



**VILNIUS UNIVERSITY  
BUSINESS SCHOOL**

**DEEPTech ENTREPRENEURSHIP STUDY PROGRAM**

**Justas Miškinis**

**MASTER THESIS**

<p>EXPLORING THE CHALLENGES FACED BY LIFE SCIENCE START-UPS IN COMMERCIALIZING THEIR TECHNOLOGIES</p>	<p>SUNKUMŲ, SU KURIAIS SUSIDURIA GYVYBĖS MOKSLŲ STARTUOLIAI KOMERCIALIZUODAMI TECHNOLOGIJAS, TYRIMAS</p>
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Supervisor **dr. Saulė Mačiukaitė-Žviniene**

Vilnius, 2023

**SUMMARY**

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JUSTAS MIŠKINIS

EXPLORING THE CHALLENGES FACED BY LIFE SCIENCE START-UPS IN  
COMMERCIALIZING THEIR TECHNOLOGIES

MASTER THESIS

Supervisor – dr. Saulė Mačiukaitė-Žviniienė

Work done – Vilnius, 2023

Scope – 65 pages

Number of tables – 7

Number of figures – 5

Number of literature sources – 50

**Short description and main problem:**

In this work, the aim was to find out what are the main difficulties of the commercialization process faced by Lithuanian life sciences start-ups. A literature review was conducted, which showed that there is a sufficient amount of information on how to study the commercialization process, but little knowledge on the challenges faced by start-ups, especially in the life sciences sector. Such information would be useful in streamlining the commercialization process and potentially contributing to a higher success rate for life science start-ups that would be beneficial both economically and socially. During the research of this work, representatives of three Lithuanian life sciences companies, that have passed the start-up stage, were interviewed. Based on the collected answers, questions were prepared for six representatives of Lithuanian life sciences start-ups in order to find out the main difficulties of the commercialization process and operational characteristics. Based on the analysis of the collected answers, a conceptual business model was compiled, which was commented on by an expert in the field of life sciences. A final conceptual business model has been created to provide guidance for life science start-ups to streamline the technology commercialization process.

**Main objective:**

To identify main challenges by Lithuanian life science start-ups in the technology commercialization process and create a business model concept to serve as guidelines in the technology commercialization process.

**Goals:**

1. to explore the concept of innovation, technologies, and commercialization in the context of life sciences;
2. to explore specific commercialization challenges in the life-science industry according to literature;
3. to identify business model influence in life-science technology commercialization success;
4. to conduct research and identify main obstacles hindering life science technology commercialization;
5. to create a business model concept for Lithuania life science start-ups;
6. to formulate conclusions and provide recommendations for successful technology commercialization in the life science sector.

**Results and conclusions:**

During this research, it was found that Lithuanian life sciences start-ups face difficulties in the process of commercializing technologies. The most common problems identified are difficulties in attracting finance and accurate assessment of market and client needs. Life sciences companies that have passed the start-up stage also mentioned similar problems. These identified problems corresponded well with those described in the literature. After analyzing the responses of the respondents, a conceptual business model was created, and it was commented on by an expert in the field of life sciences. This business model could serve as a guideline for life science start-ups to organize their operational and technology commercialization processes. The analysis of Lithuanian life science start-ups provides general insights into the specifics and most common problems of life science start-ups, so it could serve as a starting point for further research in this area, as well as for the formation of practical tools that help start-ups to carry out their activities successfully.

**SANTRAUKA**  
VILNIAUS UNIVERSITETO  
VERSLO MOKYKLA  
AUKŠTŲJŲ TECHNOLOGIJŲ VERSLAS  
JUSTAS MIŠKINIS  
SUNKUMŲ, SU KURIAIS SUSIDURIA GYVYBĖS MOKSLŲ STARTUOLIAI  
KOMERCIALIZUODAMI TECHNOLOGIJAS, TYRIMAS  
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Darbo vadovas – dr. Saulė Mačiukaitė-Žvinienė

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**Darbo apibūdinimas:**

Šio darbo metu buvo siekiama išsiaiškinti, su kokias pagrindiniais komercializacijos proceso sunkumais susiduria Lietuvos gyvybės mokslų startuoliai. Buvo atlikta literatūros analizė, kuri parodė, kad yra daug informacijos, kaip tirti komercializacijos procesą, tačiau tik nedaug žinių apie tai, su kokiais sunkumais susiduria startuoliai, ypač gyvybės mokslų srityje. Tokia informacija būtų naudinga efektyvinant komercializacijos procesą ir potencialiai prisidedant prie didesnio gyvybės mokslų startuolių sėkmės dažnio, kuris būtų naudingas tiek ekonomiškai, tiek socialiai. Šio darbo tyrimo metu buvo apklausti trijų Lietuvos gyvybės mokslų įmonių, kurios yra praėjusios startuolio etapą, atstovai. Remiantis surinktais atsakymais, parengti klausimai šešioms Lietuvos gyvybės mokslų startuolių atstovams, siekiant išsiaiškinti pagrindinius komercializacijos proceso sunkumus ir veiklos ypatybes. Pagal surinktų atsakymų analizę, sudarytas konceptualus verslo modelis, kuris buvo pakomentuotas gyvybės mokslų srities eksperto. Sudarytas galutinis konceptualus verslo modelis, kuriuo siekiama parengti gaires gyvybės mokslų startuoliams, siekiant sėkmingai vykdyti technologijų komercializacijos procesą.

**Darbo tikslas:**

Identifikuoti pagrindinius iššūkius, su kuriais susiduria Lietuvos gyvybės mokslų startuoliai komercializuodami technologijas ir sukurti konceptualų verslo modelį, kuris tarnauti kaip gairės technologijų komercializavimo procese.

**Uždaviniai:**

1. išnagrinėti inovacijas, technologijas ir komercializacijos procesą gyvybės mokslų srityje kontekste;
2. remiantis literatūra išnagrinėti specifinius komercializacijos proceso iššūkius, su kuriais susiduriama gyvybės mokslų srityje;
3. identifikuoti verslo modelio įtaką gyvybės mokslų technologijų komercializacijos procesui;
4. atlikti tyrimą ir identifikuoti esmines kliūtis, kurios stabdo gyvybės mokslų technologijų komercializaciją;
5. sukurti konceptualų verslo modelį, skirtą Lietuvos gyvybės mokslų startuoliams;
6. suformuluoti išvadas ir pateikti rekomendacijas sėkmingam gyvybės mokslų technologijų komercializavimo procesui.

**Darbo rezultatas ir išvados:**

Šio tyrimo metu buvo nustatyta, kad Lietuvos gyvybės mokslų startuoliai susiduria su sunkumais technologijų komercializavimo procese. Dažniausios įvardijamos problemos yra sunkumai pritraukiant finansus bei rinkos ir kliento poreikio tikslus įvertinimas. Panašias problemas įvardijo ir gyvybės mokslų įmonės, praėjusios startuolio stadiją. Šios identifikuotos problemos gerai sutapo su aprašomomis literatūroje. Atlikus respondentų atsakymų analizę, sudarytas konceptualus verslo modelis, jis buvo pakomentuotas gyvybės mokslų srityje eksperto. Šiuo verslo modeliu gyvybės mokslų startuoliai galėtų vadovautis kaip gairėmis, organizuojant savo operacinius ir technologijų komercializavimo procesus. Atlikta Lietuvos gyvybės mokslų startuolių analizė pateikia bendras išvagas apie gyvybės mokslų startuolių veiklos specifiką ir dažniausias problemas, todėl galėtų tarnauti kaip atskaitos taškas atliekant tolimesnius tyrimus šioje srityje, taip pat formuojant praktinius įrankius, padedančius startuoliams sėkmingai vykdyti jų veiklą.

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## INTRODUCTION

As the world's population grows at an ever-increasing pace, the activity of the industrial sector becomes more intensive, climate change is affecting human habitations and food production, new problems are encountered that were not so significant until now. Epidemics of various diseases are becoming more frequent (Marani et al., 2021), climate effects are causing food shortage crises (Rivero et al., 2022), and the number of people who need effective treatment is increasing (Hajat & Stein, 2018). As a result, more and more attention is being paid to the life sciences sector. The life sciences industry is an area of great importance for both businesses and society because it is essential in advancing human health, raising standards of living, and promoting economic development (Lokko et al., 2018). It includes disciplines like medicine, biotechnology, genetics, and pharmaceuticals that work together to develop innovative therapies, diagnostics, and high-tech solutions that can offer more resistant varieties of plants used for food, far more advanced treatment devices and methods, alternative and nature-friendly sources or innovative measures to combat pollution crisis. The life science sector is a promising source of new, potentially disruptive technologies and inventions, therefore, interest in the life sciences area and its production rates continues to grow. In 2022 life science sector was evaluated at 144 billion dollars, and it is predicted that this number will increase to 330 billion dollars by 2030 (*Global Life Science Tools Market Size & Growth Report*). Promising growth and high value-added technologies provided by the life sciences sector contribute significantly to the formation of public welfare, although for these technologies to reach various governmental organizations, businesses, medical institutions, or every end user, they must be successfully commercialized (Chiesa & Frattini, 2011; Frattini et al., 2012; Gilbert et al., 2018; Mehta, 2022). Many of the technologies within this sector are extremely complex, their development is expensive, require a large number of highly paid specialists, and the time from the creation of the concept to the implementation of the final product is relatively long (Hafer et al., 2021). Due to various factors, these technologies often do not cross the so-called “valley of death” and do not reach the market where they could be realized (M. Kim et al., 2019). This is a problem of great interest because it not only slow down scientific and technological progress but also increases the time it takes for new technologies to become available to the general public. The imperative of effectively bringing life science technologies into the market is evident, yet the factors hindering the successful commercialization of certain innovations in this sector remain a subject of exploration (Chiesa & Frattini, 2011) .

Many sources can be found in the literature that analyzes the commercialization process (Kirchberger & Pohl, 2016). Although, the majority of authors provide only generalized suggestions and insights on how to investigate the commercialization process and its potential outcomes, usually without the main focus on a specific industry or business sector (Al-Shaikh & Siddiqui, 2021; Daneshjoovash et al., 2021; M. Kim et al., 2019). An even more unexplored topic is the technology commercialization process challenges faced by life science sector businesses. However, some authors attempt to evaluate specific problems (Earle et al., 2019; Jordan, 2021; Mehta, 2022; Saarela et al., 2018) though there are a relatively minor number of such studies, especially focusing on the life science sector. More importantly, it is agreed that to provide the most relevant observations and conclusions, identified problems need to be assessed by business executives and other related parties within the commercialization process (Al Natsheh et al., 2021). The life science sector is of great importance for both scientific and economic aspects. A broader understanding of the commercialization process and investigating challenges that must be overcome to successfully guide inventions to a viable product in the market could provide valuable insights and information, which in turn could be used to create more efficient processes and strategies, leading to faster delivery of the advantages of commercialized inventions to the end user. The purpose of this research is to analyze the literature sources and review the commercialization process, the methods in identifying arising difficulties, and the causes of their occurrence, relating it with changes in the business model and its adaptation. With the focus on the life science sector with technological or technology-based ventures within the context of research and development (R&D) activities, pharmaceuticals, medical devices, bioengineering tools, and other related processes and technologies, determine what difficulties Lithuanian life sciences start-ups face in the commercialization process and what strategies they choose to overcome these challenges. Research analysis and the findings following would contribute to the identification of specific obstacles and strategies, thereby creating references and suggestions for other life sciences businesses on how to make the commercialization process more efficient, helping adapt and refine their business model, or serve as a valuable guidelines in creating more effective business support programs, that would help to increase the number of successfully operating businesses within the life science area.

**Problem:** there is a lot of fundamental knowledge on how to identify challenges of the commercialization process, however, there is a lack of information on what specific difficulties companies face when commercializing innovations, especially in the life sciences sector and start-ups operating within it.

**Objectives:**

1. to explore the concept of innovation, technologies, and commercialization in the context of life sciences;
2. to explore specific commercialization challenges in the life-science industry according to literature;
3. to identify business model influence in life-science technology commercialization success;
4. to conduct research and identify main obstacles hindering life science technology commercialization;
5. to create a business model concept for Lithuania life science start-ups;
6. to provide recommendations for successful technology commercialization in the life science sector.

# 1. LITERATURE ANALYSIS

## 1.1 Concept of innovation

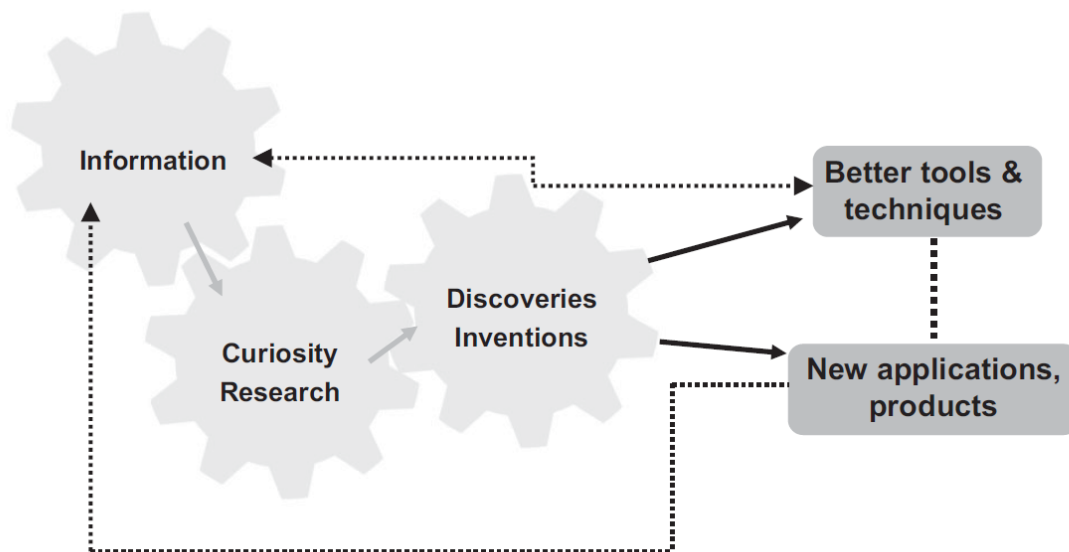
One of the main aspects of this work is the commercialization of innovations, however, this concept has become extremely broad and covers many spheres. Therefore, it is important to understand what innovation is and what is defined by this term, linking it with the area of life sciences and technologies. From a general point of view, innovation is the driving force behind advancements and growth in our world. It is about coming up with new ideas and better ways to achieve higher efficiency in producing goods or developing processes that are relevant to businesses, science, or society. If we want to achieve constant improvement and growth in our surroundings, attention should always be paid to innovation and the process of innovating. It is undoubtedly an important process that must be aimed at. Consequentially, the word innovation is becoming something of a buzzword. This is because innovation itself is an extremely broad notion, and there is no single and correct way how it should be described (Edwards-Schachter, 2018; Kahn, 2018). Despite the numerous sources of literature that try to point out the meaning of innovation, there is still a tendency towards general concepts. A good observation is made by Edwards-Schachter, 2018, who emphasizes that “Innovation is an umbrella term involving a myriad of innovation types <...>”. However, trying to define it properly might not be much of use, when it narrows down to the particular area or context where the idea of "innovation" is deployed. In other words, it's crucial to concentrate on the unique context in which something like innovation is being discussed.

The primary focus of this work is on the life science sector with technological or technology-based ventures, and innovation will be discussed focusing on the context of various technologies, including most recent pharmaceuticals, medical devices, bioengineering tools, R&D activities, and all the processes related to bringing inventions to the market. As correctly observed by Gilbert et al., “<...> innovation is not simply an invention, but it is the result of a design process that a market has endorsed. Ultimately, it is about successfully bringing to market profitable requests (products or services), for which the company undertakes a reshuffle of knowledge and existing skills in order to offer new products or services.” (Gilbert et al., 2018). Innovation is defined as a set of actions to commercialize an invention, technology, or process that can also be highly adaptive: “The appearance of new definitions indicates the evolution of the concept of innovation and the influence of historical and sociocultural contexts where innovation types emerge”, Edwards-Schachter, 2018,

states. In summary, innovation is taking an existing concept, product, or procedure and refining or adapting it. Therefore, regarding the interdisciplinary nature of life sciences, the term innovation will be complacently used as a broad term to describe new technologies, inventions, and processes that tend to be commercialized.

## **1.2 Commercialization of high-tech products**

In recent years, the importance of high-tech businesses is not in doubt. Such companies make a significant contribution to innovation and economic growth. However, at the same time, it is noticed that these businesses also have the highest risk of failure (Cantamessa et al., 2018). Multiple authors agree, that the success rate could be increased by better delving into the products being developed and thoroughly investigating the process of their commercialization (B. Kim et al., 2018; Marx & Hsu, 2019). Consequentially, commercialization can be considered as one of the main pillars in business processes, because it fills the gap between an idea or invention and its realization as a fully viable product or service. It does not only ensure that significant discoveries may be accurately identified as profitable or owing the demand in the market, but it also encourages economic growth by opening up new markets, creating job places and even pushing forward technological advancement. Keeping in mind the logical economic cycle, where businesses fund scientific research, and that research often leads to the creation of new products, enabling those businesses to generate profits, commercialization could ensure a return on investment for companies' R&D efforts, which encourages keeping economic cycle running, as it is illustrated in Figure 1. This synergy must be considered as a goal to be achieved because the life science industry provides products that require significant investment but on the other hand, also have the potential to be highly profitable for businesses. Therefore, the commercialization process ensures that new ideas are implemented practically and broadly shared, fostering societal, economic, and industrial advancement and, most importantly, should be analyzed in detail by each business individually.



**Figure 1.** Technologies link curiosity, discoveries, and new applications in a cycle of innovation.

Source: Mehta, 2022.

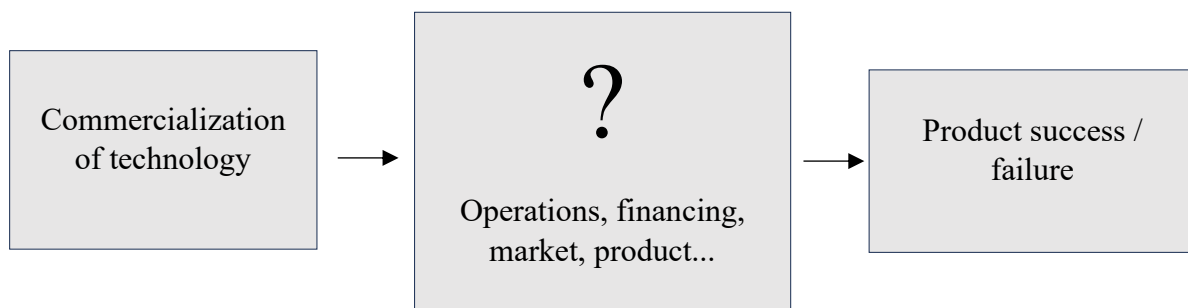
As a concept, a new idea, service, or product gets commercialized when it is released into the market to make a profit. The commercialization of advanced entrepreneurial concepts entails several phases, including research and development, the creation of a novel high-tech item, and its subsequent introduction to the market (Daneshjoovash et al., 2021). Several steps are involved in this process, including market research to determine the demand for the product, the creation of marketing and distribution plans, stepping up production, and eventually the introduction of the product to the target market. These aspects should be critically evaluated even before the expected product launch to ensure that all related risks are assessed.

High-technology is the type of such technology that differs significantly from low- or medium-tech. These differences are brought by the requirement for highly qualified personnel, a high rate of research and development, and challenging procedures that lead to unique high-tech products (Daneshjoovash et al., 2021). Consequentially, high-tech ventures should be considered by taking into account these aspects when evaluating the process of commercialization. It is also important to understand the risks associated with developing high technologies. Such companies often have limitations in internal resources, difficulties in the process of identifying opportunities, a high pace of product development, and the nature of competition (Marx & Hsu, 2019). These businesses have greater difficulties in commercializing innovative ideas compared to low- or

medium-tech businesses, therefore it is of a great relevance for life science businesses that are based on high-tech technologies development and commercialization. However, from the knowledge point of view, high-tech businesses are important objects of research focus due to their significant role in the market landscape. These businesses are key market participants, they do not only drive technological advancement but also generate high financial returns, influencing the market environment. Therefore, the commercialization process of high technologies should be deeply understood to avoid possible mistakes and increase chances for business success.

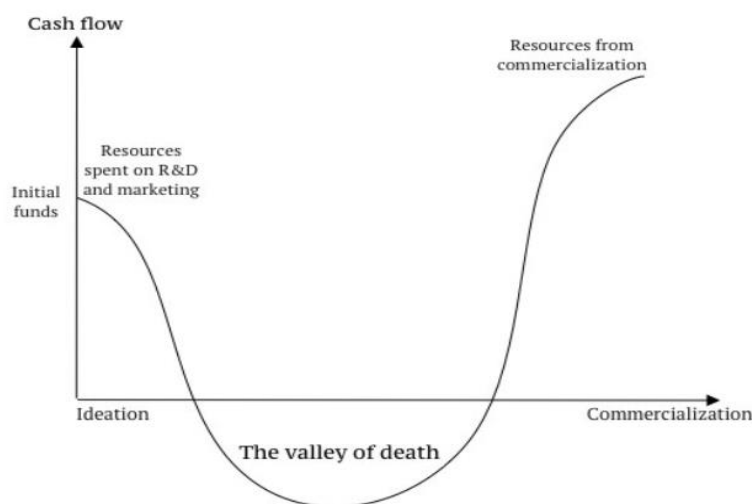
### 1.3 The gap between innovation and commercial success

Novel technologies and products cannot successfully get into the market without passing through the commercialization process because it is a crucial step in the realm of innovation that brings inventions to the market. Many products tend to stumble and fail during the commercialization stage, unable to successfully perform the transition from concept to market. Regarding this situation, Chiesa & Frattini, 2011, note that “this is clearly evinced by the abundance of new high-tech products that fail on the market chiefly due to poor commercialization. Yet there is no clear understanding, in management theory and practice, of how commercialization decisions influence the market failure of new high-tech products”. In other words, there is still a lack of reliable knowledge of where fundamental mistakes are made and what factors lead to product commercialization failure. This problem might be described in terms of the concept of a black box, without knowing what exactly modulates the output of the system, or in this case what factors lead to unsuccessful commercialization (see Figure 2).



**Figure 2.** Lack of research on the commercialization of technologies. Compiled by author.

A fundamental question for both business and science is understanding the key factors that create a gap between an innovation and its successful commercialization. One of the main factors described in the literature is often called the gap between innovation (product or service) and its commercialization process (Barron & Amorós, 2020; M. Kim et al., 2019). The term "gap" can often be considered as a specific factor that hinders the commercialization process of a product, or in other cases, leads to unsuccessful commercialization. However, this perception might not be sufficiently precise. Kim et al., 2019, note that "The gap is not simply considered to be a disconnection between the technology development stage and the commercialization stage. It occurs at each gate between stages in the commercialization process like a stage-gate process". Thus it can be assumed, that challenges can emerge at any smaller stage of the commercialization process and the gap between innovation and commercial product might occur due to accumulative effects between multiple obstacles in this process (Gbadegeshin, 2019). Regarding numerous challenges, another common term that describes the obstacles faced when the idea is being transitioned to the market-ready product, is the "valley of death." In the entrepreneurial context of commercializing innovations, this term was first used by Markham, 2002, to describe a venture that is unable to sustain a viable business model. To this day, this notion adopted a broader perception and according to Al-Shaikh & Siddiqui, 2021, "Valley of Death (VoD) is a metaphor often used to describe the situation in which many new start-ups fail to survive", indicating that this concept has acquired a broader meaning and touches on more factors than just the business model.



**Figure 3.** Illustration of "Valley of Death". *Source:* Ta et al., 2020.



Based on the literature, the terms "gap" and "valley of death" in the context of innovation commercialization refer to the set of challenges that companies face while bringing their products to market. These terms are often used interchangeably to describe the same set of obstacles and difficulties.

Taken shortly, the gap (or valley of death) is what separates a technology or a product from successful commercialization. However, measuring or evaluating success is difficult because it depends on many different variables. Even though, to maintain clarity of terminology, the concept of successful commercialization should be defined. In short, the service or a product might be considered successfully commercialized if it generates value. According to Santisteban et al., 2021, "Success involves making profits, selling products and/or services, meeting the demands of customers, selling the company, or being listed on the stock market". Therefore, in the realm of transferring technologies to the market, success is achieved if the product or service satisfies the needs of consumers and organizations, earn a reasonable amount of money compared to other businesses in the same industry, get bought by larger enterprises at a higher value compared to their initial worth, and have a stock market value that is higher than their initial investment (Frattini et al., 2012). In case of success, businesses can increase their chances of creating viable products and services, maximize return on investment, and lower the risks involved with introducing new goods or services by identifying and fixing the causes of previous failures.

Multiple scientific sources are linking the concept of the "valley of death" with entrepreneurship and start-ups, for example (Barron & Amorós, 2020; Datta et al., 2015; Jucevicius et al., 2016; Stefanelli et al., 2020). However, there is no definitive study or model that predicts what actions need to be taken for businesses to navigate over the "valley of death" successfully. However, this topic merited considerable attention, because failures in commercialization may provide important insights about consumer preferences, market dynamics, and potential flaws in the development or marketing processes (Datta et al., 2015).

#### **1.4 Presumptions and causes of commercialization gap**

The literature reveals a consistent trend in the opinions of various authors regarding methods to identify challenges in the commercialization process. Numerous sources, irrespective of the technology or sector in question, aim to establish methodologies for recognizing and improving

barriers that hinder technologies from reaching the market. While the proposed strategies are somewhat broad, they serve as valuable guidelines for systematically outlining the challenges involved in the commercialization process. Numerous literary sources suggest exploring potential causes from various viewpoints. For example, the authors Al-Shaikh & Siddiqui, 2021, point out that it is worth looking at the difficulties of commercialization through the components, or domains, of the entrepreneurial ecosystem. Even though the entrepreneurial ecosystem comprises multiple elements, such as institutions, organizations, resources, and others. However, applying Isenberg's, model of entrepreneurial ecosystems as a cornerstone for the analysis, Al-Shaikh & Siddiqui, 2021, proposed a model, where obstacles in the commercialization process can be described through generalized entrepreneurial ecosystem domains:

- government policies and leadership;
- available financial capital;
- cultural aspects;
- infrastructure and institutional support;
- human capital and its quality;
- markets that are friendly for products.

These domains, or in this case possible aspects to consider, might serve as beneficial guidelines, offering a structured and systematic approach to address the typical challenges that businesses encounter when bringing novel products to the market. Another point of view is proposed by authors Chiesa & Frattini, 2011, which aims to understand the effect of commercialization decisions on the performance of new products. Authors have proposed to analyze the difficulties arising during the commercialization process through such a prism evaluating a selected set of both strategic and tactical variables:

- Timing of the innovation's launch on the market;
- Targeting and positioning the market for innovation;
- Interfirm relationships;
- Configuration of the whole product itself;
- Critical functions of distribution channels;
- Types of advertising channels and promotion.

In contrast to other research seeking comprehensiveness and including a larger number of variables, the authors intentionally diminish the number of key variables to concentrate on how the

commercialization of innovation decisions impacts the market success of specific technological innovations.

Author M. Kim et al., 2019, recommend a method for identifying challenges in the commercialization process by breaking it down into three distinct stages: technology, product, and market, on the basis that “these mediating effects are suggested as a bridge to overcome both the technology transfer and market transfer gaps”:

- Technology stage. The main focus is on a measure of Perceived Technology Innovativeness (PTI) which is being analyzed from a consumer's viewpoint. PTI is composed of three factors: Perceived Technology Newness, Perceived Technology Usefulness, and Perceived Relative Advantage. These factors describe how novel and improved technology is compared to existing ones in the market, including the convenience and utility of using the technology.
- Product stage. Analysis of both, emotional and rational values of products where technology is applied. Emotional values are explained as joy, excitement, or fun felt by experiencing new technology. Rational values are analyzed in terms of perceived utility, which refers to the advantages and usefulness of the new product.
- Market stage. Adoption of a new product is being understood as a behavioral change of the consumer and therefore being analyzed as a variable called Purchase intention. These are factors such as motivation, needs, attitudes, and others, related to the probability of a consumer’s decision to purchase the product.

By examining each of these stages proposed by (M. Kim et al., 2019), it becomes possible to pinpoint the critical factors that impede the successful commercialization of innovations. Compared to other authors, this approach allows for a more comprehensive analysis of the obstacles at the same time using a lower number of variables.

The literature offers different methodologies, recommended variables, and diverse perspectives for studying the challenges encountered by businesses in bringing innovations and products to the market, though some summarizing insight of methodologies mentioned above can be made. Firstly, the approaches of the authors regarding the research concept are quite different. For this reason, it can be difficult to choose one or the other methodology that would be the most suitable. In this case, the analysis carried out will likely be guided by a set of criteria from the recommendations of several authors, taking into account the specifics of the business being studied and focusing on certain parameters such as the market, product specification, etc. Moreover,

considering the analyzed literature, described research aspects provide valuable guidelines for future research, which, in paradox, to this day is currently lacking completeness and strictness, despite the evident benefits it can bring to businesses, society, and the regional economy itself. Lastly, given the critical importance of understanding the specific obstacles that frequently hinder businesses in the process of introducing innovations or products to the market, it becomes important to concentrate more on the origin of the cause rather than on the methods of analysis and explore the particular issues highlighted in scientific literature by various authors.

It is also equally important to examine the causes of the commercialization gap. Although the literature sources often avoid specifying individual reasons due to the great individuality of each of the businesses, a certain leitmotif of reasons can be observed among literary sources.

### **Ineffective communication**

According to Kim et al., 2019, one of the main reasons hindering commercialization is that stakeholders involved in this process do not always share the same understanding of technology due to a lack of communication among them. From a knowledge standpoint, technology commercialization demands teamwork amongst various stakeholders to complete difficult and complex tasks. It involves carrying out the entire procedure of generating an idea, incubating, promoting, and maintaining a technology. The process of commercializing a product may be hindered when multiple stakeholders fail to work together efficiently. In practice, lack of coordination might result in quick fixes rather than the most effective choices, which frequently leads to strategies that are not viable for the long term. Such decisions may increase costs in the future harm the company's reputation within shareholders and investors and even lower the trust in the company itself. Inadequate cooperation may also lead to unfavorable contracts with suppliers and an inability to respond to shifting market demands. All in all, communication problems and leading differences in the vision of the product might not only increase the costs and diminish the quality of the commercialization process but also elevate the risk of the product or service failing in the market.

### **Novelty and complexity of knowledge**

The complexity of knowledge often becomes a significant hurdle in the commercialization of technology. In today's fast-paced technological era, innovations are becoming progressively

complicated, composed of various components and technological solutions, with each of them demanding a high level of engineering and scientific expertise. Consequently, this leads to a significant increase in both the scope and complexity of information associated with these technologies, making it challenging to navigate during the commercialization process. This complexity not only creates new challenges in terms of research and development but also in transferring these advancements into market-ready products or services. As it was noticed by Zahra et al., 2018, “Typically, radically new knowledge, which is usually the source of innovative products and processes, is understood only by a few experts who alone appreciate its technical meaning and theoretical substance. Such knowledge is often abstract and hard to comprehend, complicating its transformation into products. New scientific knowledge also typically exhibits higher levels of complexity, further frustrating commercialization”. Such new scientific or technical information that has left the laboratory stage but has not yet been fully standardized is referred to as early-stage technology. In a defined research laboratory environment, new concepts in disciplines like physics, mechanics, chemistry, or biology are frequently discovered, leading to the development of new technologies. However, it is still unknown how these technologies will act and what characteristics they will have when used in actual commercial contexts (Molner et al., 2019). Therefore, the process of commercializing technologies based on the most recent knowledge and know-how is often time-consuming and involves multiple iterations, which might discourage businesses from seeking commercialization. Consequently, they might lead to essential mistakes when assessing the worth of new knowledge and, as a consequence, allocate insufficient resources to its further development and eventually miss the opportunities for commercialization. Taken shortly, the process of commercialization can face difficulties due to the huge volume of information, its complicated interpretation, and the consequent potential for opportunities to be overlooked. In such situations, it becomes essential to not only focus on generating knowledge and technologies but also on attracting specialists who can effectively facilitate their utilization.

### **Financial resources**

The process of commercialization requires significant financial resources because it is considered the main fuel to carry out crucial research and development projects, improve prototypes, and increase production (Gbadegeshin, 2019). Additionally, a significant part of finances is spent on marketing and distribution initiatives, enabling innovations to successfully reach their intended audience.

During the early stage of product development, before starting its commercialization process, it is possible to prepare for commercialization and secure financial capital using various financial instruments. In the case of successful commercialization, the financial plan is drawn up carefully and correctly to cover the estimated financial need. However, it is worth mentioning that high-tech products often face many different difficulties once commercialization has already started, such as the urgent need for improvements and new iterations, changing market conditions and the need to adapt, and the necessity to present the product at various media channels. All this requires new financial injections which are often demanding in terms of amount. If the product receives some attention in the initial stage, for example, pre-sales are carried out, trial versions are sold, and additional income is received, it is possible to make the necessary improvements. It also helps to convince investors and shareholders to secure further financing for the commercialization of the product. However, if the commercialization process takes place inefficiently, the financial sources are exhausted, in which case the commercialized products end up at the bottom of the “valley of death” and do not reach the market, or even if manage to reach it, are unprofitable and ultimately do not remain on it (Al Natsheh et al., 2021; Klitsie et al., 2019).

In summary, the reviewed literature gives useful insights about the factors that impact the success of product commercialization. However, it is worth emphasizing that only a limited number of authors have made the effort to pinpoint and elaborate on these specific factors, indicating that this area still needs more in-depth research. While many of the conclusions in existing studies are based on a broad analysis of various cases to specify common patterns, leading to one or another outcome, it's crucial to understand the uniqueness of each case. These inherent differences make it a challenging task to define specific problems for businesses that might arise during commercialization, and this is reflected in the literature. To get a clearer understanding, it is essential to set strict guidelines and specify parameters, such as the type of business activity and the industry sector it operates within (Gbadegeshin, 2019). By doing so, the likelihood of identifying particular issues in the commercialization process can be increased and, in turn, boost the precision of overall conclusions.

### **1.5 Commercialization challenges in the life-science industry**

The life sciences sector is experiencing rapid growth with a notably high annual turnover. Worldwide, the sector's market size was valued at 144 billion dollars in 2022, and it is expected to increase to 330 billion dollars by 2030, solidifying its position as one of the world's fastest-growing sectors (*Global Life Science Tools Market Size & Growth Report, 2030*). This sector is undoubtedly one of the most important industries, having a huge direct impact on business, economics, society, and people's well-being. This is because the sector is particularly interdisciplinary. It includes a variety of areas, such as medical therapeutic procedures, drug development, medical diagnostic devices, biotechnology, environmental science, and environmental protection, and is even related to the space industry research and search for life conditions on other planets. The technologies and methods in this sector are aimed at addressing several crucial issues. These include the development of cutting-edge drugs for cancer and other diseases, efforts to alleviate food shortages through the creation of more resilient crop varieties and artificial food substitutes, the development of microorganisms capable of degrading spilled pollutants to combat environmental contamination, and the advancement of medical devices that are bringing us closer to personalized medicine. The value and significance of technologies and products originating from this sector are exceptionally high. This became evident during the COVID-19 pandemic when the global community recognized the critical role of the life sciences sector in the development of vaccines to combat the disease. As a result, businesses, private entities, and governmental organizations are increasingly focusing on the life sciences sector, allocating greater human and financial resources, and implementing a growing number of support programs. To reap the rewards of the investments made, it's essential for the technologies developed in this sector to be effectively commercialized. Unfortunately, numerous start-ups in the life sciences sector struggle to achieve business success and tend to exhibit survival rates that are no better than the industry average. Recognizing the unquestionable economic and social significance of businesses in this sector, it is crucial to pinpoint the obstacles that hinder the successful commercialization of the products and innovations they develop. This would enable businesses to better recognize emerging risks, adopt best practices, and enhance their chances of achieving success. Consequently, in this discussion, the most prevalent challenges found in the literature that life science businesses encounter when attempting to bring their inventions and innovations to market will be discussed.

### **1.5.1 Inflexible financing sources**

Numerous promising life science solutions do not originate in large, financially robust institutions or businesses. Instead, a considerable proportion of high-potential ideas emerge from research centers and university organizations that operate with severely limited financial resources. Typically, the high-technology based industry requires highly paid employees, however, turnover of those employees is high – „The duration of scientific research projects and the fast turnover of temporary staff require much funding over a long term with an uncertain outcome“, states (Kampers et al., 2021). This presents a significant issue because academic groups that play a crucial role in the initial stages of product commercialization often rely on government grants and collaboration projects for funding. However, these funding sources come with stringent requirements, including detailed operational plans and rigorous financial reporting. When securing this type of financing, application providers must create long-term work schedules, and pre-planned positions, demonstrate the direct applicability of the technology under development, and outline specific goals. The downside is that this funding can become highly inflexible, making it challenging to adapt to unforeseen needs or make changes in funding allocation, such as acquiring additional equipment or services that were not originally accounted for. Moreover, such projects and collaborations have scientific papers quota with an estimated technology readiness level to reach, which typically lies between 2-3 due to patenting potential, resulting in a natural stop to research (Kampers et al., 2021). Therefore, a lot of technologies are stuck in the stage of proof of concept and are no longer being developed.

### **1.5.2 Unpredictable market acceptance**

One of the most significant challenges in bringing a new product to market lies in the uncertainty of how the market will react and accept the innovation. This uncertainty is especially emphasized in the life science sector, where products often encompass diagnostics, medications, and even increasingly complex technologies such as gene editing. These innovations can be hard to understand and unfamiliar to the general public, leading to skepticism and unreasonable hesitations among potential users (Cape, 2020). Such attitudes can be felt throughout the market, impacting adoption rates. For instance, genetically modified wheat, which, thanks to life science technologies, offers resistance to diseases and increased yields, benefiting both people and the economy.



However, despite these advantages, some segments of the population had serious concerns about health risks, illustrating the challenge of arising misconceptions and the fact that the benefits of advanced life science technologies must be proved. In such a situation, there are even risks that are closely related to some kind of form of so-called innovator's dilemma when companies balance between offering new technologies to the user in an already familiar form, running a risk of not using the full potential of the technology (A. O'Reilly & Tushman, 2021). The market acceptance challenge is not only influenced by societal education levels and technology trends but also by shifting medical guidelines, evolving patient preferences, and the overall profitability of life science products and services. Thus, navigating market uncertainties in the dynamic life science industry requires not only keeping up with “technological trends”, but also in-depth market research and effective risk management. However, this is an inevitable price that technology pioneers must pay to bring cutting-edge technologies to the market.

### **1.5.3 Regulatory hurdle**

Various regulations, certifications, and similar procedures are often involved in the life sciences commercialization process. This is inevitable because life science technologies are often interdisciplinary, dealing with technologies that have an impact on human health, requiring precision and reliability. Regulations are one of the biggest challenges facing life sciences companies, and according to author Jordan, 2021, this is because the cost of these processes is prohibitively high: „A start-up’s regulatory pathway is one of the most, if not the most, expensive aspects of commercializing a life sciences technology“. Thus these processes for young businesses become more financial hurdle, rather than bureaucratic. Moreover, the price highly depends on the regulatory pathway, which is different for the type of product under assessment, regulatory bodies, and countries, where the assessment is carried out (Mehta, 2022). For products such as cures, medical devices or similar, assessment procedures might require such tests as clinical trials, which would be unacceptable for young companies in terms of price. Undoubtedly, this is a problem that requires a solution to increase life science start-ups' success rate. A possible solution was proposed by the Korean government in 2013 with the idea of creating a less obstructive environment for start-ups in terms of mitigating regulatory hurdles (B. Kim et al., 2018). Such activities might be vital in promoting the start-up ecosystem, especially by providing financial or regulatory support to ensure the technology development and commercialization process is undisturbed by regulatory hurdles.

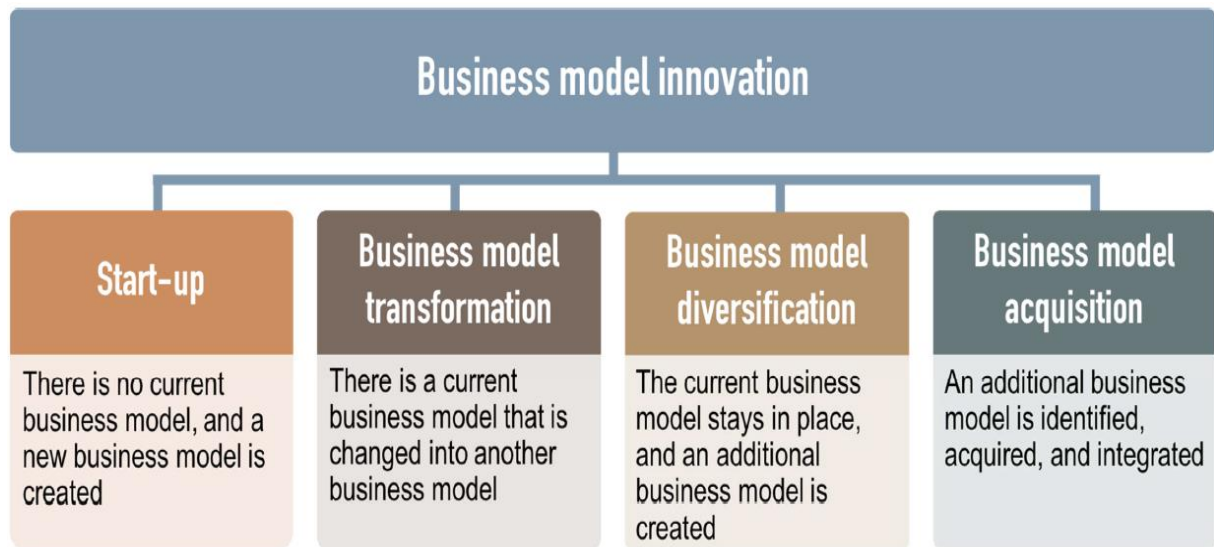
## 1.6 Business Model Adaptation

One of the cornerstones in commercializing innovations is the business model. The latter can be described as the sum of factors that allows the company to create added value and deliver it to customers, or in other words “a business model is a simplified and aggregated representation of the relevant activities of a company. It describes how marketable information, products, and/or services are generated using a company's value-added component”, according to Wirtz et al., 2016. The business model guides companies' decisions regarding pricing, distribution channels, partnerships, and target customer groups. Therefore business model is an important component in leveraging companies success or failure: “potential economic value of a new technology product can be realized only by employing a business model that effectively responds to market requirements”, Pellikka & Malinen, 2014. Business model shapes the path to turning innovative concepts into products that are successful in the market. High-tech companies in the life sciences sector frequently operate in an interdisciplinary environment, requiring them to navigate dynamic market conditions, complex product development processes, and stringent regulatory requirements for sales. These multifaceted challenges push forward the development of various business plans to address the unique demands of the industry. According to (Mehta, 2022), a few dominant business model types can be distinguished between life sciences and biotechnology ventures:

- **Vertical model.** A company exploiting a vertical business model has a specific product focus with vertical integration within the whole value chain to discover, develop, and provide to market a single technology or set of technologies. This kind of business model allows to capture the maximal value of the investment and therefore is suitable for small but fast-growing companies.
- **Horizontal.** Companies that use a horizontal model operate within a certain value chain segment and provide a product or service that is broadly relevant to a variety of industries, including the health sector, agricultural, and industrial biotechnology. Several businesses that use this horizontal strategy have emerged as a result of radical advancements in biotechnology, such as those successfully exploiting gene editing tools and "big data" analysis. These businesses captured the value of intellectual property and process know-how. They then turn these assets into cash by offering them for sale or under license as services, goods (such as array chips for particular diagnostic measurements), or intellectual property rights.

- **Hybrid I (tools for product development).** Over the value chain, this company model holds both a horizontal and vertical position. Although the organization provides services or products to many industries, it concentrates the majority of its resources on just one particular industry. The company typically adopts a horizontal business plan, in the beginning, to generate revenue rapidly before investing in resources to integrate vertically to increase value generation.
- **Hybrid II (services backward-integrating to discovery).** Similar to hybrid model I, this business model mostly occupies a horizontal position along the value chain. Such companies have utilized their current R&D service capabilities and income to conduct in-house research and development. However, the use of these hybrid business models has been approached cautiously in the past due to concerns about potentially causing discomfort among existing customers, who might perceive the service provider as now competing with them.
- **Venture capital-led.** This particular model is commonly observed in drug therapy and medical device companies. In this approach, a venture capital firm collaborates with inventors and scientists to nurture projects that are at an early stage and not yet ready to become independent companies. These projects typically require one or two crucial experiments to either confirm the viability of the idea or determine that it should be abandoned. Furthermore, the company can gain early-stage access to expertise and support, which might have been more challenging to obtain if it were a company solely funded for a single product.

To gain deeper insights into what drives success or failure in the commercialization of innovation, it's valuable to focus on the business model and its adaptability to evolving market conditions and requirements. Multiple authors refer to the capacity to quickly and successfully transition into new business models as a significant source of long-term competitive advantage and a crucial lever for enhancing an organization's performance sustainability (Geissdoerfer et al., 2018; Horvath et al., 2019; Pellikka & Malinen, 2014; Wirtz et al., 2016). Changes in the business model are usually referred to as business model innovation. Numerous descriptions of business model innovation can be found in the literature, though according to Geissdoerfer et al., 2018, "These definitions refer to business model innovation as a change in the configuration of either the entire business model or individual elements of it, either as a reaction to opportunities or challenges in the organization's environment or as a vehicle for diversification and innovation". Depending on the specific case, conceptual changes in business models can be divided into a few types (Figure 4).



**Figure 4.** Types of business model innovation. *Source:* Geissdoerfer et al., 2018.

It is possible to identify several institutional characteristics of the biotechnology sectoral system of innovation as the primary drivers of experimentation with business model innovations (Niosi & McKelvey, 2018). According to the authors, several institutional drivers encourage businesses to innovate, take chances, and attempt to commercialize novel concepts, such as the need to allocate resources for research and development, comply with institutional conditions for new venture opportunities, foster the commercialization of new technology, instruments, models, databases and other products or services.

Start-ups in the life sciences sector focus on developing technologies, which are often complex, and their possibilities for implementation and market demand are not always clear. This leads to the frequently undetermined business models that these kinds of companies usually adopt. Technological ideas are evaluated, they are tested and eventually developed to the level of the prototype. Then market demand is explored. This sequence of actions is a typical phase in the technology development process in the life science area. However, once the commercialization process starts, it is essential to efficiently identify the existing technology, understand its market demand, and accordingly adjust the company's business model. The literature commonly presents the prevalent business models of biotechnological and life sciences sector companies. Each of the described business models is suitable for implementation, depending on the technology specifics. A critical aspect for start-ups is the adaptation of their business model, which requires their special

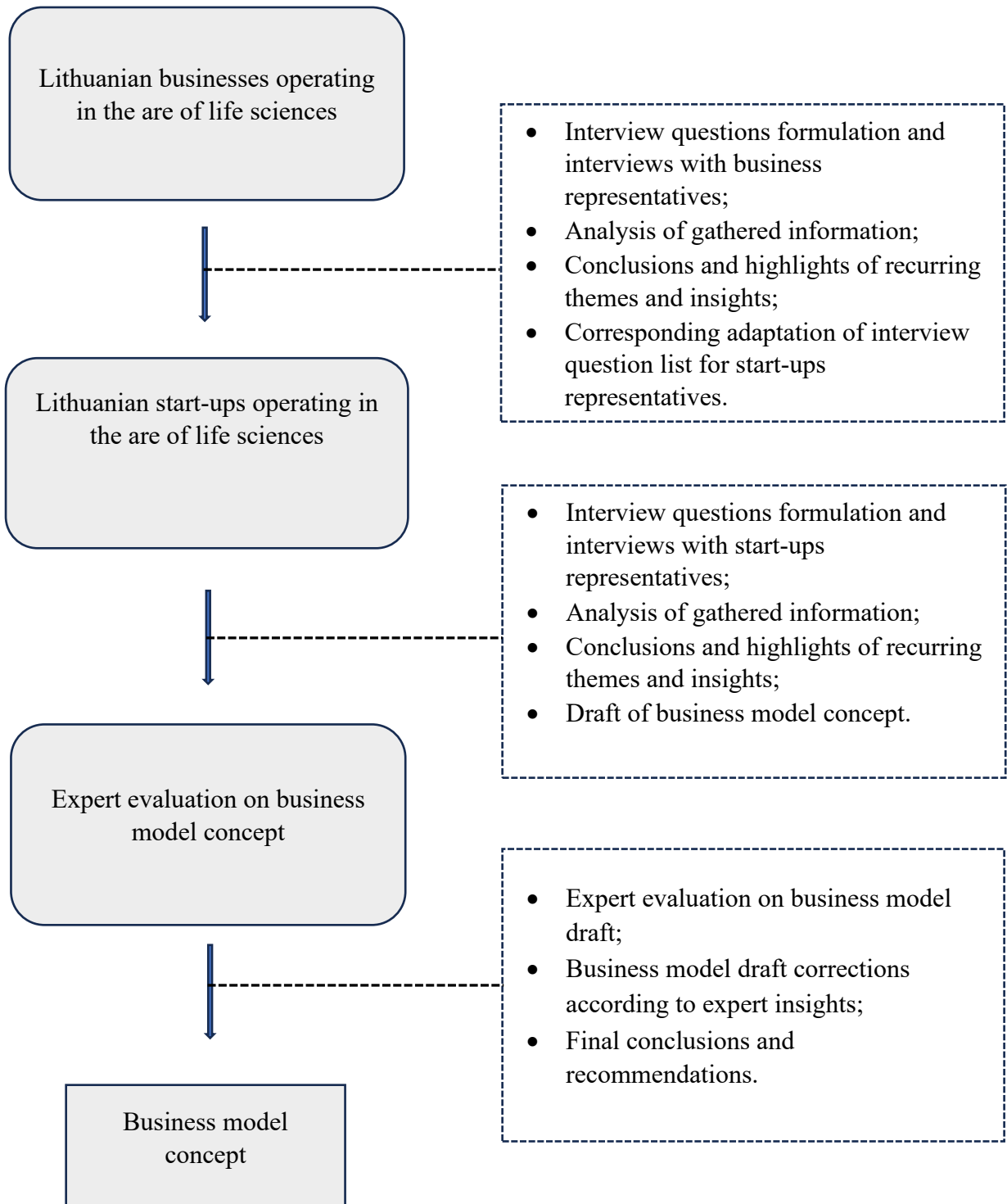
attention. During the commercialization of technologies, new product features or customer and market needs may emerge unexpectedly. Therefore, making a well-timed decision to adjust the business model can be key to the success of these businesses.

To sum up, business model innovation is a significant factor in the life sciences industry. It helps to ensure that businesses successfully adapt to changing market conditions and secure all the necessary resources to commercialize technologies and products. Although business model innovation is described in the literature as one of the factors contributing to successful commercialization, there is still a lack of information and extensive research on exactly what changes businesses should make to increase the likelihood of successful technology commercialization.

## 2. METHODOLOGY

### 2.1 Research model

Based on the insights of the authors examined in the literature section and formulated problems, a quantitative study was conducted. This involved interviewing 10 individuals representing life sciences companies and professionals in the field. The objective of the study was to comprehensively evaluate the challenges encountered by life science start-ups in the process of commercializing technologies and based on the gathered information, compile conceptual business models applicable to life science start-ups as well as to formulate conclusions and recommendations. To reflect the current aspects of the Lithuania life science industry as accurately as possible, and to provide realistic recommendations, a three-stage research model was created. This model included two groups of companies and an expert assessment. First, companies that are operating in the life sciences or related field, the company is operating in Lithuania or Lithuania and abroad, and have already passed the start-up phase (have more than 50 employees or operating for more than 5 years). Second, companies that fall within the stage of a start-up (has less than 50 employees or operating for less than 5 years), have at least one product that is intended to be used in the field of life sciences, and are in the stage of prototype or is commercially available. Based on the analysis of company representatives' answers to the open-ended questions, a conceptual business model was created, that applies to the life science start-up companies. Third, experts in life science with no less than 15 years of experience in the field were asked to comment on the compiled business model concept and to provide insights and recommendations for business model improvement. This expert assessment was then used to compile the final version of the business model concept for life science sector start-ups. The model of conducted research is depicted in Figure 5.



**Figure 5.** Scheme representing a model of the conducted research. Each group of respondent answers is followed by qualitative analysis of gathered information and then process to adapt for further analysis stages according to key points described in the scheme.

The research topic lacks information in the literature, it is not fully disclosed and analyzed. Therefore, to obtain the most realistic information possible, which is based on the real practice and experience of the respondents, as well as to adapt to the individual fields of activity and nuances of companies, semi-structured research will be conducted. Therefore formulation of the questions presented to the respondents during the research is recommendatory and may differ depending on the completeness of the interviewee's answers, the sequence of the questions, the duration of the interview, and other human factors. The questions are prepared in such a way that the interviewer would reveal as much information as possible about the commercialization difficulties experienced by the company, and the characteristics of the company's operation, focusing primarily on gathering information that will help to prepare a business model concept. An example of interview transcription is provided in Annex 1.

**Research object** – representatives (executives) of the businesses, that are operating in Lithuania's life science sector or Lithuania and abroad.

**Table 1.** Selection criteria for research participants.

<b>Object</b>	<b>Criteria</b>
Life science companies	<ul style="list-style-type: none"> <li>▪ at least one product is intended to be used in the field of life sciences and is commercially available;</li> <li>▪ The company is operating in Lithuania or Lithuania and abroad;</li> <li>▪ The company has already passed the start-up phase (has more than 50 employees or operating for more than 5 years).</li> </ul>
Life science start-ups	<ul style="list-style-type: none"> <li>▪ at least one product is intended to be used in the field of life sciences and is in the stage of prototype or is commercially available;</li> <li>▪ The company is operating in Lithuania or Lithuania and abroad;</li> <li>▪ The company is in the start-up phase (has less than 50 employees or operating for less than 5 years).</li> </ul>



Expert in the field	<ul style="list-style-type: none"> <li>▪ has more than 15 years of experience in the life science field and is familiar with life science technologies commercialization.</li> </ul>
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**Sample of the research** – 9 representatives and 1 expert in the field. The research was conducted during November – December 2023.

## **2.2 Businesses operating in the life science sector.**

The initial phase focuses on collecting information about the operational aspects and related challenges of companies that offer products or services in the life sciences sector. To capture the maximal value and comprehensive representatives' insights, 9 open-ended interview questions were developed by mixing key points in the commercialization process research methodology according to the recommendations provided by authors found during the literature analysis. The questions were submitted to 3 companies' representatives. The questions were prepared by mixing different analytical approaches as it was noted in the literature as the most appropriate method to navigate between the individual aspects of each research. These questions aim to better understand the strategies companies use, how they operate, and the challenges they encounter during their main product or service commercialization process.

### **Challenges faced in the commercialization process**

Successful businesses that already have viable products in the market usually continue the commercialization process and face various difficulties. The aim is to clarify these difficulties so that during the further analysis process they can be compared with the responses of the start-ups and to identify the obstacles that have the greatest importance. This will later help to develop a more accurate business model concept, addressing the challenges that are relevant in the later stages of technology commercialization.

*Question 1:* What are the main challenges a company encounters when bringing its main product to the market?

### **Distinctive features of the company**

A key factor in a company's success is its value proposition. While the life sciences sector offers a variety of technologies, technology alone is not enough for a product's success. Therefore, the way a company delivers value to its customers is crucial.

*Question 2:* What sets your company apart from others in terms of your product or its market? Do you place a high emphasis on innovation and being innovative?

### **Customer needs assessment**

A strong focus on customer needs can greatly contribute to the successful commercialization of technology, especially in life sciences, where complex solutions must be accurately adapted to individual customer needs. According to M. Kim et al., 2019, “A customer-centric strategy demands that researchers think about customers’ unmet needs, and about products and services they may not even realize that they need yet”. Finding out if assessing customer needs is a major focus for life science businesses can serve as a guideline to use it as an important factor when interviewing start-up representatives and formulating recommendations.

*Question 3:* Does your company place a significant emphasis on the evaluation of customer needs and requirements?

### **Adaptation to the market and customer needs**

The life sciences sector is a fast-growing sector with ever-changing market needs. Understanding the market and customer needs is important for both start-ups and large businesses (Boni, 2018; De Cock et al., 2020). It helps businesses to offer relevant solutions and stay competitive in the market. Moreover, strategies utilized by strong businesses might provide useful insights for start-ups on how to adapt to market and customer needs.

*Question 4:* What strategy do you follow to adapt to market needs?

### **Methods to ensure companies' efficiency**

To make sure a business runs successfully, it is essential to focus on efficient operational processes. This is standard practice for all businesses, and start-ups are no different (Rompho, 2018).

By identifying methods and strategies for how businesses operate efficiently, it is possible to gain important knowledge for start-ups about methods to increase efficiency and start implementing them in the early stages.

Question 5: What methods do you use to ensure company efficiency?

### **Measuring companies' progress**

Measuring the company's progress is an important factor in controlling the efficient operation of the company and creating development plans. Effectiveness can be measured in many ways and measurement methods are still a matter of research (Taouab & Issor, 2019). Nevertheless, it is important to find the most suitable method for each company individually. The methodologies explored could help compare whether life science start-ups are tracking progress in the same way as long-established companies within the same industry.

*Question 6:* Do you track the company's progress and if so, how do you try to measure or evaluate it?

### **Technology development strategy**

Technology commercialization process in technology-based life science start-ups can be exploited in a few ways, such as developing brand-new technology or adapting existing technology and enabling it to be used in a new area or in a new way (Mehta, 2022). Insights about the technology development process could provide useful information on how businesses operate and which strategy they prefer.

Question 7: Is the company more focused on developing new technologies or adapting existing ones to market needs?

### **R&D processes and partnerships**

Research and development processes are considered vital in technological start-ups (Yun, 2020). These processes usually require large amounts of investments, financial as well as scientific and human resources. Start-ups are frequently facing financial and technological difficulties, which hinder R&D processes. Therefore, it is important to understand what strategies businesses exploit in R&D processes concerning partnerships, to make these processes more feasible and less financially difficult.

*Question 8:* Regarding the R&D processes, do partners have a significant role here, or do you aim to carry out all the processes yourself?

### **Securing intellectual property**

Technological advancements lead to new knowledge and ways of application, offering opportunities for competitive commercialization. Consequently, the importance of protecting intellectual property grows. Patenting technologies is one way to secure intellectual property. For the life sciences start-ups, on the one hand, this might be costly and time-consuming, on the other hand, it also draws investor interest and boosts investment potential (Krauss et al., 2021). Therefore, it is important to understand what strategies are dominant among life science sector businesses and to determine if there are any strategies that are superior to each other.

*Question 9:* Is securing intellectual property very important to you, and do you pay a lot of attention to it? What are you doing to protect it?

The questions were posed to three companies' representatives, and their responses were analyzed. The findings and conclusions from this analysis were then used to adapt questions for start-ups in the life sciences sector. This adapted set of questions includes 6 new questions for start-ups based on answer analysis from the first stage of research.

## **2.3 Start-ups operating in the life science sector**

### **Business model**

A business model is the main strategic plan for how a company will operate and provide value. Especially in the early stages of the company's activity, there may not be a clear business plan, and it may also be incomplete in the later stages of the start-up's activity. Answers from the representatives about the business plan can help determine the stage of the startup provide valuable information about the ongoing processes and compare them with companies, that have passed the start-up phase.

*Question:* Do you already have a defined business model, or are you still looking for the most suitable option?

### **Regulations and certificates**

In the first stage of the survey, regulations, and certifications were identified as one of the most important factors that help companies to operate and ensure a good reputation with customers and investors. However, according to the literature, certification and regulations can be one of the factors inhibiting the commercialization process.

*Question:* Do various regulations and certificates create difficulties for your start-up?

### **Financial investments**

Lack of financial investment was identified as one of the main problems in the first phase of the study. In the literature, this is associated with the fact that the technologies are relatively new, so their acceptance by the market is relatively difficult. This question will help to identify whether start-ups have difficulty in obtaining financial investments and whether they notice that this is related to the fact that the offered product or technology is relatively new on the market.

*Question:* Is it difficult to attract financial investments when the product or technology is relatively new?

### **Technology development and partnerships**

Partners were identified as an important part of the technological development process. However, companies that have passed the start-up phase avoid entrusting a large part of the processes to partners. This question aims to find out what kind of technology development strategy the researched start-ups follow.

*Question:* Do partners play a significant role, or do you try to develop the technology and bring it to the market on your own?

### **Market acceptance**

Targeted and ongoing assessment of market demand has been identified as one of the essential processes for the successful commercialization of available technology. The aim is to find out whether start-ups pay much attention to market analysis and determine the need for the product.

*Question:* Do you notice that a new product is often observed with caution in the market and thus it might be difficult to predict the success of the product

## **2.4 Expert evaluation**

The created business model concept is submitted for evaluation to an expert in the field of the life sciences sector. An expert will be considered a specialist who has at least 15 years of work experience in the field of life sciences and has work experience related to life science start-ups or technology commercialization processes. Evaluation of the business model concept can be completed during an interview by asking for comments on individual parts of the compiled business model concept, or by submitting comments in written form.

## **2.5 Limitations**

Part of the information provided by the respondents may not be included in the analyzed content if confidential or sensitive information was disclosed during the interview, and this was agreed with the interviewer individually. To ensure data security, the information provided is anonymized, therefore neither the name of the company representative nor the name of the company is disclosed.

## 3. RESEARCH

### 3.1 Research Overview

This research involved interviewing representatives from companies that are operating in the life sciences sector. The study encompassed companies operating both in Lithuania and Lithuania and abroad. It has been conducted in three distinct phases. In the first phase, representatives from three companies that have life sciences products and have passed the start-up phase were interviewed. The second phase included interviews with representatives from 6 start-ups, all of which either currently offer or are on the verge of introducing their products to the market. Finally, one expert was consulted to evaluate the proposed business model concept specifically tailored for emerging Lithuanian life sciences start-ups. The field of activity of the investigated companies is presented in Table 2, without disclosing the names of the companies and their representatives in accordance with the request of representatives and data protection.

**Table 2.** Field of activity of the companies studied.

	<b>Represented company</b>	<b>Field of activity</b>
1.	Company 1	Chemical analysis/animal health
2.	Company 2	Biochemical analysis / human health
3.	Company 3	Cell analysis/tools
4.	Start-up 1	Artificial tissues
5.	Start-up 2	Biosensors
6.	Start-up 3	Biosensors
7.	Start-up 4	Environmental monitoring
8.	Start-up 5	Food proteins
9.	Start-up 6	Molecular tools
10.	Expert 1	Biochemistry, life sciences

## **3.2 Analysis of life sciences companies**

### **Main challenges faced in the commercialization process**

One of the main goals of this research was to find out what difficulties Lithuanian life sciences start-ups face in commercializing their technologies. Although this question is mainly addressed to start-ups, this question was also given to companies that have already commercialized their products. Their representatives were asked to describe the difficulties they face, both retrospectively and in the present, to gain an understanding of relevant obstacles in the process.

All three company representatives indicated that the biggest difficulties are related to the acceptance of the product in the market and the evaluation of the customer's needs. According to the representatives, it is possible to create a good product or technology, but it will not necessarily be needed in the market, or the client may not even notice that need. Therefore, to avoid obstacles, a thorough market analysis and a clear presentation of value are required. This is also referred to in the work of the authors A. O'Reilly & Tushman, 2021, in which he linked the phenomenon of new technology with hesitation in the market.

Financing issues were also mentioned as another very important factor. With a complex and still relatively new technology, it is important to attract financial investments, as they are particularly important. However, this opinion was mainly expressed retrospectively as financial obstacles became less important with later stages of technology, incoming cash flow, and greater amounts from various investors. This opinion of the respondents is in good agreement with the literature analysis carried out during this work. Author Kampers et al., 2021, also confirm that financing is one of the most important factors that hinders the commercialization process of a company, and this is especially related to the fact that the technologies being developed are often in the early stages, but already require large resources.

### **Distinctive features of the company**

The interviewees described the unique attributes of their respective companies. They highlighted the integration of multiple functions, possession of necessary permits and certifications, and a balance between technology adaptability and user-friendliness compared to their competitors. These responses suggest that in the life sciences sector, various certifications play a vital role in a product's success. They help customers perceive the technology as valid and reliable. Moreover,



another crucial factor is product usability and adaptability. This indirectly assures the end user that the product offers more value than competing options by saving time or reducing operational costs.

### **Customer needs assessment**

As it was mentioned previously, respondents emphasized the uncertain market demand as one of the biggest difficulties. Therefore, the assessment of market and customer needs is considered one of the essential stages of the commercialization process. All respondents indicated that the assessment of market and customer needs is one of the most important things because other business and technology development processes depend on it, and therefore they pay significant attention to and allocate resources to this process. The importance of this aspect also strongly correlates with the literature analysis, following the analyzed author's insights (A. O'Reilly & Tushman, 2021; Kampers et al., 2021).

### **Adaptation to the market and customer needs**

Following the question of assessing consumer demand, representatives were asked to comment on how they are adapting to market and customer needs. The respondents mentioned the adaptation of the product according to the expressed need of the customer, special conditions for using the product and support of the manufacturer, and the search for the target market where the product would be most attractive. The strategies mentioned by the respondents in this question differed, but it can be said in general that they all focus on satisfying the customer's needs through different channels.

### **Methods to ensure companies' efficiency**

To learn more about the operational processes and good practices of the studied companies, the question was asked what the companies do to perform their activities efficiently. Two main aspects prevailed in the answers - ISO performance standards and continuous assessment of market conformity. None of the respondents mentioned using specific performance management tools such as LEAN, but in the topic regarding performance standards, one interviewee additionally mentioned that although the company has not implemented LEAN, it follows the principles of LEAN activities. The answers of the respondents assumed that the companies they represent have a sufficiently

defined activity structure, which is carried out according to ISO standards. Highlighting that the company follows performance standards only confirms the previously expressed idea that standards and certifications are very important in the commercialization process.

### **Measuring companies' progress**

As a follow-up to the question of ensuring the efficiency of the company's operations, the representatives of the investigated companies were asked to comment on how the company's performance results and overall company progress are tracked and measured. The answers of the respondents differed slightly, and it was indicated that the performance results and progress are measured by the number of features in the product, sales, and production throughput and utilizing the company's internal KPI analysis. The differences between the answers can naturally be caused by slightly different market and product specifics of the companies, but it can be said that in all companies the efficiency is monitored, and the monitoring tools are selected according to the specifics of the activity or product. Although the monitoring of indicators is an important process, how these indicators are compiled has not been said. Such an answer could serve as an important guideline for young companies, but in this case, the answers may be limited by the secrets of the companies' commercial activities, therefore the main indicators should be compiled by the companies individually, based on their own processes evaluation.

### **Technology development strategy**

The technology development process is one of the most important in transferring the technology to the market, and in the life sciences sector, it can often fall into one of two ways - the development of a new technology, or the adaptation of an existing technology to market needs (Mehta, 2022). One representative answered that the company is developing new technology, and two other respondents said that they are adapting technology to the market needs. Arguably, both strategies are appropriate, depending on the technology being developed. At the time of this question, it was not revealed why a specific strategy was chosen, but based on the company's field of activity, it can be assumed that it was determined by the company's technological and know-how background, which would be a logical solution for young companies to follow, if the company has already accumulated expertise in the field.

### **R&D processes and partnerships.**

The technological development process is one of the essential processes in preparing the technology for the market and constantly improving it. This process is often expensive, especially in the life sciences sector, so partners are often used in this case. All interviewed company representatives indicated that partners are used during this process. The investigated companies use partners for the supply or production of non-essential technology components and try to develop the essential components themselves. Partners are also used where the companies themselves cannot produce the relevant components, or their production inside the company is too expensive. Such a strategy can be explained by the fact that companies try to keep essential aspects of technological process know-how inside the company. References to the use of partners in R&D for cost reduction can be found in the literature, which is consistent with the view expressed by the interviewees, but there is just little reference in the literature to the relationship between partners and intellectual property. In the normal case, the number of partners should be large to reduce costs. However, when evaluating the answers of the respondents, it can be understood that in certain cases, a small number of partners is used precisely because the aim is to protect intellectual property and know-how.

### **Securing intellectual property**

Respondents were asked how intellectual property is secured in their companies. One respondent answered that intellectual property is secured by not patenting anything. Two other respondents said that intellectual property is secured specifically through patents. The answers given were quite categorical. The first case, non-patentability, is based on the fact that patents must disclose at least some information about a product or process, and a patent is a public document. Two other respondents indicated that patents not only help to protect intellectual property rights but also contribute to improving the image of a company's stability and technological advancement. According to them, they are not afraid to disclose part of the information in the patents, because the processes carried out by the company are extremely complex and require a lot of know-how information, without which, even with the information provided in the patent, the competitor would not be able to replicate the technology or process.

**Table 3.** Generalized summary of explored topics and provided answers by business representatives.

Explored topic	Summary
Main challenges faced in the commercialization process.	<p>Companies struggle with market acceptance of new products and technologies. They emphasize the importance of thorough market analysis and clear value presentation, as highlighted in A. O'Reilly &amp; Tushman's 2021 work.</p> <p>Early stages of technology development often face financial challenges. However, this becomes less significant as the technology matures and attracts more investors. This is in line with findings from Kampers et al., 2021.</p>
Distinctive Features of Companies	<p>Successful companies in this sector often have multiple functions, necessary permits, certifications, and a balance between technology adaptability and user-friendliness. Certifications are crucial for market success, indicating validity and reliability.</p>
Customer Needs Assessment	<p>Assessing market and customer needs is essential, as it influences other business and technology development processes. This aspect's importance is also supported by literature.</p>
Adaptation to the market and customer needs	<p>Companies adapt their products based on customer feedback, special usage conditions, and targeting specific markets</p>
Methods to ensure companies' efficiency.	<p>Companies focus on adhering to ISO performance standards and continuously assess market conformity. While specific performance management tools like LEAN are not universally implemented, the principles are often followed.</p>
Measuring companies' progress	<p>Companies track progress through various metrics like product features, sales, production throughput, and internal KPI analysis.</p>
Technology Development Strategy	<p>Strategies vary between developing new technologies and adapting existing ones to market needs, influenced by the company's technological background and expertise.</p>
R&D Processes and Partnerships	<p>Partnerships are crucial in R&amp;D, especially for non-essential components. This strategy helps in cost reduction and protecting intellectual property.</p>

Securing Intellectual Property	Strategies for protecting intellectual property vary, from avoiding patents to using them for protection and improving company image. This reflects a balance between disclosure risks and the benefits of patent protection
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### 3.3 Analysis of life science start-ups

During this research phase, representatives from six life science start-up companies were interviewed. After evaluating the responses from representatives of companies that have already commercialized their products and overcame the start-up phase, a customized set of questions was developed for start-ups. This aimed to identify both similarities and differences in operational aspects of the companies compared to those from the first phase. It was simultaneously intended to uncover the specific characteristics and challenges of Lithuanian life sciences start-ups that might later help make assumptions about their possible business model.

#### **Challenges faced by start-ups in the commercialization process.**

To determine what difficulties Lithuanian life science start-ups face most when commercializing their technologies, their representatives were asked an open-ended question on this topic. When analyzing the answers of the respondents, financing was named as a very common problem. It was noticed that it was difficult for companies to attract investments, consequently, the technology development and commercialization processes slowed down. However, this may also be related to the fact that the products offered by start-ups are in the early stages of development, which may reduce the credibility of the product for potential investors. One of the representatives of the start-up companies expressed such an idea: "Everyone is waiting for the next stage when you have a good product and maybe you have already entered the market a little bit, then everyone is ready to invest". Governmental or European Union support programs were also mentioned on the topic of funding. The prevailing opinion was that, fundamentally, these are great tools for financing the initial stages of a business and the technology itself. However, it was emphasized that to secure such financing, it is necessary to win tenders, which are characterized by a large amount of bureaucracy, long deadlines, complicated processes of participation and preparation of documents, and the financial amounts of support offered are relatively small and sufficient only for the very

early stages of the company's activity. Obstacles to financing start-ups corresponded well with the opinions of representatives of companies that have commercialized their products. Shortly, it can be said that financing is a significant obstacle for both early-stage start-ups and companies that have passed the start-up stage, but financial obstacles should become less important as the company grows and expands.

Reaching out to the customer and proposing the advantages of the product was also named as one of the bigger problems. According to the representatives of the companies, the development of the technology is based on the initial market assessment. However, in the very early stages of product development, the first versions of the product are presented to the customer, which do not necessarily fully meet the customer's expectations, and therefore need to be improved. Such a process is quite expensive and takes a lot of time and hinders the development of the technology itself. One of the respondents gave a thought that sums up this problem well: "It would be good if the client would immediately understand the benefits without wasting time because this is a double-edged sword, maybe you did not understand if you did everything right yourself". These ideas are also closely related to the insights presented in the first phase of the study. The representatives also noted that assessing the customer's needs and presenting the benefits were among the biggest problems holding back the commercialization process.

### **Regulations and certification**

In the first stage of research, company representatives indicated that various certificates and proven compliance with regulations contribute to the improvement of the company's performance and help form the image of a more reliable business. However, the literature analysis showed that various certification and regulatory compliance assessment procedures can be one of the factors that slow down the commercialization process of companies. Start-up representatives were asked if certification and regulations are holding this process back. The answers of the respondents on this question differed quite strongly and it can be seen that it strongly depended on the stage of development of the technology. Companies whose products have not yet reached a stage of development where commercial sales would be possible indicated that certification procedures are planned for later stages of operation, so they do not pose a difficulty at this time. Companies that have already been forced to start these processes according to the stage of product development have said that this is a big and difficult problem. According to one of the interviewed respondents, "It takes a year for certification, and you can't sell anything. This is a very cruel place in this market".

It can be assumed that this is a long-lasting process, which directly inhibits the introduction of the product to the market. Also, among the respondents who claimed that these processes cause difficulties, the opinion prevailed that it also creates a financial burden, which is significantly high for young companies. On the other hand, one respondent indicated that the certification and regulation procedures are not easy, but it is a necessary job and, overall, it does not cause too many difficulties. In summary, it can be stated that the aspect of certification and regulations is extremely dependent on the stage of development of the commercialized technology, and it was not relevant for some of the companies studied. However, in the later stages of the companies' activities, these processes become a significant obstacle, slowing down the commercialization process.

### **Business model**

To get the most accurate view of the nuances of the company's activities, the respondents were asked whether their companies already have a formulated business model. The answers to this question were very similar between the respondents. Five out of six representatives indicated that their company does not have an established and clearly defined business model. There was a tendency for the business model to be constantly adapted and changed, depending on the nuances of the company's operations and the customer's needs, sometimes even to the extent that it is changed depending on the individual customer. It should be also noted that company representatives avoided specifying more precise details of their activities and gave strongly generalized answers. This is naturally understandable, as company representatives did not want to disclose sensitive information related to commercial secrets. Although the given answers do not reveal the exact details of the activity, it can still be concluded that almost all the surveyed start-ups did not have a specific business model and tried to provide value to the client precisely by performing business model adaptation. Another conclusion from this is that business model adaptation is an important factor that ensures the functionality of a startup, so this process can be used as an area of activity for which it would be appropriate to give guidelines on how to adapt the business model to ensure the most efficient operation.

### **Financial investments**

Part of the respondents identified the difficulty of attracting investments as one of the main problems during the previous questions. However, all representatives were asked about the lack of

financial investment, associating it with the newness of technology. There was a clear opinion that it is extremely difficult to attract financial investments. Several reasons were singled out: lack of confidence in an unproven product in the market, fear of long-term investment with uncertain payback, only technology offered, and no final product yet. Moreover, one respondent proposed to immediately look for investors in foreign markets, where the financing of risky ideas is more acceptable.

### **Technology development and partnerships**

All interviewees agreed that partners play an important role in the process of technology development and commercialization. Two representatives indicated that all technology development activities are tried to be carried out inside the company, and partners are needed only for certain processes that the company itself does not have the opportunity to perform, or it would be too expensive to do so. The rest of the representatives indicated that they are looking for partners for help in developing both the technology itself and related processes. Such reasons as more favorable distribution possibilities, the possibility of applying the technology in an interdisciplinary environment, and ensuring the technological base for conducting research were given for this. These answers partially agree with the opinion of the representatives of the first stage regarding the reduction of the price of the processes. Interestingly, although securing partnerships is important for start-ups, only one company representative mentioned that entrusting processes to partners could be a potential risk of disclosing confidential information. The representative indicated that NDA (Non-Disclosure Agreement) agreements are signed for the protection of information.

### **Market acceptance**

Almost all company representatives agreed that the novelty of the product is one of the factors that make the customer look at the product with caution, which makes it difficult to predict the possible success of the product in the market. Two out of six respondents especially emphasized that the Lithuanian market is extremely small, and it is difficult to assess the real demand, so start-ups should focus on the foreign or Lithuanian and foreign markets from the very beginning. Also, one respondent said that Lithuania can be a useful testing ground for having an early-stage product.



### **Measuring companies' progress**

Monitoring the company's activities and progress is one of the essential processes to ensure efficient operation. The representatives of the surveyed start-ups indicated that monitoring and measuring progress is an important factor for their companies, all respondents indicated that certain indicators are evaluated. Analyzing the answers shows a clear trend that the studied start-ups tend to evaluate progress mainly by qualitative indicators, among which the following were indicated: number of features, client evaluation of the product, number of partnerships, number of developed technologies, and number of signed contracts, also evaluation of reached milestones. Only one respondent mentioned the amount of revenue, although this may be related to a higher stage of technological progress when the first sales of technology or services are already being generated. It can be said that companies have set certain performance evaluation indicators, but they are often evaluated subjectively, evaluation criteria are not strictly defined. This does not correspond to the indicators used by companies that are already past the start-up stage. The indicators they use are often quantitative and formulated. However, these may be natural differences related to company age and differences in sales and product development stages.

### **Securing intellectual property**

When assessing how the researched start-ups protect intellectual property, all interviewed respondents indicated that they patent their technologies or products. It is interesting that although all chose patents as a main method to protect intellectual property, the arguments for such a choice were often cited not about the information itself. Patents were chosen not to directly protect intellectual property but as evidence of proper company performance, which allows it to shape a better impression on investors and acts as an advertising tool. In many cases, it was indicated that the most important information is not included in patents and remains as know-how of certain processes, which is held inside within the company itself and is often protected by agreements with the company's employees or stakeholders.

**Table 4.** Generalized summary of explored topics and provided answers by life science start-up representatives.

Explored topic	Summary
Challenges faced by start-ups in the commercialization process.	Attracting investments is a significant hurdle mainly because products are often in early development stages, lowering their trust in success to potential investors. This challenge is exacerbated by the complexities and limitations of governmental or EU funding, which, while beneficial for early stages, involve bureaucratic processes and provide only minimal financial support. Additionally, start-ups struggle with reaching out to their customers effectively. Early product versions usually do not meet customer expectations, requiring expensive and time-consuming improvements. This issue is compounded by the need for start-ups to accurately assess customer needs and communicate the benefits of their products, which is vital yet challenging, especially in the initial stages of market entry.
Regulations and certification	Certificates and compliance with regulations are seen as beneficial for company performance and credibility. However, they can also slow down commercialization due to lengthy and costly certification processes.
Business model	Most start-ups lack a clearly defined business model, often adapting it based on operational nuances and customer needs. This flexibility is essential for their functionality. Most respondents avoided disclosing specific business details for confidentiality.
Financial Investments	Attracting financial investments is a significant challenge, mainly due to untrust about unproven products and the risks associated with long-term investments. Some suggest seeking investors in foreign markets more open to funding innovative ideas.
Technology Development and Partnerships	Partnerships are crucial in technology development and commercialization. While some companies handle most development in-house, outsourcing certain processes can be more cost-effective. However, this introduces risks of confidential information leakage, typically mitigated by NDA agreements.
Market Acceptance	The novelty of products often leads to cautious customer reception, making market success hard to predict. Start-ups are advised to focus on

	both Lithuanian and foreign markets due to the limited size of the local market.
Measuring Progress	Start-ups mainly use qualitative indicators to measure progress, like client feedback and partnerships, which differ from the quantitative measures used by more established companies.
Securing Intellectual Property	All start-ups patent their technologies primarily as a performance indicator and to attract investors, keeping the most crucial information as internal know-how protected by internal agreements.

After analyzing the answers of life science start-up respondents, the collected information was used to develop a business model concept as the business model canvas, using the model proposed by Osterwalder & Pigneur, 2010. This business model is created to be adaptable, incorporating ideas and viable solutions to address the identified challenges and issues within the operational aspects of life science companies. The business model concept is compiled according to 9 aspects: key partners, key activities, value proposition, customer relationships, customer segments, key resources, channels, cost structure, and revenue streams. This model is provided in Table 5.

**Table 5.** Initial business model concept depicted through key components of business model canvas, by Osterwalder & Pigneur, 2010.

Type of Activity	Description
<b>Key partners</b>	Non-essential components manufacturers or service providers. Process distribution through various partners to protect intellectual property and know-how knowledge.
<b>Key activities</b>	Market analysis, and assessment of client needs. R&D activities. Product development. Exploitation of iterative development model. Assessment of regulatory standards and compliance procedures.

<b>Value proposition</b>	A technological or procedural solution for the client that exactly meets the client's needs and has a clearly expressed pragmatic benefit. Characterized by ease of use, offering a better price-functionality ratio than customers.
<b>Customer relationships</b>	Special conditions and dedicated support to customers, especially in the product testing phase. Highly customized solutions, based on in-depth market and customer need analysis.
<b>Customer segments</b>	Research institutions, universities, and academic laboratories. This might be a favorable option for relatively good conditions and a suitable environment for product development. Private institutions and governmental organizations.
<b>Key resources</b>	Financial investments. Scientific and technical expertise. Technological base for R&D and product development.
<b>Channels</b>	Scientific conferences and business meetings. Academic partnerships. Biotechnology, healthcare, industrial companies.
<b>Cost structure</b>	Research and Development activities. Permits and Certificates. Prototype development. Conferences and exhibitions.
<b>Revenue streams</b>	Products pre-sales and sales. Related accessories and consumables.

### 3.4 Life science expert comments on the compiled business model

In this part of the work, an expert in the field of life sciences was asked to comment on the created business model concept. This business model concept was developed based on an analysis of responses from representatives of life science companies and life science startups to questions posed to them. Expert evaluation was chosen as one of the most effective ways to assess the suitability of the created business model concept for life science start-ups at a theoretical level. Also, this method aims not only to evaluate the suitability of the model, but also to obtain valuable insights and recommendations regarding compiled business model concept. Table 6 summarizes comments and suggestions provided.

**Table 6.** Summary of comments provided by life science expert on the compiled business model concept.

Type of Activity	Comments and insights
<b>Key partners</b>	Partnerships are highly individual for each company. If there is a need to divide processes between partners for intellectual property protection, this is perfectly acceptable.
<b>Key activities</b>	For research and development processes, companies should evaluate tools such as Open-access centers, where they can quickly and qualitatively test their ideas with the professional equipment provided.
<b>Value proposition</b>	Life sciences have complex research processes, which makes them very expensive and time-consuming as they generate knowledge. Knowledge creates products or technologies that solve problems. The market demand is monitored, and it is analyzed whether it is possible to do business in a specific case individually.
<b>Customer relationships</b>	It depends a lot on the work of the sellers. It is often their main task to deliver products. There are separate processes for this.
<b>Customer segments</b>	Focusing on both, private and governmental organizations, as well as private businesses.
<b>Key resources</b>	Resources are one of the most difficult aspects, especially financial ones because the attitude of investors is extremely cautious. All possible methods are used to attract financial investments, such as personal connections, advertising, marketing agents, and any other possible.
<b>Channels</b>	Conferences are one of the best ways to present a product, but their membership fees are often very high and sometimes unaffordable. In this case, one should choose the most targeted conference so that the investment pays off.
<b>Cost structure</b>	One of the main activities is R&D. There are often no ways to reduce such costs. However, amounts depend a lot on the company, for example, whether the product under development is a device or whether it is a certain substance.
<b>Revenue streams</b>	It can be anything that the company can offer, such as various reagents, devices, or technologies, and various measurements using available technologies.

During this stage of research, an expert in the field of life sciences was asked to evaluate the compiled business model, as well as to provide insights and recommendations to help supplement this conceptual model. Based on these comments and recommendations, as well as the analysis of responses from representatives of life sciences companies and start-ups presented earlier, a final business model concept was compiled. The detailed business model concept, cornerstone ideas and insights are presented in the Table 7.

**3.5 Business model concept**

**Table 7.** Final business model concept.

<p><b>KEY PARTNERS</b></p> <p>Choosing individually, based on provided service or technology.</p> <p>Targeting manufacturers or service providers for non-essential components.</p> <p>Processes might be distributed through various partners to protect intellectual property and know-how knowledge.</p> <p>Contract Research Organizations. Infrastructure and service for initial phase idea testing.</p>	<p><b>KEY ACTIVITIES</b></p> <p>Market analysis, in-depth assessment of client needs. R&amp;D activities. Using Open access centers for initial or early-stage idea testing. Product development. Exploitation of iterative development model. Regulatory standards and compliance procedures.</p>	<p><b>VALUE PROPOSITIONS</b></p> <p>A technological or procedural solution for the client that exactly meets the client's needs and has a clearly expressed pragmatic benefit.</p> <p>Characterized by ease of use, offering a better price-functionality ratio than concurrent.</p>	<p><b>CUSTOMER RELATIONSHIPS</b></p> <p>Special conditions and dedicated support to customers, especially in the product testing phase. Highly customized solutions, based on in-depth market and customer need analysis. High focus on team members with sales competencies.</p>	<p><b>CUSTOMER SEGMENTS</b></p> <p>Research institutions, universities, and academic laboratories.</p> <p>Private institutions and governmental organizations. Highly dependent on the nature of the product.</p>
<p><b>COST STRUCTURE</b></p> <p>Research and development activities Permits and Certificates Prototype development</p>	<p><b>KEY RESOURCES</b></p> <p>Financial investments. Scientific and technical expertise. Technological base for R&amp;D and product development. Resource acquisition through personal connections, advertising, and marketing agents</p>	<p>Focussing on knowledge and competencies as a key element for a new product or service proposition.</p>	<p><b>CHANNELS</b></p> <p>Scientific conferences and business meetings. Focussing on the most suitable ones depending on price and content. Academic partnerships Biotechnology, healthcare, industrial companies. Highly dependent on the proposed product.</p>	
<p><b>REVENUE STREAMS</b></p> <p>Products sales and pre-sales. Related accessories, e.g. reagents, and consumables, depending on product or technology. Services. Exploiting technological base and expertise (e.g. custom measurements, analysis)</p>			<p><b>COST STRUCTURE</b></p> <p>Conferences and exhibitions Personnel and administrative expenses</p>	

## 4. CONCLUSIONS AND RECOMMENDATIONS

### 4.1 Conclusions

1. After analyzing the literature on innovation, technology, and commercialization, it was noticed that the complexity of innovation and technology demands effective commercialization to turn technologies into market-ready products and services. The process faces challenges, usually described as 'valley of death' which represents a gap between concept development and market success. This implies the importance of understanding the commercialization process and challenges faced, therefore in-depth research and strategies are essential. Developing specific guidelines and gaining deeper insights, expectedly, would be beneficial in enhancing innovation and commercial success in this sector.
2. In the literature, the most information can be found on such challenges of the commercialization process as difficulties in attracting financial investments, difficulties in assessing and making predictions about market demand, in addition to difficulties in dealing with product regulation in the market, various permits and certifications. The analysis of the research showed that these difficulties coincide well with those indicated by representatives of life sciences companies and start-ups during the interviews.
3. In the life sciences sector, the success of commercializing technologies heavily relies on the business model a company adopts. The ability to adapt business models to changing market conditions and emerging customer needs is key to commercial success. While business model innovation is acknowledged as vital for sustaining competitive advantage, more research is needed to understand the specific changes that enhance the likelihood of successful technology commercialization in the life sciences sector.
4. Lithuanian life science start-ups primarily face two significant commercialization challenges: securing financing and effectively engaging customers. Attracting investments is difficult for early-stage products, which tend to lower investor confidence because of the high risk of success. Moreover, start-ups struggle to meet customer expectations with their initial product versions, leading to costly and time-consuming revisions. This impacts



both technology development and the overall commercialization process, highlighting the need for clear communication of product benefits and a better understanding of customer needs.

5. A business model concept was created, primarily for Lithuanian life sciences start-ups as guidelines, which will help to carry out the commercialization process of a product or technology more effectively by changing certain aspects of the business model accordingly. The concept of the business model was compiled based on the analysis of the conducted research, during which representatives of life sciences companies and start-ups expressed their opinions and insights to the specific points discussed. The business model concept is presented in the form of a business model canvas according to 9 key points, according to Osterwalder & Pigneur, 2010. This theoretical model was chosen as the most appropriate way to provide main and applicable information for life science businesses.
6. It was found that most of the start-ups do not have an established business model and also face difficulties in commercializing the technologies. Therefore, targeted recommendations and guidance provided at an early stage of a company's operations could create significant added value in streamlining processes, related to commercialization.

## **4.2 Recommendations**

During this research, the main difficulties faced by Lithuanian life sciences start-ups were identified. To extract maximal value in this particular topic analysis, the study should be carried out on a larger scale, involving a greater number of respondents, businesses, and professionals in the field. It would also be appropriate to refine each of the identified difficulties as a separate research topic to propose highly specific ways of solving the commercialization process problems. Further research should also include the company's field of activity, and the type of commercialized product as a separate variable, as this may influence the course of the commercialization process and related factors such as regulations, financing, and others. The research done could serve as orientational guidelines for creating a research structure for similar types of work. From a practical point of view, the collected research data could be useful as a basis for developing consulting programs for life sciences start-ups, as well as useful information for company executives that are worth paying attention to. The created business model concept will be offered firstly to the representatives of the interviewed start-ups as

recommendations that would clearly reflect the operational characteristics of their activities, the difficulties they face during the commercialization process, and possibly help them carry out the technology commercialization process more efficiently, possibly avoiding the most common mistakes. It was also observed that a common startup does not have an established business model, therefore such recommendations could create the most value at an early stage of the company's operation.

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## 6. ANNEXES

### **Annex 1. Example of interview transcription - representative of life science Company 1**

*Q -Question, A – Answer*

Q1: What are the biggest challenges the company faces in commercializing its main product?

A1: Market probably, if you choose a bad product. This is stopping the product, which means there may not be a need in the market. This is very disturbing. The second thing is that the issue of financing is probably also a big one, financing conditions hinder the creation of new products because they oblige the business to reach new indicators. It means that if you want to receive support for the development of a new product, you must commit to making sales. Also, the market reaction, if the product is completely new, the market may not even need it. And to commit, you must already have sales, which is a big obstacle.

Q2: What do you think distinguishes you the most from other similar companies (in terms of product or the market for that product), do you pay a lot of attention to innovation?

A2: Exclusivity is created by regulations, that is, the licenses we have, permits, processes in the company, quality system, and production processes. Another factor is that we have the opportunity to register medical devices, so there is production control, and we can produce well, which means reliably. We are reliable manufacturers, we do not make mistakes. If we do, we fix them right away. This thing probably makes us relatively successful.

Q3: Do you pay much attention to customer need assessment?

A3: Of course. Not the customer's need, but the market's need. If we see that there is a need in the market, it means a need, and when talking to customers, the customer says that they need, possibly need. That's how we're going to see it. After that, the real need of the market becomes clear when it is necessary to sell.

Q4: What strategy do you follow to adapt to market needs?

A4: We create a product. We look at the market demand, if the market wants something different, we update the product. It's a simple process, you plan and execute the plan, and see if something doesn't work, then change the plan.



Q5: What methods do you use to ensure company efficiency (management systems, etc.)?

A5: We have a quality management system for the production of medical devices, here is ISO 13485, which includes the nuances of the quality management and production system. We do not apply lean, but we apply lean principles.

Q6: Do you track the company's progress and if so, how do you try to measure or evaluate it?

A6: Sales. And production throughput. One is sales, the other is production throughput. How much can we make in a week, how much can we make in a month. We do not measure quality indicators because we cannot let us have mistakes.

Q7: Is the company more focused on developing new technologies or adapting existing ones to market needs?

A7: We may apply existing technologies to new things. It is the application of existing production technologies in new areas. We are not capable of creating new technologies, we are capable of creating new processes, adapting existing technologies, supplementing and expanding them.

Q8: Regarding the R&D processes, do partners have a significant role here, or do you aim to carry out all the processes yourself?

A8: Depending on the project. When we can do it ourselves, we do it ourselves. When we are not capable, we lack some competencies or knowledge, and development stalls, then it is the partner, the same Life sciences center. Regarding production processes, we do everything from our resources.

Q9: Is securing intellectual property very important to you, or do you pay a lot of attention to it? How do you go about protecting it?

A9: Do not patent. Do not publish. Otherwise, it's a disclosure, unless it's supposed to be some kind of super-innovative technology.