent **threat** due to its heavy reliance on a single natural resource for energy generation. This technological limitation is forcing a strategic pivot toward a hybrid model to reduce risk and improve reliability. As a result, the core **Value Proposition (VP)** is being reshaped, with a subsequent effect on its resources, i.e., **Value Creation (VC), (VP->VC)**.

Favorable Policy (Trigger) enhances Market adoption of product (Pivot)

> *We see in the [Policy X]] for example that [Market x] gets funding to buy a sustainable equipment or renewable equipment, the same market that our product is in. So we try to pursue that market because we become just easier to reach and more price competitive.*

Description: Company targets subsidy-backed markets to enhance product competitiveness and increase accessibility.

Observation: The policy by international organization provides favorable financial incentives to the consumers to adopt company's product, acting as an **Opportunity** for the company to expand accessibility in the market, i.e., **Value Delivery (VD)**, and the financial support that policy provides for buying the product, positively effects company's revenue, i.e., **Value Capture (VCA) (VD -> VCA)**

5.2. Company G

Company G (name anonymized) is a Dutch startup established in late 2010s in the field of clean energy storage, with a focus on sustainable energy solutions to replace traditional non-renewable energy production. The idea started with solving problem of energy optimization in temporary establishments that conventionally use non-renewable source of energy for their functioning. The product line started with developing energy storage solutions utilizing sustainable energy whenever and wherever possible. Fast forward to today, the company houses technology that facilitate easy transportation and access of sustainable energy storage solution to remote and temporary locations cutting the gap of non-renewable energy utility.

The product is designed to be modular, with possibilities to combine seamlessly with renewable sources of energy such as solar, wind and hydrogen energy paving the path towards developing hybrid solutions. They also help access and supply energy to no-grid zones helping expand the market outreach. The product also involves multiple features to accommodate varying energy settings, adding to the agility of its use. In addition to hardware product, the company has innovated a software for their users that allow in-depth analysis of energy monitoring, track wastage, and measure CO2 emissions. There are multiple product combinations within the company harboring request from various type and needs of markets and customers. Revenue model consists of allowing consumers the flexibility to buy the energy storage solution or license the software or both.

In terms of finances, company B has secured approximately €50 million in investments from sources of venture capital, with focus on expanding the team, market application, R&D and product offerings. They currently have operations in more than 10 countries with regulations approximately the same in all operational countries.

Company B has multiple partnerships with companies to facilitate manufacturing of their proprietary product, and collaborations to facilitate the utility of product to new applications and areas. The product has been awarded internationally backed certification that has provided further boost towards application and scale of the product. Environmental factors such as COVID-19 has helped the company expand their expertise to new arenas.

5.2.1. Triggers Experienced and Subsequent Pivot Action

Interview was conducted with the 'Chief Operation Officer and Co-Founder' and all the following excerpts have been extracted from that interview.

Global Pandemic (Trigger) resulting in exploring alternate customer segments (Pivot)

> *"COVID also meant that we lost our complete clientele because there was no need anymore....So all customers that we had in 2019-2020 or like in 18 and 19 were not there anymore in 20 and 21. And that's when we decided that we needed to widen our target customers. We then focused on [customers X & Y], who mainly face grid congestion problems....we also had to diversify our offering and not so much in the portfolio of batteries that we had, but in how we define the product and how we offer that to the markets. "*

Description: Loss of primary customers due to global pandemic led to market diversification and targeting new customer segments

Observation: Global pandemic acted as a **threat**, resulting in company losing all its previous clientele, i.e., impacting the **Value Delivery (VD)**. This resulted in company diversifying its customer segments and changing its strategies of selling the product, **Value Creation (VC) ; (VD->VC)**.

Market demand (Trigger) yielding expansion to new geographical region (Pivot)

> *"I think the biggest change then was early 2023 when we decided to to take on the [Country X] market due to an opportunity, eventually making our products and all product offering a multinational, a product offering with setting up teams over the channel and distributing assets over Europe and [Country X]....so that also meant that we needed to do a lot more in terms of tax management."*

Description: Expansion into new country, establishing multinational operations and regional distribution to satisfy new market demand.

Observation: A new market demand and **opportunity**, allowed expansion of company to new geographical area, i.e., **Value Delivery (VD)**. This change brought about significant impact on the company's cost and taxes, i.e., **Value Capture (VCA) ; (VD->VCA).**

Differing country-specific regulation (Trigger) compel modification of product (Pivot)

> *"....there are adjustments needed that we need to incorporate. For instance, in [Country X], they have other legislation where we need an extra breaker. In the [Country Y], they want to understand how fast certain breakers work."*

Description: Different geographical regions having different technical regulations, requiring product adjustments

Observation: Application of product in differing geographical areas require making technical adjustments in the product (**Value Proposition (VP)**), acting as a **threat** and hampering company's existing resources, i.e., **Value Creation (VC) (VP->VC)**.

New Partnerships (Trigger) promoting an opportunity to shift sales strategy (Pivot)

> *"So the main thing also what happened when we moved to the [Country Y] early 2023, we shifted our market approach from direct to indirect. This is mainly that we found like a handful of rental companies that rent out our products, meaning that we are really light on team and can deploy a lot of assets with a really limited amount of people on the ground. Whereas in [Country X] still today and also since 2018 we really focused on the direct channels, which, need a lot more work before they bring up contracts."*

Description: Transitioned the sales strategy and revenue model in a new country due to favorable new partner networks for high scale deployment with minimal resource investment.

Observation: New partnerships and collaborations opened the door to a shift in the companys strategy and revenue model. This **opportunity** primarily impacted the companys key resources, enabling a leaner

team and reshaping how value is created, i.e., **Value Creation (VC)**. These changes also had a direct effect on the companys cost structure and revenue streams, influencing how value is ultimately captured (**Value Capture (VCA)**)(**VC->VCA**).

Regulatory barriers (Trigger) causing changes in product technology (Pivot)

> *"....that's because the electrification with [product X] is going a little faster than legislators can move. And also innovation on [product X] is going a lot faster than legislators can sort of put in their texts in their drafts. And that's what we now from time to time, find ourselves stuck with. Those [product X] types described by the legislation are no longer available or used, and then they moved on from [product X version 1] to [product X version 2] and still everything was sort of focused on the risk of [product X version 1]. And so we really closely follow all the developments regarding [product X] regulations and make [product X] adjustments, because at some point it can really hurt us."*

Description: Technological advancements taking place faster than regulatory updates, creating compliance challenges and market uncertainty.

Observation: Regulatory and legislative updates concerning product technology are evolving slower than technological advancement in the field, posing as a **threat** to company's functioning. This impacts the survival of company's value offering directly,**Value Proposition (VP)**, followed by incorporating changes in company's operation to stay up-to-date, i.e., **Value Creation (VC)** (**VP->VC**).

Fickle sustainability and political scenation (Trigger) negatively impacting investor confidence and investments (Pivot)

> *"What we've really experienced is that today there's quite a bit of headwinds for everything that has to do with environmental sustainability, which was pretty strong actually the past two years and especially last year It was like a massive election year....And you also saw that a lot of our partners were sort of Putting their foot on the brake with with further expansion of the of the product offering via [Company G] because they first needed to understand and find out in what situation we will be after elections"*

Description: Volatile market condition due to shifting sustainability priorities and political (election) driven regulatory changes, causing inconsistent expansion of product offering.

Observation: Inconsistent political scenario and changing sustainability goals resulting in dwindling investor confidence in the product (**threat**), impacting the investment in company, i.e., **Value Creation (VC)**. This further negatively influences the advancement of product offering **(Value Proposition (VP)) (VC->VP)**.

5.3. Company N

Company N (name anonymized) is a Dutch scale-up technology provider in the field of producing sustainable fuel from waste using proprietary patented in-house technology. The focus is to develop and advance the technology necessary to produce sustainable fuels for heavy-duty applications. The research on technology began in late 2000s and the product was later commercialized as a product offering, instituted as a startup in late 2010s. Since then the company has grown into a scaleup, with first successful commercial project started in early 2000s.

The product is modular and decentralized helping consumers/clients establish their own small-scale sustainable fuel production unit, further limiting reliance on existing congested grid infrastructure and reducing emissions. The operation of technology lies free from human intervention, allowing continual production and constant vigilance opportunities using proprietary monitoring software. The technology supports significant GHG emission abatement owing to its product's patented features. The product operates in capital intensive environment, which implies forming strong collaboration with players in similar industry to scale the product. The company has made significant partnerships and collaborations, both nationally and internationally to help facilitate the production of fuel in various application using varying waste, helping explore the application of technology for multifarious applications. These

relations also aid in building the infrastructure necessary to accelerate the expansion towards sustainable fuel generation.

The technology has been awarded grants worth approx €5 million by international initiatives and innovation funds for actively working towards sustainable development goals. In addition, the company has also received investments from large multinational companies and strong commercial backing in terms of technological and market collaboration. As of 2025, the product has been launched in multiple countries and collaborations have been made accordingly to facilitate this expansion. Currently two markets are being targeted, with plans to venture into multiple other in near future.

5.3.1. Triggers Experienced and Subsequent Pivot Action

Interview was conducted with the 'Marketing Manager' and all the following excerpts have been extracted from that interview.

Customer feedback (Trigger) stimulates product modification and eventual new product offering(Pivot)

> *"When we had the first version of the technology, we would advertise that technology to [Fuel X] producers that produce a certain amount of [Fuel X]. From talking and learning from producers that produce less or more than what we can handle, now we are more flexible. We are working on new versions of our current technology so that we can scale up, we can handle more [Fuel X]. And so these are becoming 2 slightly different products. And these two different products will be in terms of outgoing marketing and how we position ourselves in the market. Those two will also be a little bit different."*

Description: Modified new product versions to meet identified market need, enabling exposure to new customer types.

Observation: Customer feedback on market needs poses as an **opportunity** to facilitate product modification and eventually new value offering, i.e., **Value Proposition (VP)**. This allows company to venture into new customer segments and markets, expanding its outreach - **Value Delivery (VD) (VP->VD)**.

Identification of new market opportunities (Trigger) encourage development of new technology (Pivot)

> *"With usage and understanding market, pretty quickly, we recognize that we needed to have different skills of technology for different types of [Customer X]. And we also recognize that when the scale of a plant comes down, then of course the amount of [Fuel X] that you produce will also be less And then there is a shift in optimization....So hence we needed to change some of the technology for smaller size plants. And that's what we've done, yeah"*

Description: Developing new technological solutions to cater to new market possibilities.

Observation: With industry experience the company identified the gaps in market that their product can fill. These new market **opportunities** motivated the company to develop new technology for better product-market fit, implying primary effect on **Value Proposition (VP)**, followed by revising their business operation to cater to these changed product specs, i.e, **Value Creation (VC) (VP->VC)**.

Supportive regulations (Trigger) enhance demand and product adoption within market (Pivot)

> *"Just this week, there was news about the [International Organization X], which is a global organization. And they have introduced some sustainability goals that will mandate use of [X fuel], you know, help grow the adoption and demand for [X fuel] in the world. So it's good news. These types of sustainability targets from either the sector themselves that increase the demand of [Product X], in this case such as from [international organization] or from governments, the EU or individual countries has helped us a lot with penetrating new markets."*

Description: Sustainability goals set by governing organizations in a market boosting company's product demand in new markets.

Observation: Supportive regulations implemented by international organization create mandate (**Opportunity**) for consumers to use product generated by Company N's product, i.e., **Value Delivery (VD)**, resulting in increased product adoption in market and increased revenue, i.e., **Value Capture (VCA). (VD->VCA)**

Varying compliance laws in different geograhical region (Trigger) enforces product modification (Pivot)

> *"When we supply to different countries, sometimes it requires making technological adjustments of the product according to compliance. For instance, we do see Different Quality demands between northern Europe and southern Europe"*

Description: Differing compliance laws between regions causing technological adjustments in the product.

Observation: Unique compliance laws of each region act as a **threat** resulting in adjusting product technology (**Value Proposition (VP)**), and corresponding changes in company's operations to incorporate those changes (**Value Creation (VC)**) **(VP->VC)** .

Competition from counterfeit products (Trigger) enforces strategic changes in company resources (Pivot)

> *"what some companies want is they want to produce [Fuel X] By greenwashing fossil [fuel] with certificates, and this is in fact already allowed in some countries in Europe. Because it's cheaper, it's interesting for particularly the [Industry X]. So that is a competitive production route for us. It's a challenge for us as a technology company to fulfill that demand with just a lot of [Product X] plants. So we may need that alternative production route. The downside of that alternative production route is that we continue to to remain dependent On fossil molecules, because that's the only way that you can produce it... So it's not a long-term sustainable solution so we are trying strategies to find a way around"*

Description: Facing competition from counterfeit/greenwashed product, threatening company's product credibility and resources.

Observation: Unfair competition from cheap counterfeit products acts as a competitive **threat** for company's product by negatively effecting company's market demand, i.e., **Value Delivery (VD)**. This results in company trying to tweak its operational strategies to overcome the barrier - **Value Creation (VC) (VD->VC)**.

New collaborative partnerships (Trigger) provide support and expansion of product in new market (Pivot)

> *"So when we supply our customers in [Country X] or [Country Y] or [Country Z] With installations, and those customers need on site support, we need to fly to those countries. And for one plant, that's OK, but as we, you know, scale up, you need some local Presence there. Either by employing people in [country X or Y] ourselves, or by using a partner that can help us with local support of our customers and we are only doing this."*

Description: Developing new partnerships to expand in new geographical region

Observation: When the company enters a new market/geographical region, it forms partnerships to provide support to their product, i.e., primarily impacts **Value Creation (VC)**. This helps to further commercialize and expand the product in the new market - **Value Delivery (VD) (VC->VD)**. - **Opportunity**

5.4. Company E

Company E (name anonymized) is a Dutch firm specializing in Advanced Materials for sustainable energy sector. The company was founded in mid 2010s and operates across Europe. They have developed a patented technology intended for battery application, increasing the storage capacity, sustainability, manufacturing capability and ensuring circularity.

A pilot-size manufacturing facility with capacity of few tonnes was set-up recently that allows the company to scale their operations and prove their product expertise. To further expand their outreach, they have also collaborated with multiple research institutions across Europe and private stakeholders to improve their product performance and identify new applications. Company E has also made collaborations with companies from another continent in order to expand the scope of market offering and currently in process of figuring out strategies.

In terms of financial support, they have won approximately €20 million euro investments from external investors and government grants. The funds aid in research & development of the firm and allow wide-scale commercialization - such as setting up manufacturing firm. In order to support the end-of-life cycle of their product, the company also developed a new proprietary technology for recycling their products, with potential of a value offering in the future. Due to very sensitive nature of technology and few players in the market, very less information is being provided to ensure utmost privacy and secure identity.

5.4.1. Triggers Experienced and Subsequent Pivot Action

Interview was conducted with the 'Program Manager' and all the following excerpts have been extracted from that interview.

Customer Feedback (Trigger) influencing modification of product (Pivot)

> *"So whilst we produce a product, that product has a variety of properties which can be varied. And depending on the end use and the requirements of the end user, those properties have been modified. So we have a range of properties that our product can take and really it's a case of that's why we work not only with manufacturers but with end users as well, because we need to supply a product that's optimized for them. So yes, so there are learnings from feedback and change in product to suit to their needs."*

Description:Product technical properties adjusted to cater to different customer and market needs.

Observation: Customer feedback and understanding the requirements of the market provides an **opportunity** for company to diversify its value offering, i.e., **Value Proposition (VP)**, resulting in company eventually approaching and exploring new customers and markets, i.e., **Value Delivery (VD)**. **(VP->VD)**

Regulatory uncertainties (Trigger) impacting company's administrative operations (Pivot)

> *"We have a product that we can market on the evidence of the sustainability we have done, life cycle assessments etc of our product. But we also have to keep abreast of all the changes that are coming in sustainability reporting, in ESG reporting. It's surprisingly even for an SME, it's a surprisingly heavy workload.... There is actually quite a workload on sustainability reporting on ESG reporting for the company."*

Description: Uncertainty in environmental regulations creating challenges in business administration and product approvals.

Observation: Changing environmental and sustainability regulations pose as **threat** to company's day-to-day operations, i.e., **Value Creation (VC)**. These changes directly impact the company's value offering by accommodating the required changes from regulations viewpoint, i.e., **Value Proposition (VP)**. **(VC->VP)**

Energy prices (Trigger) affecting company's revenue (Pivot)

> *""Energy costs for us are very important, they affect both the sustainability of our products and also the the cost of the goods that we're producing, that would then bite into a profit margin or affect a sales price. We are always exploring ways to reduce the dependence."*

Description: Dependence on external energy sources negatively impacting company revenues and product sustainability.

Observation: Wide macroeconomic factor, i.e., energy availability and costs, **threaten** the company's revenue (**Value Capture (VCA)**), followed by company tweaking its strategies to overcome the overhead costs, i.e., secondary impact on **Value Creation (VC)**. **(VCA->VC)**

Grid congestion (Trigger) altering company's infrastructural expansion plans (Pivot)

> *"What's also has been more critical, for us is also actually energy availability, because especially in the Netherlands, that when we've been looking for sites for our plants, there's an extreme restriction on the grid in terms of energy availability, so that that is also very crucial for us, as the ability to be able to make that expansion. And that is very restricted for us at this moment in time."*

Description: Energy grid congestion and limited energy availability thwarting expansion of company operations to larger locations.

Observation: Lack of sufficient energy availability due to grid congestion poses as a major **threat** towards company's infrastructural expansion goals **(Value Creation (VC)**).

Circularity and sustainability goals (Trigger) facilitate new technological advancement (Pivot)

> *"To support sustainability of our product, we have built a recycling process pilot to make sure that all of the materials used in our process are fully recycled, with minor losses but close to 100% circularity. It's actually cheaper for us to pay to develop the recycling process and to have the recycled process materials. We actually save money than constantly buying new process material. That's beneficial for us both from a sustainability point of view, but also from a financial point of view."*

Description: Developed new complementary technological process and infrastructure to facilitate circularity of existing product for sustained growth.

Observation: The aim for developing circular product provides an **opportunity** for company develop a new proprietary recycling process (**value Proposition (VP)**), that facilitates the company to reduce their overall cost and increase revenue, i.e., secondary impact on **Value Capture (VCA)**. **(VP->VCA)**

5.5. Company T

Company T (name anonymized) is a Dutch deep-tech startup in the field of nuclear energy as a technology provider. The company was established in later part of 2010s in an effort to advance the methods of producing nuclear energy. The technology evolved as a research-based spin-off with eventual patented technology, and now the company is exploring the commercialization of product.

The company currently has its research operation in multiple countries, with attempts being made to collaborate with national and international institutions from other countries. The technology functions in a strictly supervised regulatory environment further adding to the challenge. This requires achieving high safety standards, complying with policies at a sensitive level. The company has invested in developing relations with regulatory institutions to enhance product actualization and fast-tracking safety protocol. Currently under product development phase, they have collaborated with multiple multinational corporations excelling in the field for technology testing and validation, consultancy and manufacturing firms to bring product to life, and academicians to strengthen product validity.

The company is significantly invested by research grants, venture capital and government institutions (amount not disclosed for privacy reasons).

5.5.1. Triggers Experienced and Subsequent Pivot Action

Interview was conducted with the 'Business Development Director' and all the following excerpts have been extracted from that interview.

External investments (Trigger) driving advancement of product technology (Pivot)

> *"We are now in the middle of phase two, where a part of the funding has been achieved that allow us to get full scale [product X] prototype detail design."*

Description: Investment funds used for technological advancement of product.

Observation: Financial investment in company from investors (**Value Creation (VC)**), poses as an **opportunity** for company to facilitate the technological development of product, i.e., **Value Proposition (VP) (VC->VP).**

Advancement of technology (Trigger) helped company expand its product application portfolio (Pivot)

> *"The product offer changed over the years due to different innovations and market possibilities. For example, our product in addition to electricity can now also produce industrial heat efficiently, increasing the application of output....And this means that you can have a lot of industrial applications using this heat."*

Description: Expanding product portfolio by leveraging newly developed tech utility.

Observation: Favorable technological progress in industry and existing product (impacting **Value Proposition (VP**)), helped the company to identify new use cases, expand its value offering to its customers and widen its scope of market, i.e., **Value Delivery (VD) (VP->VD)**. - **Opportunity**

External investments (Trigger) helping company expand its office in new country (Pivot)

> *"Eventually we went through a couple of investment runs and we have expanded our team with an office in [Country X] and some [country Y] colleagues"*

Description: Investment facilitated expansion of company activities to new geographical regions

Observation: Investment from external sources in company's resources **(Value Creation (VC))**, provides **opportunity** for the company to expand to their office and markets to new country (secondary impact on **Value Creation (VC)) (VC->VC)**.

Differing compliance laws in different countries (Trigger) forcing company to alter its product offering (Pivot)

> *"We are currently pursuing application in three countries, and there is significant impact on technological requirements for each. For instance, [country A] requires red colored wire, whereas [Country B] requires blue colored wires for a certain part. That impacts the type of suppliers we have in each country to cater to those needs."*

Description: Regulatory variation in different countries/regions creating challenges on product technology and subsequent partnerships.

Observation: Varying regulatory and compliance laws in different countries, acts as a **threat** to country's operations (**Value Creation (VC)**), which mandates firm to make modification to its product to make it compliant, i.e. secondarily impacts **Value Proposition (VP)**. **(VC->VP)**

Fickle environmental laws and political scenario (Trigger) urge company to expand network (Pivot)

> *"The technology is still in nascent stage and the changing political scenario concerning the environment is impacting the market and investor confidence in the technology. So we have now started engaging more closely with policymakers to better respond to these [regulatory] changes."*

Description: Changing environmental regulations affecting investor and market confidence in the product.

Observation: Fickle environmental and political situation (**threat**) negatively impacts adoption of technology idea in the market (**Value Delivery (VD)**). This urges company to make better networks with policymakers to make the situation more clear for further development (secondarily impacts **Value Creation (VC)**) **(VD->VC).**

Expensive nature of existing product (Trigger) forces company to make it modular (Pivot)

> *"We then focused on developing a modular product to make it much cheaper, replaceable efficiently and reduce the impact on the environment, and also makes more predictable".*

Description: Advancing product technology to modular system to reduce cost, increase re-usability and increase consistency of product.

Observation: Expensive nature of existing product **threatens** company to technologically advance the product to modular system, i.e., impact on **Value Proposition (VP)**. This helps to further reduce cost and increase re-usability of the product - secondary impact on **Value Capture (VCA) (VP->VCA)**.

5.6. Company B

Company B (name anonymized) is a Dutch Clean-tech company focusing on sustainable energy storage technology tackling problems of grid congestion. The product was initiated as a research project that was later commercialized via means of establishing as startup in late 2010s. The product is modular in nature with innovation in storing energy in recyclable materials. The idea was driven by the ideology to reduce the impact of traditional lithium-ion batteries on environment and utilizing renewable sources to store energy.

Funding information regarding the company is in stealth mode.

The company recently shell out of stealth mode, hence company's operations are confidential, and not much information is available to public.

5.6.1. Triggers Experienced and Subsequent Pivot Action

Interview was conducted with the 'Chief Executive Officer' and 'Commercial Director' and all the following excerpts have been extracted from that interview.

Customer feedback (Trigger) compelling product modification (Pivot)

> *"Upon doing business cases and talking to customers, understanding their utility and revenue forecast, we decided to redesign the product to make it cheaper and also make it more connected to the needs of the market."*

Description: Redesigning product to increase affordability upon consultation with customers to match their needs and financial behavior.

Observation: Understanding customer feedback forces the company (**threat**) to redesign the product (impact on **Value Proposition (VP)**), and realign with market/customer needs (**Value Delivery (VD)**) (**VP->VD**).

Expensive product (Trigger) stopping product development (Pivot)

> *"there was one part that was quite expensive (information redacted). Yeah, again, that part was actually quite expensive to make and also didn't produce a lot of electricity. So that was not a lot of value for the investment, and we decided to stop developing that."*

Description: Product was stopped from developing further due to expensive nature and not enough value offering.

Observation: **Threat** from expensive nature of product forced the company to stop the development of product offering, i.e., impact on **Value Proposition (VP)**. This evidently has effect on company's existing resources that helped develop that product, i.e., secondary impact on **Value Creation (VC) (VP->VC)**.

Market obsolete product components (Trigger) restructured company's partnerships (Pivot)

> *"So, for the initial idea here were several components, that were pre-ordered and we had to stop these orders because they were outdated and wouldn't fit the market's needs anymore. Yeah. So now we are actually in the process of connecting to new suppliers as well. so we are in the process of building up several say partnerships with suppliers, but also quitting some."*

Description: Obsolete product components forced supplier changes, ending some partnerships while establishing new ones.

Observation: Outdated components of the product (**threat**), impacted the company to formulate new partnerships (**Value Creation (VC)**), allowing them to fit the market availability and needs better (**Value Delivery (VD)**). (**VC->VD**).

Supportive international policy (Trigger) optimize company's revenue (Pivot)

> *"So the [Policy X], it's more or less a tax on fossil fuels that'll be entered I think in 2027 or 2028 and that will give a tax on fossil fuel use. When you enter that into your business model for your customer you say, well, now you have a gas production site, and we will go to partly electrification, you will not only save gas, That $0.68 per cubic meter, but you will also save $0.10 of taxes and that will spike towards $0.40 in 2031. So that really changed our revenue or savings and that's part of what we sell to our customer now."*

Description: Government policies positively supporting company's product towards better revenue possibilities.

Observation: Supportive government policies (**Opportunity**) allow company to positively restructure and optimize their revenue model, i.e., **Value Capture (VCA)**, with further secondary impact on its customers and the way product is sold **(Value Delivery (VD)) (VCA->VD)**.

Customer preference accommodation (Trigger) resulting in new product development (Pivot)

> *"what a good change we made is that we went from one kind of product that could do a few things, went to step out and cut the product into pieces, so we have now more separate modules, so we can go with these modules to more different customers....And also because we think that potential customers will not go in one step from in in one day from the complete energy system to something new. They want to do it step by step and therefore these modules are also more interesting."*

Description: Product advanced from single-unit to modular unit helping cater to unique customer needs and aiding gradual transition from status-quo.

Observation: To accommodate customer feedback and preference better (**Opportunity**), firm undergoes new product development that is modular in nature (**Value Proposition (VP)**), that helps to fit aptly to the market's needs (**Value Delivery (VD)**) (**VP->VD**).

6

Cross-Case Analysis

This chapter focuses on conducting a detailed cross-case analysis, across qualitative data achieved through semi-structured interviews with 6 sustainable energy based companies, as described in Chapter 5. Analyzing multiple cases in parallel allows identification of trends, which can be further explicated by supporting data from literature and content analysis. This gives way for deeper understanding of impact of external triggers causing pivots in business models of new age sustainable energy companies.

The analysis starts with understanding the triggers causing changes in business model of companies. The triggers are thematically analyzed using Gioia methodology, to observe generalized themes across the data concerning triggers. Similarly in the following section, pivots happening in business models of companies, i.e., corresponding changes in BM due to interaction of trigger, are observed. The content is thematically analyzed using Gioia method to find recurring pivoting themes and its nature across the dataset. The data is also segregated into 'opportunity' and 'threat' by understanding the tone and intent of respondents, to understand whether the trigger was observed to be an opportunity or a threat. Gioia methodology is employed to figure out representative themes and common link.

To understand the nature of change happening, the analysis identifies whether the pivoting action in business models of company was a 'Business Model Innovation (BMI)' or 'Business Model Adaptation (BMA)'. The data allows improving the conceptual framework more catered towards use cases.

6.1. Analysis of Triggers

Interview data from sustainable energy company representatives was collected that focused on understanding what external triggers impacted their business model, how they were perceived by the company, and what kind of change or pivot did the company undergo to absorb or react to the trigger. To begin with analysis, interview quotes were extracted that exactly matches the above description. These excerpts served as the basis for our qualitative content analysis following the Gioia methodology.

A detailed description of the quotes was created to understand the event by staying as close to interviewees perspective and intent. The analysis focuses on using Gioia method for content analysis of the quotes, which comprise of segregating the data (first-order code) into specific unique themes (second-order code) and 'Aggregate Dimensions'. In case of triggers, the detailed description of the quotes were further refined into short and well-defined events capturing causal relationship - "trigger X causing pivot Y". These were used as the First-Order code for analysis.

The triggers were further segregated and themed into 'Second-Order codes', that reflect broad categorization of data. Following which, 'Aggregate Dimensions' were created from the second order code, providing higher-order theoretical constructs capturing nature and patterns of external triggers impacting firms in sustainable energy based companies. Providing an example of coding process as follows:

Trigger Coding Example 1 - Market Trigger

> *"COVID also meant that we lost our complete clientele because there was no need anymore....So all customers that we had in 2019-2020 or like in 18 and 19 were not there anymore in 20 and 21. And that's when we decided that we needed to widen our target customers. We then focused on [customers X & Y], who mainly face grid congestion problems....we also had to diversify our offering and not so much in the portfolio of batteries that we had, but in how we define the product and how we offer that to the markets." - Company G*

Detailed Description: Loss of primary customers due to global pandemic led to market diversification and targeting new customer segments

First-order code: Targeting new customer segments after losing core clientele during pandemic

Second-order code: Macroeconomic Market Disruption.
The triggering event is the global pandemic that forced change in the market outlook, which has been categorized as external shocks and uncertainties within the market.

Aggregate Dimension: Market Trigger

Trigger Coding Example 2 - Market Trigger

> *"(Rental model) we did the market segmentation, and upon asking potential clients we found that the most promising market wanted that, i.e., The energy-as-a-service model....So that is why we are trying to get the rental phase to work, which is still a small adaptation, but a smaller gap than going for a purchase." - Company K*

Detailed Description: Adopted a revenue model to match customer preferences, ensuring market fit and enabling future growth opportunities.

First-order code: Adopting new revenue model upon customer feedback.

Second-order code: Customer feedback and preference adaptation.
The triggering event is the feedback from customers for a preferred purchase mechanism, which has been categorized as Customer feedback and preference adaptation.

Aggregate Dimension: Market Trigger

Trigger Coding Example 3 - Environmental Laws and Regulatory Triggers

> *"Just this week, there was news about the [International Organization X], which is a global organization. And they have introduced some sustainability goals that will mandate use of [X fuel], you know, help grow the adoption and demand for [X fuel] in the world. So it's good news. These types of sustainability targets from either the sector themselves that increase the demand of [Product X], in this case such as from [international organization] or from governments, the EU or individual countries has helped us a lot with market exploration." - Company N*

Detailed Description: Sustainability goals set by governing organizations in a market boosting company's product penetration in new markets.

First-order code: Increasing product demand due to supportive government sustainability goals.

Second-order code: Environmental and energy policies.
The triggering event is the new policy put in place by regulatory bodies to enhance market adoption of product line that company functions in.

Aggregate Dimension: Environmental Laws and Regulatory Triggers

Trigger Coding Example 4 - Technological Trigger

> *"And in the first year, that was also just me managing it by hand, like by logging in on the screen by a [technology X] and then see what was happening and and then making changes. And I think by April 2019 we were able to remotely operate that [product X] through [technology Y].....So we now have very limited manpower in the team to set up projects because the [product X] makes it really simple and we also have very limited people to maintain the project because the [product X] does most for us and then the customers need really limited airtime with our engineers because they can read about most of it themselves through our platform" - Company G*

Detailed Description: Automated product monitoring and management system with technological advancement to enhance operational efficiency.

First-order code: Automating product operations to boost efficiency with technological advancement.

Second-order code: Technological advancements.
The triggering event is the evolution of technology on an external scale that allows company to make improvements to its product technology.

Aggregate Dimension: Technological Trigger

Trigger Coding Example 5 - Resource and Financial Trigger

> *""We are now in the middle of phase two, where a part of the funding has been achieved and we are working to get full scale [Product X] prototype detail design." - Company T*

Detailed Description: Investment funds used for technological advancement of product.

First-order code: Advancing technology with aid of external investments.

Second-order code: Funding and investment.
External funding access acts as an external trigger that facilitates the development of technology

Aggregate Dimension: Resource and Financial Trigger

This results in following Gioia tree (Refer Fig 6.1), that progresses from refined short quotes to abstract theoretical themes. This methodology allowed systematic interpretation of nuanced mechanisms through which sustainable energy firms are triggered externally. *Note*: Examples of all other second order codes related to the triggers have been mentioned in Appendix A.1.

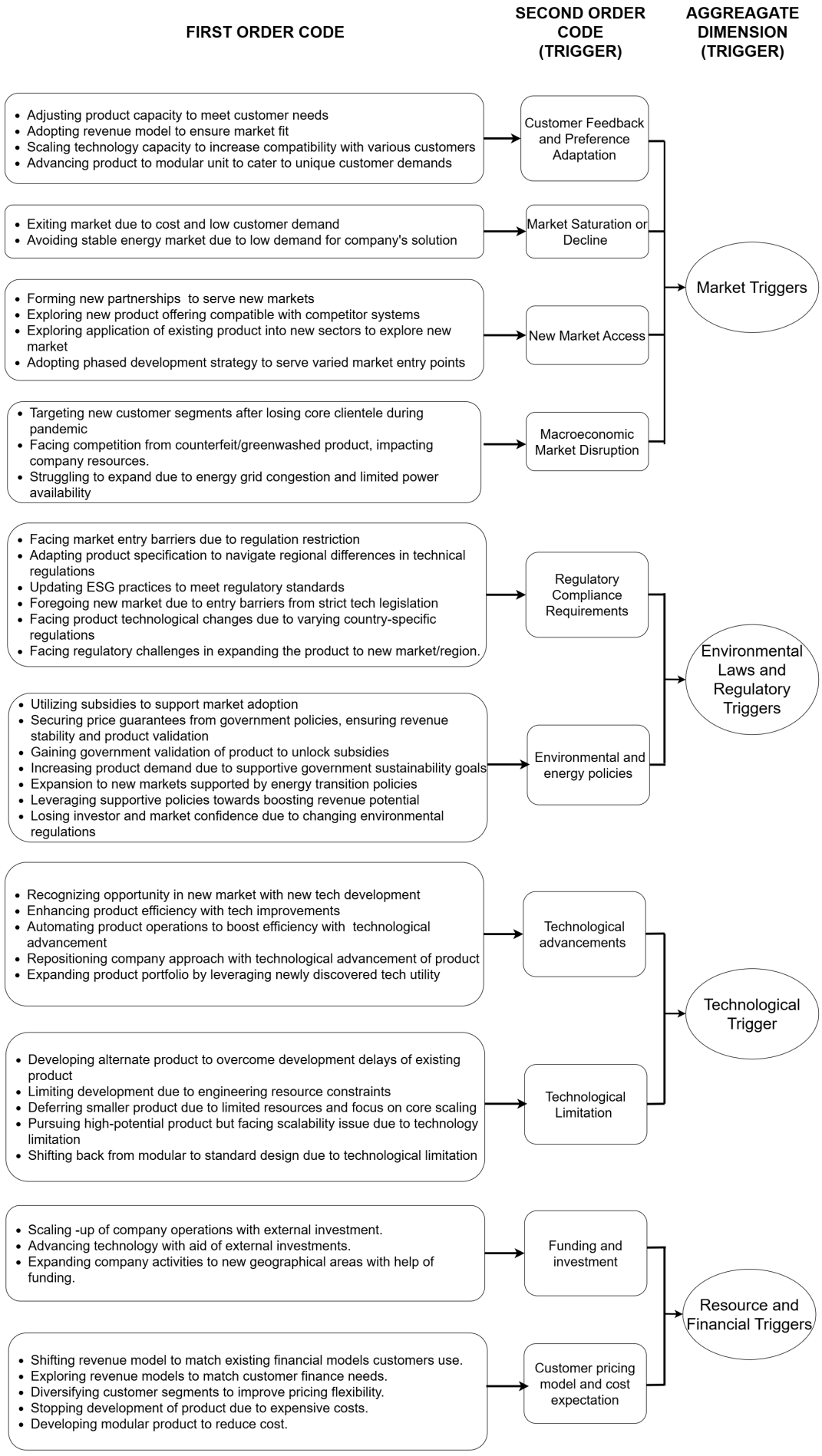

Figure 6.1: Trigger Gioia Tree (*author's interpretation*)

Explanation of Trigger Gioia Tree

The tree follows the structure of moving from granular real-world scenarios of trigger events acting on a company to abstract conceptual groupings via thematic categorization. Following is the explanation of rational behind a code and its significance:

1. **Market Triggers**: This aggregate dimension understands how external market-related triggers induce changes in a company's functioning.
    - **Customer Feedback and Preference Adaptation**: This categorizes how company adjust their business model in response to customer demands, feedback, and preferences.
    - **Market Saturation or Decline**: This code identifies the external situation wherein the need for company's product is declining or if there is low customer demand.
    - **New Market Access**: Accessibility to new market or customer opportunities, encouraging companies to expand partnerships, make product alterations or changed strategies.
    - **Macroeconomic Market Disruption**: The trigger event comprises of disruptions caused by events such as global pandemic (COVID-19), counterfeit products or national grid congestion, resulting in company adapting its working to ensure survival.
2. **Environmental Laws and Regulatory Triggers**: This dimension underscores the impact of regulatory, political and environmental policy events on the functioning of firm.
    - **Regulatory Compliance Requirements**: Categorizes triggers with regards to changes in regulation, environmental laws, and compliance requirements, hampering firm progress compelling them make changes to ensure compliance.
    - **Environmental and Energy Policies**: Contrarily, companies got a boost from supportive government actions - like subsidies, price guarantees, or policies that aligned with sustainability goalswhich made it easier for them to enter the market and prove their products had real value.
3. **Technological Trigger**: The dimension involves external technological changes inducing changes in firm's product offering and business strategies.
    - **Technological Advancements**: This category comprises of external technological advancement in the industry allowing firms to leverage the tech to enhance product efficiency, repositioning strategy or expand value proposition.
    - **Technological Limitations**: This code observes the technological setbacks companies face due to engineering limitations or immature progress of technology, resulting in resulting in delayed product offering or the need to rewire strategies
4. **Resource and Financial Triggers**: These reflect how external investment, financial behavior of market, and other revenue/finance related constraints/opportunities influence company's progress.
    - **Funding and Investment Influence**: This category refers to how external financial grants and investment by external parties like venture capital, angel investing, grants or impact investors, drive company's functioning.
    - **Customer Pricing Model and Cost Expectation**: This theme addresses how companies deal with financial pressure and status-quo from customers/market, pushing them to rethink their revenue model to adapt accordingly.

6.2. Analysis of Pivot

Upon exploring the triggers impacting the sustainable energy-based companies, the following section delves into understanding how these companies adapt their business models in response. This is done by identifying the nature and type of pivots or changes undertaken by companies. The Gioia analysis comprises of raw interview quotes refined into short, well-defined events, capturing the causal relationship - "Trigger X causing Pivot Y", which are used as 'First-Order Codes'. These codes are further categorized into 'Second-Order Codes' or themes, and synthesized into 'Aggregate Dimensions', capturing the core logic. This coding specifically looks at the change/pivots undergone by companies to subsume, adapt

and react to external triggers. Following are examples of how coding was done for observing pivots in business models of sustainable energy firms, and idea of categorization:

Pivot Coding Example 1

> *"That's because the yeah, the like electrification with batteries is going a little faster than legislators can move. And also innovation on battery is going a lot faster than legislators can sort of put in their texts in their drafts. And that's what we now from time to time, find ourselves stuck with.....And so we really closely follow all the developments regarding battery regulations and adjust, because at some point it can really hurt us. "*

Detailed Description: Technological advancements taking place faster than regulatory updates, creating compliance challenges and market uncertainty.

First-order code: Managing compliance risk due to slow rate of regulations formation.

Second-order code: Strategic Realignment of Company Operations.
The pivoting event is adjustment in company's administration and compliance with changing policies to stay relevant, competitive and comply with new policies.

Aggregate Dimension: Company Resource and Financial Pivot

Pivot Coding Example 2

> *"We get requests, but we specifically pick countries that have the same regulation framework... If we want to go to [geographical region X]... we will have to make changes in product. So yes, we explore the markets especially in [geographical region Y] because they are easy to reach and the laws for us to manufacture our product and to be able to operate is the same as the market in the Netherlands."*

Detailed Description: Product and company resources introduced in geographical regions having similar regulatory framework, facilitating product introduction in new markets.

First-order code: Introducing product in regions with aligned regulations.

Second-order code: Strategic Expansion into New Industries & Markets.
The pivoting event is expansion to new market/country, with similar regulatory framework facilitating easy expansion.

Aggregate Dimension: Market-outlook Pivots

Pivot Coding Example 3

> *"When we had the first version of the technology, we would advertise that technology to [Fuel X] producers that produce a certain amount of [Fuel X]. From talking and learning from producers that produce less or more than what we can handle, now we are more flexible. We are working on new versions of our current technology so that we can scale up, we can handle more [Fuel X]. And so these are becoming 2 slightly different products. And these two different products will be in terms of outgoing marketing and how we position ourselves in the market. Those two will also be a little bit different."*

Detailed Description: Modified new product versions to meet identified market need, enabling exposure to new customer types.

First-order code: Scaling technology capacity to increase compatibility with various customers.

Second-order code: Product Modification for Compliance and Customization.
The pivoting event is modification of product offering to cater to new customer needs.

Aggregate Dimension: Product Technological Pivots

This results in following Gioia tree (Refer Figure 6.2), that progresses from refined short quotes to ab-

stract theoretical themes. This methodology allowed systematic interpretation of nuanced mechanisms of pivots undergone in sustainable energy firms. Following is the explanation of the terms of Pivot Gioia Tree. *Note*: Examples of all other second order codes related to the pivots have been mentioned in Appendix A.2.

Explanation of Pivot Gioia Tree Components

1. **Company Resource and Financial Pivot**: With an emphasis on shifting operational structure, partnerships, strategies, or revenue models, this aggregate dimension records a number of changes or pivots in the overall internal functioning of business operations and finances.
    - **Strategic Realignment of Company Operations**: This theme encompasses revising internal company operations to adapt to varying environmental, legal and technological scenarios.
    - **Rebuilding Collaborative Networks**: This observes how firms actively restructure and reform their partnerships, collaborations and networks in ecosystem, to tackle market expansion or technological challenges.
    - **Repositioning Commercialization Strategy**: This relates to how companies toggle their go-to-market strategies and phased development, by repositioning their value offering approach, or refining sales strategy. These changes were driven as a response to changing customer needs, market dynamics, and overall technology advancement.
    - **Revenue Model Diversification and Optimization**: This consists of how companies remodel and refurbish their revenue strategies to make it more flexible, customer-friendly and fit to market's preference.
2. **Product Technological Pivot**: This dimension encapsulates changes or pivots made in the value offering by tapping into new market gaps, incorporating new tech features, expanding offering portfolio or terminating product altogether.
    - **Creating New Technology or Product to Meet Targeted Demands**: This theme comprises of observations where companies tend to develop new products when facing untapped market/customers or solving macroeconomic problems (e.g., pandemic, sustainability and circularity).
    - **Product Line Expansion**: This relates to when companies undergo changes by expanding their product portfolio, for instance to be compatible with competitor's product, or uncovering its application in new arenas.
    - **Product Modification for Compliance and Customization**: Companies have been observed to actively undergo alterations and modifications of their products to adapt to varying regulations across markets, affordability concerns, wide market needs and so on.
    - **Product Termination due to Technical Limitations**: These relate to pivots in company's value offering, wherein the product offering and development was completely eliminated due to limited technology availability, large setbacks from market or expensive costs.
3. **Market Outlook Pivots**: This aggregate dimension relates to how companies pivot their market objective and outlook with evolving business environment, to cater to changing customer demands and new market applications.
    - **Targeting Alternative Customer Segments**: Companies have been observed to revamp their product offering to different customer segments as a response to market saturation or global pandemic.
    - **Strategic Expansion into New Industries and Markets**: These comprise of pivots as proliferation into new industry or area, driven by supportive government policies, budding demand for product from new regions, access to funding and so forth.
    - **Adapting to Shifting Market Adoption**: Companies have been seen to tweak their business processes based on changing adoption behavior from the market, owing to changing sustainability goals, subsidy access, and political uncertainty.

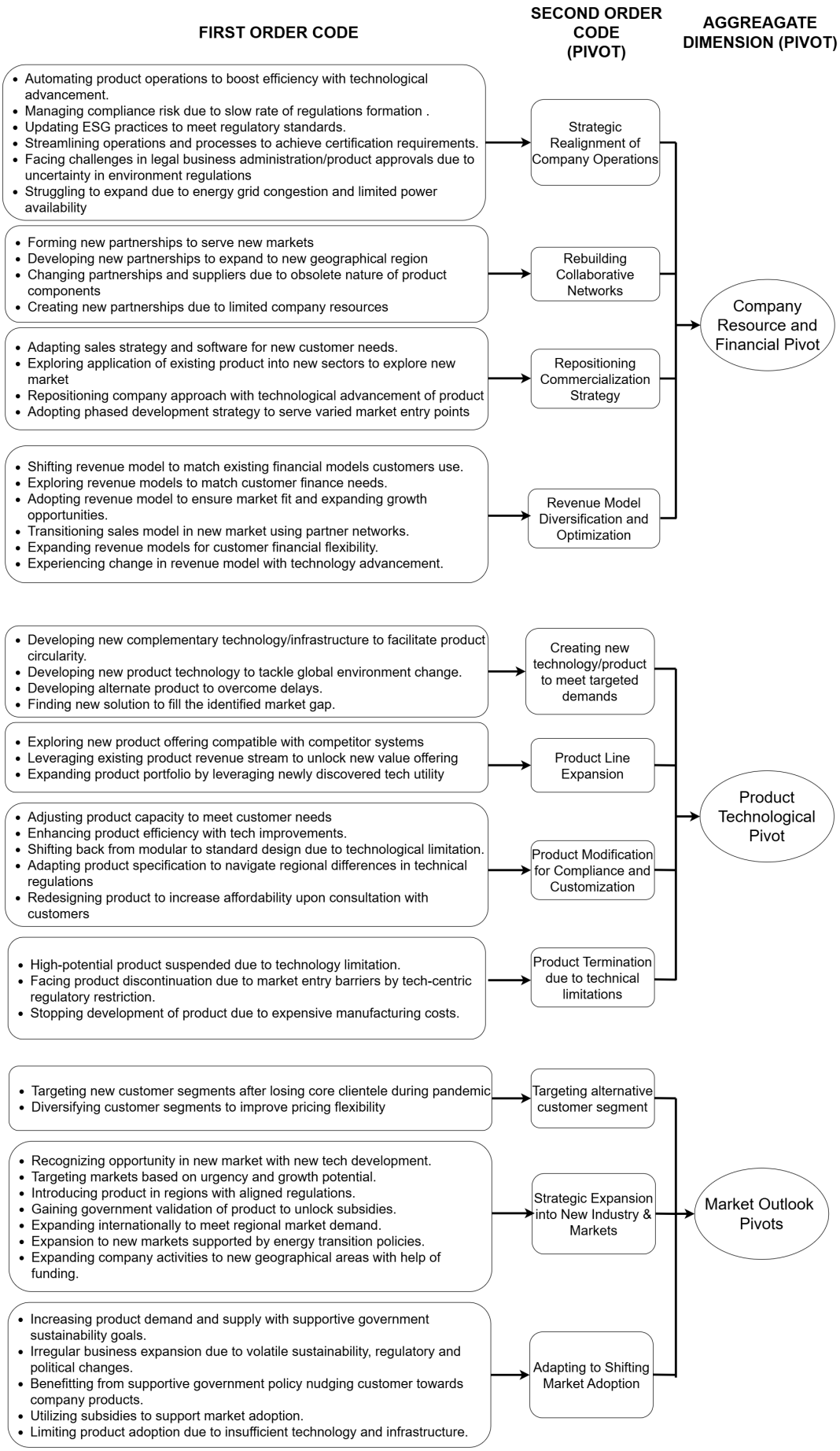

Figure 6.2: Pivot Gioia Tree (*author's interpretation*)

6.3. Analysis of Opportunity and Threat

To further explore how sustainable energy-based firms perceive the external trigger to be a threat or an opportunity, a third layer of analysis was carried out. This focus is based on the understanding that perception plays a critical role in deciding strategic responses within decision makers. The same external factor (such a change in the market or regulations) can be understood differently depending on leadership approach, organizational readiness, and resource availability. Using a structured inductive approach, the Gioia methodology was used. The first phase involved honing the interview quotes and developing a first-order code that gives a sense of the tone, language, and perspective of the interviewee's perception of the trigger. This involved uncovering the emotion behind the statement by closely observing the respondent's behavior and understanding the background of where the answers come from.

Following that, these first-order codes were assigned into 'Second-Order Themes' that combined recurrent themes in the interpretation of these occurrences. Lastly, the broad theoretical categories of perception 'Opportunity' and 'Threat' were reflected in the 'Aggregate Dimensions'. These two unique frames included multiple second-order codes, describing why businesses and decision makers perceived the triggers as beneficial or an adversary.

Opportunity Example 1

> *"....but it was not out of an urgent need that we went for this market. It was more that we see that we can have a more expensive product and a more or higher electricity price In this market, so it aligns with our road map that once we scale up and our costs come down, more markets will unlock and in the end we can scale in more different markets. But for now, it was just A matter of seeing which market has the most urgent need for our product and see which one is willing to pay the highest price for that."*

Detailed Description: Targeted markets based on demand urgency, revenue possibilities, and forecasting scaling opportunities.

First-order code: Market focus on customers willing to pay more.

Second-order code: Untapped Market and Customer Acquisition Opportunities.
Better revenue possibilities in new untapped markets acts as an opportunity for company

Aggregate Dimension: Opportunity

Opportunity Example 2

> *"And in the first year, that was also just me managing it by hand, like by logging in on the screen by a [technology X] and then see what was happening and and then making changes. And I think by April 2019 we were able to remotely operate that [product X] through [technology Y].....So we now have very limited manpower in the team to set up projects because the [product X] makes it really simple and we also have very limited people to maintain the project because the [product X] does most for us and then the customers need really limited airtime with our engineers because they can read about most of it themselves through our platform"*

Detailed Description: Automated product monitoring and management system with technological advancement to enhance operational efficiency.

First-order code: Product automation reduces manpower needs.

Second-order code: Product Innovation Enhances Competitive Advantage
Advancement of external technology posed as an opportunity for company to advance their product and widen the scope of their application, further reducing their reliance on manpower

Aggregate Dimension: Opportunity

Threat Example 1

> *"We have a product that we can market on the evidence of the sustainability we have done, life cycle assessments etc of our product. But we also have to keep abreast of all the changes that are coming in sustainability reporting in ESG reporting. It's surprisingly even for an SME, it's a surprisingly heavy workload.... There is actually quite a workload on sustainability reporting on ESG reporting for the company"*

Detailed Description: Uncertainty in environmental regulations creating challenges in business administration and product approvals.

First-order code: ESG reporting imposes a heavy administrative workload.

Second-order code: Policy, Regulation, and Compliance Constraints.
Constant changes in regulatory mandated ESG reporting poses as a threat to company's operation, where company has to continually stay in touch with regulatory changes and invest resources to keep them updated.

Aggregate Dimension: Threat

Threat Example 2

> *"What's also has been more critical for us is also actually energy availability, because especially in the Netherlands, that when we've been looking for sites for our plants, there's an extreme restriction on the grid in terms of energy availability, so that is, that's also very crucial for us, as the ability to be able to make that expansion. And that is very restricted for us at this moment in time."*

Detailed Description: Energy grid congestion and limited energy availability thwarting expansion of company operations to larger locations.

First-order code: Limited grid capacity restricts company infrastructure expansion.

Second-order code: Macroeconomic Uncertainty.
Grid congestion in the country poses as a major threat to company's infrastructural expansion plans.

Aggregate Dimension: Threat

Note: Examples of all other second-order codes related to the opportunity and threat have been mentioned in Appendix A.3.

Explanation of Opportunity-Threat Gioia Tree Components

1. **Perceiving Trigger as 'Opportunity'**: Triggers were presented as facilitators of strategic growth, innovation, or market expansion by companies that saw them as opportunities. Startups and scaleups that showed flexibility, external funding support, and a proactive approach to managing systemic changes shared these views.
    - **Untapped Market and Customer Acquisition Opportunities**: This theme reflects a market-expansion viewpoint and explores how companies perceived customer behavior changes, access to new geographical regions, and new application of product as an opportunity to expand.
    - **External Funding Supports Company Expansion**: This theme observes how company perceive funding from external parties - that help expand their market, product and resources - as opportunity.
    - **Product Innovation Enhances Competitive Advantage**: Companies identified opportunity via means of innovation in their product that allowed them to gain competitive advantage.
    - **Government Regulatory Support Enabling Market Expansion and Adoption**: This theme observes how companies benefit from government policies such as mandates that expand market opportunities, provide subsidies for product development/market adoption, or grants for product development, acting as opportunity that support company's business.

2. **Perceiving Trigger as 'Threat'**: On the other hand, companies also perceive external triggers as threat or adversaries that can act as a hurdle to their plans, strategies and business operations.
    - **Technological and Operational Limitations**: The theme poses as market innovation-readiness gap, that observes lack of advancement in external technological and operational environment - such as, no recycling process for company's product in market - as a hurdle to company's growth.
    - **Macroeconomic Uncertainty**: This includes how uncertain and unpredictable market forces and systemic shocks - such as pandemic, counterfeit products, energy congestion - act as threats to company's sustenance.
    - **Market Demand Misalignment**: Companies view mismatch in their product and customer's requirement as a threat to further development, forcing them to pivot to ensure survival.
    - **Policy, Regulation, and Compliance Constraints**: While some policies are observed as opportunities, there are also policies and regulations that act as threat to company's expansion or operation. For instance, mandates on certain technological requirements for a country/market, extensive certification requiring unnecessary resources, slow speed of regulation development and so forth.

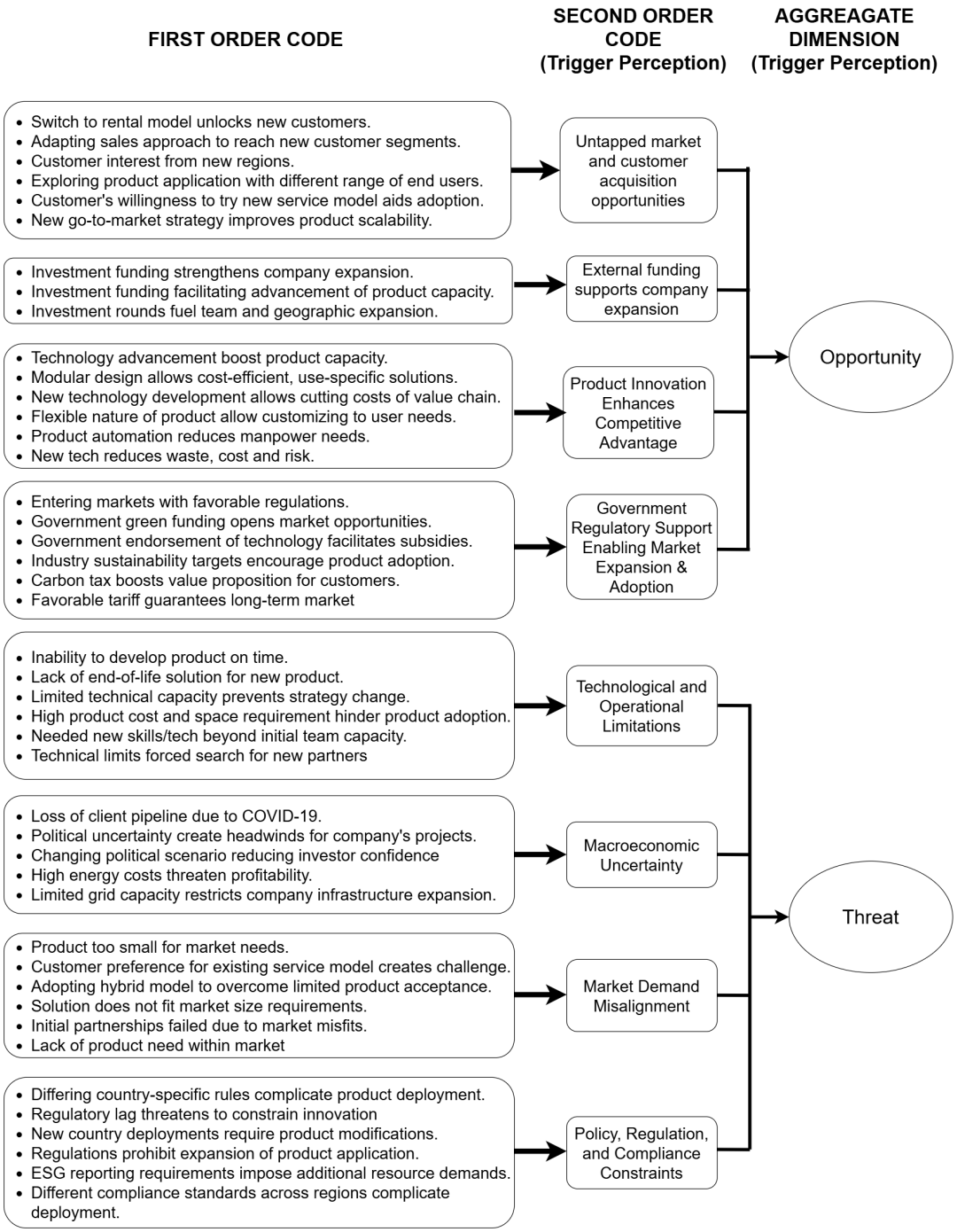

Figure 6.3: Opportunity-Threat Gioia Tree (*author's interpretation*)

6.4. Business Model Innovation (BMI) and Adaptation (BMA)

Upon exploring the external triggers impacting the sustainable energy companies, how they were perceived by decision makers as 'opportunity' or 'threat', and subsequent pivoting action undertaken in response, the fourth analysis focuses on understanding whether the changes in business models of companies were 'Innovation' towards something novel or 'Adaptation' of existing product or processes. Using an inductive approach, Gioia methodology was used, which involved systematically categorizing and interpreting the data using three-step coding process as described in the previous analysis. The process involved understanding the nature of BM change in companies, and deciphering by understanding the

contextual information. Following are examples of how coding was done for capturing the changes and classifying them as innovation or adaptation.

Business Model Adaptation - Example 1

> *"And then at some point, they (engineers) were just simply able to increase the capacity from [Capacity X] to [Capacity Y]. But like technologically, the machine is exactly the same. It's just only that the [Product X] architecture changed a bit, which meant that we grouped more energy into [Product X]" - Company G*

Detailed Description: Enhanced product capacity with technological improvements, increasing efficiency and value within existing design.

First-order code: Enhancing product efficiency with tech improvements.

Second-order code:Incremental product refinement.
Evolution of technology allowed company to adapt its product offering by increasing the capacity while keeping the core machine technology unchanged.

Aggregate Dimension: Business Model Adaptation

Business Model Adaptation - Example 2

> *"So the [Policy X], its more or less a tax on fossil fuels that'll be entered I think in 2027 or 2028 and that will give a tax on fossil fuel use. When you enter that into your business model for your customer you say, well, now you have a gas production site, and we will go to partly electrification, you will not only save gas, That $0.68 per cubic meter, but you will also save $0.10 of taxes and that will spike towards $0.40 in 2031. So that really changed our revenue or savings and thats part of what we sell to our customer now." -Company B*

Detailed Description: Government policies positively supporting company's product towards better revenue possibilities.

First-order code: Leveraging supportive policies towards boosting revenue potential.

Second-order code: Adjusting company operations and partnerships.
New regulations allows company to achieve new revenue possibilities by tweaking its strategies and jump onto the bandwagon.

Aggregate Dimension: Business Model Adaptation

Business Model Innovation - Example 1

> *"We reduce the long lived [Waste X] so that there's less [waste X] on the planet. It's saved by design because it's using a different principle, as a consequence, we can construct in a significantly cheaper way." - Company T*

Detailed Description: Launched new product technology to tackle global environmental problem with focus on reusing resources helping reduce cost.

First-order code: Launching new technology to tackle global environmental problem.

Second-order code: Creating Novel Product Offerings.
Company innovated a new technology to curb accumulation of hazardous waste [X]

Aggregate Dimension: Business Model Innovation

Business Model Innovation - Example 2

"....with these technological changes, we are at the point of relaunching or repositioning our company. So, we've done it within the company, but now we're going to go to the outside and tell who we are, what we do" - Company B

Detailed Description: Transformation of product's technology and value offering causing repositioning of company in the market.

First-order code:Repositioning company approach with technological advancement of product.

Second-order code: Strategic Market Repositioning.
Innovation of technology and development of novel product facilitated the company to reorient and reposition their business model to new ways

Aggregate Dimension: Business Model Innovation

Note: Examples of all other second-order codes related to innovation and adaptation have been mentioned in Appendix A.4.

Explanation of BMI-BMA Gioia Tree components

1. **Business Model Adaptation**: This aggregate dimension comprises of changes in BM of companies that adjust, refine, optimize or modify the products, processes, services or strategies to align better with changing business environment scenarios. They are incremental in nature, and build on existing competencies.
    - **Adjusting Company Operations and Partnerships**: This theme involves adjustment of internal company processes or restructuring partnerships to enhance their flexibility and efficiency, without significantly altering their core identity and processes. Includes situations such as enlarging company operations, handling risk with regulations, adjusting operations to handle more customer demand and so forth.
    - **Incremental Product Refinement**: This theme comprises of situation where firms make incremental adjustments to their value offering, such as increasing capacity, enhancing efficiency, toggling technical properties etc.
    - **Realigning Target Markets**: This focuses on customer and market focused adjustments, reflecting demand-side optimization, and include situations such as targeting subsidy-backed markets, accessing specific geographical location, exiting certain market and so forth.
    - **Regulatory Driven Model Adjustments**: This theme comprises of situation wherein companies tweak their business model to comply with regulations such as updating their ESG reporting or administrative challenges.
2. **Business Model Innovation**: This aggregate dimension captures fundamental changes in BM of companies via means of technological breakthroughs, strategic repositioning or innovating new ways of capturing revenue. Involves following second order themes:
    - **Creating Novel Product Offering**: Companies develop completely new products or services that disrupt the market by filling market gap, redesigning completely novel product, or finding new solutions.
    - **Strategic Market Repositioning**: This comprises of situations wherein firms recognized conditions to fundamentally alter their market approach, positioning and identity, facilitated by evolution of technology, updates in regulations or entrepreneurial insight.
    - **Transforming Revenue Capture Mechanisms**: This theme captures scenario wherein companies completely overhauled their existing means of gaining value from the market by innovating new revenue models, such as energy-as-a-service, subscription based services, leasing model, financial partnerships and so forth.

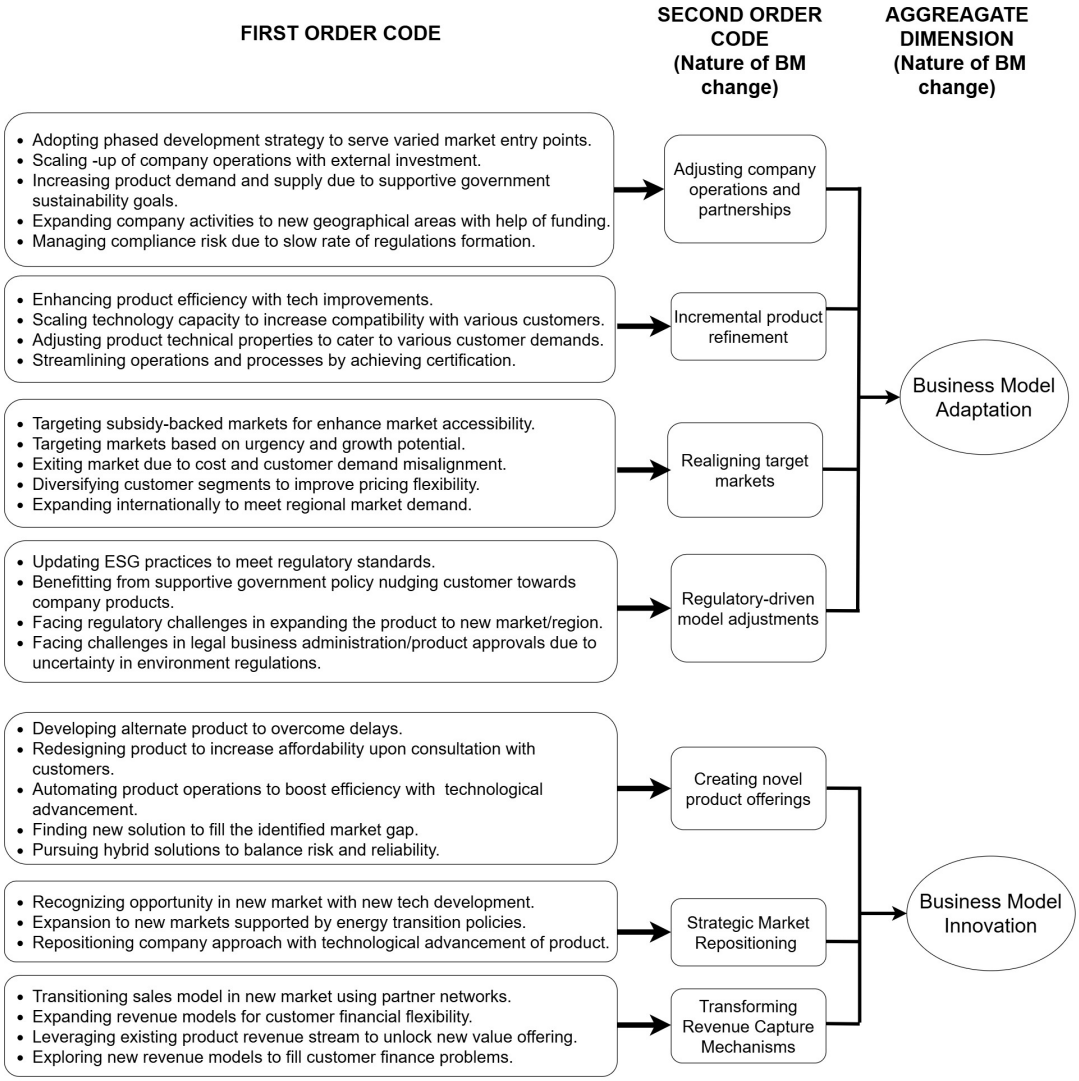

Figure 6.4: BMI-BMA Gioia Tree (*author's interpretation*)

6.5. Not Act situations

This sections observes the data wherein, companies, upon external impact chose 'Not to Pivot' or 'Not Act' on those instincts. Of the 74 external trigger observations, only following instances were found to be 'Not Act'. Due to less information available, no generalizations or analysis could be conducted.

No pivot due to limited resource capacity

> *"So, a very clear example I can give you is actually I get a lot of requests for an even smaller system. So, [Y capacity], and right now we are not engaging with them. So, I keep track of them and it's my responsibility to map it to understand if there's a business case for us to make some smaller systems of [Y capacity]. But we are not actively pursuing because it distracts us from building something towards [X capacity]. And what it would require is for us to go to back to our partners who have made something for [X capacity] to ask them to make something for [Y capacity]. So we would have to redesign a full new product and right now that doesn't fit because we have only the engineering capacity to build 1 product."*
> *- Company K*

Observation: Company receives preference for a particular product from customers, however, doesn't undergo pivot or change, due to limited engineering capacity, i.e., resources.

No pivot due to confidence in product's future application

> *".... and the [policy X] pushing [solution X] definitely made us think. It somehow felt like pressure on us to adjust. We did try, whether do we try to realign what we offer to fit the new direction. But it just didn't feel right. Our focus has always been on addressing [solution Y], and changing our approach just to match policy would've taken us off our goal. So we decided to avoid. It was bit of a risk, but were still confident in the space were operating in right now" - Company K*

Observation: Company faces pressure from changes in policy that could impact their value offering, however decides to not pivot given their confidence in technology and its future.

No pivot due to low market demand

> *"Yeah, when the gas prices shot up across Europe, a lot of companies started looking into expanding to new markets like, where could they step in and help with the energy shortage, or where demand might spike. [Country X] has a lot of [Energy X], so they don't have less problems with electricity than we have here in Holland or in [Country Y]. So, we said, OK, that will not be a focus country for us, because they don't need us. We just thought, you know, lets stick to where the need is real, no point chasing something that isnt there." - Company B*

Observation: Energy crisis caused by geopolitical instability across regions urges company to diversify to newer markets where there might be a need for company's product. However, lack of market demand in [Country X] prevents company from expanding to that region.

No pivot due to stringent regulations and product-market misalignment

> *"At some point, there was a lot of buzz around offshore, people were asking, like, hey, can't you guys do something in that space, especially with all the new offshore wind plans and targets. Yeah, usually we had to and we tried a lot and we also found that there's some places that the model just doesn't work. Because the scale of power is uncompared to what we do it bigger or smaller. Certain sectors were just not there to, to even look into this, and there's also sectors with like super, super strong legislation like offshore where our product just wasn't diaper proof for to like be put on the ship and then sail into the North Sea. So yeah, we didnt go there, it just didnt fit." - Company G*

Observation: Stringent regulations and mismatch between product and market needs, restricted company from following a market, resulting in no pivoting action undertaken.

No pivot due to extensive compliance needs

> *"Yes, so lately theres been all these subsidies coming up, like, if you tweak your tech a bit or add some specific feature, you might qualify. And yeah, we looked at it, but... So we don't have, we don't change our product to be eligible for new, for new types of subsidies. So there's no pivot for us there because we feel that we are confident. That that the core of the product is already good enough for most subsidies that we would like to aim for. So yeah, we're not really building around the subsidy rules. We're just doing what we do." - Company K*

Observation: Despite shifting subsidy regulations, company purposely avoids adjusting their value offering to fit better with changing subsidy requirements. They believe that the core product offering meets criteria for relevant subsidies they currently are aiming for, hence no need to change.

No pivot due to extensive compliance requirements

> *"Well we did think about going into those bigger [Market X], but, I mean, the rules there are just like, like a lot. Like, everything's gotta be certified, fixed down properly, super official. And that's just not really how our system works, its more like quick and flexible...we ended up realising maybe that space's not for us." - Company G*

Observation: Company avoids venturing into a potential market due to stringent regulations.

6.6. Cross-Tabulations of Variables and Results

Sustainable energy startups function in environments bound with constant external triggers - such as changes in market scenario, regulations, technology or finances. To conquer these external impacts, the firms are forced to adjust their processes, strategies and product to comply with changing scenarios. Hence, to understand the implication of these triggers on business models of Dutch sustainable energy startups and scaleups, we explore what factors made companies perceive the trigger as an opportunity or threat. Followed by, which BM element was primarily impacted by these triggers and what type of pivoting action did the company undergo to absorb the impact. This gave way to understanding which BM element was secondarily impacted and what type of innovation or adaptation did the company undergo. As explained in previous sections, we analyzed using Gioia Methodology, the type of triggers companies face, followed by their perception of trigger as opportunity or threat, their subsequent pivoting actions undertaken and its nature (Business Model Innovation or Business Model Adaptation). During analysis, we observe 74 trigger events across 6 interviews that forms the dataset for our results.

6.6.1. Frequency Observation

External Triggers and Frequency

As observed in Section 6.1, the triggers were categorized into 4 groups, namely, - 'Market Tiggers', 'Environmental Laws and Regulatory Triggers', 'Technological Trigger', 'Resource and Financial Trigger'. Market triggers (such as access to new markets, customer feedback, market decline) and environmental/regulatory triggers (such as regulatory compliance and environmental policies) were both most commonly observed, i.e., each 22 out of 74 instances. This was followed by triggers associated with technology (such as technological advancement and limitations in industry) - with 19 out of 74 instances. Triggers related to company resource, revenue models and external finances were observed to be comparatively less at 11 out of 74 cases.

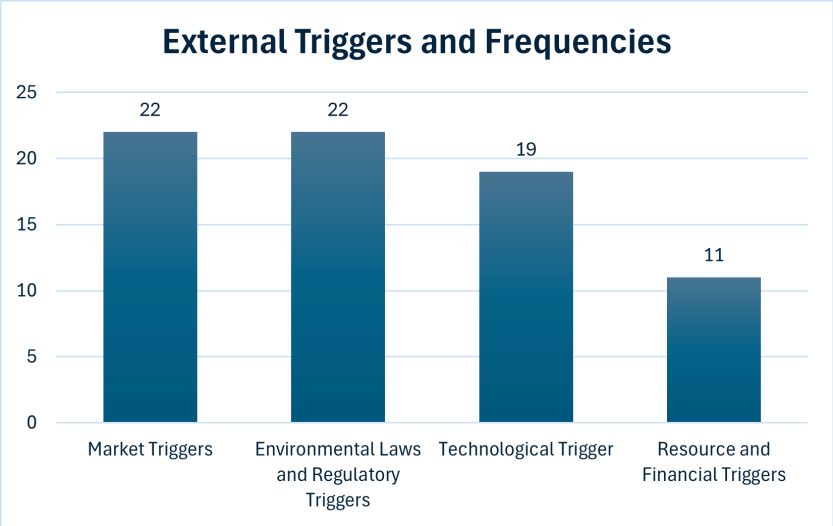

Figure 6.5: Observation of External Triggers and their Frequencies

In terms of second order codes, the following triggers had the highest occurance - 'Environmental and energy policies' (11 instances), 'Regulatory compliance requirements' (11 instances), 'Technological Limitation' (10 instances), 'New Market Access' (9 instances). The insinuates the fact that companies need to closely monitor environmental and regulatory policy changes to stay relevant and deeply understand their position in the market. All the firms were observed to face direct impact of fickle policies, while some supportive, others had a negative impact. Further, these policies had significant impact on the market accessibility and technology advancement/modification, implying company's need to explore the deeper implication of regulatory changes on their activity and integrate their future directives in parallel to policy developments. Given how sustainable energy firms function in hi-tech environments, the triggers faced by companies with regards to technological limitations were also pretty high.

Business Model Elements Impacted and Frequency

Upon observing the triggers impacting the BM of sustainable energy based firms, it was observed that out of 4 BM elements that we consider for our study - Value Proposition (VP), Value Creation (VP), Value Delivery (VD), Value Capture (VCA) - few of them were more impacted than others. According to our data, the Value Proposition (VP) was most impacted primarily (27 out of 74 instances), indicating the fact that most of the triggers are directed towards company's value offering, compelling firms to innovate and modify their core value offering. Next, Value Delivery (VD) was observed to be impacted in 21 out of 74 instances, i.e., effect of the trigger on how company delivers its value to customers, markets and their relationships. This was followed by Value Creation at 17 out of 74 instances, i.e., impacting the way business operations, strategy and resources function, and Value Capture at 9 out of 74 instances (least primarily impact) - effecting the cost structure and revenue model.

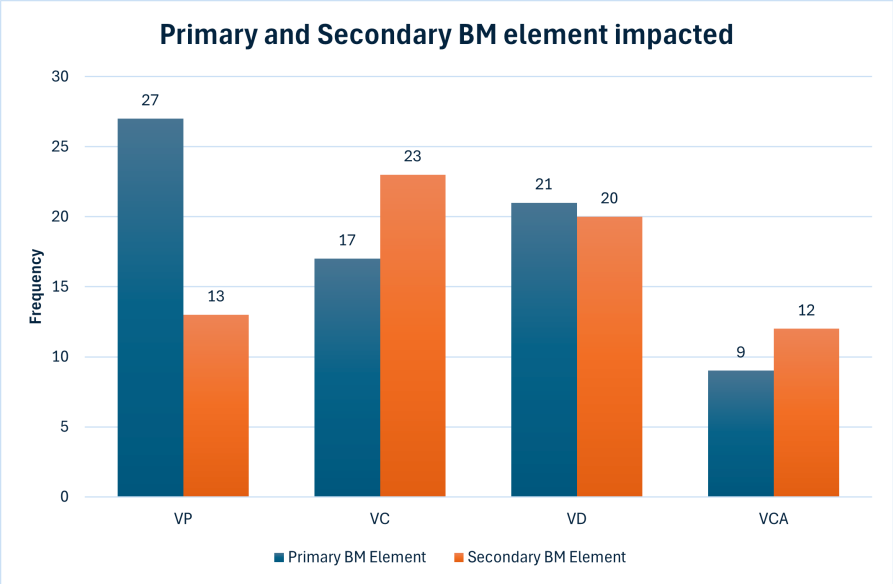

Figure 6.6: Primary & Secondary element comparison

However, observing the secondary BM element impact, we see that Value Creation (VC) was most impacted (23 instances), showing that companies need to absorb these external impacts in their internal functioning and strategies. For example, when a company undergoes technological changes in its product as a result of a trigger, it forces the company to modify its operations and resources to cater to those changes. This was followed by Value Delivery (VD) (20 instances) - implicating the need for companies to realign their market outlook in face of external impacts. Impact on Value Proposition (VP) and Value Capture (VCA) was observed to be the least at 13 and 12 instances respectively. As a result, observation finds that triggers prominently impact the Value Proposition (VP), i.e., what value company offers, followed by who they offer it to. To accommodate these impacts, companies need to direct inwards and realign their strategies and operations and revise their market outlook. Figure 6.7 shows the snowball/cascading effect of impact of business model element from 'X' to 'Y'.

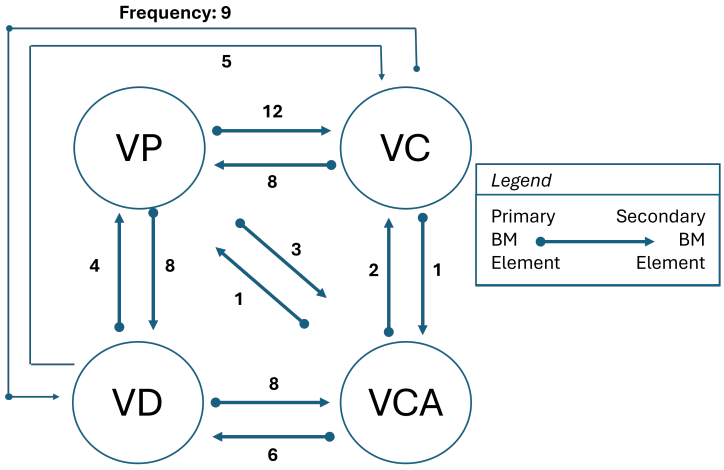

Figure 6.7: Cascading effect across BM elements and their frequencies

The insight shows that BM elements are interconnected, where a pivot associates with multiple other elements getting impacted in tandem. This cascading effect of one element on another, accentuates the systemic nature of business models.

Pivots and Frequency

As described in Section 6.2, the pivot actions were categorized into 3 main aggregate dimension, i.e., 'Company Resource and Financial Pivots' ,'Product Technological Pivot' and 'Market Outlook Pivots'. Pivots in company's resources and financing strategies was observed to be the most (26 cases out of 68), showing that firm's primary mode of reaction is by changing its internal operations, capabilities and revenue schemes. This was followed by pivots in company's technology offering - such as developing new technology, modifying product or terminating development- (24 out of 68 cases). Pivots associated with change in market and customer segments were observed to be slightly less as compared to other two, however still a considerable amount - 18 cases out of 68. The dataset also observes 6 instances wherein no pivot actions were taken by companies in response to triggers, as a result of deliberately resisting due to confidence, unwillingness or restrictions.

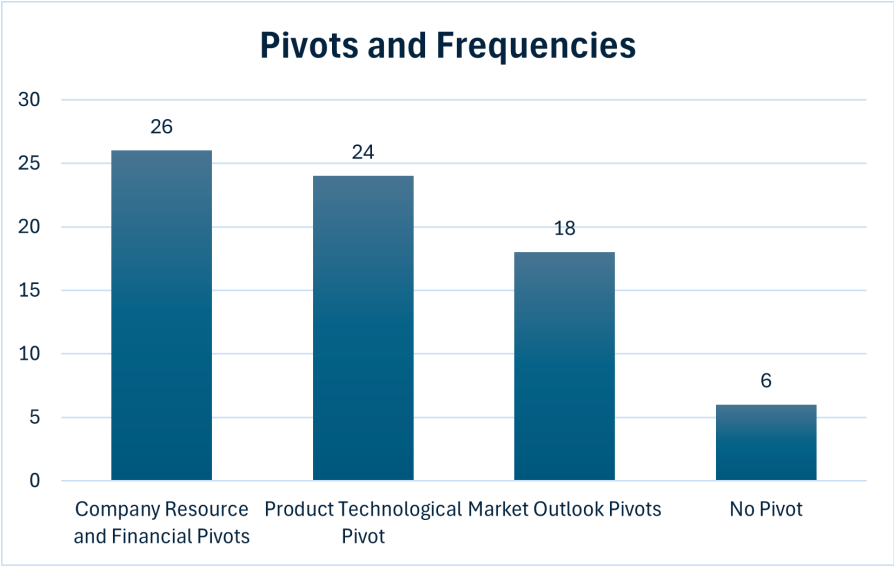

Figure 6.8: Observation of Pivots undergone and their Frequency

Delving a bit into fine grained insights, the second-order pivot - 'Product Modification for Compliance

and Customization' was observed to be highly recurring (10 cases out of 68), showing that companies often adapted their value offerings to meet customer or regulatory demand, pin-pointing the need for companies to be agile in their product development. Followed by companies restructuring their operations and diversifying their revenue model to fit better with market/customer requirements - 'Strategic Realignment of Company Operations' and 'Revenue Model Diversification and Optimization' (8 cases each out of 68).

Opportunity/Threat - Frequency

As described in Section 6.3 , the triggers were categorized into two sections, namely, 'Opportunity' and 'Threats', as a means of how they were perceived. Out of total 74 instances, 'Opportunity' was more frequently observed at 43 cases, i.e., 58%. 'Threat' on the other hand was observed in 30 cases (41%).

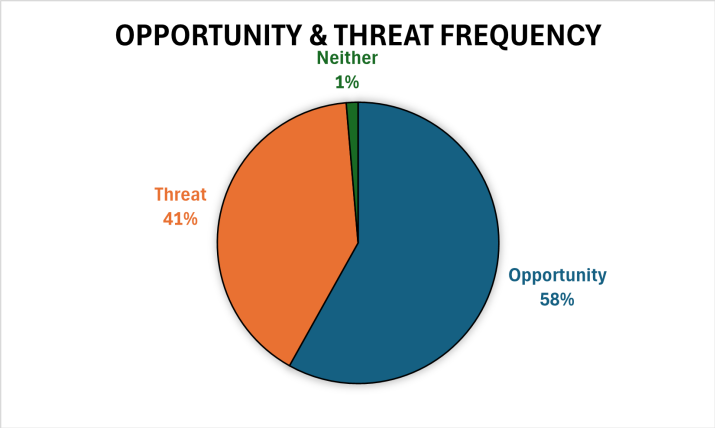

Figure 6.9: Opportunity and Threat Frequency

Business Model Innovation and Business Model Adaptation - Frequency

As explained in **Section 6.4**, the changes in business model as a response to the trigger were classified into two categories, i.e., Business model Innovation (BMI)' and 'Business Model Adaptation (BMA)'. There were also instances when the triggers did not cause any pivots or changes in the business model of the companies. These were categorized as 'Neither'. BMA was most frequently observed at 43 cases out of 74 instances (57%). On the other hand, BMI was observed in 25 out of 74 instances (34%). This was followed by 6 cases of no changes (8%). This reflects that startups more often lean towards incremental adjustments and improvements of their products and business processes to stay resilient and competitive. A substantial amount of BM innovation undergone by Dutch sustainable energy tech startups/scaleups also further put forth the insight that companies are increasingly overturning external impacts as a launchpad for innovation.

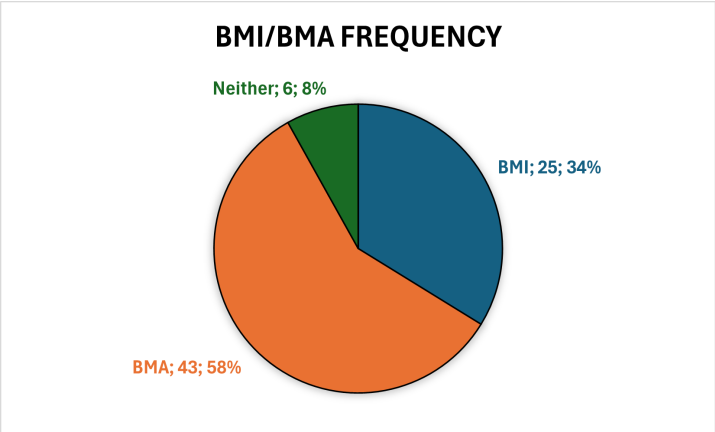

Figure 6.10: BMI/BMA Frequency

6.6.2. Cross Tabulation

Observation of relation between Trigger x Primary Business Model Element Impacted

This section explores relation between a trigger type and which BM element it primarily impacted most prominently, helping us observe patterns. Following are some statistical observations that we found for each trigger type:

- **Technological Triggers** primarily impacted the **Value Proposition (14 out of 19 instances)**, implying that changes in technological scenario of a company, whether advancement or limitation, forces company to rethink their value offering - for instance, developing a new technology, modifying existing product for better market fit, or product termination.
- **Market Triggers** in majority of cases impacted the **Value Delivery (VD)** primarily (10 out of 22 cases) - such as access to new markets and accommodating customer feedback - followed by Value Proposition (6 cases out of 22), hinting at the fact that changes in market conditions often urge companies to question their product offering.
- **Environmental Law and Regulatory triggers** most prominently affected the **Value Creation (VC)** of BM (9 out of 22 cases), showing that fickle policies in the sustainable energy sector affect the core functioning and operations of the company, prompting companies to restructure their strategies, resources and partnerships.
- With **Financial Triggers** such as access to external funding, and customer pricing expectation, companies notably see an impact on **Value Capture (VCA)** (5 cases out of 11), resulting in company having to rethink their revenue models to cater better to customer's preference.

Table 6.1: Cross Tabulation: External Trigger x Primary Business Model Element Impacted

Trigger (Aggregate)	VP	VC	VD	VCA
Market Triggers	6	4	**10**	2
Environmental Laws and Regulatory Triggers	5	**9**	6	2
Technological Trigger	**14**	3	2	0
Resource and Financial Trigger	2	3	1	**5**

Observation of external triggers and their perception

The following graph 6.11 shows how each second order theme of external trigger was observed to be an opportunity or threat. Some triggers are completely considered to be a threat, while some are observed to be completely an opportunity with few having mixed results (often skewed towards opportunity).

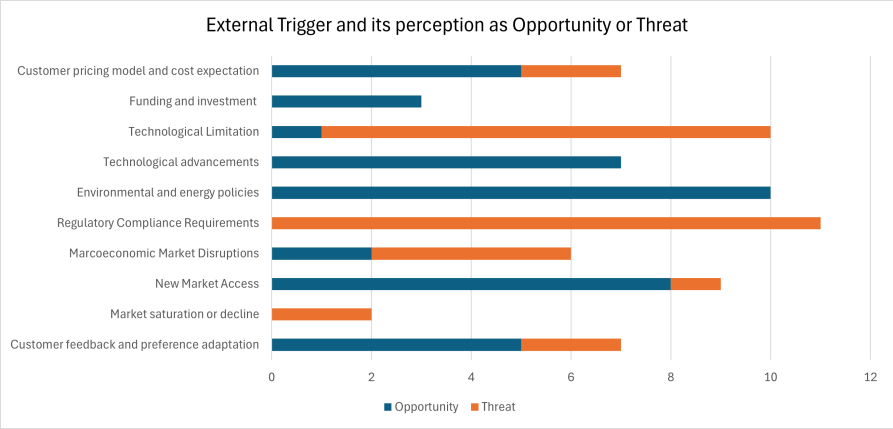

Figure 6.11: External Trigger and its Perception

Observation of relation between Trigger (aggregate) x Pivot (aggregate)

This tabulation explores relation between external trigger type (aggregate) and subsequent pivot (aggregate) action undertaken.

- **Market Triggers** such as changed customer preference or market opportunities, prominently influenced changes in company resources (9 out of 21 instances) - such as changing strategies, developing partnerships, tweaking operations - and alteration in product's technology (8 out of 21 instances), i.e., new product development, modification of existing product or termination of product. This aligns well with lean startup ideology where customer/market feedback loops drive product and process iteration.
- **Resource and Financial Triggers** such as funding investment from external parties or existing state of pricing model in market, dominantly resulted in restructuring of company's resources (5 out of 11 instances) and also product's technological development (4 out of 11 instances).
- **Technological trigger** such as evolution or limitation of technological progress in the market, dominantly observed companies tweaking their product technology to stay in line (8 out of 16 instances). Hence supporting the idea of technology-push innovation (Hötte, 2023), where advancement of broader technology promotes product development and aligning resources.
- Impacts from **environmental laws and regulations**, prominently facilitated the way company approached the market (10 out of 20 instances), such as changing core customer type or entry into new markets and industries.

Table 6.2: Observation between external trigger and corresponding pivot action undertaken in response by companies

	Product Technological Pivot	Market Outlook Pivot	Company Resource and Financial Pivots
Market Trigger	8	4	**9**
Resource and Financial Trigger	4	2	**5**
Technological Trigger	**8**	2	6
Environmental Laws and Regulatory Trigger	4	**10**	6

Observation of relation between Opportunity/Threat x BMI/BMA

This tabulation explores relation between how triggers are perceived by the company, i.e., as an opportunity or a threat, and the corresponding response in terms of changes in business model, i.e., BM Innovation (BMI) or BM adaptation (BMA).

Table 6.3: Observation between trigger perception (opportunity/threat) and business model change (innovation/adaptation)

Perception	BMI	BMA	Neither	Total
Opportunity	20	22	1	43
Threat	5	20	5	30

As evidently observed, companies have a skewed preference to adapt their business models rather than indulge in innovation when faced with a trigger perceived as threat. This suggests that firms are not willing to undergo high-risk change when under pressure or uncertainty, and prefer to engage in defensive manner with incremental changes to their processes, for instance, product modification, reducing cost, changing suppliers. This structures well with behavioral theories like the 'Threat-Rigidity theory' (Staw et al., 1981), where it has been found that threats elicit risk-averse behavior in decision makers that prefer small adaptations or adjustments over radical changes.

On the contrary, companies are equally divided between innovation and adaptation when they view triggers as opportunity. 20 out of 43 cases of opportunity observed companies indulging in innovation - e.g., creating new technology, innovating pricing model - whereas 22 cases observed incremental adaptations in business model. This shows that while some firms were bold to grab on to opportunity and innovate, there were also instances of companies undergoing minor adjustments in equal proportions.

Observation of relation between Primary BM Element Impacted x BMI/BMA

Drilling a bit deeper into effect of an external trigger on certain business model element (primary) and observing whether the pivot is a BM Innovation or BM adaptation, we find relation between BMI/BMA and primary BM element impacted. In following Table 6.4, we see that BMA is more frequently associated with impacts on Value Creation (17 cases out of 42) and Value Delivery (13 cases out of 42), implying the fact that adaptation is prominently directed towards operational strategy of companies, and is reactive and process-focused, i.e., impacts the "how". Whereas, on the other hand, BMI is heavily skewed towards impact on Value Proposition (13 cases out of 25) showcasing its proactive and value offering focused nature, i.e., impacts the "what".

Table 6.4: Observing patterns between primary BM element impacted and subsequent nature of changes in BM (BMI/BMA)

	VP	**VC**	**VD**	**VCA**
BMI	**13**	2	4	6
BMA	10	**17**	13	2

6.7. Improved Conceptual Framework

Upon conducting the interviews, reviewing case studies of company's experiences with external triggers and cross analysing the information across all 6 Dutch Sustainable energy context, in this section, we improve the conceptual framework proposed in Chapter 4. The improved conceptual framework identifies changes from the previous version, in the sense of identifying the changes in primary BM element section. Basing the changes on logical reasoning from interview results, the new framework aims to provide a more robust and empirically and theoretically backed concept.

The initial model layed out the fundamental process of linking external trigger to changes in business model, i.e., pivot (Refer Figure 4.4). The process started with cognitively identifying a external trigger to be an opportunity or threat, followed by understanding the impact of the trigger on certain business model element. However, our analysis of interview experiences suggests that decision makers evaluate the external trigger to be an opportunity or a threat only when it tangibly impacts the BM or is being perceived as such. If the external trigger in no way is being perceived as impacting the business model element, the triggers are not deemed relevant to be considered for cognitive recognition as 'opportunity' or 'threat' and subsequent pivoting. To visualize this observation, the updated conceptual model swaps the positioning of 'opportunity' and 'threat' with 'Primary BM element impacted'. In addition, an extra element is added in 'Primary BM element impacted' section, i.e., 'No BM element impacted' - to showcase the irrelevance of external trigger to company's functioning, resulting in no institution of pivots or business model change. This can also be a result of human error or bias, where the decision maker deliberately might choose to ignore the influence of external trigger on their BM, or oversee its presence (Refer Figure 6.12 for improved framework).

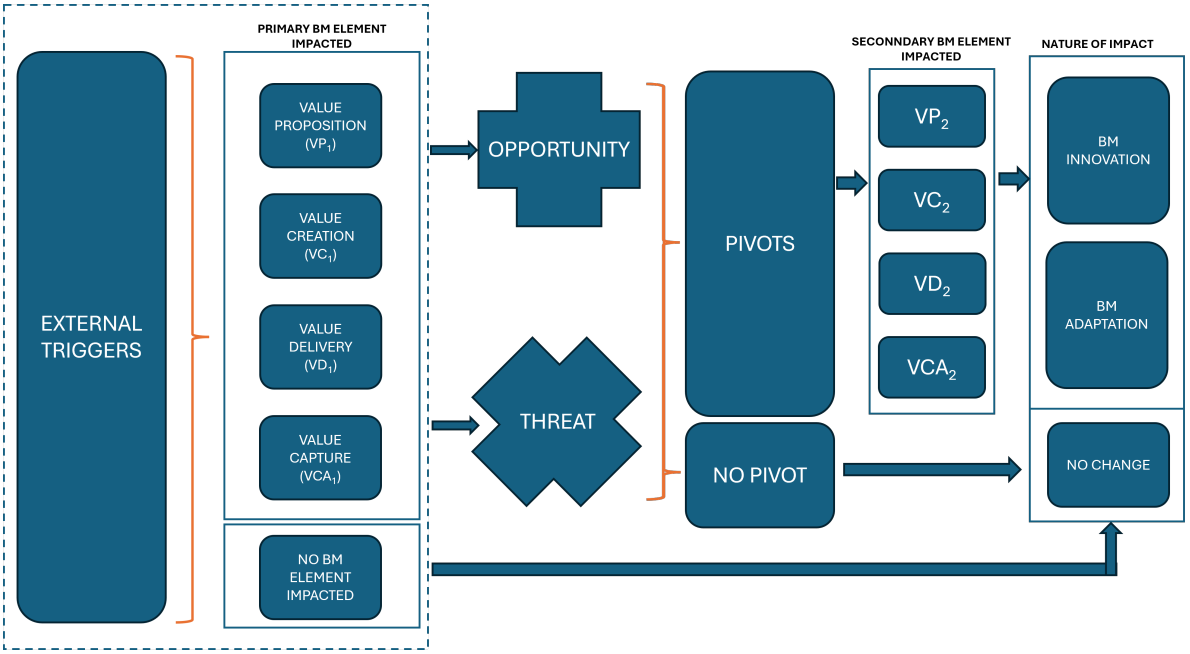

Figure 6.12: Improved Conceptual framework based on empirical and theoretical study (*author's interpretation*)

The sections 'External Triggers' and 'Primary BM element impacted' are further grouped together using dotted box. This showcases the fact that when decision makers cognitively identify the external trigger to be an 'opportunity' or a 'threat', they evaluate not in isolation but from contextual perspectives. This implies that they take into account both the trigger as well as its corresponding effect on firm's business model to identify the phenomena to be an adversary or opportunity. This line of thought aligns well with Osiyevskyy and Dewald (2015)'s observation, that proves that "strategic decisions are influenced by other stimuli (such as threat, urgency, lack of satisfaction with current performance, or prior experience of implementing risky decisions), besides perceived opportunity". This also corresponds to Kirtley and O'Mahony (2023)'s pivot centric strategic decision making process (Refer Figure 3.19). As can be observed in the framework proposed by them, the 'Beliefs Affected' corresponds to 'Primary BM Element Impacted' in our conceptual model ; similarly, 'Beliefs Unaffected' correspond to 'No BM element impacted' in our model. In their framework, once the beliefs are observed to be affected, it provides way towards cognitively identifying 'opportunity' or 'threat', and subsequent changes in the business model, just as conceptualized in our framework.

7

Discussion, Conclusion and Recommendation

7.1. Conclusion

The following chapter provides a discussion of the above research study, focusing on explicating the impacts of external triggers on business models of Dutch sustainable energy based startups and scaleups, causing them to pivot their course of action. To reach a verdict, the study aims to explore following three sub-research questions: 1. How do startups evaluate the external trigger to be an opportunity or a threat? ; 2. Which section of Business Model (i.e., 'Value Proposition', 'Value Creation', 'Value Delivery' and 'Value Capture') does the external trigger primarily impact and what is the pivot effect? ; 3. How do these pivots in one section of Business Model impact other elements of Business Model? This is followed by discussion, and limitations & recommendations for future studies.

7.1.1. RQ1: How do startups evaluate the external trigger to be an opportunity or a threat?

To answer this sub-research question, the study relies on both theoretical academic knowledge and empirical research. The process starts with exploring the prominent external triggers impacting the startups/scaleups in Dutch sustainable energy sector. Followed by how these triggers were perceived by the decision makers/companies as an 'opportunity' towards something better or a 'threat' to their processes and survival. Building on the theoretical knowledge of PESTEL analysis (Buye, 2021) and Macroenvironment Model (Kotler and Armstrong, 2011) described in section 3.5, the external triggers were derived accordingly for sustainable energy based firms using Gioia Methodology. It's important to note that these external triggers are not exhaustive and various other forms of external triggers can act on company. To effectively consider wide areas of impact, PESTEL and Macroenvironment Model theories were utilized.

We found that companies faced multiple external triggers from all phases of environmental, economic and social constructs, that potentially resulted in them having to pivot to stay aligned with goals. Upon conducting Gioia analysis, codifying the recurring themes, and aggregating them into main categories, we found the external triggers originating from four sectors:

1. **Market Triggers**: This module comprised of triggers originating from the market via means of customers, industry, market demand, and competition. Companies mainly faced effects from changing customer/market preferences, access to new markets, decline of certain market and disruption caused due to macroeconomic conditions.
2. **Environmental Laws and Regulatory Triggers**: These triggers emerged from changing regulations and policies concerning environment and region/country specific compliance. This included instances of alterations in subsidy schemes, new restrictions, or varying energy goals of nation.

3. **Technological Trigger**: These triggers emerged due evolution or limitation of technology scenario in the external environment of the company, that resulted in company having to adjust or react to those changes to stay on course and relevant.
4. **Resource and Financial Triggers**: These triggers were associated with financial factors such as external funding, investment or existing revenue models in the market that resulted in companies updating their resources.

Market and Regulatory triggers were extensively found to be the most across the interviews (30% each), suggesting their high relevance, followed by technological triggers (25%) and resource triggers (15%). The observation points at the highly volatile market dynamics in energy sector and fickle political landscape (Wang et al., 2022). This underscores the need for companies to proactively make increased efforts to stay in touch with customer and markets to make the product more personalized to user's needs, and gain a competitive position in market. In addition, due to uncertain regulatory scenario with changing global conditions, companies in the sector need to increasingly associate with policy makers and regulatory bodies, to stay on course with fickle laws, while at the same time voice their opinion on government goals from a practical standpoint. This allows the politicians to understand the situation from a ground level perspective, realize the plights faced by startups and facilitate laws more deeply connected to new-age company's needs that are prominently driving innovation in this capital intensive industry. These external triggers thus incorporate the full PESTEL spectrum, but provide better understanding of a more nuanced trigger type the firms are facing. Market triggers as a subset of PESTEL's - 'Social' ; Environmental Law and Regulatory Trigger as a subset of - 'Political', 'Environmental' and 'Legal' ; Technological Trigger as a subset of 'Technology' ; Resource and Financial Trigger as a subset of 'Economic'. Similarly, the triggers are identified in Macroenvironment model - 'Market Triggers' as a part of 'Demographic' and 'Cultural' ; 'Environmental Laws and Regulatory Triggers' comes under 'Natural' and 'Political'; 'Technological Trigger' as a subset of 'Technology' ; 'Resource and Financial Triggers' under 'Economic'.

Next, the research delve deeper into the situations where decision makers observed the trigger to be an opportunity or a threat. A similar approach of Gioia coding is followed to identify categories of situations of how companies perceive them. We find the following observation in Dutch energy tech setup:

1. **Opportunities**: We see that companies perceive the scenarios wherein they get the chance to tap into new markets/customers as a huge opportunity. Events such as access to external funding, evolution of technology resulting in innovative of their product, and supportive government laws and policies pose highly positive for firms.
2. **Threats**: Scenarios wherein companies faced technological limitations, uncertainty in macroeconomic environment, misaligned product with market or stern policy and regulatory scenario as a major cause of threat and concern.

Upon cross analysis of external trigger with subsequent perception (Opportunity or threat), we see following patterns (Refer Figure 6.11):

- Some trigger types were more prominently devised to be threats from startup's perspective. Limitations in technology and regulatory requirements from government and regions were unanimously observed to be a major threat to company's functioning.
- Triggers such as funding investment, advancement of global technology, policies supporting environmental projects, and access to new markets posed as a major opportuity for sustainable energy firms
- Mixed obervations were found for situations of customer pricing expectations, product feedback and accessing different markets. However, they were skewed towards being perceived as opportunity.

When a company faces an external trigger, it impacts a certain element of business model, regardless of whether decision makers decide to act or not on those instincts. In the research, these situations have been tagged as 'Primary Business Model Element Impacted'. To delve deeper into the decision making process, we find relation between the Opportunity/threat and the primary business model element being impacted within a company. It's observed that triggers are often perceived as opportunities

when they are outward facing, i.e., when the BM element primarily impacted is Value Proposition (company's product offering to its customers) or Value Delivery (how the company approaches its customers). On the contrary, firms often view triggers to be a threat when it impacts the internal resources, unique capabilities, partnerships and strategies of the company, i.e., Value Creation (Refer Figure 6.11). These triggers have the potential to disrupt the core operational stability of the company resulting in company undergoing survival threat and resorting to defensive mechanism. Furthermore, the triggers are identified as opportunity or threat not in isolation, but instead by considering the subsequent contextual factors such as its impact on their functioning.

7.1.2. RQ2: Which section of Business Model (i.e., 'Value Proposition', 'Value Creation', 'Value Delivery' and 'Value Capture') does the external trigger primarily impact and what is the pivot effect?

Upon empirical analysis of the experiences the firm had, it is observed that external triggers impact different sections of the business model with different frequency and intensity. Furthermore, certain external trigger tend to impact a particular BM element more prominently. To answer this sub-research question, we first identify all the BM elements being impacted in our study, followed by explicating patterns observed between an external trigger and primary business model element impacted, and explaining the subsequent pivoting action undergone by companies as a response to these primary impacts on BM elements.

The research follows the Sustainable Business Model Canvas devised by Bocken (2021b), which brackets a business model into 4 segments, i.e., Value Proposition, Value Creation, Value Delivery and Value Capture. A line of thought is observed during interviews concerning the fact that when an external trigger impacts a firm, it prominently has an affect on certain element of the business model (the research does not delve into intensity of these affects). This initial impact has been labeled as the 'Primary business model element impacted'. Once the decision makers realize these impacts on BM, they categorize them as opportunity or threat and make subsequent decision to pivot.

The empirical research study of the interviews show that Value Proposition (VP) was the most primarily impacted by the external triggers (37%) (company's value offering to its customers), followed by Value Delivery (VD) (28%)(how the company reaches its customers), Value Creation (VC) (23%) (how company creates value offering), and Value Capture (VCA) at (12%) (Refer Figure 6.6). Hence these triggers potentially affect both the outward facing (VP, VD) and internal functioning of the company (VC, VCA). The dominance of VP being affected signifies the critical complementary nature of product offering and its place in the market. Firms are increasingly facing misalignment between the two, especially in energy industry driven by fickle technological and political changes.

Taking a closer look, pattern between individual external triggers and subsequent primary BM element impacted is observed (Refer Table 6.1). Triggers originating from technological arena primarily impact the Value Proposition (VP) (74%) - for instance, Company K faced limitation in availability of technology in the market that resulted in them having to create an alternate product. Market Triggers in almost half of the cases impacted the Value Delivery (VD) of firm (46%) - e.g., Company G got access to new markets that additionally provided them to make changes to the way they approach their customers. Environmental and regulatory triggers prominently influenced the Value Creation (VC) (41%)- e.g., Company E identified that with new environmental policies they were able to enhance their resources. Resource and Financial Triggers were comparatively less observed, however, they primarily affected the Value Capture (45%)- for instance, Company B recently received external funding that provided the flexibility to try novel pricing model.

Building upon the theoretical knowledge of pivoting described by Ries (2011) and Kirtley and O'Mahony (2023), companies undergo changes in their business model to adapt to these trigger effects (Refer Section 3.7). Companies 'sense' and 'seize' the triggers, and make appropriate decision whether or not to 'transform' their course of action. To understand this change brought about in company's functioning, Section 6.2 provides a cross-case analysis of pivoting action observed in 6 Dutch sustainable energy based companies. The Gioia analysis facilitated in understanding the pivots specific to Sustainable energy startups/scaleups and allowed narrowing down to three segments:

1. **Company Resource and Financial Pivot**: These pivoting actions comprised of changes brought

about in company's internal resources, i.e., realignment of strategies and operations, restructuring networks and diversifying their revenue models.

2. **Product Technological Pivot**: These implicated changes in company's value offering as a reaction to the trigger. Mainly categorized into four sub-sections, creating new value offering, expanding product application, modifying product for better fit and ceasing product. Within this section, modification of product was observed to be the highest, showcasing the need for companies to actively pursue agility as a second nature.
3. **Market Outlook Pivots**: These pivots constitute of changes in the way company approached the market, such as aiming at new customers, expansion to new markets, or undergoing changes in the BM to adapt to varying market adoption behavior.
4. There were also cases wherein upon analyzing the external triggers, the decision makers refused to or chose not to bring about any changes within the company, which are identified as 'no pivots'.

The startups realize these impacts from external environment on their businesses. This makes them run into the loop of identifying the characteristics of these impacts, and comprehend the effects it might have on their functioning. This deciphering of initial impact aligns well with the 'sensing' capability as described by Teece (2007) in the Dynamic Capability Framework (Refer 3.14). Further, once these external triggers impacting a BM element is 'sensed', the decision makers undergo 'seizing', wherein they identify and analyze the trigger and its affect on their BM to be an opportunity or a threat, and pinpoint the need to pivot or not. Once the decision to 'seize' is completed, companies undergo 'transformation' wherein changes are made to their business models in an effort to absorb the impacts and stay aligned.

7.1.3. RQ3: How do these pivots in one section of Business Model impact other elements of Business Model?

When companies undergo pivots in their business model as a response to an external trigger, it is observed from empirical research that these affects on BM are not constricted or confined to a single element. They instead unfold in a snowball/cascading manner upon other BM elements, further tagged as 'Secondary Business Model Element impacted' in the research. This understanding is supported by theories of dynamic and systemic nature of business models as suggested by Khodaei and Ortt (2019) and Zott and Amit (2010). The theories underscore interdependent-ness of BM elements and how reconfiguration across complementary elements is necessary to undergo innovation or adaptation. Building on these theoretical constructs and empirical research conducted, we answer this sub-research question by first exploring the secondary BM elements impacted upon pivoting, followed by exploring patterns of cascading effect among BM elements, and next we conclude by exploring whether the pivots gave way for innovation or adaptation in BM of companies.

Observation of repercussions of pivoting action in BM of Dutch sustainable energy companies show that, Value Creation (VC) was most impacted (secondarily) (34%), suggesting that firms often have to reflect and make changes in company's internal operations and resources. This is followed by Value Delivery (VD) (29%) (subsequent effect on how companies approach their customers), Value Proposition (VP) (19%) (subsequent effect on how companies alter their value offering), and Value Capture (VCA) (18%) (subsequent effect on company's costs and revenue models) (Refer Figure 6.6).

To further enhance understanding of cascading effect across BM elements, we explore causal relations, where the changes are tracked from primary to secondary BM elements (Refer Figure 6.7). From our observation of energy-based firms, it is seen that external triggers most often impact their value offering (VP) that compelled firm to change the way it creates value (VC) for its customers, such as changing strategies, updating resources/infrastructure, restructuring partnerships and so forth. For example, when Company K faced limitation in terms of global scale technology, it compelled the firm to rethink novel hybrid product offering for its customers (primary BM element - VP), that consequently required forming new partnerships and investing in new resources (secondary BM element - VC). These results are in line with Schaffer et al. (2020)'s research, who in their study of 36 research papers identified significantly high interrelation between the value proposition and value creation. A similar cascading effect was closely followed by situation wherein, when external triggers impacted the way company creates value (VC), it had subsequent effect and changes in the way firm approached its customers

(VD). For instance, when Company N identified a new market (trigger), its initial impact and first course of action was to rethink and restructure its partnerships to enter that market (primary BM element - VC), that allowed company to approach customers in novel ways (secondary BM element - VD). Furthermore, results were also observed where no pivot action was undergone, resulting in no BM element being secondarily impacted.

These pivoting actions causing BM changes are further categorized into Business Model Innovation (BMI) or Business Model Adaptation (BMA), depending on the nature of change undergone by the firm. As distinguished by Saebi (2015), Business Model Innovation comprises of disruptive and novel changes within a business model, whereas Business Model Adaptation comprises of adjustment of the model components to align better with the market needs. The research identifies these nature of changes during pivoting action of sustainable energy based companies. The Gioia methodology facilitated observation of following factors that identified the changes to be innovation or adaptation.

- **Business Model Adaptation**: These changes in business models were associated with adjustment in company's resources and partnerships, modification of product, aligning better with target market, and minor adjustments required to comply with regulations.
- **Business Model Innovation**: These comprised of fundamental changes in the way company offers its product (such as novel technology development), strategically repositioning their place in the market, and rebuilding the way they capture revenue from its customers.

The empirical research conducted suggests that companies noticeably tend to rely on adaptation of BM to reach their goals, stay relevant and aligned with the market (57%). However, given their agility and entrepreneurial mindset, a significant proportion of innovation (34%) suggests that sustainable energy companies are progressively capitalizing on external triggers to give way for innovation. It is crucial to understand that when company makes changes upon external trigger's impact, there is tendency and possibility for both innovation and adaptation to take place simultaneously or sequentially in various sectors. In such cases, we narrow our scope by identifying the strongest effect felt overall.

In conclusion, BM is systemic in nature, i.e., the elements are interrelated with tendency to impact/cascade one another, and identifies it to be adaptive in nature with potential to undergo minor adaptations or radical overhaul.

7.1.4. Main Research Question: How do external triggers instigate pivots in Business Model elements of Dutch Sustainable Energy-Tech startups and what are corresponding effects on other elements of Business Model?

The research in an overview delves deeper into the implication of external triggers causing pivots in business models of Dutch sustainable energy tech firms and observes the chronology of the entire process. As discussed before, this begins with identifying sources of external trigger, followed by understanding its impact on individual BM elements (primary). These impacts are further cognitively discerned either to be an adversary threatening the survival/processes or opportunity towards something better for development. Upon rationalizing the impact of a trigger, pivoting action is undergone in response to absorb the impact of the external trigger. Similarly, there's potential for the company to not pivot even upon acknowledging the affect of the trigger, resulting in no further changes. The pivoting is followed by monitoring sequential impact on secondary business model element. This provides way to understanding the cascading effect of impact from one business model element to another, and finally categorizing these changes in business model to be disruptive or just an adaptation.

Each of the components of this chronology have been explained in the answers to sub-research questions 1,2 and 3. For answering the main research question, we shall begin with incorporating the individual elements from each sub-research questions into our improved conceptual model, showcasing the overview of external triggers causing pivots and business model changes, in context of Dutch sustainable energy based firms. Further, we explain observations of pattern found between trigger perception (opportunity/threat) and subsequent BM changes (BMI/BMA).

The following conceptual model (Refer Figure 7.1) incorporates the four categories of external triggers and three categories of pivots observed for sustainable energy based firms. The external trigger section comprises of: a. Market Triggers, b. Environmental Laws and Regulatory Triggers, c. Technological

Trigger, and d. Resource and Financial Triggers. If relevant, the trigger is observed to inflict primary impact/footprint on business model elements, namely, a. Value Proposition, b. Value Creation, c. Value Delivery and d. Value Capture. If not relevant, which may potentially be due to negligence by human error or irrelevance of external trigger on firm's working, then no impact is observed on BM, eventually resulting in no-change. Once the trigger and its influence is 'sensed' by decision makers, they cognitively analyze the situation to be an opportunity or a threat, based on their contextual understanding and capabilities, i.e., 'seizing'. We discern some factors relevant to our data that facilitate this recognition, and has been explicated in answer to Sub-RQ1.

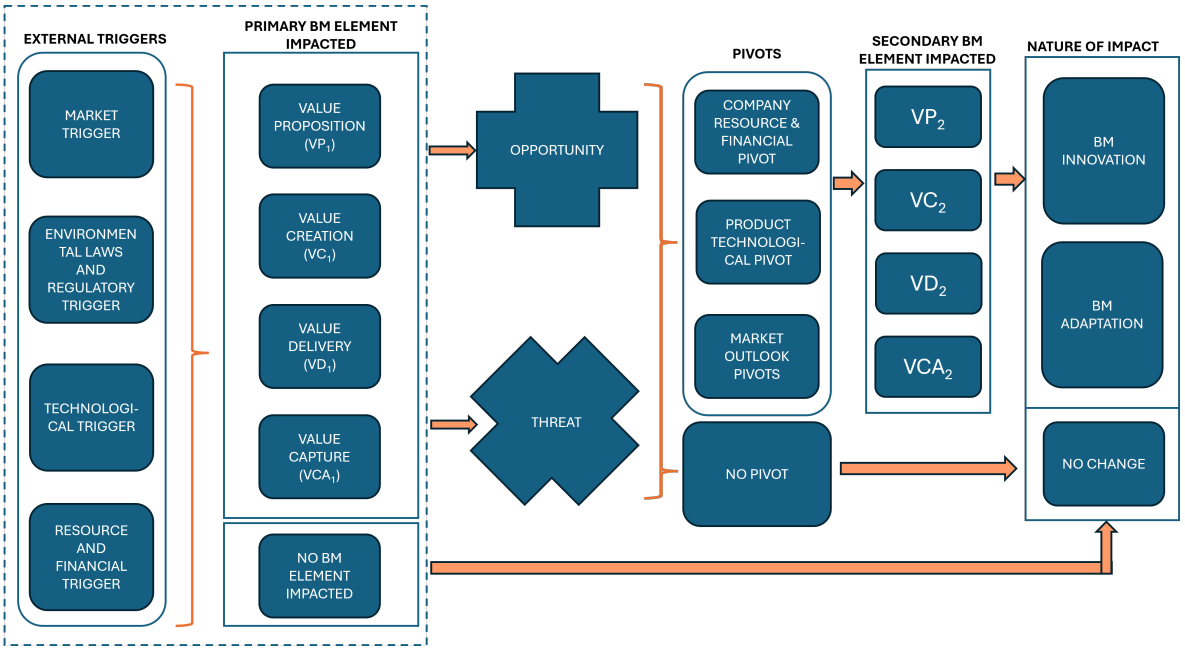

Figure 7.1: Detailed final conceptual framework showcasing external triggers causing pivots in business models of Dutch sustainable energy based startups (*author's interpretation*)

In response to identification and cogitation of these triggers and their perception, manifests following specific pivot actions or 'transformation', a. Company Resource and Financial Pivot, b. Product Technological Pivot, c. Market Outlook Pivots. Certain scenarios are also observed wherein the company, even upon identification of trigger refuse to pivot due to reasons such as confidence in product, limited resources, low market demand, and extensive compliance requirements. This results in no changes in the business model. These actions once implemented result in cascading effect or reverberation on different elements of business model, herein categorized as 'secondary BM element impacted', specifying the systemic nature of BM. Next, these changes are categorized into Business Model Innovation (BMI) and Business Model Adaptation (BMA), based on the nature and type of changes happening. Based on the interview data, these changes are thematically analyzed to identify the factors differentiating between the two.

A notable observation was found upon comparing the perception of trigger (opportunity or threat) with subsequent nature of BM change (innovation or adaptation). We build on line of inquiry of 'Threat-Rigidity theory' by Staw et al. (1981) and empirical research of 134 managers conducted by Aarøen and Selart (2020), showing that decision makers are more risk-seeking in gain scenarios as opposed to loss scenario. Business model innovation involves embracing the unknown, portraying risk seeking behavior. The same is reflected in our data, where majority of triggers perceived as threat resulted in business model adaptation (67%), while only 16% resulted in innovation. On the contrary, the perception as opportunity led to almost equal divide between innovation (47%) and adaptation (51%) (Refer Table 6.3).

Hence, this conceptual framework provides understanding of how external triggers instigate pivots in business models of sustainable energy tech startups, while exploring the mediating influence of cognition

and various inter-related business model elements.

7.2. Discussion

The discussion chapter provides an in-depth overview of the research objective, subsequent approach taken, analysis conducted and the findings observed, concerning how external triggers instigate pivots in business models of Dutch sustainable energy-tech startups. The observations are situated with existing academic literature, followed by explaining its practical and theoretical relevance.

The core objective of the research was to explore the effects of external triggers causing pivots in the business models of Dutch sustainable energy-tech startups. The process begins with exploring the type of external triggers impacting the firms in this arena, and which component of the business model is being impacted. This is followed by studying how the triggers and its effect are perceived to be an opportunity or an adversary. Next, the pivoting action is explored, providing way to understanding the secondary business model elements being impacted after the pivoting action, and concluding with exploring the nature of business model change, whether it was an innovation or adaptation.

Using the geographical context of The Netherlands, interviews with six sustainable energy-tech startups were conducted to understand the external triggers impacting them and corresponding pivots undertaken to thrive. Upon conducting individual case studies of the experiences, a cross case analysis was conducted using Gioia methodology, to identify themes and patterns. Based on theoretical constructs, a tentative conceptual framework is developed before conducting case study, that is further improved upon analysis of cases. The overall analysis provides insightful findings.

First, the startups are facing significant triggers from market and environmental regulations, each accounting to 30% of observed triggers. Significant amount of regulatory triggers hints at the industry's unique symbiosis and relation with government policies. The Dutch landscape's political support towards developing sustainable energy technologies such as SDE++, while tackling major problems of grid congestion, suggests that firms have to not only compete for "product-market fit", but also "product-policy fit". The research builds on PESTEL model (Buye, 2021) and Macorenvironmental Model (Kotler and Armstrong, 2011), but customizes for triggers in sustainable energy based context. These triggers observed are not exhaustive and there is a potential to observe more triggers. However, based on empirical and contextual understanding of company and the environment they work in, the research observes aforementioned triggers by utilizing PESTEL and Macroenvironment model as a guide. The above study decomposes external events into individual triggers to trace in a clean manner the solitary impact of trigger on business model elements of the companies to gain a microscopic view of 'one-to-many' effect. However, in real-life projects, firms are often hit with an avalanche of triggers from various sectors that are mutually interacting and connected before impacting the firm, i.e., 'many-to-many'. Our study does not delve into those messier inter-connected triggers to reduce the complexity of study and inspect the fine-grained effects of individual trigger types on a company.

Second, it's observed that when external trigger strikes the company, it prominently affects the Value Proposition and Delivery. However, these impacts are further reverberated towards company's Value Creation, i.e., impacts on how company functions its internal operations and strategies. High frequency of changes in value proposition causing impacts in value creation in our data suggests company's need to enhance and strengthen their capability of agile processes. This requires them to constantly be in touch with customers for their needs, build up modularity and increase efficiency of their pivots. This reinforces the concept of Dynamic Business Model by Teece et al. (1997), that proves interdependence of individual business model elements, and identifies its systemic nature, showcasing that a change in BM element is reverberated through different elements. These pivots are rarely isolated, and most often dispersed throughout business model. In reality, situations were observed wherein a particular trigger led to simultaneous changes in multiple elements of business model. In addition, there were also cases where an external trigger resulted in both innovation and adaptation concomitantly. However, in such cases, to streamline the line of study given its growing complexity, the most strongly effected individual BM element was identified based on interviewee's response and company's contextual environment.

Third, as stated by Osiyevskyy and Dewald (2015), leaders undertake strategic decisions from contextual point of view. The same gets reflected on our study, wherein the firms identify trigger to

be an opportunity or a threat once it impacts their business model. Certain triggers such as compliance with regulations and technological limitations in the environment were strongly observed to be threats, whereas triggers such as advancement of technology, environmental policies and funding were plainly observed to be opportunities. Further, it is seen that when triggers are observed as threats, they prominently result in adaptation rather than innovation, and otherwise when considered as opportunity, signifying risk seeking behavior in case of gain scenarios. Hence, reinforcing the concept of 'Threat-Rigidity Theory' by Staw et al. (1981). In the study, the triggers have not been categorized as opportunity or threat in isolation, but instead, contextual information surrounding the company event was analyzed to understand their impact on business model, making it more specific for use case.

The research portrays the illustration of Dynamic Capability framework by (Teece, 2007), wherein the decision makers 'sense' these external triggers, 'seize' the scenario by analyzing its effects on BM, and 'transform' via means of pivots to stay aligned. By identifying specific triggers, perception factors, pivoting action and nature of BM change, this research solidifies the theoretical construct towards practical observation. Further, by building on the concept of 'pivot' by Ries (2011), the research identifies the pivots observed in sustainable energy based context in the NL. The improved conceptual framework from research learning is supported by 'Strategic Decision Framework' developed by (Kirtley and O'Mahony, 2023).

7.2.1. Practical & Managerial Implication

The above research thesis yields several insights for sustainable energy-tech startups, entrepreneurs, decision makers, investors and macroeconomic policy makers. The empirical research showcases the significant influence of market and regulatory triggers, each accounting approximately 30%, and hence highlights the crucial need for companies to proactively stay in touch with changing market needs and enhance their environmental scanning capabilities. This consists of incorporating agile business development methodology, allowing development of product more centered towards customer's use case and engaging in constant feedback sessions to understand the pain points. The research pinpoints at the fact that external triggers predominantly impact the company's value offering (VP) and its customer approach (VD), further underscoring the importance of adopting agility as a second nature in terms of their product development, formation of partnerships and collaborations, and sales/revenue models to align better with consumers.

In addition, given the fickle nature of policy, laws and regulations in the industry, there is an utter need for entrepreneurs and firms to be more involved in political scenario by building networks and voicing their opinion and plights, that can help devise laws with holistic consideration. Observing from the fact that all regulatory triggers were perceived as 'threats', it is essential for firms to build relations with policy-makers and lobbyists to anticipate the changes better, stay prepared for pivots and align their functioning of businesses accordingly. Their experiences at ground level can further help the legislators to effectively focus their efforts towards sustainable energy transition. Given the uncertainty, the legislators can devise phased roadmaps, and formalize dialogue constructs such as startup working groups, to ensure that companies are in line with current and future goals and foster learning through previous experiences.

As observed in literature review, the investor confidence in Dutch energy industry is declining. This thesis highlights the need for investors to observe not just the future of product offering, but also distinguish the agility of firms and base their decision on the capability of the company to handle constantly shifting market and regulatory scenarios, and how well other BM elements (VC,VD,VCA) are structurally aligned. Active evaluation should be made of how companies 'sense' the triggers, 'seize' its implication and 'transform' their approach, as defined by Teece (2007). Furthermore, pivots often have been observed to impact the internal resources and strategies of the company as a consequence of triggers. This emphasizes the need for investors to regularly assess the resilience of company's structure. Significant amount of innovation being performed within sustainable energy companies further highlights the positive future outlook of companies in this industry.

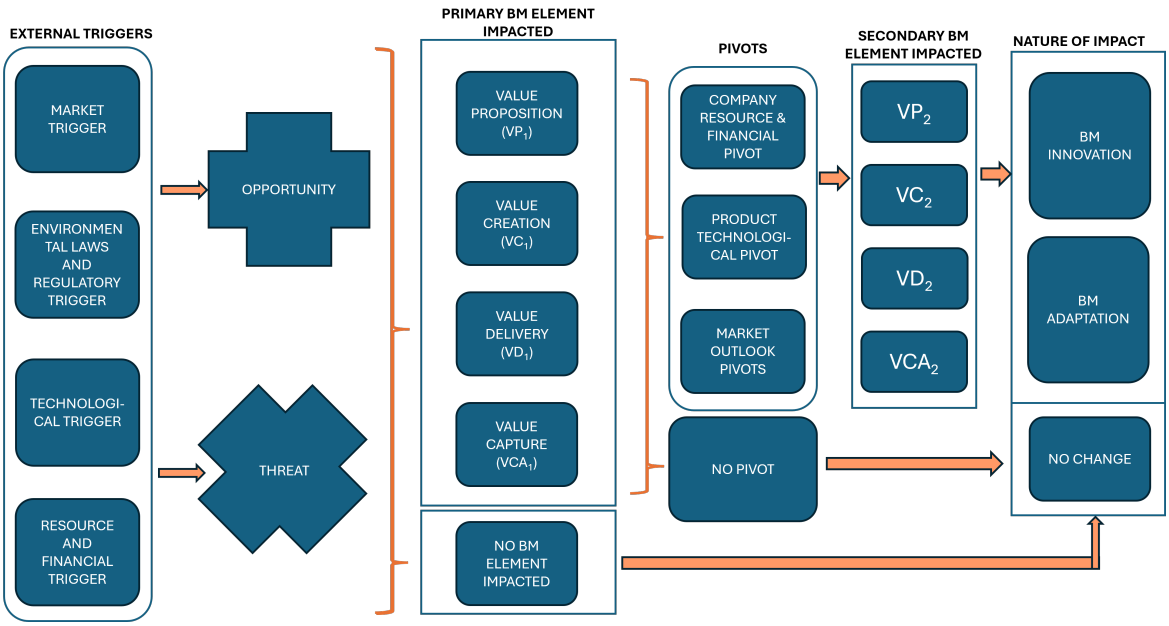

Figure 7.2: Practical Conceptual Model

The figure 7.1, reflects the academically research backed sequence wherein the companies identify the trigger to be an opportunity or a threat after the trigger's interaction with the company, and its implication on certain BM element. This implies that the cognition of trigger happens upon tangible impact on company's operations. However, in various real-life scenarios, the decision makers at the company are also constantly bombarded with external triggers that are initially idenitfied as opportunity or threat, and further impacts on company are studied thereafter. Hence, in an effort to cater more closely to practical scenario, an alternative process is visualized in figure 7.2. Conceptually, both viewpoints converge towards same direction, however the initial identification can vary depending on unique situation.

For more practical benefit of the conceptual model, the companies can follow the below steps:

- **Step 1: Developing "Trigger Radar"**

  Based on the trigger families observed during research (not limited to), i.e., Market, Technological, Environmental Laws and Regulatory, Resource and Financial - a continuous scanning platform/dashboard can be developed. This can help develop activity heatmap, mapping where the companies are facing most influence from. Following guide can be used to identify trigger events:

  - Market Triggers: Adoption lags, competitor strategic moves, feature requirements by consumers, commodity price volatility, partnerships/collaboration opportunities.
  - Technological Trigger: AI energy management, advanced material availability, battery technology, smart energy monitoring, energy transport.
  - Environmental Laws and Regulator Triggers: Emissions standards, water usage, waste management, land use, Life cycle assessments (LCA), decommissioning rules, carbon credits, pollution mandates.
  - Resource and Financial Triggers: Interest rates, inflation, raw material availability, supply chain disruptions, infrastructure health, operational cost changes, funding accessibility.

  The list is not exhaustive but just provides an overview of what type of external triggers a company can face in these sectors. Tracking these triggers can allow companies to identify areas of impact, allowing proper resource allocation. Color coding or intensity monitoring can help quantifying the effect.

- **Step 2: Ascertain as opportunity or threat** This involves labeling each external trigger observed as an opportunity or threat with explanation of point of view and confidence level. Rationalize time to impact (near future, few months, a year or later).

  Example:

Ext. Trigger	Opp/Threat	Rationale	Time frame
VC grant awarded	Opporutnity (High)	Enhances runway for product market penetration	4 months
Policy X tightened	Threat (Medium)	Adds up on compliance process and scrutiny checks	3 months

Table 7.1: Caption

- **Step 3: Identifying primary BM element impacted** This comprises of identifying the initial footprint on certain business model element, i.e., VP, VD, VC or VCA. This can be done by quantifying the intensity of trigger's primary impact on each of these elements. If none, then 'No BM element impacted'. Following non-exhaustive possibilities are provided for better understanding.
  - Value Proposition: Improvements in product technology, specification changes, modularity incorporation, change in product-market fit.
  - Value Creation: Change in inventory, supplier changes, talent access, increased manufacturing capabilities, process automation.
  - Value Delivery: New distribution channels, after sales service upgrade, customer training, mobile service units, customer support outsourcing.
  - Value Capture: Change in product/service price, share price fluctuation, royalty agreements, licensing opportunities, leasing, smart bundled service offering.
  - No BM element impacted: If the team cannot find any impact on their business operations or if they cannot place a footprint at current time, then label it as no BM element impacted and re-check after a certain period.
- **Step 4: Pivoting type**

  Based on the impact of the external trigger identified as opportunity or threat, and analyzing the intensity of its impact on the BM element, this step identifies the primary pivot action company feels appropriate for a particular scenario. If the trigger does not feel important to be acted upon, decision makers can choose to not pivot.
- **Step 5: Monitoring Secondary impacts**

  Once primarily impacted and pivot action identified/undertaken, predict the secondary impact on subsequent BM elements. Keep an inspection log to track whether the changes were successfully observed as expected, if yes, record the direction of change and its intensity. If no, identify secondary element more prominently impacted and reason for this phenomena.
- **Step 6: Classifying as Innovation/Adaptation**

  After a given cycle period, the trigger radar and pivot card should be closed to identify whether the changes undertaken were an innovation or adaptation. This helps the decision makers understand what type of triggers and subsequent pivoting actions are leading towards innovation or adaptation.

Taken together from steps 1-6, the framework can be optimized and customized to a practical decision system. For every cycle, the decision makers can log external triggers, understand its impact, identify their ways of thinking, how they incline towards a particular line of thought and categorize them as opportunity or threat. Followed by how they perceive the impacts on individual BM element, corresponding decisions undertaken and accuracy of their predictions. Quantifying and tracking these data allows reinforcing the company's capabilities by understanding the hurdles and improving the prediction for future actions. This results in faster processing, targeted actions, clear accountability, and repeatable systems to suppress noisy signals to streamline decision making.

7.2.2. Theoretical Implication

The research provides several contributions to the theoretical concept of identification of external triggers, dynamic business models, subsequent pivoting action and nature of BM change.

First, building on Teece (2007)'s Dynamic Capability framework, the research contextualizes the ability of Dutch sustainable energy based firms to 'sense', 'seize' and 'transform' their business models in response to external triggers. It weighs in on the prominent external triggers companies in this industry and geographical region are facing, allowing to further the knowledge on the way they are responding and reacting to these effects. This process involves showing how decision makers in the industry are identifying external triggers to be an opportunity or a threat, and what consequent pivoting action is undergone as a response to absorb or adapt to these triggers. Certain conceptual aspects of the dynamic capability theory are explicated using empirical methodology centered around sustainable energy industry.

Second, building on the theoretical and practical knowledge of PESTEL analysis by Buye (2021), we explore the triggers applicable for Dutch sustainable energy context, in an attempt to provide a more granular interpretation of external triggers impacting the business models. The broader PESTEL framework categorizes the triggers into 6 sectors, i.e., 'Political', 'Economic'. 'Social', 'Technological', 'Environmental', 'Legal', which lacks the industry-specific granularity, that is needed for practical applications. Empirical analysis using Gioia methodology allows categorizing these triggers into four constructs, i.e., 'Market Triggers', 'Environmental Laws and Regulatory Triggers', 'Technological Triggers', 'Resource and Financial Triggers', that are further categorized into subsequent themes. This encompasses all the required elements of the PESTEL framework, but also subsequently provides better foray into the external triggers personalized for the sustainable energy industry in Dutch region.

Third, the research contributes to the literature of pivoting in business models, as initially conceptualized by Ries (2011) and Kirtley and O'Mahony (2023). It provides insight into the pivoting actions performed by the sustainable energy based firms, which are classified into three ways, i.e., 'Company Resource and Financial Pivot', 'Product Technological Pivot', 'Market Outlook Pivots', providing way towards a more nuanced lens. With a structured Gioia approach, these pivots have been further segmented into themes that are unique to geography and industry. Rather than studying pivots in isolation, this research explores the corresponding repercussions and environmental changes surrounding the pivoting action, to observe the causal effects on BM of companies. It demonstrates the interconnectedness of pivot action, as to how pivot in one section of BM traverses to different part of BM.

Fourth, as observed in literature, a conceptual distinction is made between Business Model Innovation and Business Model Adaptation by Saebi (2015), which suggests that innovation comprises of radical, disruptive changed, while adaptations involves incremental adjustment to the existing course of actions. Building on this line of thought, this research provides a more real-world foray centered around sustainable energy based startups, identifying the highly nuanced borderline between innovation and adaptation by observing patterns using Gioia methodology. It contributes theoretically to the observation that Dutch sustainable startups increasingly demonstrate both innovation and adaptation in their journey, and explores contextual patterns surrounding these business model changes.

7.3. Limitations and Recommendation

7.3.1. Limitations

The study provides valuable exploratory insight into impacts of external triggers on business model of Dutch sustainable energy tech startup, however there are several limitations that needs to be acknowledged.

- Limited Sample Size: The research conducted was based on studying the experiences of 6 Dutch sustainable energy companies. This sample size makes it difficult to generalize the study across broad categories of energy field. Furthermore, the geographical location has been restricted to Netherlands, which does not capture the experiences in different countries and context.
- Confidentiality Concerns of Interviewees: Since the data tended to delve a bit deeper into company's experiences of their business model changes and strategies, most of the data lie at the

brim of confidentiality concerns for interviewees. Hence, they were highly careful with disclosing any information that might be unique to the company and might hamper their company's future. Therefore, information surrounding certain areas such as financial information, its impact on the company, unique business outlook, their strategies on tackling triggers and so forth, was very limited. To add to that, most of the interviewees preferred to answer in highly confidential manner, resulting in lack of information depth.

- Interview information from single perspective: Semi-structured interviews were conducted with a single person in most of the companies, causing bias due to personal experiences, social, emotional and environmental context to creep in. This might affect the veracity of company's experiences.
- Research duration: The research focused on understanding the impact of external triggers causing pivots in business models. Often, the repercussions of the triggers take time to unfold within company, and hence there's a possibility that only a part of the story line was captured during certain instances. In addition, there's also possibility that interviewee might leave out some crucial information due to human error and long time since occurrence of event.
- Internal Triggers: The study focused extensively on external triggers, while not exploring the mediating effect of internal triggers. These triggers have the potential to be inter-related given the dynamic nature of business model, potentially leaving some gaps in the judgment.
- Isolated Triggers: The study traced triggers with individual characteristics and how their effects propagates through company's business model. However, triggers in reality are mostly interconnected and have a compounding effect on the company's operation.

7.3.2. Recommendation for future research

To enhance the research towards capturing the whole dynamics at play, following recommendations are suggested for future study:

- Broaden the scope of study: Future research can aim to expand the scope via means of geography and domain (fields of business) to increase the generalization of results. In addition, the research can also be narrowed to a single domain (such as single energy sector, e.g., nuclear energy) to help improve the accuracy of results for a better practical inclination.
- Longitudinal study: The study focuses on variables, i.e., triggers and corresponding pivoting action, that take time to unfold and develop. A longitudinal study can help to capture the nuances over long time horizon, providing opportunity to observe delayed impacts, progressive pivoting action, while having contextual understanding of environment surrounding the business.
- Increase sample size: The sample size of the research can be increased to include more startups across various domains to improve the applicability to various startups and domains.
- Quantitative Analysis: In addition to the qualitative analysis, quantitative parameters such as revenue information, sales, customer retention performance etc., can further help provide more insights on the performance of corresponding pivots.
- Narrow down external triggers: While this research focused on external triggers in general, to further improve the insights, the study can be limited to a single external trigger family and increase the sample size to explore deeper into the significant effects of that single trigger.
- Micro-Pivots: The research did not differentiate between micro and major pivoting action undergone in within the company. Most of the pivoting actions develop over time incrementally. A real-time longitudinal study can allow the researcher to delve deeper into understanding how small actions at smaller scale compound to formulate a pivot. This provides a better understanding of the decisions companies have to take to undergo pivots.
- Intensity of impact: Future study can aim to allocate intensity factor to the changes in business model of companies. This can further aid understand the nuances of changes and relate the study to subsequent pivoting action.
- Time Metric: A time/speed element can be incorporated in future study to analyze time lapsed between i. External trigger event and its primary impact on company, ii. subsequent Pivot/No-Pivot decision making undergone, iii. Impacts on further business model elements. This allows

exploring the decision making speed and identifying places to remove redundancies.

- Trigger divergent impact: In above research, to identify the primary business model element impacted, the criteria was identifying the most prominently impacted element as viewed by decision makers. For future research, a quantifiable effect can be incorporated, wherein impact of external trigger can be rated across various business model elements primarily to identify a pattern.
- Trigger Readiness Scorecard: Future study can develop a scorecard that rates startup's capabilities of responding to these external triggers and to what extent it impacts the business models of companies. It provides insight into company's resilience and act as a pre-pivot health check.
- Not Act situation: The above research faced limitations in observing 'Not-Act' scenarios, i.e., situations wherein company refused to act upon external trigger's impact. Future study can isolate the research objective where such decisions were undertaken, and explore subsequent reasons for the same.
- Comparing outcomes by first BM element moved: Further study can be delineated by considering a single business model element primarily impacted, i.e., VP,VC, VD or VCA, and exploring in great detail subsequent changes throughout its life to deepen the understanding of ripple effects uncovered over time and identify patterns for a set of companies (sample).

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A

Appendix -A

A.1. Explanation of Trigger Tree - Second Order Codes

1. Regulatory Compliance Requirements (Environmental Laws and Regulatory Triggers)

Trigger Coding Example

> *""We are currently pursuing application in three countries, and there is significant impact on technological requirements for each. For instance, country A requires red coloured wire, whereas Country B requires blue coloured wires for a certain [Part X]. That impacts the type of suppliers we have in each country to cater to those needs." - Company T*

Detailed Description: Regulatory variation in different countries/regions creating challenges on product technology and subsequent partnerships.

First-order code: Facing product technological changes due to varying country-specific regulations.

Second-order code: Regulatory Compliance Requirements.
The triggering event is the varying compliance requirements in different countries that compels company to identify new partners who can satisfy those criterias.

Aggregate Dimension: Environmental Laws and Regulatory Triggers

2. Market saturation or decline (Market Trigger)

Trigger Coding Example

> *""We strongly believed in that the market for [market X] was gonna explode, like [application X] needs a lot of power...But time on time, on time we just found out that in the end they wouldn't go through...this is not gonna work and then we just decided to stop the contract of the of the people doing business" - Company G*

Detailed Description: Withdrew from an emerging market after recognizing high costs, low demand and misaligned customer expectations.

First-order code: Exiting market due to cost and customer demand misalignment.

Second-order code: Market saturation or decline.
The triggering event is the saturating market possibilities due to constant product-customer misalignment in requirements.

Aggregate Dimension: Market Triggers

3. New Market Opportunities (Market Trigger)

Trigger Coding Example

> *"So when we supply our customers in [Country X] or [Country Y] or [Country Z] With installations, and those customers need on site support, we need to fly to those countries. And for one plant, thats OK, but as we, you know, scale up, you need some local Presence there. Either by employing people in [country X or Y] ourselves, or by using a partner that can help us with local support of our customers and we are only doing this." - Company N*

Detailed Description: New partnerships created to expand to new geographical region.

First-order code: Developing new partnerships to expand to new geographical region.

Second-order code: New Market Opportunities.
Access to new market acts as an external trigger for company to invest and focus on building new partnerships.

Aggregate Dimension: Market Triggers

4. Customer pricing model and cost expectation (Resource and Financial Triggers)

Trigger Coding Example

> *"You also have customers that are sort of they you come in touch with them. They're really interested, but they just want to own the asset because their business model works basically on CapEx. We focused on rental in the beginning. And we recently added resell and and lease as some some people are just waiting to get really long commitments and then we are also willing to to drop the price. So in that sense it's just a way to create bigger vendor lock in and at the same time also like sort of increase our partner portfolio" - Company G*

Detailed Description: Expanded from single revenue model to multiple revenue models to accommodate varying customer preferences.

First-order code: Expanding revenue models for customer financial flexibility.

Second-order code: Customer pricing model and cost expectation.
Pricing model expectation of customers acts as a trigger for company to rethink their revenue model.

Aggregate Dimension: Resource and Financial Triggers

5. Technological Limitation (Technological Trigger)

Trigger Coding Example

> *"So, for the initial idea here were several components, that were pre-ordered and we had to stop these orders because they were outdated and wouldn't fit the market's needs anymore. Yeah. So now we are actually in the process of connecting to new suppliers as well. so we are in the process of building up several say partnerships with suppliers, but also quitting some." - Company B*

Detailed Description: Obsolete product components forced supplier changes, ending some partnerships while establishing new ones.

First-order code: Changing partnerships and suppliers due to obsolete nature of product components.

Second-order code: Technological Limitation.
Outdated technology for developing the product poses as a limitation and external trigger, resulting in company forming new partnerships for newer technology

Aggregate Dimension: Technological Trigger

A.2. Explanation of Pivot Gioia Tree - Second Order Codes

1. Rebuilding Collaborative Networks - Company Resource and Financial Pivot

Pivot Coding Example

> *"So, for the initial idea here were several components, that were pre-ordered and we had to stop these orders because they were outdated and wouldn't fit the market's needs anymore. Yeah. So now we are actually in the process of connecting to new suppliers as well. so we are in the process of building up several say partnerships with suppliers, but also quitting some." - Company B*

Detailed Description: Obsolete product components forced supplier changes, ending some partnerships while establishing new ones.

First-order code: Changing partnerships and suppliers due to obsolete nature of product components.

Second-order code: Rebuilding Collaborative Networks.
In response to outdated technology for developing the product, company undergoes forming new partnerships for newer technology

Aggregate Dimension: Company Resource and Financial Pivot

2. Repositioning Commercialization Strategy - Company Resource and Financial Pivot

Pivot Coding Example

"(Hybrid Power Plant): We believed that If we need to bump up reliability, or if we need to be independent of only [natural resource X], then we still need to be aware that there are other competitive alternatives.... Then we need to be aware that we can maybe make a hybrid plant where we combine the few things that that I just mentioned and offer that as a total solution, and thats what we are aiming to offer with this plant." - Company K

Detailed Description: Exploring hybrid solutions while prioritizing core technology to enhance reliability, mitigate risk and fulfil customer needs.

First-order code: Adopting hybrid commercial model to balance risk and reliability.

Second-order code: Repositioning Commercialization Strategy.
Company changed its strategy of offering the technology to its customers via means of hybrid solution to reduce risk.

Aggregate Dimension: Company Resource and Financial Pivot

3. Revenue Model Diversification and Optimization - Company Resource and Financial Pivot

Pivot Coding Example

"(Rental model) we did the market segmentation, and upon asking potential clients we found that the most promising market wanted that, i.e., The energy-as-a-service model....So that is why we are trying to get the rental phase to work, which is still a small adaptation, but a smaller gap than going for a purchase." - Company K

Detailed Description: Adopted a revenue model to match customer preferences, ensuring market fit and enabling future growth opportunities.

First-order code: Adopting new revenue model upon customer feedback.

Second-order code: Revenue Model Diversification and Optimization.
Company changes their revenue model upon feedback from customers for a preferred purchase mechanism

Aggregate Dimension: Company Resource and Financial Pivot

4. Creating New Technology or Product to Meet Targeted Demands - Product Technological Pivot

Pivot Coding Example

"With usage and understanding market, pretty quickly, we recognize that we needed to have different skills of technology for different types of [Customer X]. And we also recognize that when the scale of a plant comes down, then of course the amount of [Fuel X] that you produce will also be less And then there is a shift in optimization....So hence we needed to change some of the technology for smaller size plants. And that's what we've done, yeah" - Company N

Detailed Description: Developing new technological solutions to cater to various customer segments.

First-order code: Developed a new product in response to customer demand.

Second-order code: Creating New Technology or Product to Meet Targeted Demands.
Company created new technology to meet the technical needs of smaller product as a response to customer demand

Aggregate Dimension: Product Technological Pivot.

5. Product Line Expansion - Product Technological Pivot

Pivot Coding Example

> *"The product offer changed over the years due to advancing technology and market possibilities. For example, our product in addition to [Output X] can now also produce [Output Y], increasing the application of output" - Company B*

Detailed Description: New technology utility developed in existing product and capitalizing the new feature for product portfolio expansion.

First-order code: Expanding product portfolio by leveraging evolution of technology in market.

Second-order code: Product Line Expansion.
Company could diversify their product offering due to evolving technology in market

Aggregate Dimension: Product Technological Pivot.

6. Product Termination due to Technical Limitations - Product Technological Pivot

Pivot Coding Example

> *"...we decided to invest in [Product line X]. The product by itself is a fantastic product. It's just that it is fairly expensive to build, and then especially when you put it in perspective to the amount of energy that it can produce. So there we need mass production to get the cost down, but then we also need quite a lot of space and customer size to install this. And yeah, that's just really hard today. So we we've tried to push it, but yeah, there's just very limited success on that, so, we are you know, dialing it down now" - Company K*

Detailed Description: Pursued a high-potential product but faced limited market success due to expensive costs and space constraints, causing product termination.

First-order code: Facing product termination due to scalability issue caused by technology limitation.

Second-order code: Product Termination due to Technical Limitations.
Firm decides to terminate a product due to technological limitations

Aggregate Dimension: Product Technological Pivot.

7. Targeting Alternative Customer Segments - Market Outlook Pivots

Pivot Coding Example

> *"We expanded our market to minimize risk....By changing the end use, what it does is it means that you can, as I say, you can get much faster market. You can shorten those time frames. it means as we're scaling up production, we can have off takers that require much smaller amounts....They also have a different price point, which is important as well, because if you're supplying in smaller amounts for a more niche market, you can get more for your your product. So they have a very different price point Per unit of what we're selling" - Company E*

Detailed Description: Diversified customer base to minimize risk by accelerating market entry and optimizing production and finances.

First-order code: Diversifying customer segments to improve pricing flexibility.

Second-order code: Targeting Alternative Customer Segments.
Company targets various other customer segments from the complex value chain it operates in, to reduce their risks of unique customer financial possibilities and limitations

Aggregate Dimension: Market Outlook Pivots.

8. Adapting to Shifting Market Adoption - Market Outlook Pivots

Pivot Coding Example

> *"What we've really experienced is that today there's quite a bit of headwinds for everything that has to do with environmental sustainability, which was pretty strong actually the past two years and especially last year It was like a massive election year....And you also saw that a lot of our partners were sort of putting their foot on the brake with with further expansion of the of the product offering via [Company G] because they first needed to understand and find out in what situation we will be after elections" - Company G*

Detailed Description: Volatile market condition due to shifting sustainability priorities and political (election) driven regulatory changes, causing inconsistent expansion of product offering.

First-order code: Irregular business expansion due to volatile sustainability, regulatory and political changes.

Second-order code: Adapting to Shifting Market Adoption.
Unsure investor confidence and market adoption of product, due to uncertain regulations and election results, company had to adapt its operations to match slower rate of adoption.

Aggregate Dimension: Market Outlook Pivots.

A.3. Explanation of Opportunity-Threat Gioia Tree - Second Order Codes

1. Government Regulatory Support Enabling Market Expansion and Adoption - Opportunity

Opportunity Coding Example

> *"We see in the [Policy X]] for example that [Market X] gets funding to buy a sustainable equipment or renewable equipment, the same market that our product is in. So we try to pursue that market because we become just easier to reach and more price competitive." - Company K*

Detailed Description: Company targets subsidy-backed markets to enhance product competitiveness and increase accessibility.

First-order code: Government green funding opens market opportunities.

Second-order code: Government Regulatory Support Enabling Market Expansion and Adoption.
Government policy and funding poses as a good opportunity, increasing the market adoption by reducing the cost of equipments for customers

Aggregate Dimension: Opportunity

2. External Funding Supports Company Expansion - Opportunity

Opportunity Coding Example

" In year four we received series-A investment round, so from a financial point of view, that was the big milestone because what that allowed us to do was really to fund the scale up of the company. We've doubled in size in that period, but it's also about scaling up the engineering of our process. Up till then, we're working on a pilot line, relatively small amounts. And this money, that's from the Series A allows us to scale up to the next phase and that allows us therefore to have clients which demand more product" - Company E

Detailed Description: Investment by external party fueling scale-up of company commercial operations.

First-order code: Investment funding strengthens company expansion.

Second-order code: External funding supports company expansion.

Aggregate Dimension: Opportunity

3. Technological and Operational Limitations - Threat

Threat Coding Example

"There was one part that was quite expensive (information redacted)... Yeah, again, that part is actually, was actually quite expensive to make and also didn't produce a lot of electricity. So that was not a lot of value for the investment, and we decided to stop developing that." - Company B

Detailed Description: Product was stopped from developing further due to expensive nature and not enough value offering.

First-order code: Product termination due to high manufacturing costs.

Second-order code: Technological and Operational Limitations.

Aggregate Dimension: Threat

4. Market Demand Misalignment - Threat

Threat Coding Example

"So also what I learned now from our potential customers and for most of them, the [X capacity] is too small. Like it doesnt impact enough on what they need, so their energy demand is higher than what we can deliver with the [X capacity]. So thats where we at right now, trying to increase the capacity to target their needs" - Company K

Detailed Description: Existing product size inadequate according to customer feedback, prompting development of a more suitable technical solution.

First-order code: Product too small for market needs.

Second-order code: Market Demand Misalignment.

Aggregate Dimension: Threat

A.4. Explanation of BMI-BMA Gioia Tree - Second Order Codes

1. Realigning target markets - Business Model Adaptation

Business Model Adaptation

"....but it was not out of an urgent need that we went for this market. It was more that we see that we can have a more expensive product and a more or higher electricity price In this market, so it aligns with our road map that once we scale up and our costs come down, more markets will unlock and in the end we can scale in more different markets. But for now, it was just A matter of seeing which market has the most urgent need for our product and see which one is willing to pay the highest price for that."" - Company K

Detailed Description: Targeted markets based on demand urgency, revenue possibilities, and forecasting scaling opportunities.

First-order code:Targeting markets based on urgency and growth potential.

Second-order code: Realigning target markets.
Company adjusting their access to new markets based on better revenue possibilities

Aggregate Dimension: Business Model Adaptation

2. Regulatory-Driven Model Adjustments - Business Model Adaptation

Business Model Adaptation

"We have a product that we can market on the evidence of the sustainability we have done, life cycle assessments etc of our product. But we also have to keep abreast of all the changes that are coming in sustainability reporting in ESG reporting. Its surprisingly even for an SME, its a surprisingly heavy workload....There is actually quite a workload on sustainability reporting on ESG reporting for the company" - Company E

Detailed Description: Uncertainty in environmental regulations creating challenges in business administration and product approvals.

First-order code: ESG reporting imposes a heavy administrative adjustments.

Second-order code:Regulatory-Driven Model Adjustments.
Heavy requirements of ESG practices compels company to adapt their business model to stay aligned

Aggregate Dimension: Business Model Adaptation

3. Transforming Revenue Capture Mechanism - Business Model Innovation

Business Model Innovation

> *"So the main thing also what happened when we moved to the [Country Y] early 2023, we shifted our market approach from direct to indirect. This is mainly that we found like a handful of rental companies that rent out our products, meaning that we are really light on team and can deploy a lot of assets with a really limited amount of people on the ground. Whereas in [Country X] still today and also since 2018 we really focused on the direct channels, which, need a lot more work before they bring up contracts."" - Company G*

Detailed Description: Transitioned the sales strategy and revenue model in a new country due to favorable new partner networks for high scale deployment with minimal resource investment.

First-order code:Transitioning sales model in new market using partner networks.

Second-order code: Transforming Revenue Capture Mechanisms.
Company found novel ways to sell their product, further facilitating them to keep the team light and reduce the overhead costs.

Aggregate Dimension: Business Model Innovation

B

Appendix B

B.1. Invitation Email

B.2. Informed Consent Form Example

Outlook

TU Delft - Research on Business - Brief Interview

From Bhavesh Abhang <B.E.Abhang@student.tudelft.nl>
Date Wed 2 Apr 2025 15:59
To [redacted]

[redacted]

Dear team,

I got in touch with [redacted] recently over phone and was directed towards email to discuss my case. My name is Bhavesh Abhang, and I am a Master's student in Management of Technology (TPM) at TU Delft.

Under guidance of the Delft Center for Entrepreneurship (DCE), I am researching on how Dutch Sustainable Energy-Tech companies respond to external events (e.g., Market changes, customer demands, technology advancements) that influences company's business model. We firmly believe [redacted] and energy [redacted] field would be highly valuable for research.

Surprisingly, very little research has explored the effects of these external impacts on a company's business model and its chain reaction throughout the company. My study therefore aims to understand how Product, People and Price - core elements of business model - are affected and interlinked when external situations change.

Given [redacted] exponential growth in energy storage and partnerships with organisations like [redacted] your rich experience of this industry and technology would be highly valuable for furthering the research, and a **short 30-45min interview** shall be immensely helpful. We can meet online or, if you prefer, over coffee at a location convenient for you - whichever suits you best.

I would also like to **emphasize** that for [redacted] best interest, the interview can be **completely anonymised** and **no** product name, product type, market operation, current regulatory scenario, customer background, financial information, strategy (unique to the company), previous events and future outlook shall be discussed during the interview. Thus ensuring [redacted] privacy and complete protection, wherever needed.

Why this matters:

- It highlights the agility needed to adapt a sustainable-tech business model.
- Provide deeper understanding on how one change can set off chain reaction for the entire company.
- Actionable insights for navigating industry changes.

If you're open to participating, please let me know a few suitable dates/times. I'm also happy to share interview guide and more details/answer your questions. Thank you in advance for considering this, and looking forward to the potential of sharing knowledge.

Best Regards,

Bhavesh Abhang

M.Sc. Management of Technology

Figure B.1: Example of invitation email sent to companies

Informed Consent Form

You are being invited to participate in a research study titled "Pivots in Dutch Sustainable Tech Startups/Scaleups: Investigating External Triggers Causing Pivots in Business Model". This study is being conducted by Bhavesh Abhang, a Master's student at TU Delft, Faculty of Technology, Policy and Management, under the supervision of Dr. Hanieh Khodaei. This research is part of the graduation thesis for the MSc Management of Technology programme.

The research focuses on studying the pivots caused by external triggers on business models of new-age sustainable-tech startups/scaleups by understanding the snowball effects on different elements of BM. The interview will take approximately 30-45 minutes to complete.

You will participate in a semi-structured interview focusing on external triggers that impacts your firm's business model. Your participation is voluntary, and you may choose not to answer any questions you are uncomfortable with. With your consent, the interview will be recorded and transcribed, after which an anonymous summary will be prepared and shared with you for review. You are welcome to suggest modifications before it becomes publicly accessible as part of the MSc thesis. The collected data may also be reused for future research and educational purposes on business models of energy based sustainable-tech firms, but all outputs will ensure your anonymity. All personal data will be stored on TU Delft's institutional storage, accessible only to the research team.

As with any online activity, there is a minimal risk of data breach, but we will take all necessary precautions to maintain confidentiality. No personal identifiers, such as names or gender, will be included in the published results. Interview recordings will be securely stored on password-protected university servers, and all data will be anonymized during analysis and used solely for academic purposes. However, due to the niche nature of your work, there remains a small possibility that individuals familiar with the field could infer your identity.

Your participation is entirely voluntary, and you can withdraw at any time. If you choose to withdraw, you may request the removal of your data within a week after the interview. Please note that data collected from you will be retained for a period of 1 month following the completion of the study, after which it will be securely deleted.

By participating in the interview, you acknowledge that you have read and understood this information and agree to participate in the study under the conditions stated above.

If you have any questions about this study or your participation, please contact:

Corresponding Researcher:
Name: Bhavesh Abhang
E-mail: [redacted]

Responsible Researcher:
Name: Dr. Haineh Khodaei
E-mail - [redacted]

X

Name

Designation

Figure B.2: Informed consent form