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Faculty of Business Economics

Master of Management

Master's thesis

Decision models for strategic entrepreneurship

Achraf Yassine El Ghilali
Faith Thecla Nakiyingi

Thesis presented in fulfillment of the requirements for the degree of Master of Management, specialization Strategy and Innovation Management

SUPERVISOR :

Prof. dr. Yannick BAMMENS

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ADAPTING DECISION MODELS IN HIGH-TECH STARTUPS: A CONTINGENCY-BASED FRAMEWORK

2025

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MASTER OF MANAGEMENT: STRATEGIY & INNOVATION MANAGEMENT

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ABSTRACT

High-tech startups operate in dynamic environments where established decision models (e.g., effectuation, lean startup, design thinking, causation) often prove insufficient when applied in isolation due to varying contingencies like lifecycle stage and uncertainty. This study examined how these decision models, and their pragmatic hybrids, effectively guide strategic decision-making in such ventures. Employing a qualitative multi-case study design with ten Belgian high-tech startup founders, this research adopted a contingency-based lens to identify gaps in existing approaches. The core output is an empirically grounded framework that explains how startups adapt and combine decision logics. This framework highlights five key interacting dimensions: Venture Context & Contingencies, Founder Influence & Orientation, Organizational Capabilities & Structure, Entrepreneurial Learning & Process Adaptation, and Strategic Decision Logics & Responses. The findings reveal that hybridity is an adaptive necessity driven by specific conditions and that model applicability evolves across the startup lifecycle. This research offers actionable insights for practitioners and enriches the academic understanding of contingent decision-making in uncertain entrepreneurial contexts.

KEY THEMES

Entrepreneurial Decision Models: Strengths, limitations, and critiques.
Contingency Perspective: When and why decision models need adaptation.
High-Tech Startup Context: Lifecycle stages, risks, and innovation pressures.
Hybrid Decision Framework: Developing and validating a novel, integrated model.

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
B2B	Business-to-Business
CEO	Chief Executive Officer
CTO	Chief Technology Officer
FFF	Friends, Family, and Fools (Investment)
FIT	Flanders Innovation & Trade
HR	Human Resources
IoT	Internet of Things
IP	Intellectual Property
KPI	Key Performance Indicator
MVP	Minimum Viable Product
NTBF	New Technology-Based Firm
PMF	Product-Market Fit
R&D	Research and Development

RQ Research Question

SaaS Software-as-a-Service

VC Venture Capital

VLAIO Agentschap Innoveren & Ondernemen (Flanders Innovation & Entrepreneurship)

CHAPTER 1: INTRODUCTION

"Startups are not smaller versions of large companies. They are temporary organizations designed to search for a scalable and repeatable business model." (Blank, 2018, June)

The dynamism of innovation and high-tech startups, particularly within the European ecosystem, is a field that is constantly evolving, and at a very fast pace. The emphasis on agile and adaptable decision-making frameworks highlights the need to understand how these ventures navigate the turbulent waters of today's fast-paced markets.

The proliferation of high-tech startups in recent years is undeniable, fueled by globalization, technological advancements, and an ever-growing demand for disruptive solutions. These startups, often operating on the fringes of established industries, are pivotal in driving innovation and reshaping the technological environment. They are, in essence, the crucibles of the 21st century, where groundbreaking ideas are forged and brought to life (Baumol, 2014).

However, the very nature of high-tech startups characterized by prolonged R&D cycles, inherent technological uncertainties, and the relentless pace of innovation-presents unique challenges (Peykani, Namazi, & Mohammadi, 2022). These businesses must confront not just the standard challenges encountered by any new enterprise but also the complexities of emerging technologies and changing market conditions. These unique challenges faced by high-tech startups highlight the limitations of relying solely on traditional decision-making models.

Within this set of circumstances, various decision-making models have emerged, each offering a structured approach to navigating uncertainty. Effectuation, with its emphasis on leveraging available resources (Sarasvathy, 2001);Lean Startup, advocating for iterative learning and adaptation (Ries, 2011); and Design Thinking, with its user-centric and empathetic approach (Brown, 2008), have all gained prominence. Yet, their standalone applicability often falters when confronted with all the contingencies that high-tech startups face, such as the specific stage of their lifecycle, the nuances of their industry, and the level of uncertainty they encounter (Cocchi, Dosi, & Vignoli, 2023; Ousghir & Daoud, 2022).

This study explored these decision-making models, seeking to understand the conditions under which they can be most effectively employed, either individually or in combination, within the specific context of high-tech startups. Moreover, we looked at the different lifecycle stages, and how the decision-models can be adapted. The research is motivated by a desire to bridge the gap between theoretical frameworks and the practical realities faced by high-tech startups, offering a contingency-based lens through which to view decision-making in these dynamic environments. It is further driven by the recognition that, while much has been written about the individual merits of effectuation, lean startup, and design thinking, there remains a notable absence of a comprehensive, hybrid framework adapted to the unique challenges and opportunities that characterize the high-tech startup ecosystem (Ghezzi & Cavallo, 2020).

The scope of this introductory chapter is to establish the context of decision-making within high-tech startups, highlighting the limitations of existing models and underscoring the need for a more

nuanced, adaptable approach. By examining the interaction between different decision-making frameworks and the specific contingencies they face, this research aims to contribute to a deeper understanding of how high-tech startups can effectively navigate uncertainty, foster innovation, and achieve sustainable growth.

1. STATEMENT OF THE PROBLEM

High-tech startups operate in a fast-paced, unpredictable environment and they face extended research and development cycles, big technological challenges, and intense pressure to innovate quickly (Peykani, Namazi, & Mohammadi, 2022). These challenges are amplified by the fact that many high-tech startups are founded on innovative technology with unknown market potential.

Established decision-making models like effectuation (Sarasvathy, 2001), lean startup (Ries, 2011), and design thinking (Brown, 2008) offer frameworks for navigating this uncertainty. Effectuation suggests leveraging available resources and forming partnerships to shape new opportunities. Lean startup emphasizes iterative learning and customer feedback to validate business models. Design thinking focuses on user-centric problem-solving and fast prototyping.

However, these models, when used in isolation, often fall short in the context of high-tech startups. Their limitations become apparent when confronted with the specific contingencies of different startup lifecycle stages and the varying demands of diverse industries. For instance, effectuation's strength in early-stage, highly uncertain environments may become less effective as a startup matures and requires more structured planning (Fukugawa, 2018). Similarly, while lean startup excels at iterative product development, it offers limited guidance for managing the complexities of scaling a high-tech venture (Picken, 2017). Design thinking, with its user-centric approach, may not fully address the rapid technological shifts and scalability needs inherent to high-tech environments (Ousghir & Daoud, 2022).

Moreover, the existing literature lacks a comprehensive framework that integrates these models into a coherent, adaptable approach. This deficiency leaves founders without a clear guide on how to link these frameworks effectively, especially when facing critical decisions at different stages of growth. The gap is particularly evident in high-tech startups, where long R&D cycles, high technological uncertainty, and rapid innovation demands are common.

Consequently, high-tech startups often struggle to align their strategic goals with their operational realities. They may over-rely on a single decision-making model that is not well-suited to their current context, leading to inefficient resource allocation, missed market opportunities, and potentially, venture failure. This situation highlights the urgent need for a contingency-based hybrid framework that can adapt to varying conditions and startup stages, ultimately enhancing their ability to navigate uncertainty and achieve sustainable growth. This study seeks to address this need by developing a framework that integrates the strengths of multiple decision models while accounting for the unique challenges of the high-tech startup environment.

2. RESEARCH QUESTIONS

Main Research Question:

- How can decision-making frameworks be integrated and adapted across the lifecycle stages of high-tech startups to effectively navigate uncertainty and achieve innovation goals?

Sub-Research Questions:

- How do lifecycle stages influence the applicability and effectiveness of decision models like effectuation, lean startup, and design thinking within the high-tech context?
- Under what conditions can high-tech startups adopt hybrid decision models to navigate uncertainty and achieve innovation goals?
- What gaps exist in current decision-making frameworks for high-tech startups, and how can they be addressed through a contingency-based hybrid approach?

These research questions will guide the study's exploration of decision-making in high-tech startups, focusing on the integration and adaptability of multiple frameworks.

3. OBJECTIVES AND SCOPE OF THE STUDY

The primary goal of this research was to develop a contingency-based hybrid framework for decision-making in high-tech startups. This involved:

- **Evaluating the Relevance of Existing Models:** Assessing the applicability of effectuation, lean startup, and design thinking across different startup lifecycle stages (ideation, scaling, growth).
- **Identifying Gaps:** Pinpointing the limitations of these models when applied in isolation, particularly in contexts characterized by high technological uncertainty, long R&D cycles, and rapid innovation demands.
- **Developing a Hybrid Framework:** Creating a contingency-based framework that integrates the strengths of multiple decision models to address the unique challenges of high-tech startups.
- **Empirically Grounding and Enriching the Framework:** The study employed qualitative methods, including semi-structured interviews with founders of high-tech startups, to provide empirical grounding for the developed framework and enrich its components with detailed participant accounts.

Scope: The study focused on high-tech startups in Belgium at different stages of their lifecycle. Insights are aimed at both academic and practical audiences, with a focus on enhancing decision-making in uncertain environments.

Audience: The insights are aimed at entrepreneurs, investors, policymakers, and researchers. The goal was to provide both theoretical contributions and practical guidance for navigating uncertainty and fostering innovation in high-tech startups.

4. SIGNIFICANCE OF THE RESEARCH

- **For Academia:** This study addresses a significant gap in entrepreneurship literature where decision-making models like effectuation, lean startup, and design thinking are often examined in isolation or limited combinations, frequently lacking a comprehensive framework that explains their integrated and adaptive use contingent upon the specific realities of high-tech startups (Ghezzi & Cavallo, 2020; Fukugawa, 2018).Existing research also offers insufficient empirical insight into how these models are pragmatically blended across varying lifecycle stages and dynamic contexts (Brettel, Mauer, Engelen, & Küpper, 2012) (Cocchi, Dosi, & Vignoli, 2023).This research makes distinct academic contributions by:
    - **Developing an Empirically Grounded Contingency Framework:** It introduces a novel framework (Figure 1) that articulates the dynamic interplay between five core dimensions (Venture Context & Contingencies, Founder Influence & Orientation, Organizational Capabilities & Structure, Entrepreneurial Learning & Process Adaptation, and Strategic Decision Logics & Responses). This provides a structured and holistic lens to understand how decision-making approaches are shaped in high-tech startups.
    - **Advancing the Understanding of Hybridity as a Process:** Moving beyond simply noting the existence of hybrid approaches, this study empirically details *how* hybridity emerges as a pragmatic, learned response. It shows founders selectively borrowing, combining, and sequencing elements from different decision logics based on evolving contingencies, rather than adhering to a single, static model.
    - **Illuminating Lifecycle Stage Contingencies:** The research offers specific empirical evidence on how the applicability and blend of decision models (e.g., increased reliance on effectual principles in early stages, integration of causal planning in later stages) are contingent upon the startup's lifecycle stage, thereby adding critical nuance to the application of these models over time.
- **For Entrepreneurs:** This research provides actionable guidance to high-tech startup founders on how to navigate uncertainty by using tailored decision models that adapt to their specific lifecycle stage and industry context. It offers a practical roadmap for making more informed strategic choices, potentially reducing the risk of venture failure and enhancing innovation outcomes.

- **For Policy and Ecosystems:** The research offers insights that can inform the design of policies and support mechanisms for startup ecosystems. By understanding how decision-making frameworks can be tailored to different stages and contexts, policymakers and ecosystem stakeholders can better foster innovation and support the growth of high-tech startups.

5. METHODOLOGY OVERVIEW

This study employed a qualitative, exploratory approach to examine the contingencies influencing decision-making in high-tech startups. The methodology included:

- **Semi-structured Interviews** were conducted with founders of high-tech startups across different lifecycle stages to gather rich, in-depth insights into their decision-making processes, challenges, and strategies.
- **Thematic Analysis** was used to identify recurring patterns, themes, and gaps in the application of decision models. This involves coding the interview data and synthesizing key findings.
- **A contingency-based framework** was developed based on the empirical findings and existing literature. The framework provides guidelines on when and how to integrate different decision models based on specific contingencies.

6. ORGANIZATION OF THE THESIS

The thesis is structured as follows:

- **Chapter 1: Introduction**
- **Chapter 2: Literature Review**
- **Chapter 3: Research Methodology**
- **Chapter 4: Results**
- **Chapter 5: Discussion**
- **Chapter 6: Conclusions**

CHAPTER 2 : LITERATURE REVIEW

The modern business environment, particularly for high-tech startups, is characterized by increasing complexity and uncertainty. This reality demands a move away from traditional, predictive decision-making approaches towards more adaptable and iterative models (Peykani, Namazi, & Mohammadi, 2022; Ousghir & Daoud, 2022). This chapter reviews the relevant literature on decision-making models and contingency perspectives, laying the groundwork for understanding how these models can be integrated and applied to the unique challenges faced by high-tech startups. These models are examined, progressing from those best suited to high-uncertainty environments to those that incorporate more structured approaches - a conceptual framework mirroring an "uncertainty pyramid," where the apex represents the highest levels of ambiguity, and the base represents greater structure and predictability.

1. OVERVIEW OF DECISION MODELS

This section provides an overview of four key decision-making models that have gained prominence in the entrepreneurial and innovation literature: effectuation, design thinking, lean startup, and causation (traditional methods). Each model offers a distinct approach to navigating uncertainty and making decisions, each possessing its own strengths and weaknesses. Understanding these approaches individually is crucial before exploring their potential integration in a hybrid framework.

1.1. EFFECTUATION

Effectuation provides a distinct approach to entrepreneurial decision-making, particularly valuable in uncertain environments where high-tech startups operate. Rather than relying on prediction and planning, effectuation emphasizes leveraging existing resources, adapting to change, and co-creating opportunities with stakeholders. There is a lot of research done on this particular decision model because the practices have commonly been adopted by expert entrepreneurs. We see that the concept first appeared in Sarasvathy's writing where she explains it in depth (Sarasvathy, 2001).

KEY PRINCIPLES AND CONCEPTS

Effectuation, as articulated by (Sarasvathy, 2001), presents a logic of entrepreneurial expertise that contrasts with traditional, predictive approaches to business development. It posits that expert entrepreneurs, when faced with uncertainty, do not attempt to predict the future but rather focus on controlling aspects of an unpredictable future. At its core, effectuation is a non-predictive decision-making logic: It inverts the traditional approach of setting a specific goal and then gathering the necessary resources. Instead, effectual entrepreneurs begin with their available means and allow goals to emerge over time (Sarasvathy, 2001).

The organization is dependent on various external factors that can be hard to predict, making it difficult for decision makers to have preferences. With uncertainty, the outcomes are not known therefore probabilities cannot be estimated. The most reliable model in this case is effectuation where entrepreneurs focus on what is controllable, the available means rather than forecasting (Dew, Sarasathy, Read, & Wiltbank, 2009).

Effectuation is also said to be an alternative approach to traditional entrepreneurship theories, which tend to emphasize planning, prediction, and control. Instead, effectuation focuses on how entrepreneurs start with what they have namely their means, makes use of the presently available means to start up something (Klenner, Gemser, & Karpen, 2022). The theory enables resource-poor entrepreneurs to create new firms amidst a lot of uncertainty. The effects of the created firm align with the aspirations of the entrepreneur with invests that they are willing to lose, but also, a number of effects can be possibly created despite the initial goal (Arend, Sarooghi, & Burkemper, 2015). Decision makers practice continuous learning from dynamic environments, mainly paying attention to their current situation and adapting to changes that develop with a lot of flexibility which enhances firm performance compared to that of competitors (Wiltbank, Dew, Read, & Sarasvathy, 2006).

(Sarasvathy, 2001) mentions a set of guiding principles to adapt and co-create opportunities in a dynamic context. These principles, derived from studies of expert entrepreneurs, provide a framework for understanding how to act under uncertainty (Wiltbank, Dew, Read, & Sarasvathy, 2006; Sarasvathy, 2001). They guide entrepreneurs to act and make decisions based on available resources, acceptable losses, and emerging partnerships, rather than being driven by pre-defined goals. The key principles are:

- **Bird-in-Hand Principle:** This particular principle emphasizes that entrepreneurs should start with what they have to create the future. It could be their knowledge, expertise and network (Klenner, Gemser, & Karpen, 2022). These can be utilized to create something of value thus availing entrepreneurs with opportunities to get started. This is contrary to causation which states that a goal should be set then gather resources to work towards it (Sarasvathy, 2001). Entrepreneurs begin by assessing their available means: "Who am I?", "What do I know?", and "Whom do I know?". This includes their personal traits, tastes, abilities, knowledge, experience, and social network (Sarasvathy, 2001).

- **Affordable Loss Principle:** Effectuation being viable in uncertain conditions, it is difficult to calculate returns of a given venture making it impossible to select the most profitable alternative, therefore the entrepreneur makes investments with only what he can afford to lose as a way of overcoming risk. They are discouraged from investing too much with hope of making profit which can be lost due to market uncertainty (Chandler, DeTienne, McKelvie, & Mumford, 2011; Dew, Sarasathy, Read, & Wiltbank, 2009). Rather than focusing on maximizing potential returns, effectual entrepreneurs determine in advance what they are willing to lose and use this as a criterion for selecting between possible actions and opportunities (Dew, Sarasathy, Read, & Wiltbank, 2009).

- **Crazy Quilt Principle:** Together with stakeholders, entrepreneurs are in position to create new opportunities. Forming partnerships with them (founders, customers, investors) enables the entrepreneur to create a desired future by combing resources and limit uncertainty (Read & Sarasvathy, 2005). The entrepreneur

maintains flexibility and can only control events through working together with others. By this, commitments are obtained in advance from reliable stakeholders (Chandler, DeTienne, McKelvie, & Mumford, 2011). Effectuation emphasizes building partnerships and pre-commitments with self-selecting stakeholders and through this co-creation process, the venture's goals are shaped, and uncertainty is reduced (Read & Sarasvathy, 2005).

- **Lemonade Principle:** The principle emphasizes that entrepreneurs embrace surprises as opportunities to innovate and grow. Startups operate in dynamic situations and being flexible is one way to beat the uncertainty by seeing the good in every situation (Read & Sarasvathy, 2005). Unexpected events are not seen as deviations from a plan, but as potential sources of new opportunities. Entrepreneurs leverage contingencies and adapt their goals and strategies based on new information (Read & Sarasvathy, 2005).

- **Pilot-in-the-Plane Principle:** Entrepreneurial actions and decisions can create an ideal future; with this they gain control of what lies ahead unlike predicting what is likely to happen. They can pay attention to situations they can control other than those they can't like external factors. (Wiltbank, Dew, Read, & Sarasvathy, 2006). This principle emphasizes the entrepreneur's control over the future. Rather than trying to predict an uncertain future, entrepreneurs focus on actions they can take to shape it (Wiltbank, Dew, Read, & Sarasvathy, 2006).

The five principles encourage entrepreneurs to navigate uncertainty by adapting to market changes and creating a desired future through collaborations. Overall, effectuation encourages entrepreneurs to make practical decisions to overcome uncertainty and adapt to constantly changing market. This is the true nature of an entrepreneur (Read, Dew, Sarasvathy, Song, & Wiltbank, 2009). These principles, taken together, provide a non-predictive approach to venture creation, contrasting sharply with the traditional, causation-based approach that emphasizes planning and prediction.

Strengths:

- High degrees of adaptability and flexibility which are needed in highly uncertain stages.
- Focuses on control rather than prediction.
- Allows changes along the way.
- Build collaborations and partnerships.

APPLICATION IN HIGH-TECH STARTUPS

Effectuation is often seen as particularly well-suited for high-tech startups due to the inherent uncertainty and dynamism of these environments (Ghorbel, Hachicha, Boujelbene, & Aljuaid, 2021). The emphasis on leveraging available resources, adapting to change, and co-creating value with stakeholders aligns well with the challenges and opportunities faced by these ventures.

However, even in high-tech contexts, a purely effectual approach may need to be complemented by other decision-making models as the startup matures and scales (Fukugawa, 2018). The findings also align with (Varadarajan, 2020) who explore the link between effectuation and design thinking, they both have an iterative nature, and value human interaction and collaboration.

1.2. DESIGN THINKING

Design thinking is a creative approach that is customer centric, it aims at solving the users' problems at hand. By the entrepreneur exploring the environment around, they are able to identify a challenging situation that needs attention. Design Thinking is fundamentally a human-centered, iterative problem-solving approach that prioritizes understanding user needs and developing innovative solutions that meet those needs (Beckman & Barry, 2007; Brown, 2008). Unlike traditional, linear approaches to problem-solving, Design Thinking embraces ambiguity, encourages experimentation, and emphasizes learning through continuous feedback loops. It is presented as a problem-solving methodology that can be applied not just to the product design or graphics but across a wide range of disciplines including business, health care and social innovation (Vnukova, Makovoz, Vakareva, & Kuzmenko, 2021; Brown T & Katz, 2011).

KEY PRINCIPLES AND CONCEPTS

Design Thinking is not just a process, it's also a mindset (Schweitzer, Groeger, & Sobel, 2016). It's about adopting a particular way of thinking and approaching problems. According to (Carlgren, Rauth, & Elmquist, 2016), Design Thinking follows principles of user focus, problem framing, visualization & prototyping, experimentation and iteration for it to be executed. Key principles and characteristics that define this mindset and process are as discussed below:

- **User-Centricity/Empathy:** Research for design thinking is mainly ethnographic by directly observing the routine and behavior of users (Suri & Howard, 2006; Beckman & Barry, 2007). This involves immersing oneself in the user's world, observing their behaviors, and understanding their needs, motivations, and pain points. Design Thinking places the user at the very core of the innovation process and this involves actively seeking to understand the user's needs, motivations, and pain points through various research methods, such as ethnographic observation, interviews, and user journey mapping (Beckman & Barry, 2007; Brown, 2008).

- **Problem Framing:** A problem is identified, and solutions are figured to fix it. Rather than accepting a problem as given, Design Thinking encourages a critical examination of the problem itself, often reframing it to uncover new opportunities and perspectives (Brown, 2008).

- **Diversity and Collaboration:** The model bases on user focus, which involves critically identifying the needs and behaviors of users of a particular product or service. Design Thinking thrives on diverse perspectives and encourages collaboration among individuals with different backgrounds, skills, and experiences to generate a wider range of ideas and solutions (Buhl, et al., 2019). Different experts from diverse teams come together to develop the product (Buhl, et al., 2019).

- **Ideation and Experimentation:** Through visualization, samples or a prototype are developed to experiment if the tangible ideas are going to work for the users. Design Thinking promotes a bias towards action and experimentation. It encourages the generation of a wide range of ideas, followed by rapid prototyping and testing to gather feedback and iterate on solutions (Carlgren, Rauth, & Elmquist, 2016; Brown, 2008).
- **Prototyping and Iteration:** By iterating products, prototyping aims to explore and improve various solution ideas (Geissdoerfer, Bocken, & Hultink, 2016). This phase is done with limited resources because the product is still under development, and its main purpose is collecting accurate feedback from users and developing teams (Buhl, et al., 2019). Prototyping is not just about creating a final product; it's about creating tangible representations of ideas that can be tested and refined. This iterative process of prototyping, testing, and learning is central to Design Thinking (Geissdoerfer, Bocken, & Hultink, 2016; Buhl, et al., 2019).
- **Experimentation and iteration:** The fifth and last principle, here the entrepreneur focuses on failing many times in the beginning stage rather than much later to get a better version of the product and all the initial trails are abandoned (Buhl, et al., 2019).

While Design Thinking is not a rigid methodology, it is often associated with a specific process, commonly represented by the "Double Diamond" model (Council, 2007) or the "Three I's" model (Brown, 2008). These models emphasize the iterative and cyclical nature of the process that enables entrepreneurs to understand, observe, define, ideate, prototype and test (Geissdoerfer, Bocken, & Hultink, 2016). Design thinking can be disruptive in nature as it involves using different technologies, innovative thinking, design process and available products to create something new for the market (Chou, 2018). The process is not linear and involves going back and forth between different stages based on new insights and feedback (Chou, 2018).

Strengths:

- **User-Centricity:** Design Thinking ensures that solutions are deeply rooted in user needs and preferences, increasing the likelihood of product-market fit.
- **Innovation:** The emphasis on ideation, prototyping, and testing fosters creativity and the generation of novel solutions.
- **Collaboration:** Design Thinking encourages collaboration and the integration of diverse perspectives.
- **Risk Reduction:** The iterative process and early user feedback help to reduce the risk of developing unwanted products.

APPLICATION IN HIGH-TECH STARTUPS

Design Thinking's user-centricity and iterative approach are highly relevant to high-tech startups seeking to create innovative products and services. The design thinking procedure ensures that there is full collaboration of team members, continuous user engagement to acquire more feedback

and respond accordingly with refined designs (Chou, 2018). However, the resource-intensive nature of Design Thinking and its potential limitations in addressing broader market factors and scalability needs must be considered. Integrating Design Thinking with other approaches, such as effectuation and Lean Startup, can create a more comprehensive and adaptable framework for high-tech ventures.

1.3. THE LEAN STARTUP

In the digital economy, whoever learns fastest wins, just like the lean startup model where entrepreneurs are invested in rapid learning, hypothesis testing, minimizing investments at the initial stages of business, customer involvement and use of prototypes to acquire feedback from users as a way of reducing uncertainty, costs and risk, which is contrary to the traditional planning methods (McGrath, 2024). The Lean Startup methodology, popularized by (Ries, 2011), offers a structured approach to this rapid learning and adaptation. It provides a framework for entrepreneurs to systematically test their assumptions, gather customer feedback, and iterate on their business models and products, with the ultimate goal of achieving product-market fit (Blank, 2018, June).

KEY PRINCIPLES AND CONCEPTS

At the heart of the Lean Startup is the idea of validated learning. This means prioritizing learning what works and what doesn't through direct experimentation and customer interaction, rather than relying on assumptions or traditional market research. This approach centers on several key principles (Blank, 2018, June; Ries, 2011):

- **Build-Measure-Learn Feedback Loop:** The core of the Lean Startup approach is the "Build-Measure-Learn" feedback loop, a continuous cycle of developing a minimum viable product (MVP), measuring customer response, and learning from the feedback to iterate and improve the product (Ries, 2011). This iterative cycle is designed to minimize waste and maximize learning by focusing on fast experimentation and customer feedback.
  Minimum Viable Product (MVP): With the increased number of startups to support innovations and technological developments, they have adopted decision models like the lean startup which require less effort when launching products. They rely on developing an MVP at the first stage of the business lifecycle and carry out several iterations to test user needs and wants with the aim of shortening the lifecycle (Lee & Geum, 2021). It is a new methodology that has come up to reduce the risk of going wrong in business. An MVP is not simply the smallest possible product, but rather the version of a new product which allows a team to collect the maximum amount of validated learning about customers with the least effort (Ries, 2011). This is a crucial distinction because the MVP is a tool for learning, not just a simplified product. Andrea goes ahead to define the MVP as an initial product that entrepreneurs use to gain more customer information in terms of feedback with ease (Contigiani & Levinthal, 2019). It is a crucial element of the Lean Startup, as it allows entrepreneurs to test their assumptions and gather feedback with minimal investment (Ries, 2011), and it also emphasizes failing fast and continued learning to increase chances of success in the long run (Blank, 2018, June).

- **Validated Learning:** The lean startup through validated learning, has replaced several processes that were practiced traditionally, for example experimentation, user feedback and product iteration have replaced business planning, intuition and upfront design respectively (Blank, 2018, June). Validated learning is the process of rigorously testing assumptions and hypotheses through experiments and data analysis. It's about gathering empirical evidence to support or refute key aspects of the business model (Blank, 2018, June; Ries, 2011). The method has gained popularity amongst researchers who acknowledge it as an alternative to the long planning and development procedures (Bruton, Pryor, & Cerecedo Lopez, 2024).
- **Pivot or Persevere:** (Tanev, 2017) describes the lean start up as a system that allows entrepreneurs to seek opportunities by testing their product ideas for a particular group of users. Based on the validated learning, entrepreneurs make informed decisions about whether to pivot (change direction) or persevere (continue) with their current strategy. This iterative process allows for continuous adaptation and course correction. The concept is mainly adopted by new startups that want to raise their likelihood of success (Contigiani & Levinthal, 2019).

While the Lean Startup methodology offers a valuable framework for overcoming uncertainty and promoting innovation, it has also faced critiques regarding its limitations in addressing the complexities of different startup lifecycle stages and its applicability in certain high-tech contexts (Ghezzi & Cavallo, 2020). The main concept of this model is the MVP upon which iterations are made with experiments until a desired product is developed without altering the vision of the business, however various strategies can be employed to develop the product or service.

Strengths:

- **Rapid Iteration and Learning:** The Lean Startup enables quick cycles of experimentation, allowing startups to learn rapidly from customer feedback and adapt their product and business model accordingly (Ries, 2011).
- **Reduced Risk:** By focusing on validated learning and testing assumptions early, the Lean Startup minimizes the risk of investing significant resources in unproven ideas (Ries, 2011).
- **Customer-Centricity:** The emphasis on customer feedback and the MVP ensures that the product or service is aligned with market needs (Blank, 2018, June; Ries, 2011).
- **Flexibility**: Lean Startup's inherent flexibility allows startups to efficiently pivot to the most efficient strategy (Contigiani & Levinthal, 2019).

APPLICATION IN HIGH-TECH STARTUPS

The Lean Startup methodology is particularly relevant to high-tech startups due to its emphasis on rapid iteration, customer feedback, and validated learning (Ghezzi & Cavallo, 2020). These principles align well with the dynamic and uncertain environments in which many high-tech startups operate. However, some adaptations may be necessary to address the specific challenges of long R&D cycles, regulatory hurdles, and technological uncertainty.

1.4. CAUSATION

Before going into more contemporary decision-making models, it's essential to understand the traditional approach that has long dominated business strategy and planning, causation.

Causation represents a predictive approach to decision-making, contrasting sharply with the adaptive logic of effectuation (Sarasvathy, 2001). It operates under the assumption that the future can be forecast with reasonable accuracy, allowing entrepreneurs to set specific goals in advance and develop detailed plans to achieve them based on prediction (Racat, Ricard, & Mauer, 2024; Sarasvathy, 2001). Entrepreneurs make rational decisions through setting objectives, making a plan with information obtained through market analysis. The entrepreneur with the best search and implementation skills succeeds most when the theory is applied (Chandler, DeTienne, McKelvie, & Mumford, 2011).

KEY PRINCIPLES

- **Goal-Driven:** Causation starts with a predetermined goal or objective. The focus is on identifying the optimal path to achieve that goal. This contrasts with effectuation, where goals may emerge and evolve over time. The emphasis is on deductive reasoning, starting with a general goal and working towards specific actions (Chandler, DeTienne, McKelvie, & Mumford, 2011).

- **Analysis and Planning:** Traditional methods emphasize extensive analysis of the market, competition, and internal capabilities. This analysis forms the basis for developing detailed plans and strategies. This often includes comprehensive market research, competitive analysis, and financial forecasting (McGrath, 2024). Planning and analysis become essential as uncertainty increases, the more firms aim to accurately predict outcomes, the better they outperform others. Planning is further mentioned as one of the important strategies used to evaluate choices (Wiltbank, Dew, Read, & Sarasvathy, 2006; Dew, Sarasathy, Read, & Wiltbank, 2009). This often involves forecasting, market research, and competitive analysis.

- **Resource Acquisition:** Once a goal is set and a plan is developed, resources are acquired and allocated to execute the plan. The focus is on obtaining the necessary resources to achieve the predetermined objective. Resources are seen as inputs to a predefined process, rather than as starting points for exploring possibilities.

- **Risk Management**: Causation typically involves identifying and mitigating potential risks through careful planning and analysis. Risk is seen as something to be minimized or avoided. This often involves creating contingency plans and building buffers to protect against potential disruptions (Sarasvathy, 2001).

- **Linear Process:** Traditional approaches often follow a linear, sequential process, with clearly defined stages and decision gates. This contrasts with the more iterative and flexible approaches of Lean Startup and Design Thinking, which embrace cyclical processes

and feedback loops. The Stage-Gate process, with its distinct phases and go/no-go decision points, is a prime example of a causation-based approach (Cooper R. G., 1990).

Researchers emphasize that Causation and Effectuation are interconnected and should be used as complements of each other, to predict situations that present the possibility with the former and switch to effectuation for control of uncertain entrepreneurial conditions (Racat, Ricard, & Mauer, 2024). As causation emphasizes goal setting to shape the business environment, effectuation can back it up by providing the ability to make decisions in dynamic and uncertain situations. Entrepreneurs use a hybrid logic by using the two models simultaneously (Sarasvathy, 2001). In situations of high uncertainty, effectuation proves suitable, however, during times of resource abundance, proper planning is required thus the need to use causation.

Major contrasts between Causation and effectuation:

Situation	Causation	Effectuation
Objective	Set a goal	Start with available means
View of external firms	Conduct market analysis with the basis of competition	Crazy quilt, form partnerships with them
Future perspective	Planning and forecasting	Apply flexibility according to situation at hand
Attitude towards competition	Encourages competition	Fights competition by forming partnerships
Attitude towards risk / financial perspective	Focus on gains of the venture (return on investment)	Invest only what entrepreneur can afford to lose
Planning	Exploitation of pre-existing knowledge	Exploitation of contingencies

(Racat, Ricard, & Mauer, 2024; Dew, Sarasathy, Read, & Wiltbank, 2009).

However much it's a planned model, it discourages the entrepreneur from positively responding to unplanned events. The model has no room for surprises thus ineffective towards certain decision-making situations and avoids persistence (Racat, Ricard, & Mauer, 2024). Causation may also limit and miss out on innovation opportunities since the entrepreneur strictly works with a plan and may not deviate from it (Sarasvathy, 2001).

Examples of Causation-Based Methods:

- **Business Plans:** Comprehensive documents that outline a company's goals, strategies, market analysis, and financial projections. These plans serve as a roadmap for achieving a predefined objective, based on extensive analysis and forecasting (Brinckmann, Grichnik, & Kapsa, 2010).

- **Stage-Gate Processes:** Structured, phased approaches to new product development with clearly defined decision points. These processes emphasize control and predictability, with each stage requiring approval before proceeding to the next (Cooper R. G., 1990).
- **SWOT Analysis:** A framework for analysing a company's strengths, weaknesses, opportunities, and threats. This analysis is used to inform strategic planning and decision-making, aiming to maximize strengths and opportunities while minimizing weaknesses and threats (Helms, 2010).
- **Porter's Five Forces:** A model for analysing the competitive forces within an industry. This model helps to understand the competitive landscape and develop strategies for achieving a competitive advantage (Porter, 1980).

APPLICATIONS IN HIGH-TECH STARTUPS

While causation has been the dominant paradigm in business strategy for many years, its effectiveness in the context of high-tech startups is increasingly being questioned. The inherent uncertainties, rapid pace of change, and need for continuous innovation in high-tech industries often render traditional planning methods inadequate (Peykani, Namazi, & Mohammadi, 2022). This has led to the rise of alternative approaches, such as effectuation, lean startup, and design thinking, which are more adaptable and better suited to the dynamic environments in which high-tech startups operate.

However, it's important to recognize that causation and effectuation are not mutually exclusive. Many entrepreneurs use a combination of both approaches, adapting their decision-making style to the specific context and stage of development (Sarasvathy, 2001). Rigid adherence to pre-defined plans can stifle creativity and limit the ability to adapt to unforeseen circumstances. Furthermore, the extensive analysis required by causation-based approaches can be time-consuming and resource-intensive, potentially delaying the launch of new products or services in fast-moving markets.

2. CRITIQUES OF DECISION MODELS

While the aforementioned decision models of effectuation, lean startup, design thinking, and causation offer valuable frameworks for navigating uncertainty and fostering innovation, they are not without their limitations. This section examines some of the key critiques that have been levelled against these models, particularly in the context of high-tech startups and across different lifecycle stages.

2.1. GENERAL LIMITATIONS AND BOUNDARY CONDITIONS

A common thread across these decision models is that, while they provide valuable frameworks, they are not "one-size-fits-all" solutions. Each model has inherent limitations and boundary conditions that must be considered:

- **Simplification of business processes:** Effectuation theory suggests that entrepreneurs can navigate uncertainty by leveraging available resources, forming partnerships, and

adapting as they go (Read & Sarasvathy, 2005; Sarasvathy, 2001). This approach works well for businesses in dynamic and emerging markets, where flexibility and quick decision-making are key. However, when operating in environments with high regulatory oversight, complex infrastructure, or significant technological risks, effectuation's emphasis on immediate action may be insufficient. In these cases, structured methodologies and rigorous risk assessments become essential to ensure long-term success (Kitching & Rouse, 2020).

- **Lack of proper planning:** Effectuation is highly effective in fast-changing industries where adaptability outweighs long-term predictability (Wiltbank, Dew, Read, & Sarasvathy, 2006). However, for businesses that require extensive resource planning, long-term financial forecasting, or structured market entry strategies, relying solely on effectuation can pose significant challenges. The absence of formal strategic planning may become a liability when scaling operations, securing external funding, or managing regulatory compliance (Arend, Sarooghi, & Burkemper, 2015) . Under such conditions, a hybrid approach that combines effectual flexibility with structured planning may be more appropriate (Kitching & Rouse, 2020).

- **Reliance on rapid iterations:** The Lean Startup methodology thrives in industries where products can be developed and tested with a number of iterations with minimal investment (Lee & Geum, 2021). However, when dealing with industries that require significant upfront investment, extensive regulatory approvals, or long research and development (R&D) cycles, rapid iteration may not be practical. In such cases, businesses may need to prioritize rigorous testing and validation before bringing products to market, rather than continuously iterating based on customer feedback alone (McGrath, 2024).

- **Little focus on technical feasibility:** Lean Startup principles emphasize market-driven development, encouraging entrepreneurs to validate ideas through customer feedback and iterative testing (Contigiani & Levinthal, 2019). While this is beneficial for consumer-oriented businesses, industries that depend on technical precision, safety compliance, or engineering feasibility cannot rely solely on customer validation. A product may generate strong market interest but still fail due to technical limitations, regulatory barriers, or production constraints. In these situations, businesses need to balance customer feedback with in-depth technical assessments before proceeding with development (McGrath, 2024).

- **Resource intensive process:** Design Thinking is a powerful tool for fostering innovation, particularly in industries where user experience is a key differentiator (Brown, 2008). However, when businesses operate under strict time and budget constraints, the extended research, prototyping, and testing phases of Design Thinking may not be viable. In highly competitive environments where speed-to-market is crucial, a more streamlined approach to product development may be necessary (Liedtka, 2014).

- **Emphasis on predictive environments:** Causation theory assumes that success can be achieved through careful planning and forecasting (Dew, Sarasathy, Read, & Wiltbank,

2009). This works well in stable and predictable markets where historical data can guide decision-making. However, in industries characterized by rapid change, evolving consumer demands, or disruptive competition, strict reliance on predictive models may lead to rigidity and missed opportunities. Businesses operating in such environments must remain adaptable and open to alternative decision-making approaches, such as effectuation or agile methodologies (Chandler, DeTienne, McKelvie, & Mumford, 2011).

2.2. LIMITATIONS ACROSS THE STARTUP LIFECYCLE

A common critique is that these models, while effective in certain phases, may not be universally applicable across all stages of a startup's lifecycle. The effectiveness of each decision model - effectuation, lean startup, design thinking, and causation often vary depending on the stage of a startup's development. What works well during ideation might be less suitable for scaling, and vice versa. This necessitates a nuanced, stage-contingent approach to decision-making.

- **Effectuation:** For instance, effectuation, with its emphasis on flexibility and leveraging existing resources, is often seen as particularly well-suited for the early, ideation stages of a venture (Sarasvathy, 2001). Its "bird-in-hand" principle and emphasis on emergent goals align well with the high uncertainty and limited resources characteristic of this phase. However, as a startup matures and moves towards scaling and growth, the need for more structured planning and prediction may increase. In these later stages, the purely effectual approach may become less effective (Fukugawa, 2018). This suggests a potential mismatch between the inherent logic of effectuation and the evolving needs of a growing venture. This is because effectuation principles of flexibility and the leveraging of existing resources may not be sufficient to address the complexities of scaling, which often requires more formal planning, resource allocation, and organizational structure (Fukugawa, 2018). Moreover, the “emergent” nature of effectuation, where goals and plans are constantly evolving, may conflict with the need for stability and predictability in later stages (Arend, Sarooghi, & Burkemper, 2015). While effectuation emphasizes starting with available means, it offers less direct guidance on acquiring resources, which becomes increasingly critical during scaling (Frese, Geiger, & Dost, 2020).

- **Lean Startup:** Similarly, the Lean Startup methodology, with its focus on rapid experimentation and iterative learning, is often praised for its effectiveness in the early stages of product development and market validation (Ries, 2011). The "build-measure-learn" loop and the emphasis on Minimum Viable Products (MVPs) are well-suited for testing assumptions and gathering customer feedback quickly. However, critics argue that its emphasis on "failing fast" and pivoting may be less suitable for ventures that require significant upfront investment or have longer development cycles (Contigiani & Levinthal, 2019). This is particularly relevant in high-tech industries where R&D cycles can be lengthy and costly. Moreover, the Lean Startup's focus on the "build-measure-learn" loop may not provide sufficient guidance for managing the complexities of scaling a high-tech venture, which often involves intricate organizational structures and processes (Picken, 2017). As a startup moves from the initial validation phase to the growth and maturity phases, the

need for more formal planning and structured decision-making may increase, potentially conflicting with the iterative and adaptable nature of the Lean Startup approach. Furthermore, the emphasis on rapid experimentation and customer feedback may be challenging to implement in industries with stringent regulatory requirements or where MVPs are difficult to create (Ghezzi A. , 2019; Contigiani & Levinthal, 2019). The Lean Startup also offers limited guidance on establishing a long-term strategic vision, which becomes increasingly important as a startup scale (Bortolini, Nogueira C, Danilevicz, & Ghezzi, 2021)

- **Design Thinking:** Design Thinking, while valuable for fostering user-centric innovation, also faces critiques regarding its applicability across different lifecycle stages. Its strengths lie in the early phases of ideation and prototyping, where understanding user needs and generating creative solutions are the most important (Brown, 2008). The emphasis on empathy, user research, and iterative prototyping aligns well with the need to develop products and services that meet real user needs. However, as a startup progresses towards scaling and commercialization, the emphasis on user-centricity may need to be balanced with other considerations, such as technological feasibility, operational efficiency, and market competition (Ousghir & Daoud, 2022). While user needs remain crucial, factors like scalability, operational efficiency, and competitive strategy become increasingly important. (Ousghir & Daoud, 2022) point out that Design Thinking, in its pure form, may not fully address the rapid technological shifts and scalability needs inherent to high-tech environments. This suggests that while Design Thinking can be a powerful tool for generating innovative ideas, it may need to be complemented by other approaches to effectively manage the entire lifecycle of a high-tech startup. Furthermore, the iterative and resource-intensive nature of Design Thinking can be challenging for startups with limited resources or those facing tight deadlines (Liedtka, 2014; Gonen, 2020). The focus on extensive user research and multiple iterations may conflict with the need for rapid scaling and market penetration in later stages (Ousghir & Daoud, 2022).

- **Causation:** The model assumes that entrepreneurial events can be planned ahead of time basing on cause-effect conditions (Chandler, DeTienne, McKelvie, & Mumford, 2011; Sarasvathy, 2001). However, this approach is limited in the early business stages because resources are scarce and the level of uncertainty is high (Sarasvathy, 2001). It is better to apply effectual principles here of being flexible and focusing on available means instead of planning for the unknown. Planning is more applicable in the maturity stages making causation more beneficial in the maturity stages unlike in the beginning (Picken, 2017). This limitation is evident in the early stages of startups characterized with limited resources and high uncertainty which make planning less effective. But as the firm grows and gains stability, causation principles can be validated because of the need for formal planning and systematic decision making. While valuable for providing structure and predictability, especially in more stable environments, causation's emphasis on upfront planning and prediction can be a weakness in the early, uncertain stages of a high-tech startup

(Sarasvathy, 2001). The assumption that the future can be accurately forecast is often unrealistic in dynamic and rapidly changing industries.

3. INTEGRATING DECISION MODELS IN CONTINGENCY FRAMEWORKS

Recognizing the limitations of individual decision models and the need for a more tailored approach, researchers and practitioners have begun to explore the integration of multiple models into contingency frameworks. The inherent limitations of relying solely on one decision making logic, be it causation, effectuation, lean startup, or design thinking have prompted a move towards hybrid approaches. These frameworks aim to combine the strengths of different models, offering a more comprehensive and adaptable approach to navigating the complexities of high-tech ventures (Cocchi, Dosi, & Vignoli, 2023; Ousghir & Daoud, 2022).

It is important to clarify the conceptualization of 'hybrid approaches' as used within this thesis. While 'hybrid' can sometimes imply a purely 'simultaneous mix' of different elements, this study adopts a broader perspective. Here, hybrid approaches in entrepreneurial decision-making refer to the pragmatic and context-dependent ways in which startups consciously or intuitively combine, sequence, or selectively borrow principles, tools, and practices from various established decision logics—such as effectuation, lean startup, design thinking, and causation. This encompasses not only the simultaneous application of elements from multiple models but also their sequential use across different venture stages or specific tasks, as well as the dynamic adaptation and blending of these elements to best suit the evolving contingencies faced by the startup. The focus is on the resulting synergistic and adaptive utility derived from these combinations, rather than adherence to a strict, singular definition of 'mixing.'

But before discussing these new frameworks, here are the definitions of some important concepts necessary for a better understanding:

- **Agile methodology:** (Gemino, Horner Reich, & Serrador, 2021) describe it as a project management tool that relies on flexibility, iterative learning, formation of partnerships with others and maintenance of close contact with stakeholders. Firms using this methodology apply flexibility toward changing environmental situations. They maintain a rough plan, encourage different functions to work together to produce results. The iterative nature of this tool ensures that there is continuous improvement of processes (Gemino, Horner Reich, & Serrador, 2021; Cocchi, Dosi, & Vignoli, 2023). According to (Almeida & Bálint, 2024), agile methodologies are a set of principles commonly adopted in the development of software which are iterative with the aim of creating a better outcome based on feedback from stakeholders other than creating a final product at once. The methodology involves a number of steps which start with planning, implementing, testing and reviewing outcomes. Since the technology industry requires rapid innovation, agile approach is suitable as it is efficient and flexible, responding to change at a fast rate, not forgetting that it enhances creativity amongst workers. (Gemino, Horner Reich, & Serrador, 2021) further note that using agile, traditional or hybrid approaches impacted similar results when it came to performance on grounds of scope, time, quality and budget. However, agile and hybrid

approaches significantly registered more success compared to the traditional approach in terms of stakeholder objectives meaning aspects like strategic goals, and product success are more positive with these two approaches.

- **Traditional Gantt Chart** is a visual project management tool that is used to make plans and schedule tasks with the ability to track them over a certain period of time. It includes tasks alongside the time frames. It ensures that everything is planned when the project begins, some events could come after the completion of others and the chart is updated upon completion. It is a good planning, tracking and resource allocation tool (Vijayasarathy & Turk, 2008; Geraldi & Lechter, 2012).

- **Traditional methodology** is characterized by a linear approach that requires upfront systematic planning of processes from one phase to another with detailed documentation. It requires the entrepreneur to stick to the set plan while implementing actions. The method suits ventures with clear requirements and doesn't tolerate deviation from the predetermined plan (Gemino, Horner Reich, & Serrador, 2021).

- **The stage gate approach** refers to a structured tool where entrepreneurs move from one stage to another in a linear format while making decisions. The process involves systematic evaluation and decision making is well-structured at different gates upon approval at these phases /decision points (Cocchi, Dosi, & Vignoli, 2023). The approach is more like the traditional planning method that involves strategic planning ahead of time. It helps manage risk because of the constant reviews done at various gates for decision validation before more investments are made.

3.1. EXAMPLES OF HYBRID APPROACHES

Several studies have documented the emergence of hybrid approaches that combine elements of different decision models to address the specific needs of high-tech startups. Some examples include:

- **Agile and Traditional Methodologies:** The use of Hybrid approaches as a decision-making tool towards project efficiency is an emerging sector in research. The approach is known to combine a number of methodologies, such as integrating practices from traditionally plan-driven approaches with Agile methods. (Gemino, Horner Reich, & Serrador, 2021) examine this concept further with the combination of traditional and agile practices in managing projects specifically in the high-tech industry. They found that while both Agile and traditional methods have value, a hybrid approach often yields the best results, especially in complex projects. The key is to find the right balance between structure and flexibility. The author goes ahead to mention that most large projects employ both approaches with agile dominating the largest percentage. It is used by entrepreneurs who want to maintain the traditional methods and those that adopt the agile practices therefore, they end up combining the two to develop a particular methodology. Usually, methodologies are combined to solve issues present with the other approach, for

example, firms using the traditional approach can later on adapt the agile approach to leverage outcomes.

- **Agile Project Management and Traditional Gantt Charting:** Traditional tools can be combined with agile methods in high-tech startups that are associated with constant software developments that can be complex and rapidly evolve at different cycles. For instance, Traditional Gantt Charting emphasizes planning for the future of the organization which is in line with investor needs. Combining these two approaches results into well-structured organizational practices and adaptability (Vijayasarathy & Turk, 2008). This combination leverages the strengths of both approaches: the detailed planning and visualization capabilities of Gantt charts with the flexibility and responsiveness of Agile methods.

- **Integration of Effectuation and the Lean Startup:** A blend of lean startup and effectuation for maximizing decision making at the early stages. Just like in any other industry, the high-tech startups also encounter high uncertainty during the initial operation stages that involve product development. The ideal approaches to adapt in such an environment are effectuation which emphasizes efficient resource utilisation 'starting with the available means' and engaging stakeholders as much as possible (Sarasvathy, 2001). High-tech startups can use this approach by sourcing for available resources to start with other than planning for what doesn't exist. It can be used together with the lean startup elements of developing a Minimum Viable Product upon which iterations are carried on (Ries, 2011). The feedback got from users can be essential for developing a product that is fit for the market thus avoiding time wastage on something users may not require. This combination is advantageous because it can shorten the lifecycle and save time by launching output early enough (Read, Dew, Sarasvathy, Song, & Wiltbank, 2009). Experienced entrepreneurs don't waste time making business plans but learn while implementing ideas and also try to use available resources to come up with something. This is one way they are able to make quick decisions thereby combining effectual and lean models (Standing & Mattsson, 2018). This hybrid approach leverages effectuation's broad framework for navigating uncertainty and identifying opportunities (Sarasvathy, 2001), while incorporating the Lean Startup's practical tools for testing assumptions and validating the business model (Ries, 2011). By combining these approaches, entrepreneurs can benefit from both a flexible, resource-driven mindset and a structured, iterative process for product and business development.

- **Agile/Stage-Gate Hybrid:** One of the most widely studied hybrid approaches is the integration of Agile methodologies with the Stage-Gate process This model combines the flexibility and iterative nature of Agile methodologies with the structured, phased approach of Stage-Gate. It has been applied in various industries, including software development, manufacturing, and new product development (Cooper & Sommer, 2016; Cocchi, Dosi, & Vignoli, 2023). The Agile/Stage-Gate hybrid allows for rapid experimentation and adaptation within each stage, while still providing an overall structure and decision gates to manage the development process. This approach is particularly useful when dealing with

projects that have both well-defined and ambiguous elements. For example, a startup might use Agile to develop and test specific features of a product while using Stage-Gate to manage the overall project timeline and budget (Cocchi, Dosi, & Vignoli, 2023). This hybrid approach can be implemented in two ways:

- Nested Hybridization: where Agile teams operate within the stages of a Stage-Gate process and, handed-over, where an Agile process is used to complete a project, and then the results are fed into a Stage-Gate process (Cooper & Sommer, 2016). This allows for flexibility and rapid iteration at the task level, while maintaining the overall structure and control of the Stage-Gate framework.
- Handed-Over Hybridization: Agile and Stage-Gate are used sequentially. For instance, an Agile approach might be used for the early, exploratory phases of a project (e.g., ideation, concept development), with the results then feeding into a more traditional Stage-Gate process for later stages (e.g., development, commercialization).

- **Design Thinking/Stage-Gate:** This hybrid model incorporates Design Thinking principles and methods into the early stages of the Stage-Gate process, particularly in the ideation and concept development phases (Cocchi, Dosi, & Vignoli, 2023). By leveraging Design Thinking's user-centric approach and iterative prototyping methods, companies can gain a deeper understanding of customer needs and develop more innovative solutions (Brown, 2008). This hybrid approach is particularly useful when the goal is to create products or services that are closely aligned with user needs and preferences. Design Thinking can be used to inform the early stages of the Stage-Gate process, providing a strong foundation of user insights and validated concepts before moving into more structured development phases (Cocchi, Dosi, & Vignoli, 2023).
- **Design Thinking and Lean Startup/Stage-Gate:** This hybrid model combines Design Thinking, Lean Startup, and Stage-Gate methodologies to create a comprehensive framework for new product development. Design Thinking is used in the ideation and concept phases to generate and refine ideas, while Lean Startup is employed in the business case stage to test and validate the business model (Cocchi, Dosi, & Vignoli, 2023). Stage-Gate provides the overall structure and decision gates for the entire development process. This approach allows companies to leverage the strengths of each methodology to create more user-centric, innovative, and commercially viable products: Design Thinking for user-centric innovation, Lean Startup for rapid experimentation and validation, and Stage-Gate for overall project management and control.

3.2. INSIGHTS FROM STUDIES

- (Cocchi, Dosi, & Vignoli, 2023) conducted a comprehensive review of Stage-Gate hybridization, identifying three main types of hybrid models: Agile/Stage-Gate, Design Thinking/Stage-Gate, and Design Thinking and Lean Startup/Stage-Gate. They found that these models can be adapted based on project type, market conditions, technology, and

learning gaps, providing a more tailored approach for R&D managers. Their research suggests that hybrid models can help organizations to better manage the complexities of new product development by combining the strengths of different methodologies. They also highlight the importance of considering the specific context and contingencies when selecting and implementing a hybrid approach.

- (Ghezzi & Cavallo, 2020) explored the use of Agile Business Model Innovation in digital entrepreneurship, highlighting the benefits of integrating Lean Startup approaches with effectuation and bricolage. They found that this hybrid approach can enhance flexibility and adaptability in rapidly changing environments and their findings suggest that by combining Lean Startup's iterative learning with effectuation's focus on leveraging resources and forming partnerships, startups can create a more dynamic and resilient approach to business model innovation.

- (Ousghir & Daoud, 2022) investigated the combination of Design Thinking and Lean Startup in the context of Moroccan startups. They found that this hybrid approach can help startups to better understand user needs, develop more innovative solutions, and reduce the risk of failure. Their research highlights the practical benefits of combining Design Thinking's user-centric approach with Lean Startup's iterative validation methods in a real-world startup context.

- (Peykani, Namazi, & Mohammadi, 2022) proposed a framework for bridging the knowledge gap between technology and business, emphasizing the importance of aligning technological decisions with organizational strategy. Their framework highlights the need for a contingency-based approach that considers factors such as knowledge, type of innovation, and innovation process. This study underscores the importance of considering the broader organizational context when implementing hybrid models and suggests that a contingency-based approach can help to ensure that technological decisions are aligned with the startup's overall strategy.

- (Cooper & Sommer, 2016) found that Agile-Stage-Gate hybrids can improve time efficiency, project team morale, and customer satisfaction. They also noted that these hybrids work best when applied to projects with high levels of uncertainty and complexity. This research highlights the benefits of combining the structure of Stage-Gate with the flexibility of Agile, particularly in complex and uncertain environments.

- (Sommer, Hedegaard, Dukovska-Popovska, & Steger-Jensen, 2015) highlighted the importance of adapting hybrid models to the specific needs of the project and the organization. They found that successful implementation of Agile-Stage-Gate hybrids requires a supportive organizational culture, clear communication, and strong leadership. This study emphasizes the need for a tailored approach to hybrid model implementation, considering the specific organizational context and fostering a culture that supports both structured planning and iterative adaptation.

3.3. EMERGING EVOLUTION IN THE "SCIENTIFIC METHOD" FOR ENTREPRENEURSHIP

SCIENTIFIC APPROACH TO DECISION MAKING

Entrepreneurs are devoted to continuous implementation of ideas that aid value creation. With the scientific method, entrepreneurs aim at experimenting ideas to solve customer problems at hand and exploring them through direct contact with customers to validate ideas (Felin, Gambardella, Novelli, & Zenger, 2024). The scientific method emphasizes hypothesizing of these ideas, once an entrepreneur identifies a problem to be solved, hypotheses are formed with the aim of testing them for further decision making. The approach is more like the exploratory procedure that scientists follow in their research (Camuffo, et al., 2024). They are encouraged to follow a well-disciplined hypothesis-based approach to enhance continuous learning and proper allocation of resources. The scientific method follows the principles discussed below:

- **Hypothesis testing:** Entrepreneurs are encouraged to come up with business ideas upon which hypotheses that can be formulated and tested, these should be validated through the market. The business model assumptions alone are not sufficient to test the validity of the firm, a systematic testing process can be of help when making choices (Felin, Gambardella, Novelli, & Zenger, 2024).

- **Experimentation:** Just as scientists use experiments to confirm ideas, entrepreneurs can also experiment on their products or services in a controlled setting. An MVP is made upon which tests and experimentations are carried on basing on customer feedback. Results from the testing are either validated or rejected basing on the market reaction. Pivoting is encouraged at this stage in case the ideas are not valid, the entrepreneur can change the hypothesis and aim at a different direction (Felin, Gambardella, Stern, & Zenger, 2020).

- **Iterative learning system:** The scientific method emphasizes learning through an iterative process of creating designs, testing them on users while learning from customer reactions and modification. Embracing a continuous improvement process through experiments saves the entrepreneur time by not executing what may not be viable to users. Entrepreneurs keep learning and adopt a mindset that they could be wrong at times and be open to making adjustments or coming up with totally new ideas if another fails (Felin, Gambardella, Stern, & Zenger, 2020).

RELEVANCE

The scientific method enables entrepreneurs test and modify their business models on the market before creating prototypes, manage risk and increase on the probability of success. Early failures can be seen as opportunities to do better, so adopting this mindset reduces biases of being too confident in one's ideas, confirmation bias which may push the entrepreneur to make decisions that are not viable (Felin, Gambardella, Novelli, & Zenger, 2024; Camuffo, et al., 2024). The decisions made with this method are more informed and based on accurate findings upon contingencies which in return increase the performance of the firm (Camuffo, et al., 2024). Entrepreneurs who are open to the scientific approach may easily terminate ideas that do not seem valuable and pivot

their business model segments. This is considered to be important as they do not waste resources on projects that may not be successful (Camuffo, et al., 2024).

The lean startup partly presents a traditional approach to the scientific method including business model testing, use of an MVP for product development, customer analysis and iterative learning which involve hypothesis driven experimentation (Felin, Gambardella, Novelli, & Zenger, 2024; Felin, Gambardella, Stern, & Zenger, 2020). (Felin, Gambardella, Stern, & Zenger, 2020) discuss the short comings of the scientific method:

- The use of bounded rationality limits accuracy of information, over relying on customer feedback might lead to validation of wrong ideas due to wrong customer sample, this should not be a central mechanism for decision making however experimental it may be (Felin, Gambardella, Novelli, & Zenger, 2024).
- Business model testing used to structure business ideas including the key partners, key activities, key resources, value proposition, customer relationships, channels, cost structure, revenue streams and customer segment. This tool enables entrepreneurs to test the assumptions of each element but also has limitations, as much it explores the nine blocks, they could come up with superficial ideas. Therefore, firms should use more logical theories to guide experimentation and exploration (Felin, Gambardella, Novelli, & Zenger, 2024).
- Simple experiments of the lean startup mainly lead to improvements and not continuous innovation. Validation of ideas basing on instant customer feedback may also limit formulation of long-term strategic objectives (Felin, Gambardella, Stern, & Zenger, 2020).

CHALLENGING THE TRADITIONAL SCIENTIFIC METHOD

The traditional "scientific method," with its emphasis on hypothesis testing, controlled experimentation, and objective observation, has long been considered the gold standard for generating reliable knowledge. However, in the context of entrepreneurship, and particularly in the high-tech startup environment, the applicability and effectiveness of the traditional scientific method have been questioned. This is not to say that scientific rigor is unimportant; rather, it suggests that the *way* we approach scientific inquiry in this domain needs to adapt. This is due to the inherent uncertainties, complexities, and dynamic nature of these ventures, which often require a more flexible, iterative, and user-centered approach to knowledge generation and decision-making.

Several emerging trends and perspectives are challenging the traditional view of the scientific method in entrepreneurship:

- **From Prediction to Control:** Effectuation, as a decision-making logic, embodies a shift from a focus on *prediction* to a focus on *control* (Sarasvathy, 2001). Instead of trying to predict the future, entrepreneurs using effectuation focus on shaping the future through their actions and interactions with stakeholders. This aligns with the idea that the future is

not predetermined but rather co-created through the actions of individuals and organizations.

- **From Planning to Experimentation:** The Lean Startup methodology emphasizes rapid experimentation and validated learning as the primary means of reducing uncertainty and achieving product-market fit (Ries, 2011). This contrasts with the traditional emphasis on detailed planning and upfront analysis. Lean Startup advocates for a "build-measure-learn" feedback loop, where entrepreneurs develop minimum viable products (MVPs), test them with customers, and iterate based on the feedback received. This iterative process allows for continuous learning and adaptation. This is a more dynamic method, that takes into consideration the complexities faced by the startup.

- **From Objectivity to User-Centricity:** Design Thinking challenges the traditional emphasis on objectivity and rationality in decision-making by placing the *user* at the center of the innovation process (Brown, 2008). Design Thinking emphasizes empathy, understanding user needs, and developing solutions that are both desirable and feasible. This human-centered approach recognizes that innovation is not just about technical feasibility but also about creating value for users. This allows for a more insightful approach when developing a product.

- **From Linearity to Iteration:** The Stage-Gate model, while still widely used, is being adapted and hybridized with more iterative methods (Cocchi, Dosi, & Vignoli, 2023). The realization that innovation is not a linear process, but rather an iterative one, with frequent feedback loops and adaptations, is central to this evolving approach. This creates a dynamic process which helps the startup navigate uncertainties with ease.

- **From Individual to Collective:** Entrepreneurship is not solely about individual effort; it is about the collaborative, the open, the shared, the co-creation and the cooperation, rather than strictly a competition (Read & Sarasvathy, 2005). The entrepreneurial journey involves collaborating with other stakeholders.

These emerging trends suggest a move towards a more flexible, iterative, and user-centric approach to entrepreneurial decision-making. This approach recognizes the inherent uncertainties and complexities of the high-tech startup environment and emphasizes the importance of learning, adaptation, and collaboration. This "new scientific method" for entrepreneurship is not about abandoning rigor or evidence-based decision-making; rather, it's about adapting the traditional scientific method to the unique challenges and opportunities of the entrepreneurial context. It is more suited to the complex nature of the startup and encourages adaptability to the dynamic conditions.

This adaptation, however, requires a framework that can guide entrepreneurs in choosing the right approach for the right situation. This is where contingency theory becomes crucial.

4. CONTINGENCY THEORY AND HIGH-TECH STARTUPS

Given this evolving understanding of how knowledge is generated, and decisions are made in the entrepreneurial context, it becomes clear that a one-size-fits-all approach is insufficient. No single decision-making model can be universally applied to all startups, in all industries, at all stages of development.

Contingency theory provides a valuable lens for addressing this challenge by emphasizing that the most effective organization structure depends on the environmental factors, and by challenging the universal concept of structuring and managing organizations. It also provides a valuable lens for understanding the complexities of decision-making in high-tech startups. This theory posits that there is no single best way to manage an organization or make decisions; rather, the optimal approach is contingent upon the specific circumstances and context (Lawrence & Lorsch, 1967; Donaldson, 2001). The effectiveness of a firm can be shaped by a number of environmental factors which are both internal and external, the nature of the organization and the personality of the entrepreneur. It is crucial for the entrepreneur to better understand these factors and know when and how to react to different situations, requiring them to be flexible and adapt to these situations effectively, entrepreneurs should be flexible when it comes to making strategic decisions and apply different approaches with changing situations (DeCarlo & Lyons, 1980; Donaldson, 2001).

The theory is relevant with the changing market dynamics especially with technological advancements and changing choices of customers. It is important to analyze and evaluate the prevailing situation (Donaldson, 2001). There should be a fit between the organizational capabilities and the demands of external environment for effective strategy formulation. The contingency theory emphasizes that the performance of an organization is shaped by fitting its structure to other prevailing situations in the environment (Donaldson, 2001). Firms are urged to use structures that fit different elements in the environment, and different organization characteristics affect the organization structure differently. Mechanic structures which are characterized with formal procedures, bureaucracy and decisions are made centrally in predictive and more efficient situations will be more applicable in low areas of uncertainty while organic structures which are more decentralized, flexible and informal communication to manage innovation and respond to changing situations as a way of managing competition work better in situations of high uncertainty. For example, when it comes to technology, routine tasks will attract the mechanistic approach while non-routine tasks will apply the organic structures. (Lawrence & Lorsch, 1967) demonstrate how different organizational structures are more or less effective depending on the level of environmental uncertainty. Similarly, (Woodward, 1958) showed how the effectiveness of different management styles is contingent on the type of technology used by the organization. In terms of size and complexity, big organizations are likely to use bureaucratic and systematic structures while small organizations are more effective with decentralized structures due to their flexibility. There is a direct relation between a contingency and the organization structure, the contingency determines the structure of the firm meaning the structure could change with changing contingencies (Donaldson, 2001). The theory provides a more predictive framework for reacting to changing dynamics.

In the context of high-tech startups, this means that the effectiveness of different decision models will vary depending on factors such as the startup's lifecycle stage, the industry in which it

operates, and the level of technological and market uncertainty it faces. This need for adaptable decision-making is further amplified by the inherent dynamism of the high-tech sector, where rapid innovation, evolving market conditions, and technological disruptions are commonplace (Peykani, Namazi, & Mohammadi, 2022). Therefore, a contingency-based approach, which takes into account the specific challenges and opportunities faced by each startup, is essential for navigating this complex landscape. However much the theory has registered success in different firms, it is important to note that it can be challenging and difficult to measure the exact fit between the organization structure and a particular contingency (Donaldson, 2001).

4.1. LIFECYCLE STAGES: IMPLICATIONS FOR DECISION-MAKING

High-tech startups typically progress through distinct lifecycle stages, each presenting unique challenges and opportunities (Kazanjian & Drazin, 1990). These stages can be broadly categorized as:

- **Ideation:** The initial phase where the startup is formed, and the founders explore potential opportunities, develop a business concept, and conduct initial market research. This stage is characterized by high uncertainty, limited resources, and a need for flexibility and adaptability. During this stage, decision models that emphasize exploration, experimentation, and learning, such as effectuation and design thinking, may be particularly relevant (Sarasvathy, 2001; Brown, 2008). Effectuation, with its focus on leveraging available means and embracing uncertainty, allows entrepreneurs to navigate the ambiguous early stages of venture creation. Similarly, design thinking, with its emphasis on user-centered research and iterative prototyping, can help startups to identify and validate promising opportunities (Ousghir & Daoud, 2022).

- **Development:** The stage where the startup focuses on developing a minimum viable product (MVP) and validating its business model through iterative testing and customer feedback. This stage requires a balance between experimentation and structure. Here, the Lean Startup methodology, with its emphasis on the "build-measure-learn" loop, can provide a useful framework for managing the development process (Ries, 2011). The iterative nature of Lean Startup allows startups to test their assumptions, gather feedback, and adapt their product and business model based on real-world data. This stage often involves a combination of effectual and causal logic, as entrepreneurs continue to leverage their existing resources while also seeking to validate their value proposition and refine their target market (Ghezzi & Cavallo, 2020)**.**

- **Scaling[1]:** The phase where the startup has achieved product-market fit and is focused on growing its customer base and expanding its operations. This stage demands a shift

[1] *Scaling refers to the ability of a business to grow its revenue without a proportional increase in resources. Growth, on the other hand, can refer to any increase in size, whether it's revenue, number of employees, or market share. Scaling is a type of growth, but it's a specific type that emphasizes efficiency and leverage*.

towards more formalized processes, efficient resource allocation, and a focus on operational excellence. As startups transition to this stage, they may need to incorporate more structured decision-making approaches, potentially drawing on elements of traditional strategic planning and stage-gate models (Picken, 2017). *T*he need for formalized processes and standardized operations becomes more pronounced as the startup seeks to scale its business and manage increasing complexity*.* While some flexibility is still required, the emphasis shifts towards optimizing existing processes and achieving economies of scale.

- **Growth:** The stage where the startup has established a strong market position and is focused on sustaining growth, expanding into new markets, and potentially pursuing an exit strategy. This stage requires a more strategic and long-term perspective. At this point, decision-making may involve a greater emphasis on market analysis, competitive positioning, and long-range planning (Fukugawa, 2018). While effectuation and Lean Startup principles may still be relevant, they may need to be complemented by more traditional management approaches that focus on efficiency, optimization, and strategic alignment.

The implications for decision-making vary across these stages. In the early stages (ideation and development), decision models that emphasize flexibility, experimentation, and learning, such as effectuation and lean startup, may be more suitable (Fukugawa, 2018; Ries, 2011). As the startup matures and moves towards scaling and growth, more structured and analytical approaches, such as those found in traditional strategic planning and stage-gate models, may become more relevant (Picken, 2017). This highlights the need for a contingency-based approach that adapts the decision-making framework to the specific needs of each lifecycle stage. Furthermore, the transition between these stages is often non-linear and may involve revisiting earlier stages as the startup learns and adapts (Picken, 2017). This iterative process underscores the importance of flexibility and adaptability in decision-making throughout the startup lifecycle. This transition between stages is often iterative, not strictly sequential. A startup might need to revisit earlier stages based on new information or changing circumstances. This is where the ability to switch between decision-making mindsets from effectual, to lean, to design thinking, and even to more traditional, causal approaches become critical.

4.2. HIGH-TECH SPECIFIC CHALLENGES

High-tech startups face a unique set of challenges that further complicate decision-making. These challenges include:

- **High Technological Uncertainty:** The rapid pace of technological advancements and the inherent uncertainties associated with emerging technologies make it difficult for high-tech startups to rely solely on predictive planning or static frameworks. This is especially true for startups operating in nascent industries or developing novel technologies with limited historical (Peykani, Namazi, & Mohammadi, 2022). This distinguishes it from market uncertainty. While market uncertainty relates to customer needs and

preferences, technological uncertainty relates to the feasibility, performance, and development path of the technology itself. For example, a startup developing a new type of battery technology might face uncertainty about the battery's lifespan, charging time, or safety. Design Thinking, with its emphasis on user-centered research, can help reduce market uncertainty, but it may be less effective in addressing fundamental technological uncertainties. In these situations, effectuation's acceptance of surprises and its emphasis on partnerships (to bring in diverse expertise) may be more valuable (Sarasvathy, 2001). Lean Startup's iterative approach is helpful, but the rapid pace of change may outstrip the "build-measure-learn" cycle. This uncertainty requires decision-making models that can accommodate rapid learning, adaptation, and iteration (Peykani, Namazi, & Mohammadi, 2022). The need for continuous learning and adaptation is paramount in high-tech environments, where the technological landscape can change rapidly and unpredictably.

- **Long R&D Cycles:** Many high-tech startups, particularly those in sectors like biotechnology or advanced materials, are characterized by long and complex R&D cycles. These extended timelines can make it challenging to apply iterative models that rely on rapid experimentation and short feedback loops (Contigiani & Levinthal, 2019). For example, developing a new drug or a novel material often requires years of research, testing, and regulatory approvals. Lean Startup's "fail fast" approach may be difficult to implement when each iteration cycle takes months or years. Effectuation's emphasis on leveraging existing resources may be limited if the necessary resources for long-term R&D are not readily available. Design Thinking, while valuable for understanding user needs, may not fully address the technical challenges and risks associated with long R&D cycles. Here, approaches that blend iterative methods with more traditional stage-gate processes, allowing for longer-term planning while still incorporating feedback and learning, may be more appropriate (Cocchi, Dosi, & Vignoli, 2023).

- **Regulatory Hurdles:** High-tech startups often operate in regulated industries, such as healthcare or aerospace, where compliance with stringent regulations can significantly impact their development timelines and commercialization strategies. Existing decision models may not fully account for the complexities of navigating these regulatory landscapes (Zhao, Tsai, & Wang, 2019). This requires decision models that can incorporate regulatory considerations and adapt to policy changes. The iterative and experimental approaches of Lean Startup and Design Thinking may be constrained by regulatory requirements, which often demand extensive documentation, testing, and validation before a product can be launched. Effectuation's emphasis on partnerships may be helpful in navigating regulatory hurdles, but it does not provide specific guidance on compliance (Zhao, Tsai, & Wang, 2019). Engaging with regulatory bodies and seeking expert advice can be crucial for navigating these hurdles effectively. Moreover, incorporating regulatory considerations into the decision-making process from the outset can help startups to avoid costly delays and ensure compliance (Zhao, Tsai, & Wang, 2019).

- **Resource Constraints:** Startups, by their nature, often operate with limited resources, both financial and human. This can make it challenging to implement resource-intensive approaches or to acquire the necessary expertise in all relevant areas. Decision models that emphasize leveraging existing resources and forming partnerships, such as effectuation, may be particularly relevant in this context (Sarasvathy, 2001). Additionally, the Lean Startup methodology, with its focus on minimizing waste and maximizing learning with limited resources, can be valuable for resource-constrained startups (Ries, 2011). This includes prioritizing the most critical assumptions to test and using low-cost methods for experimentation, such as minimum viable products (MVPs). However, even with these approaches, resource constraints can limit the scope and scale of experimentation and may hinder the ability to pursue certain opportunities. Design Thinking, in particular, can be resource-intensive due to its emphasis on user research and prototyping (Liedtka, 2014).

These challenges underscore the need for decision-making frameworks that are specifically tailored to the high-tech startup context. Existing models, while valuable in certain situations, may not fully address the complexities and uncertainties faced by these ventures. A contingency-based approach, which takes into account the specific challenges faced by high-tech startups and adapts the decision-making framework accordingly, is therefore essential for navigating uncertainty and fostering innovation in this dynamic environment.

5. IDENTIFIED GAPS

The existing literature on decision-making models offers valuable frameworks for high-tech startups, but a closer examination reveals critical gaps. These gaps, if unaddressed, could hinder the effective application of these models and limit their ability to guide startups toward sustainable growth and innovation. This section highlights the key areas needing further research and development, ultimately justifying the need for a dynamic, comprehensive, and empirically validated hybrid approach.

5.1. LACK OF COMPREHENSIVE AND DYNAMIC FRAMEWORK FOR HIGH-TECH STARTUPS

Existing literature often focuses on individual decision models or specific combinations, such as Agile/Stage-Gate (Cocchi, Dosi, & Vignoli, 2023) or Design Thinking/Lean Startup (Ousghir & Daoud, 2022). While these approaches offer valuable insights, they often treat decision-making models as separate entities, failing to fully explore the potential synergies and complementarities that could arise from their integration (Ghezzi & Cavallo, 2020). A truly comprehensive framework - one specifically designed for the high-tech context—needs to integrate the strengths of effectuation, lean startup, and design thinking while remaining adaptable to the dynamic nature of these ventures. This gap limits the practical utility of these frameworks for founders, who require a more holistic and adaptable approach to decision-making.

Furthermore, current models often fall short in addressing the complexities of different lifecycle stages (Picken, 2017; Fukugawa, 2018) and the unique challenges of high-tech environments, such as long R&D cycles and high technological uncertainty (Peykani, Namazi, & Mohammadi, 2022). A

static framework, even if comprehensive, may become less relevant or even counterproductive as a startup matures and its context changes. For example, while effectuation may be highly effective during the ideation phase (Sarasvathy, 2001), a more structured, causation-based approach may be needed during scaling (Picken, 2017). Similarly, rapid experimentation, a hallmark of Lean Startup (Ries, 2011), may be less feasible in industries with stringent regulatory requirements or long product development cycles (Contigiani & Levinthal, 2019; Zhao, Tsai, & Wang, 2019). A robust hybrid framework should not only prescribe which models to use but also how to transition between them smoothly and effectively. This requires a deep understanding of the interplay between different decision-making logics and the specific contingencies that trigger the need for adaptation.

5.2. INSUFFICIENT EMPIRICAL EVIDENCE AND VALIDATION IN DIVERSE HIGH-TECH CONTEXTS

While the concept of hybrid models is gaining traction, there is still limited empirical evidence to support their effectiveness, particularly in the diverse contexts of high-tech startups. Much of the existing research is theoretical, or based on individual perceptions, with few studies providing thorough and unbiased proof of hybrid models across different industries and lifecycle stages. This lack of empirical evidence in various high-tech contexts raises concerns about the generalizability and robustness of claims regarding the benefits of hybrid models.

Moreover, the existing empirical studies often focus on specific combinations of decision models, such as Agile/Stage-Gate (Cocchi, Dosi, & Vignoli, 2023), and may not be generalizable to other hybrid approaches. This limits the scope of conclusion. There is a need for more research that examines the effectiveness of different hybrid models, including those that integrate effectuation, lean startup, and design thinking, in a variety of high-tech contexts. Future studies should explore a wider range of hybrid combinations, considering the specific challenges and opportunities of different industries and lifecycle stages, which would enhance the understanding of the applicability of those methods and when best to use them. This research should also investigate the impact of hybrid models on key performance indicators, such as time to market, product success, and overall venture performance. Furthermore, studies should move beyond self-reported data and incorporate objective measures of performance (Ghezzi & Cavallo, 2020). Objective measures, such as financial data, market share, and customer satisfaction metrics, can provide a more reliable and complete assessment of the impact of hybrid models on startup performance.

5.3. LIMITED PRACTICAL GUIDANCE ON IMPLEMENTATION AND ADAPTATION

Even when hybrid models are proposed, founders and managers often lack concrete guidance on how to integrate different decision models, what tools and techniques to use, and how to adapt the approach to their specific context. Simply advocating for a hybrid approach is insufficient; there is often a lack of practical guidance on how to implement them in real-world settings. This includes a need for more research on the specific tools, techniques, and processes that can be used to support the implementation of hybrid models, as well as the organizational structures and cultures that are most conducive to their success. Startups may struggle to integrate different decision

models without clear guidelines on how to adapt them to their specific needs and contexts (Ousghir & Daoud, 2022). The existing literature offers limited practical advice on the operationalization of hybrid models, leaving a gap between theory and practice.

Furthermore, there is limited understanding of how hybrid models should be adapted over time as a startup evolves and its environment changes. The dynamic nature of high-tech startups requires a flexible and adaptable approach to decision-making, one that can respond to new information, changing market conditions, and emerging technological advancements. This requires a dynamic perspective that considers the interplay between the startup's lifecycle stage, its internal capabilities, and the external environment (Sarasvathy, 2001). Future research should investigate how startups can continuously monitor and adjust their decision-making processes to ensure that they remain aligned with their evolving needs and goals. This includes developing mechanisms for incorporating feedback from various stakeholders, such as customers, partners, and investors, into the decision-making process (Dellermann, Lipusch, Ebel, & Leimeister, 2019). This requires a deeper understanding of the mechanisms that enable startups to learn, adapt, and evolve their decision-making processes over time, and also involves considering the organizational culture, leadership styles, and communication processes that facilitate or hinder the effective implementation and adaptation of hybrid models.

CHAPTER 3: RESEARCH METHODOLOGY

This chapter outlines the research methodology used to investigate the integration and adaptation of decision-making frameworks in high-tech startups. It includes the research design, data collection methods, data analysis techniques, and ethical considerations.

1. RESEARCH DESIGN

This study employed a qualitative dominant, exploratory, multi-case study design to investigate the contingencies influencing decision-making in high-tech startups, with the ultimate goal of developing a contingency-based hybrid framework. The research was fundamentally interpretive, seeking to understand the how and why of decision-making processes through the subjective experiences and perspectives of startup founders and key decision-makers (Stake, 1995).

A qualitative approach was adopted because it is particularly well-suited for exploring complex, dynamic, and context-dependent phenomena (Creswell, Pacilio, Lindsay, & Brown, 2014). Quantitative methods, with their emphasis on pre-defined variables and statistical relationships, are less capable of capturing the nuances and intricacies of entrepreneurial decision-making in rapidly evolving environments. The exploratory nature of this research was crucial, as the existing literature provides limited guidance on how different decision models are combined in practice, and under what conditions these combinations are most effective. This study aimed to discover new insights and patterns, rather than test pre-existing hypotheses.

A multi-case study design was chosen to provide a rich and nuanced understanding of the phenomenon. This design allowed for in-depth exploration of individual cases (startups) while also enabling comparisons and contrasts across cases (Yin, 2018). This comparative approach is essential for identifying both common patterns and unique contingencies that influence decision-making. While a single case study could have provided valuable insights, multiple cases enhanced the transferability of the findings and provide a stronger basis for developing a contingency-based framework (Eisenhardt, 1989; Yin, 2018). The use of multiple cases strengthened the external validity of the research, increasing the likelihood that the findings will be relevant to other high-tech startups.

The research focused on high-tech startups based in Belgium. This specific geographic focus allowed for a deeper understanding of the contextual factors influencing decision-making within a particular entrepreneurial ecosystem. While the primary focus was on qualitative data from interviews, the study incorporated elements of quantitative data to provide additional context and support the findings. Therefore, the research design is best described as "qualitative dominant."

2. DATA COLLECTION

The primary data source for this study was semi-structured interviews conducted with key individuals within high-tech startups.

2.1. PARTICIPANTS AND SAMPLING

A purposive sampling method was used to select participants who meet the following criteria:

- **Role:** Founders, co-founders, or C-level executives (CEO, CTO, etc.) of high-tech startups. This ensured that the participants had direct experience with, and responsibility for, strategic decision-making within their ventures. Their direct involvement in the decision-making process is crucial for gaining firsthand insights into the application and adaptation of different decision models.

- **Startup Stage:** The research employed a mixed sampling strategy regarding startup lifecycle stages. The primary focus was on startups that have experienced multiple stages (e.g., transitioned from ideation to development, or from development to scaling). This longitudinal perspective within each case allowed for a richer understanding of how decision-making evolves over time. However, the sample also included startups currently at different stages (ideation, development, scaling, growth) to provide a broader overview of decision-making practices across the lifecycle. This combination of within-stage (recency) and across-stage (overview) sampling provided a more comprehensive and nuanced understanding of the phenomenon.

- **Industry:** The initial focus of the research was on software startups. This provided a degree of homogeneity, simplifying the initial coding and analysis process. *S*oftware startups were selected as the initial focus due to their typically shorter development cycles, lower regulatory hurdles, and greater prevalence of iterative decision-making approaches (e.g., Agile, Lean Startup). This provided a more controlled environment for examining the core research questions. However, the study remained open to the possibility of expanding to include startups in other high-tech sectors (e.g., hardware, biotechnology) in later stages of the research. A clear definition of "high-tech" was crucial for ensuring the relevance of the sample. For the purposes of this study, and drawing on established conceptualizations of New Technology-Based Firms (Autio, 2007) which emphasize recent establishment and a core reliance on technology, a "high-tech startup" was defined as a newly established venture (typically less than 5 years old) that relies heavily on the development and/or application of advanced technologies—such as software, artificial intelligence, biotechnology, or advanced materials, often aligned with sectors recognized for high R&D—to create innovative products or services with the potential for high growth and scalability, characteristics often central to technology-driven entrepreneurship (Shane, 2004). This definition encompasses both startups that develop new technologies and those that utilize existing technologies in novel ways to address market needs.

- **Location:** The study focused on startups based in Belgium. This geographic focus was not intended to "control" external factors in a quantitative sense, but rather to provide a manageable scope for the research and to allow for a deeper understanding of the specific contextual factors that may influence decision-making within a particular entrepreneurial ecosystem. Belgium offers a relevant context due to its growing high-tech sector and active network of incubators.

- **Funding:** Preference was given to startups that have received some form of initial funding (e.g., seed funding, angel investment, venture capital). This served as an indicator of a certain level of viability and commitment, suggesting that the startups have moved beyond the initial idea stage and were actively pursuing their ventures. However, unfunded startups that meet the other criteria were not excluded

The target sample size was 10 participants, representing at least 10 different high-tech startups. While this sample size is relatively small, it was deemed sufficient for a qualitative, exploratory study of this nature. The goal was not to achieve statistical generalizability, but rather to gather rich, in-depth insights and develop a theoretical framework that can be further tested and refined in future research. Data saturation, where new interviews cease to yield significantly new information, was used as a guiding principle for determining the final sample size (Fusch P. & Ness, 2015). It is important to acknowledge that data saturation can only be truly determined ex-post, during the data analysis process.

2.2. SAMPLE DESIGN

The final sample underpinning this research consisted of ten in-depth interviews conducted with founders or C-level executives from ten distinct high-tech startups, all operating within Belgium. This specific geographic focus facilitated a nuanced exploration of decision-making within a particular entrepreneurial ecosystem recognized for its rich high-tech sector and supportive infrastructure.

A purposive sampling strategy was employed to ensure a diverse representation of experiences within the high-tech landscape. The participating ventures spanned various industry sectors, including B2B Marketplaces (for specialized equipment and recruitment), dedicated Software-as-a-Service (SaaS) platforms (targeting areas such as hospital discharge management and sports analytics), innovative MedTech solutions (encompassing both AI-driven surgical planning software and integrated hardware/software medical devices), and Middleware platforms (providing brand-agnostic access management).

Furthermore, the sample reflected a spectrum of operational stages. It included startups in the initial development and early testing phases focused on their Minimum Viable Product (MVP), ventures actively engaged in early market traction by acquiring initial customers and iterating on product-market fit, and those poised for or beginning to navigate the complexities of scaling. The operational age of these startups varied, generally ranging from approximately 1.5 to 4 years post-formal incorporation, with several noting development efforts that commenced prior to official company establishment.

The startups also exhibited diversity in team structures and funding statuses. The leadership included sole founders as well as teams with multiple co-founders (ranging from two to five individuals). In terms of financial backing, participants had secured capital through various avenues, including angel investment, venture capital, accelerator programs, and government grants, while others were in earlier, potentially pre-seed or bootstrapped phases. All interviewees

occupied pivotal strategic decision-making roles (e.g., CEO, Founder, Co-founder), which ensured direct, firsthand perspectives on the phenomena under investigation.

To ensure open and honest responses, anonymity was guaranteed for all participants and their respective startups. The inherent diversity within this sample—across industry focus, developmental stage, team configuration, and funding history—provided a robust foundation for exploring the nuanced ways high-tech startups adapt their decision-making frameworks and cultivate hybrid approaches in response to dynamic and uncertain environments. A detailed, anonymized overview of the startups participating in interviews is presented in the table below.

Case ID	Primary Product/Service Type	Industry Sector Focus	Approx. Lifecycle Stage at Interview	Interviewee Role	Key Team Structure Insight	Key Funding Insight
I1	CAE Software for Lens Design	High-Tech Engineering Software / Optical Design	Scaling (post-product launch 2021)	CEO	Small team (7 employees), Co-founder departure experienced	Grants (Horizon Europe, VLAIO), Accelerators (iStart, Luminate), Founder/FFF Investment
I2	B2B Marketplace (Factory Equipment Sourcing)	Industrial Equipment / B2B Marketplace	Finding Product-Market Fit (Pre-scaling, aiming for 1 yr)	CEO ("Doing Everything")	Fluctuation (5 co-founders -> 8-10 -> 4 after crisis), now 4	Primarily VC, Limited Subsidies
I3	Shareholder Engagement Platform (AI-assisted)	FinTech / SaaS / Corporate Tech	Early Market Traction (Platform ready, acquiring customers)	Founder & CEO	5 Co-founders (all freelancers initially), CEO is "man with the idea"	Self-funded by founders (FFF), Seeking VLAIO grant for AI, Plans VC post-validation

I4	Hotel Room Selection Platform (SaaS)	Hospitality Tech / SaaS	Early Market Traction (Post-launch May 2023)	Founder & CEO	5 total (3 founders)	Equity (iStart), Grants (VLAIO, FIT, City), Preparing next round
I5	SaaS B2B Marketplace (Recruitment /HR Tech)	HR Tech / Recruitment / AI	Early Market Traction	Sole Founder & CEO	Sole Founder (brought prior team along, not as co-founders)	Angel (Ex-CEO of prior co.), Founder Funds, Grants (VLAIO)
I6	Hospital Discharge Management System (SaaS)	Healthcare IT / MedTech	Early Market Traction (100 care homes, pilot hospitals)	Founder & CEO	Founder (sole employee) + Part-Time Co-founder (programming)	Accelerator (iStart), Fund (Blue Elk), Grant (VLAIO)
I7	Access Management Platform (Middleware - Smart Locks)	Smart Access / IoT / Middleware	Early Market Traction	Business Co-founder	2 Co-founders (Operational)	Accelerator (iStart), Grant (VLAIO), FIT Grant
I8	AI Software (Orthopedic Surgery Planning)	MedTech AI / Healthcare AI	Development / Early Testing (MVP, pre-commercial)	CEO	3 Co-founders + Hiring First Employee + Student	Grants (VLAIO Dev.), Accelerator (iStart), Convertible Loans, Angel Round
I9	MedTech (Hardware + Software -	MedTech / Wearables /	Early Market Traction / Finding	CEO	Team Size: 6 (3 Co-founders, 1st	Grants (VLAIO), VC Funding

	Smart Insole)	Rehabilitation	PMF (10-15 customers)		employee, student)	
I10	SaaS (AI Sports Analysis Software - Football)	Sports Tech / AI / Data Analytics	Between Development & Early Market Traction	CEO / Commercial Lead	3 Founders + Hiring 4th Employee (+ Interns, total 7 soon)	Accelerator (iStart), Grants (VLAIO - Feasibility & Dev.), Angels (Pre-seed)

Table 1: *Overview of Research Sample Cases*

2.3. INTERVIEW PROTOCOL

The semi-structured interviews followed a guided conversation format, lasting approximately 30–60 minutes each (DiCicco-Bloom. & Crabtree, 2006). This format provides a balance between structure and flexibility, ensuring that key topics are covered while allowing for open-ended exploration of the participants' experiences. The interview protocol was designed to elicit detailed accounts of the participants' entrepreneurial journeys, their decision-making processes, and their experiences with different decision models. The questions were open-ended to allow for flexibility and encourage participants to share their perspectives in their own words.

The interview protocol included the following key elements (See Appendix A for the interview protocol):

- **Demographic Information:** Gathering basic information about the participant and their startup (e.g., age of startup, industry, stage, number of employees, prior entrepreneurial experience). This provided context for understanding the participants' responses and identifying potential contingencies.
- **Direct Questions:** Asking direct questions about the participants' awareness and use of decision-making principles. These questions were designed to elicit detailed accounts of the decision-making process.

    1. Think back to the very beginning of your startup. What sparked the initial idea? What problem were you trying to solve, or what opportunity did you see?
    2. As you were building and growing your startup, what principles or approaches guided your decision-making? Were there any particular ways of thinking, or frameworks, that you and your team used to make decisions? *(*Probe for principles of effectuation, lean startup, design thinking, causation, etc.)

3. At what stages of your startup's development have you found these approaches most useful? (Explicitly addresses lifecycle stages.)
4. Have you encountered any situations where these approaches were not helpful or were difficult to apply? (Probes for limitations.)
5. Can you describe a specific instance where you had to adapt or modify your decision-making approach due to changing circumstances or unexpected events?
6. When you and your team had to make decisions, what factors did you take into consideration?
7. How did you assess the potential of this opportunity?" (Probes for research methods, user engagement)
8. Thinking about your resources, at what point did you decide you had enough to develop your idea? (Probes for affordable loss)
9. Can you describe the challenges you encountered in applying those principles?

- **Follow-Up Questions:** Probing for further details and clarification on specific points raised by the participants. This enabled a deeper understanding of the reasoning behind their decisions and the nuances of their experiences.

Wrap-Up Questions: Asking about the role of funding, their definition of success, and their vision for the future.

2.4. DATA COLLECTION PROCEDURES

- **Recruitment:** Potential participants were identified through various channels, including online databases (e.g., Crunchbase, LinkedIn), startup incubators and accelerators, and personal networks.
- **Initial Contact:** Participants were contacted via email or phone and invited to participate in the study. The initial contact briefly explained the research purpose and emphasized the value of their participation.
- **Informed Consent:** Participants were provided with a clear and comprehensive explanation of the research purpose, procedures, and their rights.
- **Interview Conduct:** Interviews were conducted via video conferencing (e.g., Teams, Google Meet), depending on the participant's preference and availability.
- **Audio Recording:** With the participant's permission, interviews were audio-recorded to ensure accurate data capture.
- **Transcription:** The audio recordings were transcribed verbatim to facilitate data analysis.

3. DATA ANALYSIS

The interview data was analyzed using a thematic analysis approach (Braun. & Clarke, 2006), drawing explicitly on the principles and structured framework of the Gioia methodology (Gioia, Corley, & Hamilton, 2013) to ensure rigor in developing theoretical insights grounded in the qualitative data. This iterative process involved the following distinct phases:

1. **Phase 1: Familiarization and 1st-Order Coding:** Initial analysis involved deep familiarization with the verbatim transcripts from the 10 interviews. Subsequently, a meticulous 1st-order coding process was undertaken for each interview individually. Adhering to Gioia methodology principles, this phase focused on identifying concepts directly from the informant's terms and language ('in vivo' codes where possible) or using descriptive labels staying close to the data's meaning. This open coding aimed to capture the full range of experiences related to decision-making processes, challenges, strategies, and the use of different decision logics.

2. **Phase 2: Codebook Consolidation & Concept Refinement:** The 1st-order codes from each interview were systematically and iteratively compared against a developing Master Codebook. Unique concepts were added, while reuse was noted, ensuring all distinct ideas across the entire dataset were captured. This resulted in the verified Master Codebook v10, comprising approximately 482 unique 1st-order concepts, each with a definition and illustrative quotes.

3. **Phase 3: Developing 2nd-Order Themes:** The comprehensive Master Codebook v10 was then systematically analyzed to identify patterns, conceptual similarities, and relationships among the 1st-order concepts. This involved an iterative process of comparing and contrasting concepts, collaboratively grouping related concepts into meaningful clusters, and developing interpretive labels. This analytical phase resulted in the identification of 12 distinct 2nd-Order Themes that represent recurring patterns of meaning at a higher level of abstraction than the initial codes. Each theme was given a concise definition reflecting the essence of its constituent 1st-order concepts.

4. **Phase 4: Developing Aggregate Dimensions:** In the final stage of theoretical abstraction, the 12 2nd-order themes were analyzed for higher-level conceptual linkages. Related themes were clustered based on overarching theoretical constructs relevant to the research questions on hybrid decision-making and contingency. This interpretive step led to the development of 5 overarching Aggregate Dimensions, representing the core theoretical categories emerging from the data. Each dimension was defined based on the conceptual contribution of its underlying 2nd-order themes.

5. **Data Structure Presentation & Rigor:** The output of this multi-phase analysis is a structured data representation (detailed in Chapter 4) mapping representative 1st-order concepts to the 12 2nd-order themes and subsequently to the 5 Aggregate Dimensions, visually demonstrating the path from raw data to theoretical concepts (Gioia, Corley, & Hamilton, 2013). Throughout the process, reflexivity (Braun. & Clarke, 2006) and iterative

refinement were employed. Data triangulation using secondary sources (e.g., company information, literature) was considered to enhance validity where applicable.

4. ETHICAL CONSIDERATIONS

The following ethical considerations were taken into account throughout the research process:

- **Informed Consent:** All participants were provided with a clear and comprehensive explanation of the research purpose, procedures, and their rights. Informed consent was obtained from each participant before the interview.
- **Confidentiality and Anonymity:** Measures were taken to protect the confidentiality and anonymity of participants. All data was anonymized, and any identifying information was removed from the transcripts and reports.
- **Voluntary Participation:** Participation in the study was voluntary, and participants were informed that they can withdraw from the research at any time without penalty.
- **Data Security:** All data collected during the research was stored securely and accessed only by authorized researchers.
- **Transparency:** The research process was conducted in a transparent and ethical manner, with all findings and limitations clearly reported.

CHAPTER 4 - RESULTS

This chapter presents the findings derived from the qualitative analysis of ten semi-structured interviews conducted with founders and CEOs of Belgian high-tech startups. The primary objective of the analysis was to explore the decision-making processes employed by these ventures, particularly focusing on how they utilize and adapt different approaches like effectuation, lean startup, design thinking, and causation within dynamic environments, with the ultimate aim of informing a contingency-based framework.

Following the principles of thematic analysis (Braun. & Clarke, 2006) and the structured approach of the Gioia methodology (Gioia, Corley, & Hamilton, 2013), the interview data were systematically coded and analyzed. This rigorous process progressed from approximately 482 initial 1st-order concepts, grounded directly in the participants' experiences and language, through iterative refinement into 12 distinct 2nd-order themes representing recurring patterns of meaning. These themes were further synthesized into 5 higher-order Aggregate Dimensions that capture the core theoretical constructs emerging from the data.

The complete data structure, illustrating the progression from representative 1st-order concepts to the 2nd-order themes and the final Aggregate Dimensions, is presented in Table 2. This structure provides a transparent map of the analytical journey from the raw data to the emergent conceptual framework.

Representative 1st-Order Concepts	**2nd-Order Themes**	**Aggregate Dimensions**
Product: AI Software (Orthopedic Surgery Planning) Origin: University Spin-off Stage: Early Market Traction Team Structure: 3 Co-founders + Hiring First	**1. Startup Profile & Context** Definition: Describes the startup's fundamental identifying characteristics (e.g., product, origin, age, stage, size, structure, founder roles) defining its internal state and operational context at the time of study.	**A. Venture Context & Contingencies** Definition: Represents the confluence of the startup's internal characteristics (profile, stage, structure) and the external environmental forces (industry dynamics, market conditions, challenges, constraints) that collectively constitute the situational contingencies influencing strategic choices and operational possibilities.
Challenge: Medical Device Regulation (Cost/Time) Challenge: Market Readiness ("Too Early") Challenge: Technical (Bluetooth Connectivity) Resource Constraints Limit Opportunity Pursuit	**2. Contextual Factors, Challenges & Constraints** Definition: Encompasses the specific internal limitations and external environmental factors (e.g., industry dynamics, market conditions, regulations, technical hurdles, resource constraints) that present challenges or impose constraints influencing	

	the startup's trajectory and decision-making scope.	
Idea from Own Pain Point (Amateur Athlete) Opportunity Recognition (Gap in Market) Origin: Pivot from Failed Prior Venture	**3. Idea Genesis & Opportunity Recognition** Definition: Explains the sources and stimuli for the venture's initial conception (e.g., personal/professional pain points, prior experience, identified market gaps) and how these were recognized and framed as actionable entrepreneurial opportunities.	**B. Founder Influence & Orientation** Definition: Represents the significant impact of the founder's individual background, cognitive framing, psychological disposition, and personal circumstances on shaping the venture's origins, initial direction, risk propensity, and overall approach to navigating the entrepreneurial journey.
Prior Corporate Experience Increased Belief in Intuition Personal Coping: Emotional Detachment Consideration of Personal Liabilities (Family/Age)	**4. Founder Mindset, Psychology & Risk Approach** Definition: Encompasses the founders' individual characteristics, including their relevant background, core beliefs, motivations, cognitive assumptions, psychological coping strategies, approach to risk-taking (informed by personal situation), and overall orientation towards the entrepreneurial process.	
Funding Mix: Grants, Accelerator, Loans, Angel Decision Driven by Runway Constraint Challenge: Finding Co-founder	**5. Resource Acquisition & Management** Definition: Involves the methods, challenges, and strategic decisions associated with obtaining and managing essential financial capital (e.g., funding rounds, grants, bootstrapping) and key human resources, recognizing the influence of resource availability and acquisition processes on venture development.	**C. Organizational Capabilities & Structure** Definition: Represents the venture's internal and relational architecture, encompassing its ability to acquire and manage vital resources, its internal team structure and collaborative dynamics, its governance mechanisms, and its capacity to leverage external networks and partnerships effectively.
Decision Process: Co-founder Discussion (Transparent)	**6. Team Dynamics & Internal Governance** Definition: Addresses the composition, evolution, and	

Structure: Board of Directors (External Members) Challenge: Remote Co-founder Communication Value of Diverse Founding Team Skills	collaborative functioning of the internal team, including co-founder relationships, role definitions, communication patterns, internal decision-making protocols, and the implementation of formal or informal governance mechanisms.	
Leveraged Personal Network for Co-founders Approach: Warm Introductions Crucial Ongoing Reliance on Advisors/Board Strategic Partnership: Backend-as-a-Service	**7. Network Leveraging & Strategic Partnerships** Definition: Pertains to the deliberate cultivation and utilization of external networks (e.g., advisors, investors, peers) and the formation of strategic partnerships to gain access to resources, knowledge, market opportunities, validation, and other critical support functions.	
Early Validation Method: Figma Prototypes Method: A/B Testing Validation Metric: Actual Usage Process: Cold Calling for Validation (Pre-Product)	**8. Validation, Experimentation & Market Learning** Definition: Encompasses the portfolio of specific practices, tools, and methods (e.g., prototyping, MVPs, pilots, data analysis, user feedback mechanisms) employed by the startup to actively test assumptions, validate concepts, and generate market learning iteratively.	**D. Entrepreneurial Learning & Process Adaptation** Definition: Represents the dynamic and iterative processes through which the startup engages in learning by testing assumptions and validating concepts (Validation & Experimentation), leading to consequential adaptations in its operational methods and the evolution of its overall decision-making approaches over time
Shift from gut feeling to data Learning importance of pre-defined success metrics Retrospective: Action vs Planning/Perfection Organic evolution of decision process	**9. Evolution of Decision-Making Processes** Definition: Reflects the dynamic changes and maturation in the startup's overall decision-making approach over time, including shifts in reliance (e.g., from intuition to data), evolving views on planning, retrospective learning about effective processes, and increasing procedural formalization.	

Pivot: Drop Hardware, Focus on Software Business Model Pivot: B2B Data Provider Goal Definition Evolves (Pivoting) Shift Triggered by Market/Competition	**10. Strategic Adaptation & Pivoting** Definition: Involves substantial, deliberate changes to the venture's core strategy, business model, product direction, or target market, representing significant course corrections often triggered by learning, market feedback, or strategic reassessment.	
Identified with Planner & Experimenter Viewed models as interconnected/needed Conscious Combination/Shifting Adaptable Planning needed	**11. Hybridity & Decision Model Reflection** Definition: Encompasses founders' explicit reflections on, and perceived utilization of, different underlying decision-making logics (e.g., planning, effectuation, lean, design thinking), including their conscious combination (hybridity), situational application, perceived sequencing, and justifications for their chosen approaches.	**E. Strategic Decision Logics & Responses** Definition: Represents the overarching strategic posture and deliberate actions of the startup, encompassing major adaptive responses (pivots), the conscious application and reflection upon underlying decision-making logics (hybridity), and the forward-looking anticipation of future strategic challenges and choices.
Future Challenge: Internationalization Decision Future Decision Point: Continue vs Stop Future Challenge: Scaling Resources Future Challenge: Validating Willingness to Pay	**12. Anticipated Future Challenges & Strategic Outlook** Definition: Pertains to the founders' forward-looking perspective, including their identification of anticipated strategic challenges, key future decision points (e.g., scaling, internationalization, exit), and the overall strategic considerations guiding the venture's future trajectory.	

Table 2: *Data Structure Mapping 1st-Order Concepts to 2nd-Order Themes and Aggregate Dimensions*

The remainder of this chapter will elaborate on these findings by systematically presenting each of the 5 Aggregate Dimensions and their constituent 12 2nd-Order Themes. Each theme will be described using the definitions developed during the analysis and illustrated with representative quotes and examples drawn directly from the interview transcripts, providing rich insight into the

decision-making realities of high-tech startups. The focus here is on presenting the empirical findings; interpretation and linkage to existing literature will be reserved for the subsequent Discussion chapter.

1. AGGREGATE DIMENSION A: VENTURE CONTEXT & CONTINGENCIES

The analysis revealed that decision-making approaches in high-tech startups are fundamentally shaped by the specific situation. The first aggregate dimension, Venture Context & Contingencies (A), represents this foundational element. It was formed by aggregating themes describing the startup's inherent internal state (Theme 1: Startup Profile & Context) with those detailing the external environmental forces and internal limitations (Theme 2: Contextual Factors, Challenges & Constraints). These two themes were grouped because they collectively define the operational landscape and pre-existing conditions – the specific "givens" – that startups encounter and must navigate from the outset. This dimension thus captures the confluence of internal characteristics and external pressures that constitute the situational contingencies influencing strategic choices. While Theme 1 describes the internal makeup of the venture itself, which could be seen as a type of internal capability (Dimension C), it is distinct here as it focuses on the static descriptive profile rather than the dynamic operational capabilities developed or managed by the startup. This dimension underscores that understanding decision-making requires first understanding this baseline operational context.

1.1. THEME 1 : STARTUP PROFILE & CONTEXT

This theme describes the startup's fundamental identifying characteristics defining its internal state and operational context at the time of study. Understanding this profile is crucial as it sets the baseline for resources, complexity, and priorities. Key characteristics identified included the specific product or service being developed, ranging from complex regulated hardware/software combinations (e.g., Product: MedTech (Hardware + Software)) to more agile software platforms (e.g., Product: SaaS (Sports Analysis Software)), influencing development cycles and validation needs. The origin of the venture (e.g., Origin: University Spin-off) often shaped initial resources, networks, and potential IP constraints. Furthermore, the operational age and stage (e.g., Operating: approximately 1.5 years, Stage: Development / Early Testing, Stage: Early Market Traction) were critical indicators of maturity, dictating whether the focus was on initial validation, finding product-market fit, or scaling operations as stated by founder I5, '*We're a university spin-off working on a MedTech device that combines hardware and software. We've been operating for about 18 months, currently in early market traction, so our focus is on validating our MVP with initial users while managing a small but growing team where I'm still wearing multiple hats as CEO*' illustrating how these profile elements establish the baseline conditions and internal starting point from which the venture operates and makes decisions. Finally, the internal team structure (e.g., Team Structure: Sole Founder..., Team Size: Growing (3 Founders + 4 Employees + Interns), Role: CEO ('Doing Everything')) defined the available human capital, leadership dynamics, and internal decision-making capacity. Founders often identified their stage clearly, for instance stating they were *'in early market traction'* (I5/I6), confirming a focus on validating with initial customers and iterating the go-to-market approach after launching an MVP. These profile

elements establish the baseline conditions and internal starting point from which the venture operates and makes decisions.

1.2. THEME 2: CONTEXTUAL FACTORS, CHALLENGES & CONSTRAINTS

Complementing the internal profile, this theme encompasses the specific internal limitations and external environmental factors that present challenges or impose constraints influencing the startup's trajectory and decision-making scope. Founders frequently highlighted **industry-specific dynamics**, such as the demanding regulatory environment and long cycles in MedTech, which necessitate different approaches compared to other sectors. As one MedTech founder noted regarding rapid experimentation, *'...difficulty is that experimenting in the medical field... works very well in SaaS... For us, we have long sales cycles... so it's not very easy...'* (I9). **Market conditions**, particularly assessing market readiness (e.g., Challenge: Market Readiness ('Too Early')) or dealing with cyclical demand (Observation: Cyclical Applicant Market), were significant external pressures shaping strategic timing and approach. **Internal limitations** also played a key role, including specific technical hurdles encountered during development (e.g., Challenge: Technical (Bluetooth Connectivity)) and pervasive **resource constraints**, whether financial or human capital, which often forced founders into making difficult trade-offs. The impact of such constraints was evident when one venture had to significantly downsize: '...*were with eight to 10 people... reduced it now to four actually...*' (I2 / I3). These contextual elements create a complex, often unpredictable landscape that startups must continuously navigate.

2. AGGREGATE DIMENSION B: FOUNDER INFLUENCE & ORIENTATION

While context sets the stage, Founder Influence & Orientation (B) highlights the crucial role of the entrepreneur(s) in interpreting that context and shaping the venture's initial path. This dimension aggregate's themes concerning the venture's conceptual origins (Theme 3: Idea Genesis & Opportunity Recognition) with the individual characteristics of the founder(s) (Theme 4: Founder Mindset, Psychology & Risk Approach). The rationale for grouping these themes is that the founder acts as the primary agent who perceives opportunities and whose personal attributes (background, mindset, risk approach) directly drive the initial ideation and the venture's early orientation. This dimension thus represents the significant impact of the founder's individual background, cognitive framing, psychological disposition, and personal circumstances on shaping the venture's origins, initial direction, and risk propensity.

2.1. THEME 3: IDEA GENESIS & OPPORTUNITY RECOGNITION

This theme explains the sources and stimuli for the venture's initial conception and how these were recognized and framed as actionable entrepreneurial opportunities. Often, ideas stemmed directly from the founders' own experiences, such as personal frustrations or unmet needs encountered as consumers or professionals (Idea from Own Pain Point (Amateur Athlete)). For instance, one founder's venture originated directly from difficulties faced managing family healthcare needs: '...*my mom actually had a treatment... had to have aftercare... had to get a recovery stay... had to fight... making phone calls...'* (I6). Alternatively, opportunities were identified through recognizing market gaps (Opportunity Recognition (Gap in Market)) or spinning out

technology from university research (Origin: University Spin-off). Sometimes, the current venture emerged from the ashes of a previous one (Origin: Pivot from Failed Prior Venture), indicating that opportunity recognition is also a process of learning and adaptation from past experiences. This theme underscores that the 'where' of the idea often shapes its initial form and the founder's conviction.

2.2. THEME 4: FOUNDER MINDSET, PSYCHOLOGY & RISK APPROACH

Beyond the idea itself, the founder's individual characteristics profoundly influence decision-making, as captured by this theme. Relevant **professional background** (Prior Corporate Experience) often shaped initial approaches, sometimes bringing valuable structure but potentially lacking startup-specific agility. Core **beliefs and motivations** (Founder Motivation: Passion/Long-Term View) drove persistence, while **cognitive assumptions**, such as a reliance on intuition (Increased Belief in Intuition), guided early choices, especially when data was scarce. Founders also employed various **psychological coping strategies** (Personal Coping: Emotional Detachment, Personal Coping: Nature & Movement (Walking)) to manage the inherent stress and uncertainty of the startup journey. Crucially, the founder's **approach to risk-taking** was often explicitly linked to their **personal circumstances** (Consideration of Personal Liabilities (Family/Age), Founder Personal Situation Enables Risk-Taking). As one founder explained, *'I'm 44 years old... cannot take the risks...'* (I3), leading them to seek funding early to mitigate personal financial exposure, while younger teams felt their situation allowed for more risk (Personal Situation Allows Risk (Young Team)). This theme highlights the deeply personal element influencing the strategic and operational choices made within the venture.

3. AGGREGATE DIMENSION C: ORGANIZATIONAL CAPABILITIES & STRUCTURE

The ability of a high-tech startup to execute its strategy and adapt to its context (Dimension A), guided by founder orientation (Dimension B), is critically dependent on its Organizational Capabilities & Structure (C). This dimension represents the venture's internal and relational architecture. It groups themes related to securing and managing vital inputs (Theme 5: Resource Acquisition & Management), the internal operational engine (Theme 6: Team Dynamics & Internal Governance), and the engagement with external support systems (Theme 7: Network Leveraging & Strategic Partnerships). These three themes converge as they collectively describe the key structural and relational assets and processes that the startup develops and deploys to function and pursue its goals. While Theme 1 (Startup Profile in Dimension A) also describes internal characteristics, Dimension C focuses on the dynamic operational capabilities and actively managed structures, such as how resources are obtained, how teams collaborate and are governed, and how external relationships are strategically built and utilized.

3.1. THEME 5: RESOURCE ACQUISITION & MANAGEMENT

Central to any startup's survival and growth is its ability to acquire and manage essential resources. This theme involves the methods, challenges, and strategic decisions associated with obtaining **financial capital** and key **human resources**. Startups utilized diverse funding

strategies, often combining sources like grants, accelerator funding, loans, and angel investment (Funding Mix: Grants, Accelerator, Loans, Angel). The management of these finances was critical, with limited cash often acting as a major constraint forcing difficult decisions, sometimes leading to drastic actions like downsizing: '...*were with eight to 10 people... reduced it now to four actually*...' (I2 / I3). Equally important was acquiring human capital, particularly finding the right co-founders (Challenge: Finding Co-founder) or making the first crucial hires, which founders often described as a significant hurdle: '*I'm looking for a co-founder since the day I started... just haven't found him yet or her*.' (I5). The effectiveness of resource acquisition and management directly influenced the venture's capacity for development and experimentation.

3.2. THEME 6: TEAM DYNAMICS & INTERNAL GOVERNANCE

Beyond resources, the internal 'engine' of the startup relies on effective **Team Dynamics & Internal Governance**. This theme addresses the composition (e.g., Value of Diverse Founding Team Skills), evolution, and collaborative functioning of the team. Co-founder relationships, alignment, and clear communication were highlighted as crucial, with open discussion being a common decision-making protocol (Decision Process: Co-founder Discussion (Transparent)). As one founding team member described their process: '...*discussed it with the three of us We're really transparent...*' (I10). However, challenges such as geographical separation (Challenge: Remote Co-founder Communication) could impede this collaboration. As startups matured or sought external funding, the implementation of **governance mechanisms** became relevant, ranging from informal advisory input to establishing formal Boards (Structure: Board of Directors (External Members)). Some founders deliberately implemented corporate structures early, seeing benefits in alignment and validation (Benefit of Structure: Alignment & Buy-in), while acknowledging the potential downsides of bureaucracy (Downside: Bureaucracy/Slowness). This internal structure shapes the efficiency and effectiveness of decision-making and execution.

3.3. THEME 7: NETWORK LEVERAGING & STRATEGIC PARTNERSHIPS

High-tech startups rarely operate in isolation; they actively cultivate and utilize external relationships, as captured in this theme. Founders consistently emphasized the importance of **leveraging networks** – personal, professional, academic, and investor networks – for crucial functions like recruiting co-founders (Leveraged Personal Network for Co-founders), gaining market access through trusted introductions (Approach: Warm Introductions Crucial), and obtaining ongoing guidance (Ongoing Reliance on Advisors/Board). As one founder noted regarding accessing key stakeholders like surgeons: '...*Warm introductions are always better... if it's another surgeon that they know... suggesting the software, then they see it with other eyes*.' (I8). Beyond informal networks, **strategic partnerships** with other companies, institutions, or even service providers (e.g., Strategic Partnership: Backend-as-a-Service) were formed to access specific resources, technology, market channels, or credibility, effectively extending the startup's capabilities beyond its internal limitations. These external relationships form a critical part of the venture's relational architecture.

4. AGGREGATE DIMENSION D: ENTREPRENEURIAL LEARNING & PROCESS ADAPTATION

Operating within their context (Dimension A), guided by founder orientation (Dimension B), and utilizing their capabilities (Dimension C), startups navigate uncertainty through Entrepreneurial Learning & Process Adaptation (D). This dimension captures the venture's dynamic learning engine. It brings together themes detailing the methods of acquiring knowledge and feedback (Theme 8: Validation, Experimentation & Market Learning) with themes describing the temporal changes in the startup's overall decision-making approaches (Theme 9: Evolution of Decision-Making Processes). These themes are aggregated because they both represent the core iterative cycles through which startups reduce uncertainty, refine their understanding, and adapt their operational methods and internal decision routines over time. While Dimension E also involves adaptation, Dimension D focuses on the ongoing learning processes and the evolution of HOW decisions are made and problems are understood, whereas Dimension E centers on the discrete strategic outcomes (like pivots) and explicit reflections on decision logics.

4.1. THEME 8: VALIDATION, EXPERIMENTATION & MARKET LEARNING

This theme encompasses the portfolio of specific practices, tools, and methods employed by the startup to actively test assumptions, validate concepts, and generate market learning iteratively. Founders described a wide range of techniques crucial for reducing uncertainty. Early validation often involved creating clickable mockups or prototypes (Early Validation Method: Figma Prototypes) to test concepts with potential users before significant development investment: '...*create prototypes first. I didn't build anything at first... did it in Figma... make the drawings a bit clickable*.' (I6). As products developed, more structured experimentation methods like A/B testing (Method: A/B Testing) were used to compare feature effectiveness based on data: '...AP tests... every user has a different approach... different screen... test both of them simultaneously.' (I5). Gathering direct market feedback was essential, achieved through methods ranging from systematic pre-product cold calling (Process: Cold Calling for Validation (Pre-Product)) to ongoing pilot programs and tracking key metrics like actual product usage (Validation Metric: Actual Usage) as indicators of value: '...*customers that want to use it... Those are the two metrics... Real usage...*' (I9). This theme highlights the hands-on, empirical approach startups take to learn about their market and refine their offering.

4.2. THEME 9: EVOLUTION OF DECISION-MAKING PROCESSES

This theme reflects the dynamic changes and maturation in the startup's overall decision-making approach over time, often driven by the learning generated in Theme8. Many founders described an **evolution** from relying heavily on intuition in the early, data-poor stages towards more evidence-based approaches as the venture matured and data became available (Shift from gut feeling to data): '*initially... do a lot on gut feeling... As the company grew... We have more specific data...*' (I1). This shift was often described as an Organic evolution of decision process, happening gradually rather than through a single deliberate change. Experience also led to **retrospective learning** about effective processes; founders recognized the pitfalls of insufficient planning

(Learning: Planning is Necessary (despite preference)) or the importance of defining success upfront (Learning importance of pre-defined success metrics): '...*had to learn... define beforehand... definition of success*...' (I1). Conversely, some reflected that early action was more valuable than excessive planning (Retrospective: Action VS Planning/Perfection): '...*spent too much time in asking advice... making business plan... I just have better just... start selling.'* (I2 / I3). This theme captures the crucial aspect that how decisions are made is not static but adapts based on experience, learning, and the changing needs of the venture.

5. AGGREGATE DIMENSION E: STRATEGIC DECISION LOGICS & RESPONSES

The culmination of navigating context (Dimension A), guided by founder orientation (Dimension B), enabled by capabilities (Dimension C), and informed by learning (Dimension D), is expressed through Strategic Decision Logics & Responses (E). This dimension represents the startup's overarching strategic posture and deliberate, high-level actions. It combines themes relating to significant course corrections (Theme 10: Strategic Adaptation & Pivoting), founders' conscious reflections on and utilization of combined decision models (Theme 11: Hybridity & Decision Model Reflection), and their forward-looking planning (Theme 12: Anticipated Future Challenges & Strategic Outlook). These themes converge as they all pertain to the explicit strategic choices made, the underlying rationale or 'logics' (including hybridity) guiding these choices, and the proactive consideration of future strategic positioning. As noted for Dimension D, while both involve adaptation, Dimension E is distinct as it focuses on major strategic responses and the explicit philosophical stance towards decision models, rather than the more continuous operational learning and process evolution captured in Dimension D.

5.1. THEME 10: STRATEGIC ADAPTATION & PIVOTING

This theme involves the substantial, deliberate changes made to the venture's core strategy, business model, product direction, or target market. These significant course corrections represent major responses to accumulated learning or changing contexts, distinct from routine iterations. Examples included fundamental shifts in the product offering, such as deciding to abandon a hardware component to focus solely on software (Pivot: Drop Hardware, Focus on Software): *'...tried it with the hardware part, but it's a real pain in the ass... decided to focus on what we're good at focus on the software alone...'* (I10). Other startups described pivoting their entire business model based on market feedback and learning for example, a founder noted, *'we had to pivot the whole business model... we learned from the feedback that this was not solving the real problem...'* (I4). (Business Model Pivot: B2B Data Provider). These adaptations often occurred when initial assumptions proved flawed or when market reactions necessitated a different approach (Shift Triggered by Market/Competition), demonstrating the startups' capacity for significant strategic redirection based on evidence gathered through the learning processes of Dimension D.

5.2. THEME 11: HYBRIDITY & DECISION MODEL REFLECTION

Crucially, this theme captures founders' explicit reflections on, and perceived utilization of, different underlying decision-making logics, highlighting the practical enactment of **hybridity**. Founders rarely adhered rigidly to a single theoretical model (e.g., pure Effectuation or pure Causation). Instead, they described combining elements situationally. Many identified with traits from multiple approaches (Identified with Planner & Experimenter, Identified with Adapter & Experimenter) and viewed the models as interconnected tools rather than exclusive doctrines (Viewed models as interconnected/needed): '*Sure. It's not a one-line thing. You combine a lot of things.'* (I10). There was often a recognition of the need for **conscious combination or shifting** between approaches based on the specific context or task (Conscious Combination/Shifting), such as using planning where possible but embracing experimentation under uncertainty. Even when planning was deemed necessary, it needed to be adaptable (Adaptable Planning needed), integrating learning rather than resisting it: '...*plan will change always... don't overthink the plan... need a good plan that I can adopt very easily*.' (I5). This theme directly reveals how founders pragmatically blend decision logics in response to the contingent demands they face.

5.3. THEME 12: ANTICIPATED FUTURE CHALLENGES & STRATEGIC OUTLOOK

Finally, strategic decision-making is also forward-looking. This theme pertains to the founders' perspectives on the future, including anticipated challenges and key upcoming strategic decisions. Common future challenges included navigating international expansion (Future Challenge: Internationalization Decision), managing the complexities of scaling processes and teams as one founder remarked, '*scaling is not just doing more, it's about reorganizing everything... communication, roles, priorities... it all gets more complicated'* (I8), emphasizing the layered and complex nature of scaling a high-growth startup. (Future Challenge (Scaling): Processes & Structure), ensuring long-term financial viability or profitability (Future Challenge: Profitability/Viability), and validating willingness to pay (Future Challenge: Validating Willingness to Pay). Founders also contemplated critical future decision points, such as deciding whether to continue or cease operations (Future Decision Point: Continue vs Stop) or considering strategic partnerships or exits. As one founder anticipated the challenges of scaling, they identified the need for delegation: '...*founder cannot be the bottleneck... need processes and structure...*' (I2). This forward outlook influences current strategic priorities, necessary capability building (Dimension C), and the ongoing learning agenda (Dimension D).

6. CONCLUSION

In conclusion, this chapter has systematically presented the empirical findings derived from the qualitative analysis of interviews with ten founders of Belgian high-tech startups. The analytical process, guided by the Gioia methodology, resulted in the identification of five core Aggregate Dimensions: (A) Venture Context & Contingencies, (B) Founder Influence & Orientation, (C) Organizational Capabilities & Structure, (D) Entrepreneurial Learning & Process Adaptation, and (E) Strategic Decision Logics & Responses. These dimensions, along with their twelve constituent second-order themes, were detailed and illustrated with direct evidence from the participants' accounts, showcasing the complex reality of startup decision-making. The complete data structure

mapping this analysis was presented in Table 2. Having laid out the empirically grounded findings, the subsequent Discussion chapter will delve into the interpretation of these results, elaborate on the dynamic interplay between the Aggregate Dimensions to articulate the proposed contingency-based framework, connect the findings to relevant academic literature, and explore the theoretical and practical implications of this study.

CHAPTER 5 - DISCUSSION

This study aimed to develop a contingency-based framework explaining how high-tech startups utilize and adapt hybrid decision-making models (such as Effectuation, Lean Startup, Design Thinking, and Causation) within dynamic environments. The preceding chapter systematically presented the empirical findings derived from the qualitative analysis of interviews with ten founders and CEOs of Belgian high-tech startups. These findings were structured into five core Aggregate Dimensions: (A) Venture Context & Contingencies, (B) Founder Influence & Orientation, (C) Organizational Capabilities & Structure, (D) Entrepreneurial Learning & Process Adaptation, and (E) Strategic Decision Logics & Response, grounded in twelve supporting second-order themes and numerous first-order concepts.

This chapter now turns to the interpretation and synthesis of these findings. Its primary purpose is threefold: first, to elaborate on the emergent contingency-based framework by discussing the dynamic interrelationships identified between the five Aggregate Dimensions; second, to connect these empirical insights back to the existing theoretical landscape concerning entrepreneurial decision-making models and contingency theory; and third, to explicitly address the research questions posed at the outset of this study. Subsequently, the chapter will outline the theoretical contributions and practical implications derived from the framework, before briefly revisiting the study's limitations and proposing avenues for future research.

1. THE CONTINGENCY-BASED FRAMEWORK FOR HYBRID DECISION-MAKING

The culmination of the qualitative analysis presented in Chapter 4 is an emergent conceptual framework depicting the dynamic interplay of factors influencing how high-tech startups utilize and adapt hybrid decision-making models. This framework, illustrated in Figure 1, synthesizes the five aggregate dimensions identified from the data and highlights their key interrelationships. It offers a contingency-based perspective, suggesting that decision-making approaches are not static choices, but adaptive responses shaped by a complex interplay of situational, individual, and organizational factors.

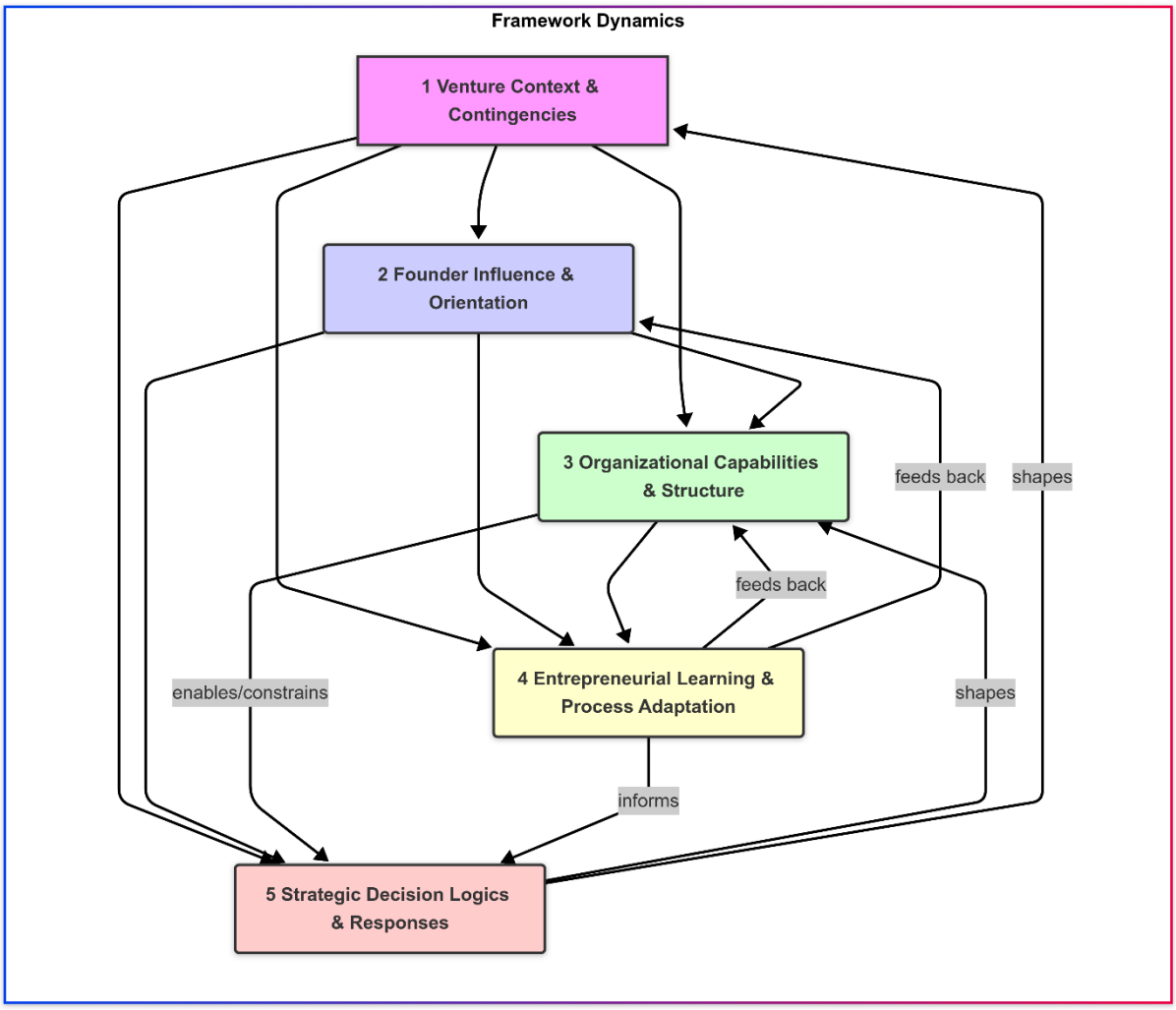

Figure 1*: A Contingency-Based Framework for Hybrid Decision-Making in High-Tech Startups*

The derivation of the relationships depicted in this framework (Figure 1) represents a blend of empirical grounding and conceptual interpretation, consistent with the Gioia methodology (Gioia, Corley, & Hamilton, 2013). While the identification of the five Aggregate Dimensions and their constituent twelve 2nd-Order Themes stemmed directly from the patterns observed in the interview data through iterative coding and thematic analysis (as detailed in Chapter 4 and Table 2), the articulation of the dynamic interplay between these dimensions involved a conceptual leap. This leap was informed by the researchers' interpretation of how these dimensions logically influenced one another based on the narratives provided by the founders, combined with an abductive process of seeking the best explanation for the observed phenomena, guided by existing theoretical lenses such as contingency theory. Thus, the framework is data-anchored, but its structural connections are the result of interpretive analysis aimed at building a coherent explanatory model.

This framework provides a robust lens through which to address the research questions posed at the outset of this study. The following discussion will elaborate on the framework's dynamics by explicitly linking them to each research question, illustrating key relationships with evidence from the participant interviews.

1.1. ANSWERING RQ1: HOW DO LIFECYCLE STAGES INFLUENCE THE APPLICABILITY AND EFFECTIVENESS OF DECISION MODELS LIKE EFFECTUATION, LEAN STARTUP, AND DESIGN THINKING WITHIN THE HIGH-TECH CONTEXT?

The framework clearly indicates that the **lifecycle stage** of a high-tech startup, a key component of its **Venture Context & Contingencies (Dimension A, Theme 1)**, significantly influences the applicability, effectiveness, and the specific blend of decision-making models employed. This is primarily evidenced through the **Evolution of Decision-Making Processes (Dimension D, Theme 9)** and the founders' reflections on **Hybridity & Decision Model Reflection (Dimension E, Theme 11)**. The data suggests a dynamic shift in emphasis rather than a wholesale replacement of models as ventures mature.

- **Early Stages (Ideation, Development, Early Market Traction):**
  These initial phases are typically characterized by high uncertainty regarding the problem, solution, and market, coupled with limited resources and a nascent organizational structure (Dimension C). Founders reported that approaches emphasizing flexibility, learning, and resourcefulness were most pertinent:
    - **Effectual Principles:** Many founders, like I2 when describing their initial approach to finding partners for factory equipment, implicitly or explicitly drew on effectual logic: starting with their available means (who they are, what they know, whom they know, Dimension B, Theme 4), focusing on affordable loss, and leveraging networks to co-create opportunities (Dimension C, Theme 7). This aligns with Sarasvathy's (Sarasvathy, 2001) theory of effectuation as a logic for navigating uncertainty. The founder of I9, for instance, described their initial resource-driven approach: *'[Focused more on] the first resources that we had.' and another* illustrated how startups often initiate action not by chasing ideal resources, but by creatively leveraging what is already within reach '*we just started with people we knew... used existing contacts to see who could help us build or connect to the right equipment providers'* (I2).
    - **Design Thinking Elements:** While not always formally labeled, user-centricity and iterative prototyping, core to Design Thinking, were evident. Founders emphasized understanding user pain points (Dimension B, Theme 3) and using early prototypes (Dimension D, Theme 8, e.g., I6 using Figma) to gather feedback and refine concepts as one founder put it*, 'We started with the problem, talking directly to users to really grasp what frustrated them. Once we had a rough idea, we built a clickable prototype in Figma and kept tweaking it based on their reactions'* (I6)*,* illustrating the integration of user insights and iterative testing central to the Design Thinking mindset.
    - **Lean Startup Experimentation:** The principle of testing core assumptions through MVPs and learning from early market interactions (Dimension D, Theme 8) was prevalent. For example, I5 detailed an extensive process of creating prototypes, conducting interviews, learning, and then adapting the MVP

idea: '*...first three months were just for the three prototypes... building... interviews... learn from it... adopt the idea of the MVP.'* However, this experimentation was often less structured initially, becoming more rigorous as processes evolved (Dimension D, Theme 9).

- **Later Stages (Scaling, Growth, Establishing Product-Market Fit):**
  As startups validate their core hypotheses, achieve product-market fit, and move towards scaling (a shift in Dimension A, Theme 1), the emphasis in decision-making often evolves. While adaptability remains crucial, there's an increasing need for structure, efficiency, and predictability:

  - **Integration of Causal/Planning Elements:** More structured planning becomes necessary for resource allocation, team expansion, process implementation (Dimension C, Themes 5 & 6), and market expansion strategies (Dimension E, Theme 12). Founders acknowledged the need for "processes and structure" as they scaled, as stated by I2. While initial skepticism towards detailed financial plans often persisted (Theme 4), operational planning gained importance. One founder mentioned, *'At some point, you can't just go with your gut anymore, you need forecasts, hiring plans, and real processes to avoid chaos'* (I7), highlighting the growing reliance on causal planning to support sustainable scaling.

  - **Lean Principles for Optimization & Scaling:** Lean Startup principles extend beyond initial validation to optimizing conversion funnels, improving key metrics, and scaling operations efficiently. The focus shifts from 'what to build" to 'how to grow and optimize.' *'Once we had traction, it became all about refining the funnel, testing every step, tightening the process, and doubling down on what moved the needle'* (I4), reflecting how Lean principles were applied to drive data-informed growth and operational efficiency.

  - **Formalization of Processes:** Decision-making processes themselves tend to become more formalized and data-driven (Shift from gut feeling to data - Theme 9). The 'organic evolution' (I1) often leads to more defined roles, responsibilities, and reporting structures (Dimension C, Theme 6) to manage increasing complexity. For example, '*We used to just huddle and decide, now we have dashboards, KPIs, and team leads reporting on progress every week'* (I5), illustrating how growing complexity drives the need for formalized, data-informed structures.

It is crucial to note that this influence is not a rigid, sequential replacement of one model by another. Instead, founders described a **shifting blend and emphasis within their hybrid approach (Dimension E, Theme 11)**. Elements of effectuation (e.g., leveraging new partnerships) or experimentation might still be vital during scaling, but they are often integrated within a more structured or planned overarching strategy. The capacity for **organizational learning (Dimension D)**, as suggested by (Argyris & Schön, 1978), enables this strategic flexibility and the refinement of the decision model mix across different lifecycle stages.

Furthermore, external stakeholders, particularly investors (Dimension C, Theme 7), often impose stage-specific expectations and milestones that influence the decision approaches adopted.

1.2. ANSWERING RQ2: UNDER WHAT CONDITIONS CAN HIGH-TECH STARTUPS ADOPT HYBRID DECISION MODELS TO NAVIGATE UNCERTAINTY AND ACHIEVE INNOVATION GOALS?

The framework reveals that the adoption of hybrid decision models is not merely an optional strategy but often emerges as a pragmatic necessity driven by the interplay of specific conditions encountered by high-tech startups. Hybridity, as captured within Dimension E (Strategic Decision Logics & Responses, particularly Theme 11), arises when the Venture Context & Contingencies (Dimension A) presents complexities or uncertainties that a singular, 'pure' decision model cannot adequately address alone.

Several key conditions fostering hybridity were evident:

- **High Uncertainty & Complexity (Dimension A, Theme 2):** Founders operating under significant market, technological, or regulatory uncertainty often found purely predictive planning (Causation) untenable. For example, the founder of I9 (MedTech) highlighted the long sales and development cycles, stating, *'...difficulty is that experimenting in the medical field... works very well in SaaS... For us, we have long sales cycles... not very easy...'.* This inherent uncertainty pushes founders to blend planning elements (necessary for aspects like regulation) with more adaptive, learning-oriented approaches derived from Lean Startup (Theme 8) or effectual thinking (Theme 4/11), allowing them to act while managing uncertainty. This finding supports Fisher's (2012) assertion that simplistic, standalone models are often insufficient for complex realities.

- **Conflicting Contingencies (Dimension A, Theme 2):** Startups frequently face simultaneous, sometimes contradictory, demands. A venture might need rapid experimentation (Lean principles, Theme 8) to find product-market fit, while also navigating strict regulatory pathways (Theme 2) that necessitate detailed planning and documentation. This tension, observed in cases like I8 (AI MedTech), forces a hybrid approach, where founders borrow relevant tools and mindsets from different logics to address distinct facets of their challenge. One founder described this adaptive strategy, stating, '*we run quick pilots to learn fast, but in parallel we maintain the documentation and structure needed for certification... we're combining both worlds'* (I8), highlighting a deliberate integration of iterative learning with regulatory discipline as a way to operate effectively under dual pressures.

- **Resource Constraints (Dimension C, Theme 5):** Limited financial or human capital, a common contextual factor (Dimension A), often necessitates resourceful and adaptive strategies. This was evident when I2/I3 downsized significantly due to funding issues. Such constraints encourage the adoption of effectual principles (leveraging existing means, focusing on affordable loss, reflected in Theme 4, Founder Mindset) combined with lean experimentation (Theme 8) to maximize learning and progress with minimal expenditure. A founder noted, "*we try to do as much as possible with what we already have... test ideas*

quickly without burning too much cash' (I3), demonstrating how startups strategically integrate effectual thinking with lean methods to stretch limited resources while continuing to iterate and learn.

- **Founder Orientation & Experience (Dimension B):** The founder's own background and cognitive style (Theme 4) influence the initial adoption and subsequent blending of models. A founder with prior corporate experience might initially lean towards planning (as seen in I3's early approach), but through entrepreneurial learning (Dimension D) and encountering contextual realities (Dimension A), may integrate more adaptive techniques. As one founder (I7) articulated, the process often involves adaptation when a clear, single path isn't evident, suggesting that hybridity allows for flexibility when *'you cannot find the needed direction... you adapt, and you try different things.'*

- **Practical Needs Overcoming Theoretical Purity (Dimension D & E):** Ultimately, the adoption of hybrid models appears driven more by practical needs discovered through ongoing learning and adaptation (Dimension D) than by a deliberate adherence to specific theoretical prescriptions. Founders combine what works for particular problems or stages, as exemplified by I5 who blended planning with significant lean experimentation: *'...plan will change always... don't overthink the plan... I need a good plan that I can adopt very easily.'* This aligns with the context-driven hybridization described by (Reymen, Berend, Oudehand, & Stultiëns, 2017).

In essence, hybrid models are adopted when the **contingencies (Dimension A)** demand a level of flexibility and multifaceted response that exceeds the scope of any single framework. This adoption is mediated by **founder preferences and interpretations (Dimension B)**, enabled or constrained by existing **organizational capabilities (Dimension C)**, and continuously refined through **ongoing learning (Dimension D)**, manifesting as context-specific **strategic logics and responses (Dimension E)** that often embody hybridity.

1.3. ANSWERING RQ3: WHAT GAPS EXIST IN CURRENT DECISION-MAKING FRAMEWORKS FOR HIGH-TECH STARTUPS, AND HOW CAN THEY BE ADDRESSED THROUGH A CONTINGENCY-BASED HYBRID APPROACH?

The interviews with high-tech founders suggest that while established decision-making frameworks offer valuable principles and tools, they often present gaps when applied in isolation to the multifaceted and dynamic realities of their ventures. These gaps are primarily addressed by founders through the pragmatic, experiential development of **hybrid approaches (Dimension E, Theme 11)**, a process best understood through the lens of the proposed contingency-based framework.

The primary "gaps" or limitations highlighted by the founders' experiences, often implicitly, include:

- **Inflexibility and Lack of Prescriptive Fit for Complex Contingencies (Dimension A, Theme 2):** Founders rarely encountered situations where a single, pure model perfectly matched all the prevailing contingencies. For example, the need to manage long MedTech

R&D and regulatory cycles (Theme 2) often clashed with the rapid iteration prescribed by pure Lean Startup. As one founder mentioned, *'...planning we never really did, I think.'* (I9), yet their MedTech context (Theme 2) inherently required structured phases for validation and compliance, suggesting a practical blend rather than outright rejection of all planning elements. This aligns with Fisher's (2012) critique that standalone models can be oversimplifications.

- **Insufficient Guidance for Navigating Multiple, Simultaneous Demands (Dimension A):** High-tech startups often juggle technical uncertainty, market uncertainty, resource scarcity (Dimension C, Theme 5), and evolving team dynamics (Dimension C, Theme 6) all at once. No single model comprehensively addresses how to prioritize and integrate decision-making across all these fronts simultaneously. One founder put it, *'You're making product, hiring, raising funds, and chasing customers, all at once, with no clear playbook for what should come first'* (I3), underscoring the fragmented nature of decision-making in complex, fast-moving startup environments.

- **Limited Acknowledgment of Lifecycle Evolution (Dimension D, Theme 9):** While some models are associated with early stages (e.g., Effectuation for uncertainty), founders expressed that the *nature* of their decision-making and the *relevance* of different model elements shifted significantly as their venture evolved from ideation to market traction and scaling. A static application of any single model across all stages was seen as ineffective. For instance, the founder of I5, while initially driven by effectual and experimental actions, noted, *'… And I learned it the hard way. It is always not the best way (to skip planning). So, it's better to start with a plan.'* This reflects learning (Dimension D) and a changing approach to address the gaps experienced.

- **Underemphasis on the Founder's Unique Influence and Pragmatism (Dimension B):** Standard models often prescribe a set of processes, but the founder's own experience, risk tolerance, and cognitive style (Theme 4) heavily influence how (or if) these processes are adopted and adapted. Founders often "muddle through," pragmatically pulling what seems useful. A case in point, *'There's no one-size-fits-all playbook, I just pick the parts that make sense for me and my team and adjust on the fly'* (I9), emphasizing the central role of personal judgment and flexibility in navigating the challenges startups face.

Founders address these gaps not by seeking an alternative "perfect" universal model, but through a **contingency-based hybrid approach, developed through Entrepreneurial Learning & Process Adaptation (Dimension D)**. They:

- **Selectively Borrow:** They extract specific tools, techniques, or principles from different established models that appear relevant to the immediate problem or context. For example, using Lean experimentation for product features (Theme 8) while employing effectual networking for partnerships (Theme 7).

- **Combine and Sequence:** They blend these elements, sometimes sequentially (e.g., initial planning followed by iterative experimentation) or concurrently (e.g., maintaining an

effectual mindset while using lean validation tools). The founder of I10 explicitly stated, *'Sure. It's not a one-line thing. You combine a lot of things.'*

- **Learn and Refine Iteratively:** Their hybrid approach is rarely defined upfront but evolves as they learn what works for their specific venture, context, and stage (Theme 9).

The **contingency-based framework** developed in this study (Figure 1) directly addresses how these gaps are managed by providing a structure to understand this pragmatic hybridization. It highlights that the "gaps" are filled by the startup's dynamic capability to sense its **Context (A)**, interpret it via **Founder Orientation (B)**, leverage its **Capabilities (C)**, engage in **Learning (D)**, and thereby craft unique **Strategic Logics and Responses (E)** that are inherently hybrid. It embraces the contingency perspective (Donaldson, 2001) by showing that the "right" blend is situation-dependent and acknowledges the role of external institutional pressures (DiMaggio & Powell, 1983) that also shape these choices (Dimension A & C).

2. THEORETICAL CONTRIBUTIONS AND ENGAGEMENT WITH LITERATURE

This study, through the development of its empirically grounded contingency-based framework, offers several important contributions to the academic discourse on entrepreneurial decision-making, particularly concerning the use and adaptation of hybrid models by high-tech startups in dynamic environments.

Firstly, the primary contribution is the articulation of a novel, holistic contingency-based framework (Figure 1). This framework moves beyond studies focusing on single decision logics (e.g., Effectuation, Causation, Lean Startup) or simple dichotomies by integrating five key interacting dimensions: (A) Venture Context & Contingencies, (B) Founder Influence & Orientation, (C) Organizational Capabilities & Structure, (D) Entrepreneurial Learning & Process Adaptation, and (E) Strategic Decision Logics & Responses. The academic importance of this holistic view lies in its capacity to provide a more comprehensive and integrated lens for understanding the complex, multi-faceted nature of startup decision-making. While prior literature has explored many of these dimensions in isolation, this research offers a structured model of their *dynamic interplay*, illustrating how diverse factors coalesce to influence the practical application of theoretical models in real-world settings. This integrated perspective is crucial for advancing a more realistic understanding of how startups actually navigate complex environments, rather than viewing their decision-making through the narrow lens of a single theoretical approach.

Secondly, the study contributes by identifying and defining these five aggregate dimensions as critical, interacting theoretical constructs that collectively explain decision-making adaptation. Although elements like context, founder traits, and resources are well-established in entrepreneurship literature, this framework offers a specific configuration and highlights their interdependent roles: Context as the foundational shaper, the Founder as an interpretive agent, Capabilities as enablers/constraints, Learning as the adaptive engine, and Strategic Logics/Hybridity as the emergent outcome. This structured conceptualization is academically interesting because it offers a more granular yet integrated understanding of the antecedents and processes leading to specific decision-making patterns. For instance, by clearly delineating the

interplay between Venture Context & Contingencies (A) and Founder Influence & Orientation (B), the framework specifies *how* objective environmental factors are translated through subjective founder perception into initial strategic choices, enriching our understanding of entrepreneurial agency within contextual constraints. This moves beyond simply listing influential factors to modeling their configured impact on how hybrid approaches are adopted and evolve.

Thirdly, this research provides a nuanced, process-oriented explanation for the emergence and enactment of hybridity in entrepreneurial decision-making (Dimension E, Theme 11). It extends existing work on hybridity (e.g., (Reymen, Berend, Oudehand, & Stultiëns, 2017)) by demonstrating that it is not merely a static combination of models but rather a *dynamic capability* that evolves through iterative learning (Dimension D) and is pragmatically constructed in response to specific contextual challenges and contingencies (Dimension A). Founders were observed actively "sensemaking" and "bricolaging" elements from various decision toolkits based on their perceived utility in a given situation. This process view is academically significant as it offers insights into the micro-foundations of how startups develop adaptive decision-making routines. It moves beyond simply identifying that hybridity occurs to explaining *how* it is achieved and refined over time as a situated practice, reflecting a form of organizational learning (Argyris & Schön, 1978) applied to the meta-level of decision strategy itself.

Fourthly, by explicitly grounding the framework in Contingency Theory (Lawrence & Lorsch, 1967; Donaldson, 2001), the study empirically specifies and reinforces its relevance for understanding entrepreneurial decision-making. It identifies concrete contextual factors (e.g., industry specifics like MedTech's regulatory environment (Theme 2), market readiness, resource scarcity), founder attributes (Theme 4), and organizational aspects (Themes 5, 6, 7) that act as key contingencies influencing the suitability and practical application of different decision logics and their combinations. This is important because while contingency theory is widely accepted, detailed empirical illustrations of which specific contingencies matter for which decision approaches in the high-tech startup domain, particularly concerning the dynamic blending leading to hybridity, enriches the theory's applicability and provides a more fine-grained understanding of "fit" in volatile environments.

Finally, the findings offer empirical nuance to the understanding of individual decision-making models like Effectuation (Sarasvathy, 2001), Lean Startup (Ries, 2011), Design Thinking (Brown, 2008), and Causation. The study empirically supports their relevance, as founders recognized elements from each (Theme 11). However, it also powerfully underscores their limitations when applied in isolation, particularly across different lifecycle stages (Dimension A, Theme 1) and under specific contextual pressures (Dimension A, Theme 2), aligning with critiques such as Fisher's (2012) regarding their standalone sufficiency. For example, the challenges of applying rapid Lean experimentation cycles in long-cycle MedTech contexts (Theme 2) or the founders' widespread skepticism towards extensive, predictive early-stage planning (Theme 4) provide concrete evidence for these boundary conditions. The observed pragmatism in borrowing and blending *elements* from these models, rather than wholesale adoption, further positions them as valuable but incomplete toolkits. This is academically interesting as it contributes to a more realistic and context-sensitive

understanding of how these widely taught models are actually used, combined, and adapted in practice, moving towards a more integrated theory of entrepreneurial action.

3. PRACTICAL IMPLICATIONS

Beyond its theoretical contributions, this study offers several practical implications for key stakeholders within the high-tech startup ecosystem, particularly founders, managers, and potentially investors and support organizations.

1. **Embrace Conscious Hybridity and Situational Awareness:** The findings strongly suggest that rigidly adhering to a single decision-making playbook (e.g., 'pure' Lean or 'pure' Effectuation) is often suboptimal. Founders and teams should instead cultivate an awareness of different decision logics and consciously adopt a **hybrid approach**, selecting tools and principles that best fit their current context (Dimension A) and stage. This requires ongoing situational assessment, understanding the specific uncertainties (market, technical, regulatory), resource constraints, and market dynamics they face at any given time.

2. **Develop Contingent Capabilities:** The framework highlights the importance of building **Organizational Capabilities (Dimension C)** that support adaptability. This includes:

    - Diverse Funding Strategies: Relying on a mix of funding sources (Theme5) can provide resilience against the constraints of any single type.

    - Agile Team Structures & Governance: Building teams with diverse skills (Theme 6) and fostering open communication enables quicker internal alignment and response. Governance should balance oversight with flexibility.

    - Active Network & Advisor Management: Proactively cultivating and leveraging networks and advisory relationships (Theme 7) provides crucial access to information, resources, and validation opportunities, acting as a buffer against internal limitations.

3. **Prioritize Actionable Learning Processes:** Effective adaptation hinges on **Entrepreneurial Learning (Dimension D)**. Startups should implement concrete processes for:

    - Systematic Validation: Employing a portfolio of validation techniques (Theme8) from quick prototypes to data analysis to rigorously test core assumptions before committing significant resources.

    - Process Reflection: Regularly reflecting not just on *what* was learned about the market/product, but also on how decisions are being made and whether the process itself needs adaptation (Theme9). Defining success metrics upfront can aid this reflection.

4. **Recognize Founder Influence and Foster Self-Awareness:** The significant impact of **Founder Influence & Orientation (Dimension B)** suggests founders should cultivate self-awareness regarding their own biases, assumptions, risk tolerance, and how their background might shape their decisions (Theme 4). Recognizing personal limitations can guide decisions about co-founder selection, hiring complementary skills, and seeking external advice (Theme 7).

5. **Implications for Investors & Support Organizations:** Investors and accelerators should recognize that startups pragmatically employ hybrid approaches. Rather than enforcing rigid adherence to a single methodology, support should focus on helping founders develop situational awareness, build adaptive capabilities (Dimension C), and implement effective learning processes (Dimension D). Understanding the specific context (Dimension A) of a startup is crucial for providing relevant guidance.

In essence, the practical implication is a shift towards viewing startup decision-making not as following a fixed recipe, but as skillfully navigating a dynamic system by consciously blending appropriate tools and approaches based on continuous learning and situational awareness.

4. LIMITATIONS AND FUTURE RESEARCH

While this study provides valuable insights into the hybrid decision-making processes of high-tech startups through the development of a contingency-based framework, it is important to acknowledge certain limitations inherent in its design, which in turn open avenues for future research.

4.1. LIMITATIONS

- The primary limitations of this study stem from its qualitative and exploratory nature, focusing on a specific sample and context. These should be considered when interpreting the findings:

- **Generalizability and Context Specificity:** The findings are based on an in-depth analysis of ten high-tech startups within the specific context of Belgium. While the multi-case approach allows for analytical generalization to theory (Yin, 2018), the direct statistical generalizability to a broader global population of high-tech startups is limited. The particular characteristics of the Belgian entrepreneurial ecosystem, including its regulatory environment and cultural contexts, may also have influenced the findings, potentially limiting the direct applicability of specific insights to other regions.

- **Reliance on Self-Reported Data and Potential Biases:** The data primarily relied on founders' self-reported accounts of their experiences and decision-making processes. This introduces the potential for recall bias (difficulty in accurately remembering past events) and social desirability bias (presenting actions in a consistently favorable light). Although efforts were made during interviews to build rapport and use probing questions to mitigate

these, such biases cannot be entirely eliminated in research relying on retrospective self-reports.

- **Cross-Sectional Design:** The study employed a cross-sectional design, capturing decision-making perspectives at a single point in time for each venture. While founders reflected on the evolution of their approaches, this design inherently limits the ability to directly observe the dynamic adaptation of hybrid models and decision processes over extended periods within the same venture. A full understanding of the nuances of Dimension D (Entrepreneurial Learning & Process Adaptation) and Theme9 (Evolution of Decision-Making Processes) would benefit from longitudinal observation to establish evolutionary pathways more definitively.

- **Sample Size Considerations:** While the sample of ten cases was deemed sufficient for rich qualitative exploration and thematic saturation within the scope of this study, it is relatively small compared to quantitative research. This inherently restricts the ability to draw statistically definitive conclusions or generalize findings broadly across all high-tech ventures.

4.2. DIRECTIONS FOR FUTURE RESEARCH

The framework and limitations of this study suggest several promising directions for future research:

1. **Quantitative Validation and Extension:** A logical next step is to quantitatively test the proposed contingency framework (Figure 1) and the relationships between the five aggregate dimensions using a larger, more diverse sample of high-tech startups across different geographies and industries. Survey-based research could develop scales to measure the key constructs (e.g., contextual factors, founder orientation, specific hybrid model utilization) and statistically examine their influence on startup performance or adaptability metrics. This would address the generalizability limitations of the current study.

2. **Longitudinal Studies of Hybridity Evolution:** To overcome the limitations of the cross-sectional design, longitudinal case studies tracking startups over several years would be invaluable. This would allow researchers to directly observe how the blend of decision-making logics (Dimension E / Theme 11) evolves in response to changing contexts (Dimension A), capability development (Dimension C), and learning milestones (Dimension D). Such studies could provide deeper insights into the triggers and patterns of adaptation in decision-making processes (Theme9).

3. **Deeper Exploration of Specific Contingencies:** While this study identified key contextual factors (Dimension A / Theme2), further research could conduct comparative studies focusing on specific contingencies. For example, comparing decision-making hybridity in highly regulated versus unregulated high-tech sectors, or comparing hardware

versus software startups, could yield finer-grained insights into how specific contextual pressures shape optimal approaches.

4. **Investigating Specific Hybrid Configurations:** The framework highlights that startups use hybrid approaches (Theme 11). Future research could delve deeper into which specific combinations of Effectuation, Lean, Design Thinking, and Causation elements are most prevalent or effective under particular conditions. Qualitative or quantitative studies could attempt to identify common hybrid archetypes and link them to contextual factors and outcomes.

5. **Exploring Founder Cognitive Processes:** While Dimension B highlights founder influence, future research using cognitive mapping techniques or think-aloud protocols during decision tasks could provide deeper insights into the cognitive mechanisms through which founders perceive context, weigh different logics, and make decisions under uncertainty, enriching our understanding of Theme 4 and Theme 11.

6. **Impact of Interventions:** Research could explore the impact of interventions designed to increase founders' awareness of different decision logics and contingency thinking (related to Theme 11 and Dimension B). For instance, studies could assess the effectiveness of training programs or coaching based on the developed framework in improving startup adaptability and decision quality.

Pursuing these avenues would further refine our understanding of how high-tech ventures successfully navigate dynamic environments and build upon the contingency-based framework developed in this thesis.

CHAPTER 6 - CONCLUSION

This research set out to better understand how Belgian high-tech startups make decisions in the face of constant change and uncertainty, so rather than relying strictly on one decision-making model like lean startup, design thinking, effectuation, or traditional planning, these founders often find themselves borrowing from all of them, adjusting as they go. Through in-depth interviews with ten founders and CEOs, this study looked at how these entrepreneurs actually navigate the messiness of real-world decision-making.

What emerged is a picture of decision-making that's anything but linear or one-size-fits-all. Instead, these founders showed a remarkable ability to adapt as they mixed different approaches depending on the situation, shaped not only by their market but also by who they are, what their company is capable of, and how they learn along the way. The framework developed here (see Table 2 and Figure 1) captures five core dimensions that shape this process: the startup's unique context, the founder's mindset and experience, the organization's internal capabilities, the way learning happens over time, and the evolving logic behind strategic choices.

This mix-and-match approach isn't just theoretical, it's what helps these companies survive. In practice, hybridity isn't a buzzword; it's a response to the realities of running a startup in uncertain, high-stakes environments. Founders aren't choosing between models, they're combining them, adapting them, and sometimes discarding them altogether, depending on what the moment calls for.

More than just confirming that hybrid approaches exist, this research offers a window into how they take shape, and it shows the importance of learning, adaptation, and context. By doing so, it provides a more nuanced, process-based view than what any one model can offer on its own, especially for fast-moving industries like MedTech.

For founders and teams, the takeaway is clear: flexibility and self-awareness matter, meaning that navigating uncertainty isn't about sticking to a single method: it's about building the ability to shift gears when needed. For investors and startup supporters, the message is to encourage that adaptability rather than pushing one framework as a universal solution.

Of course, this study has its limits as it's based on a specific group of startups, and it captures just a moment in time, but those limits also point to where future research could go: testing this framework across different settings, tracking how hybrid approaches evolve over time, and diving deeper into the role of founders' thinking and decision patterns.

In the end, high-tech entrepreneurship is rarely clean or predictable and studies like this one offers a practical lens for understanding the complex, flexible ways founders tackle that challenge, and it highlights the real-world creativity and resilience behind every strategic choice they make.

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APPENDICES

APPENDIX A: INTERVIEW PROTOCOL

-Interview Guide -

Master Thesis

Adapting Decision Models in High-Tech Startups: A Contingency-Based Framework

June 2025

Students:

Achraf Yassine El Ghilali

Faith Thecla Nakiyingi

Supervisor:

Prof. Dr. Yannick Bammens

Comments

Topic of our Master Thesis:

Adapting Decision Models in High-Tech Startups: A Contingency-Based Framework

Main Research Question:

How can decision-making frameworks be integrated and adapted across the lifecycle stages of high-tech startups to effectively navigate uncertainty and achieve innovation goals?

Structure of the Interview (Key Topic Areas):

I. Startup Background & Context

II. The Entrepreneurial Journey & Decision-Making Processes

A. Getting Started & Early Development

B. Evolution, Partnerships, and Overcoming Obstacles

III. Reflection on Decision-Making Approaches

IV. Concluding Remarks & Future Outlook

Duration: Approx. 30-60 min

Please note: The interview will be audio-recorded with participant permission. Recordings will be kept confidential, used solely for transcription and analysis, and will not be published**. All personal information and startup details will be anonymized in the research outputs.**

Interview Guide: Decision-Making in High-Tech Startups

I. Startup Background & Context (Approx. 5-7 minutes)

This section aims to understand the startup's profile and current situation.

1. **Venture Overview:**
    - Could you briefly describe your startup and its primary product or service?
    - How long has your startup been operating?
2. **Developmental Stage:**
    - Thinking about your startup's journey, which of these phases best describes where you are now, or perhaps phases you've clearly moved through? (Ideation/Concept; Development/MVP; Early Market Traction/Scaling; Established Growth/Optimization).
3. **Team & Resources:**
    - Roughly how many employees do you currently have?
    - Has your startup received external funding? (If comfortable, type: grants, seed, angel, VC).
4. **Participant's Role:**
    - What is your current role within the startup?

II. The Entrepreneurial Journey & Decision-Making Processes (Approx. 20-25 minutes)

This section explores the evolution of the startup and its decision-making from inception.

1. **Idea Genesis & Initial Exploration:**
    - What first sparked the idea for your startup? (Problem to solve, opportunity seen).
    - Initial thoughts or assumptions? (Market, technology, customers).
    - Very first concrete steps taken to explore the idea/opportunity?
        - *Probes: Focus on means vs. goals? Early risk assessment/affordable loss? Understanding user problems before building? Detailed business plan?*

2. **Development, Adaptation & Learning:**
    - How has your approach to making decisions changed over time as the startup evolved?
    - Key moments, events, or feedback that triggered significant shifts in operation, planning, or decision-making? (What happened? Trigger?)
    - How did you assess if you were on the right track during product/service development? (Typical feedback mechanisms).
    - Specific instances where feedback/results led to notable changes? (Product, target customer, strategy).
        - *Probes: If pivot/change: Crucial insight? Validation of change? If testing: How set up? What measured?*
    - Frequency of adjustments based on learning?
    - Dealing with unexpected challenges or positive surprises? (Adaptation of plans/actions).
3. **Collaboration & External Engagement:**
    - Formation of important partnerships? (With whom? Why? How did they evolve with startup stage?)
    - Involvement of potential customers/users in shaping or co-creating product/service?
        - *Probes: Example of co-creation? Impact on decisions?*
4. **Overcoming Significant Challenges:**
    - A particularly significant challenge or a time the team felt 'stuck'?
    - Immediate reaction/thought process when facing it?
    - How was a way forward ultimately decided? Steps taken?
        - *Probes: Planning vs. adaptive steps? Small experiments? Role of user perspective?*

III. Reflection on Decision-Making Approaches (Approx. 10-15 minutes)

This section aims to elicit the participant's reflections on the underlying logics or models guiding their decisions.

1. **Awareness of Decision 'Mindsets':**
    - Researchers describe different general approaches. Briefly, do any of these resonate with your experience at different points?
        - **The Planner:** Starts with a specific goal, does thorough planning and research, gathers the needed resources, and executes the plan. (Keywords: Goal First, Plan, Predict, Resources)
        - **The Adapter:** Starts with available means (skills, network), takes action, limits risk to what's affordable to lose, builds partnerships, and lets goals emerge or adapt. (Keywords: Means First, Act, Affordable Loss, Partnerships, Adapt)
        - **The Experimenter:** Focuses on quick cycles: Build a basic version (MVP), Measure customer reaction/data, learn from it, and rapidly adapt or pivot. (Keywords: Build-Measure-Learn, Experiment, Feedback, Iterate/Pivot)
        - **The Empathizer:** Focuses intensely on understanding user needs first (empathy), brainstorms ideas, builds simple prototypes, and tests directly with users. (Keywords: Empathy, User Needs, Ideate, Prototype, Test)
    - *(Probe: Which ones? When? Why did that approach feel right then?)*
2. **Hybridity & Blending:**
    - Ever consciously combined elements from different approaches depending on situation/stage?
        - *(If yes):* Example? How blended? What worked well/was difficult?
        - *(If no/unsure):* Looking back, see moments where different approaches might have been useful together?
3. **Perceived Strengths & Weaknesses of Own Approach:**
    - Main strengths/benefits of how your startup has generally approached decisions?
    - Main downsides or limitations?

IV. Concluding Remarks & Future Outlook (Approx. 5 minutes)

1. **Influence of Funding:**
    - If external funding was received, how did it influence decision-making or strategic priorities?
2. **Future Challenges:**
    - Biggest anticipated decision-making challenges for your startup moving forward?
3. **Open Floor:**
    - Anything else important about your decision-making experiences not yet covered?
4. **Follow-Up Permission:**
    - Request permission for brief email follow-up if clarification is needed.
5. **Thank You.**