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# Transforming Type 1 Diabetes Management: A Business Model Approach

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## Abstract

Title: Transforming Type 1 Diabetes Management: A Business Model Approach

Type 1 diabetes is a chronic condition with significant medical needs, and the discovery of a cure holds immense potential to transform diabetes management and improve patient outcomes. Through a combination of literature review, expert interviews, and business model canvas prototype development, this study examines key elements of a business model.

This thesis presents a comprehensive analysis of a business model for developing a cure for Type 1 Diabetes, demonstrating how innovative approaches, driven by business modeling, can steer a shift from treatment-centered to curative solutions.

The analysis highlights the importance of strategic partnerships, research and development activities, effective marketing strategies, and sustainable revenue generation models in successfully bringing a cure to market.

By providing insights into the business model for a cure for type 1 diabetes, this thesis contributes to the understanding of the commercialization process for transformative medical innovations.

Keywords: Business model, Cure, Type 1 Diabetes, Healthcare

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## Resumo

Título: Transformação da Gestão da Diabetes Tipo 1: Uma Abordagem de Modelo de Negócio

A diabetes tipo 1 é uma doença crónica com necessidades médicas significativas e a descoberta de uma cura tem apresenta um enorme potencial para transformar a gestão da diabetes e melhorar os resultados das pessoas com diabetes.

Através de uma combinação de revisão de literatura, entrevistas com especialistas e desenvolvimento de protótipos de modelos de negócio, este estudo examina os elementos-chave de um modelo de negócio.

Assim, esta tese apresenta uma análise abrangente de um modelo de negócio para o desenvolvimento de uma cura para a diabetes tipo 1, demonstrando como abordagens inovadoras, orientadas pelo *business modeling*, podem impulsionar uma transição de uma abordagem centrada no tratamento para uma cura.

A análise destaca a importância de parcerias estratégicas, atividades de pesquisa e desenvolvimento, estratégias de marketing eficazes e modelos de geração de receita sustentáveis para trazer com sucesso uma cura para o mercado.

Ao fornecer *insights* sobre o modelo de negócio para uma cura para a diabetes tipo 1, esta tese contribui para a compreensão do processo de comercialização de inovações médicas transformadoras.

Palavras-chave: Modelo de negócio, Cura, Diabetes tipo 1, Cuidados de saúde

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## List of Abbreviations

T1D – Type 1 Diabetes

T2D – Type 2 Diabetes

WHO – World Health Organization

APDP – Associação Protetora dos Diabéticos de Portugal

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## 1. Introduction

The effective management of chronic diseases is a challenging concern (BRUNNER-LA ROCCA et al., 2016). This is specifically the case of Type 1 Diabetes (T1D) considering the lifelong commitment and impact on individuals' quality of life and significant healthcare expenditure (IDF DIABETES ATLAS, 2021).

Insulin insufficiency, resulting from autoimmune-mediated beta cell death in the pancreas, is the main cause of T1D. Beta cell loss occurs gradually and often only partially in persons with Type 2 Diabetes (T2D). Although beta cell autoantibodies are an indicator of T1D, peripheral insulin resistance and defective insulin production by pancreatic beta cells are linked to the pathophysiology of T2D. There are numerous clinical consequences, so called comorbidities, linked to both types, including cardiomyopathy, nephropathy, and neuropathy often difficult and costly to manage (NDIANG et al., 2017).

The prevalence of diabetes has been rising globally and it is a challenge to predict its future evolution (IDF DIABETES ATLAS, 2021). In Portugal, in 2021, the expected prevalence of Diabetes in the Portuguese population aged 20 to 79 years (7.8 million people) was 14.1%, implying that around 1.1 million Portuguese people in this age group have diabetes (OBSERVATÓRIO NACIONAL DA DIABETES, 2023), and around 38.515 thousand have T1D (INTERNATIONAL DIABETES FEDERATION, 2023).

Moreover, there are increasing costs associated with its management, maintenance and treatment, a higher demand for technology and also a provision of education for healthcare professionals and people with chronic diseases. These costs are largely supported by public expenditures, but also by people with diabetes and their households, contributing to an economic burden (IDF DIABETES ATLAS, 2021).

Researchers and scientists are actively working on possible approaches to find a cure including:

1. Immunotherapy: it aims to modulate or modify the immune system's response to prevent the destruction of beta cells. This includes using immunomodulatory drugs, such as anti-CD3 antibodies or agents that target specific immune cells involved in the autoimmune response (BRESSION et al., 2009).

2. Beta Cell Replacement and Transplantation: a process of replacing destroyed beta cells with healthy beta cells through transplantation - islet cell transplantation, where insulin-producing islet cells are taken from a donor pancreas and transplanted into a person with type 1 diabetes. However, there are challenges associated, such as the scarcity of donor organs and the need for immunosuppressive drugs to prevent rejection (XIN-XING WAN et al., 2022).
3. Stem Cell Research: the generating of functional beta cells from stem cells, including induced pluripotent stem cells derived from the patient's own cells. The goal is to produce an unlimited supply of beta cells that can be transplanted without the need for immunosuppression (KEYMEULEN et al., 2023).

Considering the current paradigm, could it be proposed a new disruptive business model canvas for T1D management, in which it is sustained the transition from diabetes treatment to its cure, assuming a curative model provides a less expensive long-term solution?

In this context, this thesis is examining the structure, value proposition, and revenue streams of various entities engaged in diabetes care captured by possible business models, thus uncovering novel ways to deliver superior healthcare services while simultaneously reducing costs. The business model methodology acts thus as the strategic framework and drives the provision of healthcare in new ways.

In the pages that follow, in Chapter 1, section 1 the literature review about business models, its composition, importance, and healthcare business models and its importance. In section 2, the concept of industry paradigm shift and three business cases about Tesla, Netflix and Hepatitis C. in section 3, a detailed analysis of Type 1 Diabetes and the key numbers in Portugal. In Chapter 2, the methodology, in section 1, the interviews, business model prototyping and data collection, and, in section 2, the results and final business model. The chapter 3 of this thesis is the conclusion.

### 1.1. Motivation of this study

Type 1 Diabetes is an autoimmune disease characterized by the destruction of insulin-producing beta cells (NDIANG et al., 2017). Its management is a lifelong commitment, requiring multiple daily insulin injections or continuous infusion through insulin pumps (RICHARD et al., 2021). The quest for a cure has been ongoing for decades, driven by the desire to liberate

individuals from the regimen of managing their blood sugar levels and reduce the associated risks of long-term complications (NDIANG et al., 2017). However, despite significant advances in medical research and treatment options, a definitive cure is still to be discovered.

This thesis is motivated by the belief that combining academic inquiry with practical insights into the design and implementation of business models can offer a unique perspective on accelerating progress towards a cure for T1D. By studying existing models and proposing innovative frameworks, we aim to contribute to the broader discourse on how business and science can synergize to address one of the most pressing healthcare challenges of our time.

Ultimately, this thesis also aims to provide a foundation for stakeholders, including researchers, policymakers, and entrepreneurs, to rethink their approaches and forge new pathways toward a cure for this disease.

## 1.2. Research questions

The core research question of this thesis is “how the business modeling method could be used to sustain the transition of T1D treatment-oriented approach to a curative approach?”.

Such method offers a theoretical framework of how a business function (OSTERWALDER et PIGNEUR, 2010). In the event of a cure being discovered, a new business model is likely to be needed that assists stakeholder in navigating that paradigm shift, pooling resources and distributing economic benefits.

Other sub-questions can also be addressed:

- Is the business modeling innovation an effective approach to positively impact healthcare and management of T1D?
- If so, would it be viable to apply this method for a shift in treatment-oriented approach to a curative solution?
- Even if it is determined that it is not the most successful or viable option, may any of the recommendations be adapted to the current business model to make it more cure-friendly?

Through an in-depth examination of the concept of a business model in the context of T1D research, identification of strategies, participants, and frameworks that can push advancement from laboratory experiments to practical advantages to people living with diabetes can be achieved.

## 2. Literature Review

### 2.1. Business Models

#### 2.1.1. Concept

The concept of the business model does not have a single, widely recognized definition. Instead, literature consists of a variety of viewpoints, interpretations, and contextual nuances, and its significance varies according to the topic of study, cultural background, or individual perspectives (CASADESUS-MASANELL et al., 2011). As a result, attempts to define it often fall short in capturing its full essence.—Rather than seeking a rigid definition, it is more valuable to engage in ongoing discussions, exploration, and analysis to deepen our understanding of this concept through literature review.

Several authors attempted to provide a conceptualization or a definition of business model, in the past decades. The first attempt at defining business model consisted in “an architecture of the product, service or information flows, including a description of the various business actors and their roles; a description of the potential benefits for the various business actors; a description of the sources of revenues” (TIMMERS, 1998). Later, in 2001, others mentioned the purpose to create value, as “the content, structure and governance of transaction designed so as to create value through the exploitation of business opportunities” (AMIT & ZOTT, 2001). A year later, two definitions were proposed, as the business model comprised “the heuristic logic that connects technical potential with the realization of economic value” (CHESBROUGH & ROSENBLOOM, 2002)<sup>17</sup> and “stories that explain how enterprises work”, with the purpose to answer critical questions as “who is the customer?” and “what does the customer value” (MAGRETTA, 2002). Despite the heterogeneity of definitions, the business model was characterized as “a concise representation of how an interrelated set of decision variables in the areas of venture, strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets” (MORRIS et al., 2005), and as a set of “four elements, that, taken together, create and deliver value” (JOHNSON et al., 2008). Other two important contributions refer the business model as a “reflection of the realized strategy” (CASADESUS-MASANELL & RICART, 2010) and as

an articulation of “the logic, the data and other evidence that support a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value” or, in other words, the “design or architecture of the value creation, delivery, and capture mechanisms” of a firm (TEECE, 2010).

In the same line of conceptualization, others see the business model as the “blueprint for a strategy to be implemented through organizational structures, processes, and systems”, thus, a business model is “the rationale of how an organization creates, delivers, and captures value”, and it is divided in “nine basic building blocks that show the logic of how a company intends to make money” (OSTERWALDER et PIGNEUR, 2010), which is commonly known as the Business Model Canvas. Even though the literature review of FOSS et SAEBI (2017) states that most of the literature's contributions now advocate the definition of business model presented by David Teece, we adopt, in this thesis, the comprehensive framework proposed OSTERWALDER and PIGNEUR (2010).

The Business Model Canvas offers a visual representation of a business's key components. By employing this framework, we also aim to facilitate meaningful and insightful dialogue during interviews, ensuring that our analysis is both comprehensive and coherent. Thus, throughout this thesis, we will consistently reference and apply the Business Model Canvas framework to elucidate the dynamics and strategies of the businesses under investigation.

In addition, while the concept of business model was largely discussed by the literature, other authors focused their analysis in categorizing the research into three streams (LAMBERT & DAVIDSON, 2013 and ZOTT et al., 2011, as cited in FOSS et SAEBI, 2017), respectfully: as a basis for enterprise classification, an antecedent of heterogeneity performance and as a potential unit of innovation (FOSS et SAEBI, 2017) – meaning, business model innovation (BMI). Other researchers discussed its role in different theories, such as GEORGE et BOCK (2011, as cited in FOSS et SAEBI, 2017), or the evolution of the term itself, such as WIRTZ et al. (2016, as cited in FOSS et SAEBI, 2017).

Finally, during recent years, research shows its attention on the concept of business model innovation (BMI), in which some authors mention its autonomation from the concept of business model (FOSS et SAEBI, 2017), which involves significant changes on how a business creates, delivers, and captures value, often leading to disruptive or transformative outcomes. It is a process

that established players must experience to promote positive performance effects (CUCCULELLI et BETTINELLI, 2015, as cited in FOSS et SAEBI, 2017), as we will demonstrate in Tesla's case study. Business model innovation is also characterized as transformative, presenting characteristics such as more personalized products or services, a closed-loop process that substitutes a linear production process, a few shared assets, a usage-based pricing, while being an agile organization in a more collaborative ecosystem (KAVADIAS et al., 2016)<sup>31</sup>, Since 2006 developing innovative business models are a key priority for managers (CASADESUS-MASANELL et RICART, 2011)<sup>32</sup>.

### 2.1.2. Composition and Business Model Canvas

A recent review reveals that the different understandings above mentioned are convergent, regardless of the current unclear consensus among scholars on the definition of a business model (WIRTZ et al, 2016, as cited in FREDRIKSSON et al., 2017).

Some perspectives demonstrated that a business model is composed by, concretely, “*precisely delineated characters, plausible motivations and a plot that turns on an insight about value*” (MAGRETTA, 2002). Other authors consider a business model consists of four elements, namely, customer value proposition, a profit formula, key resources, and key processes (CHRISTENSEN, as cited in CASADESUS-MASANELL et al., 2011). However, some authors affirm the delimitation of elements will create preconceptions to executives and restrict the creation of new models, thus a business model is “set of managerial choices and the consequences of those choices” (CASADESUS-MASANELL et al., 2011).

A broader perspective recognizes business model as a conceptual link between strategy, business organization and systems to create, deliver and capture value (OSTERWALDER et PIGNEUR, 2010), and in the case of the Business Model Canvas (APPENDIX 1), it is composed of nine building blocks, as described below, and which reflect four main business areas – customers, offer, infrastructure and financial viability:

1. Customer Segments: customer segments, as served by an organization, can take various forms, including mass market, niche market, segmented market, diversified market, or multi-sided platforms.

2. Value Proposition: the customer problem-solving and satisfaction, achieved through value propositions, involves the aggregation or bundle of benefits that a company offers customers. Innovative value propositions may present a fresh or disruptive offer, while others might be comparable to products already on the market, but with additional features and qualities.
3. Channels: value propositions reach customers through communication, distribution, and sales channels, which can be either owned by the business or delivered through partner channels.
4. Customer Relationships: the establishment and maintenance of relationships with customer segments, with the drivers of these relationships being customer acquisition, customer retention, or upselling.
5. Revenue Streams: The outcomes of successfully delivering value propositions to customers are defined in accordance with a pricing strategy.
6. Key Resources: the assets required to offer and deliver the previously described elements, either owned by the company or by key partners.
7. Key Activities: the result of a series of key activities performed to operate successfully.
8. Key Partnerships: some activities are outsourced, whereas other resources are acquired outside the enterprise.
9. Cost Structure: the business model elements contribute to a cost structure, which can be either cost-driven or value-driven. Furthermore, this cost structure can exhibit characteristics such as fixed costs, variable costs, economies of scale, or economies of scope.

The model can be used to investigate the interactions between customer wants, product offerings, delivery channels, and revenue streams, and provide an immediate visual portrait of the model (OSTERWALDER et PIGNEUR, 2010).

### 2.1.3. Importance of Business Models

While any business strategy may thrive in a monopolistic market, a well-designed and customer-centric business model is vital for value creation (CASADESUS-MASANELL et al., 2011).

Business models also serve as valuable planning tools, representing the integration and synergy among various elements to deliver value (MAGRETTA, 2002), but warns about the significance of accurate assumptions and economic motivations, as a business model based on faulty assumptions about customer behavior may fail to deliver value, resulting in solutions without real problems to solve.

Furthermore, business models have been instrumental in micro-management research, particularly in e-commerce, strategy, and technology management (ZOTT, AMID, & MASSA, 2011, as cited in FOSS & SAEBI, 2017). They serve as the foundation of sustainable competitive advantage (CASADESUS-MASANELL et al., 2011) and act as a valuable benchmarking tool when compared with other market players, considering the rarity of monopolistic markets. However, it is crucial to avoid the pitfalls of stand-alone decision-making processes and SWOT analysis based on faulty assessments, as highlighted by CASADESUS-MASANELL et al. (2011).

Moreover, they are important to achieve one of four objectives: either to satisfy existing but unanswered market needs, or to bring new technologies, products, or services to market, or to improve, disrupt, or transform an existing market with a better business model, or to create an entirely new market (OSTERWALDER et PIGNEUR, 2010).

To summarize, it is a *blueprint* that guides resource allocation, revenue generation, and overall decision-making, whose purpose is to describe and communicate a project and its implementation (OSTERWALDER et PIGNEUR, 2010).

## 2.2. Health Business Models

### 2.2.1. Concept

Business models in health care would assist health providers, managers, and policymakers in better understanding how various organizational components and activities could be better linked to achieve the Triple Aim (FREDRIKSSON et al., 2017), meaning Care, Health and Cost (BERWICK et al., 2008, as cited in FREDRIKSSON et al., 2017).

One key challenge, according to CHRISTENSEN et al. (2009), is that health care organizations and institutions are attempting every strategy at the same time,. This presents a larger challenge considering there is no consensus about the concept of business model (FREDRIKSSON et al., 2017).

Thus, it is believed that business models are an important way to help health care organizations innovate (FREDRIKSSON et al., 2017) and, in other industries, it has been possible to “*deliver increasingly affordable and accessible products and services*” (HWANG and CHRISTENSEN, 2008)<sup>53</sup>, via the introduction of cost-reducing technologies and innovative business models.

Based on this premise, HWANG and CHRISTENSEN (2008) presented a framework to categorize and develop business models in healthcare: an attempt to make it more affordable, rather than looking for solutions to afford healthcare. Business model innovation is paired with new technologies, whose purpose is to deliver or increase value – value proposition-, thus, greater convenience at lower costs. In other words, an established causality between new technologies and value proposition. However, it is also stated that “*in health care, most technological enablers have failed to bring about lower costs, higher quality and greater accessibility*”, mainly due to the lack of business model innovation (HWANG and CHRISTENSEN, 2008).

The solution is to couple “*technological advances with appropriately matched business models*”, while not forcing the transformation of solutions shops into other business models (HWANG and CHRISTENSEN, 2008)<sup>57</sup>. When it comes to chronic diseases, for instance, the most appropriate business model would be facilitated user networks, such as dLife that already built a network for people with diabetes and their families, thus promoting an exchange of information and care (HWANG and CHRISTENSEN, 2008)<sup>58</sup>.

Innovation in the healthcare sector also faces challenges. These include the problem of fragmented care brought on by the diversity of business models, the lack of a strong retail market calling for the development of incentives to encourage product purchases and service utilization, the existence of regulatory barriers that can result in expensive care models, and the complexity of reimbursement policies. As HWANG and CHRISTENSEN (2008)<sup>59</sup> pointed out, lowering primary reimbursement rates may not always be the best course of action because it can prevent healthcare organizations and providers from providing value.

In other words, by strategically aligning technology, value propositions, and operational strategies, healthcare organizations can drive positive changes in care quality, health outcomes, and cost-effectiveness. And a successful transformation in the way healthcare is provided and experienced relies ultimately on the ability to use business models.

#### 2.2.2. Importance business model in healthcare

In the field of Healthcare Management, the value of innovation is assessed differently, with a focus on its impact on the patient's quality of life and health enhancement. The value of health innovation is captured by new drugs or treatment options, implying that medical innovation should consider several critical factors (ARONSON, FERNER, and HUGHES, 2012): the absence of existing therapies, increased efficacy of the novel approach, enhanced safety, particularly concerning drug interactions, greater convenience in application and cost-effectiveness.

A significant contribution to have in consideration is the Change Process Model, presented by KOTTER (1996). This framework is a structured approach for healthcare organizations to navigate and lead change effectively and consists of eight key steps, in the following sequence: establishing a sense of urgency, creating a guiding coalition, formulating a vision and strategy, communicating the change vision, empowering employees for broad-based action, achieving short-term victories, consolidating progress and instigating further change, and ultimately embedding new approaches for the future. Even though the change process model and the business model are not directly related, we understand that the establishment of the mentioned steps provides significant insight to create a business model, while ensuring that the transformation is well-planned, communicated effectively, and integrated into the organization's overall strategy. Moreover, business models are adaptable, guiding organizations in consolidating successful changes and embedding innovative approaches into their future. In essence, business models are integral in ensuring that Kotter's

Change Process Model translates vision into action, driving successful transformation in complex environments.

### 2.3. Industry Paradigm Shift

A cure would serve as an impulse for disruptive innovation: a promise to transform our way of life. This transformation represents a paradigm shift: a change in the perspective, concepts, and practices of how something is accomplished or works, thus it occurs in a variety of settings, including industry and scientific research (HAYES, 2022).

Thomas Samuel Kuhn firstly defined paradigm shift as a revolution that challenges and takes the place of a prevailing scientific framework, which is challenged when its normally accepted science is operating under “*incompatible or insufficient with new data or findings, thus facilitating the adoption of reviewed new theory or paradigm*” (KUHN, 1998, as cited in HAYES, 2022). This means a new paradigm will ultimately change how individuals act and think, or interact with a product or service (MITCHELL, 2022).

The concept of a *paradigm shift* holds significant importance in the pursuit of finding a cure for T1D: by embracing it, researchers and scientists can challenge existing assumptions and explore innovative avenues in the search of a cure. Such change has the potential to revolutionize the treatment landscape, and it encompasses a holistic approach that extends beyond medical interventions, thus involves considering lifestyle factors, behavioral changes, and preventive measures to address the underlying causes and risk factors associated with the disease, while promoting a proactive approach to its management.

Regarding the pharmaceutical industry, the term has also been discussed in the past decade. The present research idea disregards clinical illness and its symptoms, placing a priority on process higher than on biology and disease (SAMS-DODD, 2013). Moreover, that target-based and disease-focused techniques may now be combined because of improvements in automated procedures and imaging technologies. Three fundamental rules must be followed towards the creation of a new research paradigm, such as the use of scientifically based procedures, knowledge of customer demands, and comprehension of risks (SAMS-DODD, 2013).

The concept calls for a fundamental reimagining of systems to prioritize proactive, personalized, and preventive care.

In this context, three business cases are presented and highlight the power of paradigm shifts in different industries, challenging existing norms and setting new standards, such as Tesla, Netflix and the case of a cure for Hepatitis C. Three factors these businesses have in common with T1D are innovation and redefinition, efficiency and efficacy, and a patient-centric approach, thus explaining the selection of these business cases:

- Innovation and redefinition because Tesla revolutionized the automotive industry by pioneering electric vehicles and autonomous driving technologies and Netflix by introducing on-demand streaming and prioritizing original content production. Similarly, a potential cure for T1D might completely change the medical landscape by presenting new therapies that change how the disease is managed.
- Efficiency and effectiveness because Tesla prioritized energy efficiency in the automotive sector, while Netflix focused on user-friendly content delivery. A cure for T1D could prioritize efficiency, improving patient outcomes and healthcare efficiency, while reducing the economic burden for Governments and families.
- Patient-centric approach because a cure for hepatitis C provided a shorter, more patient-friendly treatment option, and Netflix gave priority to a user-centric strategy, adjusting content recommendations according to personal tastes. And in the case of T1D, a cure would most likely increase patient quality of life for individuals with diabetes.

#### 2.3.1.1. Tesla

When conventional automakers showed little interest in electric mobility in 2003, Tesla Motors Inc. (Tesla) was founded (VOIGT et al., 2016) and led the automotive industry revolution. Its high-performance battery electric vehicle (BEV) - the Roadster -, the direct-to-consumer sales model, continuous improvement and, recently, international expansion, represent a shift in the industry status quo (VOIGT et al., 2016).

Tesla's success can be attributed to a dynamic interplay of internal and market driving factors (VOIGT et al., 2016), reflecting the pivotal role of both market forces and strategic decisions in

shaping its business model: the importance of a well-designed business model is evident as Tesla capitalized on changing market dynamics, with rising oil prices and growing environmental concerns acting as powerful catalysts for the adoption of electric vehicles (EVs). As the world shifted towards sustainable alternatives, a niche of environmentally conscious consumers emerged, representing a prime opportunity to capture this market segment. Furthermore, governmental policies aimed at reducing carbon emissions and promoting cleaner transportation also provided a favorable regulatory environment for Tesla. These circumstances provided Tesla the opportunity to develop a groundbreaking value proposition and customer segmentation.

Additionally, the alignment of Tesla's business model with these market trends allowed the company to secure a significant first-mover advantage: there was an emergent demand for high-performance electric vehicles. In its pursuit of market penetration, Tesla adopted a gradual approach and long-term strategy, targeting a niche market segment of environmentally conscious consumers initially (OSTERWALDER et al., 2020). By building a loyal customer base and refining its products over time, being voted the most loved car in America in 2014 (OSTERWALDER et al., 2020), they incrementally expanded their reach, eventually addressing mass-producing cost-effective models (VOIGT et al., 2016), with more affordable EV models. As explained by Osterwalder et al. (2020), visionaries envision expansive market opportunities by identifying latent needs and introducing novel value propositions, thereby stimulating unprecedented growth (APPENDIX 2).

The business faced entry barriers, including high production costs and technological complexity, that were overcome by a set of solid entrepreneurial skills and a team of automotive specialists, mastering both key resources and activities of a business (VOIGT et al., 2016). And by the time traditional automakers faced considerable challenges in entering the market due to a lack of expertise, investment in production plants, and commitment to technology (VOIGT et al., 2016), Tesla was already pioneering the production and ahead of the competition.

The company seized opportunities presented by shifting market trends, while capitalizing on time-to-market advantages. However, the success is also explained with strategic partnerships, such as technology partners like Toyota, Mercedes, and Panasonic, which strengthened its portfolio of essential resources and key activities to support its vision of unleashing the market for electric vehicles (Osterwalder et al., 2020).

This evolution is illustrated in Tesla's initial business model in 2003 (APPENDIX 2) and its current business model (APPENDIX 3). This transformation reflects the curve of innovation, as proposed by Everett Rogers in 1995, which indicates that technology diffusion is correlated with the passage of time, compelling companies to progress continually to sustain their leadership positions.

#### 2.3.1.2. Netflix

The video player's mass market launch in the 1980s transformed the U.S. movie rental industry, allowing individuals to view movies at home on VHS cassettes. In the early 1990s, Blockbuster Video and Movie Gallery dominated the sector, with little mom-and-pop businesses emulating their business method: Blockbuster, with its network of physical storefronts and pay-per-rental strategy, was centered on offering instant access to popular films, while Movie Gallery targeted both rural and metropolitan regions with aggressive outlet growth. However, their unwillingness to adapt to new business models, eventually led to their demise (VOIGT et al., 2017), meaning both business models failed to adapt to quick changes in customer preferences, whereas Netflix recognized where they were failing and managed to replace these firms' deficiencies while increasing the value proposition.

The example of Netflix underscores the importance of constantly reassessing and innovating business models in response to industry shifts, meaning that companies must be willing to cannibalize their own offerings to stay relevant and gain a competitive edge. However, it is important to highlight the importance of industry paradigm shifts and the concept of cannibalization for organizations while striving to maintain a competitive advantage. These phenomena are closely linked with the evolution of business models, especially business models innovation (APPENDIX 5), and one prominent example that illustrates this interplay is the case of Netflix in the entertainment industry.

The advent of streaming technology brought about a reform in the way people consume media and Netflix's founders recognized this breakthrough and capitalized on the opportunity, transforming from a charge membership fees instead of single-entry fees in rental movie shops, to a mails' service and, finally developing from a DVD-by-mail service to a streaming platform. In other words, Netflix's disruptive entry into the entertainment industry not only was responsible for a turnaround in how content is consumed, but it also highlighted the cannibalization within traditional media channels, and in-store rentals (VOIGT et al., 2017) too.

The business cannibalization of Netflix's streaming service directly competed with its DVD rental business, leading to the decline of the second, thus presenting a strategic dilemma, as Netflix had to make the bold decision to prioritize the streaming service, even though it risked losing a substantial portion of its existing customer base (VOIGT et al., 2017). However, the later, incumbents were forced to reevaluate their offerings owing to traditional media channels reshape, leading them the development of their own streaming platforms and digital distribution strategies to remain competitive in the evolving market.

Nonetheless, the competitive advantage for Netflix emerged from its ability to embrace the sign of times, and navigate the cannibalization challenge effectively, thus confirming that a company may thrive and be competitive if its new model changes the economics of an industry – even though, nowadays, Netflix's business model is not as hard to replicate as before (MAGRETTA, 2002). The company's innovative business model centered around subscription-based, on-demand streaming allowed it to capture a significant share of the market and attract millions of subscribers worldwide – value proposition (VOIGT, 2017). In 2022, the Motion Picture Association said that 1.1 billion people worldwide have online video streaming service subscriptions as of 2020 (DURRANI, 2023).

Netflix's success demonstrates how a company can strategically cannibalize its own offerings to stay ahead in an evolving industry. By recognizing the changing preferences of consumers and proactively adapting their business model, organizations can maintain a competitive advantage. Netflix's bold move to disrupt its own business model in favor of streaming not only positioned it as a market leader but also forced traditional media companies to rethink their strategies and adapt to the streaming revolution.

#### 2.3.1.3.Hepatitis C

Among chronic diseases, Hepatitis C has a treatment with a 97% success rate (MOSKAL, 2022), which purpose is to cure the disease. According to the WHO, Hepatitis C is an inflammation of the liver caused by the Hepatitis C Virus (HCV), resulting in acute infections or in chronic infections. The innovative antiviral medicine prevents the occurrence of these complications, hence representing a cure.

The WHO, in 2020, estimated that around 71 million people around the globe are infected with HCV, declaring Hepatitis C as a plague (LAUGI, 2020), and it is estimated that 55% to 85% of people infected by HCV have CHC – although, the majority of the case may be a result of a late diagnosis, considering ACH is asymptomatic (PEDRO, 2021), and compared to 422 million people with diabetes globally, estimated in 2021, and the cause of death of 1.5 million people, in 2021.

The successful development of a cure for hepatitis C marks a remarkable achievement in the field of healthcare. Prior to the introduction of direct-acting antiviral (DAA) medications, hepatitis C was a viral infection with limited treatment options. However, the curative approach brought about by DAAs has revolutionized its management, leading to a decrease in the prevalence of cirrhosis and complications, as well as a decrease in the prevalence of hepatocellular carcinoma, mortality, and the number of liver transplants (VELOSA et MACEDO, 2020). On another hand, it also contributes to decrease the number of liver-related morbidity, hospital admissions and the number of deaths caused by HCV, which culminate in a decrease of the economic burden to manage this chronic condition. Yet, despite the efficiency of a cure, the rate of people that have received the cure is low (MOSKAL, 2022), and the WHO designed an ambitious worldwide strategy for viral hepatitis, aiming for 80% and 65% reductions in new infections and mortality by 2030, respectively. To do this, 90% of people infected with HCV must be diagnosed and treated. This translates a major challenge, as most nations failed to satisfy intermediate benchmarks by 2020 (MOSKAL, 2022).

This sustains as an argument in favor of a cure for chronic diseases and other complex medical conditions, including T1D, meaning the development of direct-acting antiviral drugs transformed hepatitis C treatment, and the path to a cure for T1D could benefit immensely from comparable strategies and proposals.

Firstly, the advantages of a successful business model, it is possible to design strategies that reach increasing rates of awareness among people with T1D of a cure, this way mobilizing public support, increasing research funding, and fostering a sense of urgency in finding a cure. Secondly, innovation also plays a significant role in the development of research and development initiatives, combined with strategic partnerships between academic institutions, biotech startups, and pharmaceutical corporations can work together to create a dynamic ecosystem that speeds the translation of scientific discoveries into a cure. Thirdly, a projection of revenues and associated

costs not only provide a structured future financial framework for shareholders and stakeholders, including investors and philanthropists, and the necessary activities and resources to elevate a business or to raise funds, but also promote transparency among stakeholders and compliance with regulations.

### 3. Type 1 Diabetes

Type 1 Diabetes (T1D), commonly known as “insulin-dependent diabetes”, is a chronic autoimmune disorder that affects the body’s ability to produce insulin, therefore, to regulate the blood sugar levels and resultant hyperglycemia (DIMEGLIO et al., 2018) - insulin deficiency caused by the autoimmune destruction of beta cells ( $\beta$ -cells) of the endocrine pancreas. In other words, T1D occurs when the pancreas stops producing insulin (NASH, 2013).

It is estimated that T1D represents 10% of the total number of diabetes cases (PASCHOU et al., 2018, and OBSERVATÓRIO NACIONAL DA DIABETES, 2023) and, although the symptomatology is complex, the process of autoimmune destruction occurs in genetically susceptible individuals by the effect of one or more causes, over a period of months to years. The main causes of autoimmunity or acceleration of the destruction of  $\beta$ -cells are environmental risk factors, increase in height and weight, increased maternal age at birth and eating habits, as well as exposure to certain viral infections (OBSERVATÓRIO NACIONAL DA DIABETES, 2023). Regarding its treatment, T1D is treated by administering insulin, produced in laboratories, unlike Type 2 Diabetes (T2D) that is treated by diet, oral medication, or smaller quantities of insulin.

In 2016, the World Health Organization (WHO) stated that “*people with diabetes can live long and healthy lives if their diabetes is detected and well-managed*” (GLOBAL REPORT ON DIABETES, 2016). Good diabetes detection involves early diagnosis, well-managed diabetes services, monitoring, education, and counseling. Periodic reviews of metabolic control and complications are crucial for preventing complications like amputation, cardiovascular disease, end-stage renal disease, or diabetic nephropathy. Primary care provides most treatment and tests, but specialist care is necessary for eye examinations, kidney function tests, heart and artery tests, acute cardiovascular disease, diabetic coma, kidney failure, and foot ulcers (GLOBAL REPORT ON DIABETES, 2016).

The symptomology of T1D is composed of increased frequency of urination, increased thirst related to dehydration, weight loss, increased hunger and muscle fatigue or weakness (OBSERVATÓRIO NACIONAL DA DIABETES, 2023). The confirmation of T1D carries challenges for the individual and the household, such as insulin injections, glucose monitoring, (CARVALHO et al., 2022) and personalized healthcare plans (MOGHADAM et al., 2022), which involves additional costs.

A person with T1D must cope with the diagnosis, which is often compared to a grieving process, depression and low mood, guilt or shame or self-blame, fear and anxiety, the use of food as a coping mechanism for emotions, communication with healthcare providers, family relationships, and sexual difficulties. This suggests that psychology may be helpful in teaching individuals with T1D coping mechanisms and methods, such as goal setting, a rewards system, acceptance and mindfulness, and the development of a solution-focused mentality, which can help them deal with future setbacks (NASH, 2013). Additional barriers and challenges such as stress, burnout, time pressure, planning, social support, parental autonomy support, and stigma, contribute to the complexity of managing the condition (MULVANEY et al., 2011). Existing factors influencing treatment and adherence are different from the mentioned barriers, which are: age, gender, family, friends and peers, technologies, the duration of diabetes, the diabetes-specific conflict, affective disorders and eating disorders (BORUS et al., 2010).

In Portugal, the economic landscape of healthcare presents its own complex challenge. In 2015, around 11% of Portuguese families spent more than 40% of its income to primary health care (OCDE, 2023). Moreover, according to the Economic Survey of Portugal (OECD, 2023), the Portuguese population is aging rapidly, and life expectancy is one of the highest in the OECD. Meanwhile, there are other structural challenges such as staff shortages – mainly due to long labor hours and low wages -, weak investment and high out-of-pocket payments, followed by a fragmented organization of primary care (OECD, 2023). In other words, Portugal faces the prevalence of chronic diseases, and the increasing costs of advanced medical treatments and technologies. In the long-term, the national budget is put under a great deal of stress because of this growing trend in healthcare spending, which also raises concerns about its sustainability.

In addition, in 2010, the cost of diabetes in Portugal represented 7% of total healthcare expenditure, an estimated value of half million euros (MENDES, 2010). In 2018, the total amount corresponded

to 740 million euros (OECD, 2020), while in 2021, the total amount increased to 1.200 million euros.

### 3.1. Public information about Diabetes in Portugal

Considering the need to understand the current Portuguese paradigm regarding diabetes, public data about diabetes was analyzed, and as a criterion of the understanding step in designing a business model.

Firstly, in Portugal, the National Healthcare Service – Serviço Nacional de Saúde – has a significant role in providing public healthcare and managing expenses, alongside associations, such as the Portuguese Diabetes Association – Associação Protectora dos Diabéticos de Portugal (APDP).

Although the government may invest in diabetes prevention and management strategies to reduce the economic burden of diabetes, the incidence and prevalence of diabetes in Portugal is rising every year.

Factors influencing the total public expenditure include the prevalence and incidence of diabetes, healthcare system policies – including hospitalization expenses, health education and prevention programs, investment in research and development, infrastructure and resources, health insurance and reimbursement policies, co-morbidities, and complications – cardiovascular diseases, kidney diseases and foot complications – and economic considerations (CHEN et al., 2020). While factors influencing the household expenditure are, for example, medication and supplies – dosage requirements and frequency of supply -, healthcare services – diagnostic tests, consultations and laboratory expenses -, medical devices and equipment, as respective maintenance, dietary needs and lifestyle factors – specialized diabetic foods and gym membership or exercise classes -, insurance coverage, education and support and co-existing conditions – if individuals with T1D have other conditions or complications, the expenses related to managing those conditions will affect the overall expenditure.

#### a. Diabetes Prevalence Rate

Prevalence refers to the total number of individuals in a population who have a disease or health condition at a specific period, usually expressed as a percentage of the population (PREVALENCE AND INCIDENCE DEFINED, 2012). In 2008, the prevalence of diabetes in the Portuguese population aged 20 to 79 corresponded to 11,7%, a total of about 905 thousand

individuals (FACTOS E NÚMEROS, 2009). In comparison, in 2021, it was 14,1%, meaning, about 1.1 million individuals in this age group have diabetes, in Portugal, that results in a difference of 2,4% or more 195 thousand individuals with diabetes (FACTOS E NÚMEROS, 2023).

Additionally, of the total 11,7% cases in 2008, around 5,1% of cases were non-diagnosed and the remaining 6,6% were diagnosed individuals, a difference of 1,5 percentage points (FACTOS E NÚMEROS, 2009). When compared to the 14,5% in 2021, around 6,1% are non-diagnosed and 7,9% are diagnosed, a difference of 1,8 percentage points (FACTOS E NÚMEROS, 2023).

	2009	2014	2019	2020	2021
Diagnosed	6,6%	7,3%	7,7%	7,8%	7,9%
Non-diagnosed	5,1%	5,7%	6,0%	6,0%	6,1%
Total	11,7%	13%	13,7%	13,8%	14,5%

Table 1: Prevalence rate of Type 1 diabetes in Portugal. Source: Factos e Números

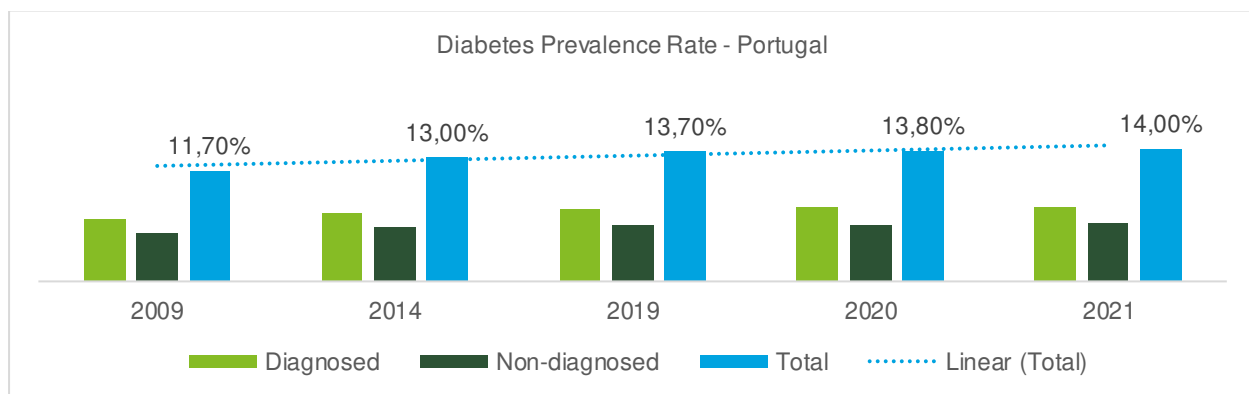


Figure 1: Linear evolution of prevalence rate of Type 1 diabetes in Portugal. Source: Factos e Números

### b. Diabetes Incidence Rate

Incidence refers to the number of individuals who develop a specific disease or experience a specific health-related event during a particular time frame (PREVALENCE AND INCIDENCE DEFINED, 2012). In 2008, per 100.000 Portuguese citizens, there were between 571 new cases of individuals with diabetes (FACTOS E NÚMEROS, 2009), as compared to estimated 680 new cases of diabetes, in 2021 (FACTOS E NÚMEROS, 2023). In 2018, it is estimated that there were between 605 and 618 new cases of diabetes per 100,000 individuals (FACTOS E NÚMEROS, 2019).

	2000	2009	2017	2018	2021
Number of New Cases per 100.000 individuals	377,4	571,1	556,4	605,2	N.A
Estimated Total number of New Cases	38.988	60.385	57.261	62.197	N.A

Table 2: Incidence rate of Type 1 diabetes in Portugal. Source: Factos e Números

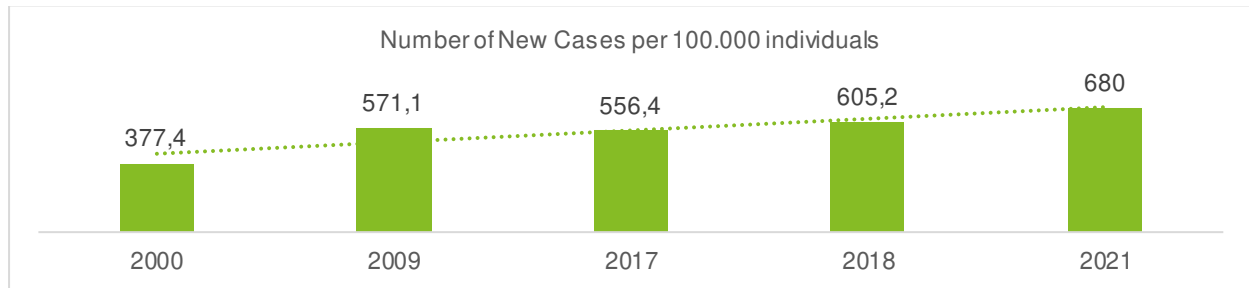


Figure 2: Linear evolution of incidence rate of Type 1 diabetes in Portugal. Source: Factos e Números

### c. Hospitalization

In this past decade, the number of patients leaving or internalized in SNS hospitals where diabetes is presumed to be the major diagnosis (excluding day cases) has decreased dramatically (-50,0% between 2009 and 2018). For its part, the number of outgoing internships with diabetes as an accompanying diagnosis has increased significantly, by 39.3% between 2009 and 2018 (as stated in FACTOS E NÚMEROS, 2009 and 2019).

However, the number of days of internment for complications or decompensations of diabetes is decreasing, 107.628 in 2009 and 63.661 in 2018 (as stated in FACTOS E NÚMEROS, 2009 and 2019).

### d. Diabetic retinopathy

Diabetic retinopathy is estimated to affect ¼ of the total number of people living with diabetes, in 2018 and 2019. Furthermore, this number is expected to grow in percentage (FACTOS E NÚMEROS, 2023), making it a significant problem and its treatment comprehends high healthcare expenses.

## 4. Methodology

This chapter provides clarification on the strategy used to accomplish the study's goals by explaining the methodology used to answer the research questions presented in Chapter 1. It also outlines the data collection methodologies, offering insights into the various channels that are used to obtain relevant data.

### 4.1. Interviews

To understand about conducting individual interviews, academic literature was studied. Individual interviews can be structured, semi-structured and unstructured (WILLIAMSON et al., 2018). Structured interviews are questionnaires administered by interviewers, asking the same questions in a fixed order. They help researchers compare answers and capture participants' perspectives. Semi-structured interviews are flexible and focus on relevant issues, allowing researchers to follow up on leads. Unstructured interviews provide the same opportunity but without a scheduled list of questions, aiming to deepen knowledge and prepare for future structured or semi-structured interviews.

As stated by CHARMAZ (2003), the viewer creates the data and ensuing analysis through interaction with the viewed thus, to collect different opinions and interpret them in order to build our final proposal for the business model. In other words, interviewers will almost certainly receive multiple and often contradictory views from interviewees, as is consistent with the key precepts of the interpretivist approach (WILLIAMSON et al., 2018).

### 4.2. Business model prototype proposal

To understand about designing business model prototypes, there was analyzed relevant academic literature.

Business models are unique to fit the company's challenges, context, and objectives, however, there is a generic business model design process (OSTERWALDER et PIGNEUR, 2010). Despite possible customization, this process must acknowledge the stage in which the business is: a new business model to create a market or to satisfy, improve or bring to market, or an established company with one or multiple business models looking for an adaptive, expansive, explorative or recreative response to market (OSTERWALDER et PIGNEUR, 2010).

Furthermore, it is a time-consuming process that requires a design attitude to find one solution (OSTERWALDER et PIGNEUR, 2010). In other words, it is not a linear process, but a two-stage exercise: an initial period of uncertainty involving research and understanding of design business model prototypes, that transitions to a period of clarity defined by implementation (OSTERWALDER et PIGNEUR, 2010).

There are 5 steps in the generic process, respectively:

- Mobilize: sketching preliminary ideas to prepare for design.
- Understand: researching and analyzing the essential elements collected. Includes brainstorming sessions, interviews with experts, study of potential customers and failed case studies, as well as pattern analysis.
- Design: generating and testing viable options, and choose the best model, in order to transform ideas into prototypes.
- Implement: implementing business model prototypes, an execution after selecting the best option. At this stage, there must be rapid ability and willingness to adapt the business model to internal and external organizational factors.
- Manage: adapting and modifying in response to market changes and needs – “business model governance” -, while scanning the industry environment.

Additionally, there are smaller steps that need to be taken into consideration (OSTERWALDER et PIGNEUR, 2010), such as the description of the value proposition, the evidence of customer need and a go-to-market strategy. Later, describe key resources and activities, with the complement of financial statements that indicate the associated costs, revenues, and cash flow projections.

Finally, study the external environment, including key trends and market, macroeconomic, and industry forces, and a risk analysis of obstacles and key success factors using a SWOT analysis.

#### 4.3. Data collection

A variety of public information was also analyzed, including public data available about the current situation of diabetes in Portugal, from 2008 to 2021, present in the annual report of the National Diabetes Observatory – *Factos e Números* -, of the Portuguese Society of Diabetology.

Alongside, a series of 5 interviews were conducted to understand the current paradigm in Portugal and build a business cases studies about different profiles of people with T1D and their expenses (TABLE 4). With this group, interviews were unstructured to better understand the topic of diabetes, its public expenses and impacts on citizens' quality of life, given the diversity in the profiles of people with T1D. The three case scenarios are based on existence of complication or other pathologies, medication, and therapy. Furthermore, an analysis of the public costs with medication, supplies and medical appointments, including treatment was conducted and later filled in for each case scenario. This information is available publicly on online services of INFARMED - Autoridade Nacional do Medicamento e Produtos de Saúde, IP, and on the website of Administração Central do Sistema de Saúde, IP (ACSS). Finally, the legislation regarding state co-payment for medications was analyzed (Portaria n.º 15/2018, 11 de janeiro).

Secondly, another series of 10 interviews were held to present the first prototype of the business model canvas and gather information to build the final proposal, with experts from different areas, including executive directors of companies with expertise in marketing and sales, academics and scholars in the healthcare area, and medical doctors with a focus on diabetes. With this group, interviews were semi-structured, following relevant questions (LESTAND, 2018) from a questionnaire (TABLE 3), however, considering the flexibility of every interviewee point of view about this topic. Moreover, the questionnaire included the most relevant questions to ask about business models and based on current trends.

None of the interviews were recorded and had a duration of 1 hour to 1,5 hours, in person or via an online platform, such as Microsoft Teams or Zoom.

Building Block	Question
Key Partners	<ul style="list-style-type: none"> <li>• What do we bring them?</li> <li>• What are the most important partners?</li> </ul>
Key Activities	<ul style="list-style-type: none"> <li>• How do we produce our offering?</li> <li>• What competencies and activities do we need?</li> </ul>
Key Resources	<ul style="list-style-type: none"> <li>• What are the most relevant key resources in your opinion?</li> </ul>
Value Proposition	<ul style="list-style-type: none"> <li>• What customer problems do we need to solve and what need do we meet?</li> <li>• What benefits do we create for people with diabetes?</li> <li>• What products and services do we need to accomplish this?</li> </ul>
Customer Relationships	<ul style="list-style-type: none"> <li>• What kind of relationships do our customers expect and how to maintain them?</li> <li>• Who influences our customers?</li> <li>• What type of relationships creates the most value for our customers?</li> </ul>
Customer Segments	<ul style="list-style-type: none"> <li>• What customer segments do we mainly serve?</li> <li>• Who are our most important customers?</li> <li>• Will the same people be here for the next 10 years?</li> </ul>
Channels	<ul style="list-style-type: none"> <li>• How can we raise awareness?</li> <li>• How to deliver our value proposition?</li> <li>• How do we allow patients to have access to the cure? What criteria should be adopted?</li> </ul>
Revenue Stream and Cost Structure	<ul style="list-style-type: none"> <li>• What generates costs?</li> <li>• Are patients willing to pay for it?</li> <li>• Having designed this business model, what revenue streams should be created to face the cost structure?</li> </ul>

Table 3: List of questions for semi-structured interviews.

## 5. Results

After an extensive review of the existing literature on business models and their application in healthcare contexts, interviews with experts in diabetes management were conducted.

These interviews were fundamental in bridging theoretical insights with real-world perspectives, providing an opportunity to present and discuss prototype business models, as well as the development of the case scenarios. Experts offered valuable feedback, insights, and critiques, which enriched the understanding of the complex dynamics involved in implementing innovative business models in diabetes management.

### 5.1. Case scenarios

The three following case scenarios were developed to reflect variations in disease duration, treatment regimens, and the presence of complications commonly associated with diabetes, with the associated public and household expenses. Thus, these case scenarios aim to elucidate the economic burden imposed by diabetes complications on healthcare systems and government budgets.

Moreover, these case studies also aim to raise attention to the diversity found in the diabetic population. By presenting individuals at different stages of disease progression, including those already experiencing complications such as neuropathy, retinopathy, or nephropathy, we aimed to emphasize the multifaceted nature of diabetes management and the associated healthcare costs.

Through comprehensive consultations and iterative revisions, each case scenario was refined to ensure authenticity and clinical accuracy (TABLE 4).

The analysis underscores a clear correlation between the progression of diabetes and the escalating financial burden borne by both governmental bodies and individuals. As the disease advances, necessitating more intensive management and treatment, the associated costs inevitably surge. This trend is especially pronounced in the case of severe complications such as retinopathy, where the deployment of advanced medical technology becomes indispensable for effective intervention, such as laser treatments.

#	Case Scenario	Monthly Treatment Details	Public Expense <sup>4</sup>	Household Expense <sup>5</sup>		
1	<b>Person with Type 1 Diabetes</b> Appointments: 3 endocrinology per year, HbA1c every 4 months, annual evaluation of general analyses (Complete Blood Count, Urea, Creatinine, Electrolytes, AST, ALT, GGT, Urine Analysis, albuminuria/creatinuria ratio, TSH, total cholesterol, HDL cholesterol, Triglycerides).	- Degludec or Glargine insulin <sup>1</sup> – 28 units/day <sup>2</sup> - 3 insulin pens of 300 units each per month	5 units/box - € 50,51	5 units/box - € 0,00		
		- Lispro insulin – 28 units/day - 3 insulin pens of 300 units each per month	5 units/box - € 41,25	5 units/box - € 0,00		
		- Continuous Glucose Monitoring (CGM) sensor – 2 a month	1 unit – € 65,90 (€ 131,80)	1 unit - € 7,99 (€ 15,98)		
		- Blood glucosetest strips – 30 per container – 5 containers per month	1 unit ~ € 18,29	1 unit - € 2,74 (€ 27,40)		
		- Ketonemia determination strips – 10 per container – 1 strip per month	1 unit ~ € 15,00	1 strip - € 1,50		
		- Injection for the treatment of severe hypoglycemia <sup>3</sup> – Glucagen - 1 pen every 6-9 months	1 unit - € 19,66	1 unit - € 12,39 (every 6-9 months)		
<b>TOTAL</b>			<b>€ 276,51</b>	<b>€ 57,27</b>		
2	<b>Person with type 1 diabetes and other pathologies derived from diabetes</b> - with proliferative diabetic retinopathy – with stage 3 chronic kidney disease Appointments: 4 endocrinology appointments per year, HbA1c every 3 months, semi-annual evaluation of general analyses (Complete Blood Count, Urea, Creatinine, Electrolytes, AST, ALT, GGT, Urine Analysis, albuminuria/creatinuria ratio, TSH, total cholesterol, HDL cholesterol, Triglycerides, PTH, Phosphorus, calcium), 2 to 4 ophthalmology appointments per year.	- Degludec or Glargine insulin – 28 units/day - 3 insulin pens of 300 units each per month	5 units/box - € 50,51	5 units/box - € 0,00		
		- Lispro insulin – 28 units/day - 3 insulin pens of 300 units each per month	5 units/box - € 41,25	5 units/box - € 0,00		
		- Continuous Glucose Monitoring (CGM) sensor – 2 a month	1 unit – € 65,90 (€ 131,80)	1 unit - € 7,99 (€ 15,98)		
		- Blood glucosetest strips – 30 per container – 5 containers per month	1 unit ~ € 18,29	1 unit - € 2,74 (€ 27,40)		
		- Ketonemia determination strips – 10 per container – 1 strip per month	1 unit ~ € 15,00	1 strip - € 1,50		
		- Injection for the treatment of severe hypoglycemia – Glucagen - 1 pen every 6-9 months	1 unit - € 19,66	1 unit - € 12,39 (every 6-9 months)		
		Specific treatment for proliferative diabetic retinopathy:				
		- Enalapril 20 mg (Hydrochlorothiazide 12.5 mg - 30 tablets)	10 tablets - € 3,61 (€ 10,83)	10 tablets - € 0,18 (€ 0,54)		
		- Amlodipine 5 mg - 30 tablets	60 tablets - € 3,49 (€ 1,75)	60 tablets - € 0,00		
		- Spironolactone 25 mg - 30 tablets	20 tablets - € 2,85 (€ 4,28)	20 tablets - € 0,00		
		- Rosuvastatin 10 mg - 30 tablets	60 tablets - € 8,40 (€ 4,20)	60 tablets - € 0,00		
- Ophthalmology consultation – up to 4 per year	≈ 35,00	€ 7,75 (€31)				
- Endocrinology consultation – up to 4 a year	≈ 35,00	€ 7,75 (€31)				
- Laser treatment	≈ 40,00	€ 0,00				
<b>TOTAL</b>			<b>€ 407,57</b>	<b>€ 73,31</b>		
3	<b>Person with type 1 diabetes and other pathologies not derived from diabetes</b> - Arterial hypertension, Mixed dyslipidemia. Appointments: 3 endocrinology appointments per year, HbA1c every 4 months, annual evaluation of general analyses (Complete Blood Count, Urea, Creatinine, Electrolytes, AST, ALT, GGT, Urine Analysis, albuminuria/creatinuria ratio, TSH, total cholesterol, HDL cholesterol, Triglycerides).	- Degludec or Glargine insulin – 28 units/day - 3 insulin pens of 300 units each per month	5 units/box - € 50,51	5 units/box - € 0,00		
		- Lispro insulin – 28 units/day - 3 insulin pens of 300 units each per month	5 units/box - € 41,25	5 units/box - € 0,00		
		- Continuous Glucose Monitoring (CGM) sensor – 2 a month	1 unit – € 65,90 (€ 131,80)	1 unit - € 7,99 (€ 15,98)		
		- Blood glucosetest strips – 30 per container – 5 containers per month	1 unit ~ € 18,29	1 unit - € 2,74 (€ 27,40)		
		- Ketonemia determination strips – 10 per container – 1 strip per month	1 unit ~ € 15,00	1 strip - € 1,50		
		- Injection for the treatment of severe hypoglycemia – Glucagen - 1 pen every 6-9 months	1 unit - € 19,66	1 unit - € 12,39 (every 6-9 months)		
		Specific treatment for arterial hypertension:				
		- Enalapril 20 mg (Hydrochlorothiazide 12.5 mg - 30 tablets)	10 tablets - € 3,61 (€ 10,83)	10 tablets - € 0,18 (€ 0,54)		
- Rosuvastatin 10 mg - 30 tablets	56 tablets - € 7,44 (€ 4,46)	56 tablets - € 0,00				
- Fenofibrate 267 mg	30 tablets - € 6,13	€ 0,37				
<b>TOTAL</b>			<b>€ 297,93</b>	<b>€ 58,18</b>		

Table 4: Case scenarios based on medical profiles and expenses

<sup>1</sup> Currently the most commonly used in clinical practice for people with diabetes.

<sup>2</sup> A standard weight of 70 kg was used to calculate the daily insulin dose.

<sup>3</sup> This condition is typically defined by a blood glucose level below 54 mg/dL (3.0 mmol/L) and is often accompanied by symptoms such as confusion, disorientation, loss of consciousness, seizures, or the inability to treat the low blood sugar without assistance.

<sup>4</sup> Values are based on Portaria n.º 15/2018, de 11 de janeiro.

<sup>5</sup> With a medical prescription.

The total government expenditure on diabetes treatment in Portugal is approximately 1,200 million euros (FACTOS E NÚMEROS, 2023), considering only individuals diagnosed within the country. With T1D accounting for around 5 to 10% of the total expenditure (APPENDIX 6), the Portuguese government's estimated expense for type 1 diabetes ranges from 60 to 120 million euros.

Based on the total expenditure, for each of the 38,515 persons with T1D, the government would allocate approximately 3,115.42 euros annually. However, it's crucial to acknowledge that actual resource allocation may vary significantly due to the diverse complications and treatment options associated with diabetes. Given the complexity of T1D and the necessity for individualized care, public expenditure on diabetes is determined through *a per capita* estimation.

Over the course of an individual's lifetime, considering an average life expectancy of 78 years, the government's expenditure per person with T1D amounts to approximately 245,930.74 euros. These calculations highlight the financial commitment of the Portuguese government in managing T1D and underscore the importance of tailored healthcare provisions for individuals affected by this condition.

## 5.2. Business model prototype

The first prototype of the business model (TABLE 5) was created mostly based on the knowledge gained from the literature review and complemented by industry trends, market dynamics, and emerging best practices.

Based on the feedback provided during the two unstructured interviews with a director from a multinational company and the director of a diabetes association, the first critical aspect to be considered was communication, thus the correct terminology would not be “diabetic”, but “person with diabetes”. While the second was to consider a patent to protect the scientific formula of the

cure, and, in the case of a vaccine, a regimen of two doses, administered at specific intervals to ensure optimal efficacy and more profitability.

<b>Key Partners</b> The Government Associations that work with diabetics Pharma companies interested in developing a cure. Research centers and universities.	<b>Key Activities</b> Research and Development Medical writing and administrative functions Clinical Trials Quality Control Marketing	<b>Value Proposition</b> To provide a better life to diabetic patients, and their families Use science to deliver better patient outcomes	<b>Customer Relationships</b> Personal engagement Brand Awareness	<b>Customer Segments</b> Diabetics and their families Healthcare institutions
	<b>Key Resources</b> Intellectual property Qualified team of researchers Facilities Science-based innovation in growing areas of diabetes management		<b>Channels</b> Communication through medical institutions – pharmaceuticals, medical professionals. Via Website – free access to the information.	
<b>Cost Structures</b> Research and Development, Technology Administrative expenses, and employee’s compensation Commercial and publicity. Raw material and distribution Licences and taxes		<b>Revenue Streams</b> Administration of the cure – price per administration of cure Licencing		

Table 5: First proposal of the business model prototype

The initial prototype and the questionnaire served as the foundation for conducting the semi-structured interviews. The feedback that resulted from these interviews included:

- Partner with the European Medicine Agency (EMA) and insurance companies.
- Position ourselves as the first provider of a cure for T1D in the value proposition.
- Define personal engagement with continuous support and patient education.
- Include feedback mechanisms as part of the customer relationships.
- Distribute through licensing agreements with pharmaceutical companies.
- Target people with diabetes as the main customer segment but include healthcare institutions.
- Include value-based pricing models and outcome-based reimbursement strategies.

The final prototype is the culmination of integrating feedback obtained from the remaining semi-structured interviews (TABLE 6), designed to meet the specific needs of the different participants in the diabetes ecosystem.

<b>Key Partners</b> The Government Associations that work with people with diabetes Pharma companies interested in developing a cure. Research centers and universities. European Medicines Agency (EMA) Insurance companies	<b>Key Activities</b> Research and Development Medical writing and administrative functions Clinical Trials Quality Control Marketing	<b>Value Proposition</b> The 1 <sup>st</sup> provider of a cure for Diabetes Type 1 To provide a better life to diabetic patients, and their families Use science to deliver better patient outcomes	<b>Customer Relationships</b> Personal engagement through continuous support and patient education Feedback mechanisms Brand Awareness	<b>Customer Segments</b> People with diabetes Healthcare institutions
	<b>Key Resources</b> Intellectual property Qualified team of researchers Facilities Science-based innovation in growing areas of diabetes management		<b>Channels</b> Communication through medical institutions – pharmaceuticals, medical professionals. Via Website – free access to the information. Distribution via licencing to pharma companies	
<b>Cost Structures</b> Research and Development, Technology Administrative expenses, and employee’s compensation Commercial and publicity. Raw material and distribution Licences and taxes		<b>Revenue Streams</b> Administration of the cure – price per unit/multiple. Royalties on intellectual property. Licencing		

Table 6: Final proposal of the business model prototype

## 6. Discussion

### 6.1 How the business modeling method could be used to sustain the transition of T1D treatment-oriented approach to a curative approach?

Business modeling offers a structured framework for conceptualizing, designing, and implementing innovative solutions to complex problems. Transitioning from a treatment-oriented approach to a curative approach for Type 1 Diabetes (T1D) requires strategic initiatives facilitated by business modeling.

The identification of key stakeholders facilitates their collaboration, then aligning efforts towards developing curative therapies. The success of the presented business model would depend on strategic partnerships between government agencies, patient advocacy groups, pharmaceutical companies, research centers, and regulatory authorities. These collaborations are essential for facing the regulatory environment, obtaining access to resources for research and development, and gaining market access – ultimately, market entry -, in addition to obtaining funds and experience.

The momentum would leverage strategic partnerships between academia, industry, and government to accelerate the discovery, development, and commercialization of curative therapies for T1D, thus later optimizing healthcare resources by shifting focus from long-term disease management to short-term intensive interventions aimed at achieving remission or reversal of T1D.

The creation of business models with this scope would then incentivize investment in research and development for curative treatments, such as outcome-based reimbursement structures. Research and development activities are important to demonstrate the safety, efficacy, and quality of the cure. This includes preclinical studies, clinical trials, and quality control measures to meet regulatory standards and obtain approval for commercialization. For example, in 2023, Novo Nordisk allocated around 4,16 billion euros to research and development, accounting for approximately 14 percent of the company's total sales. Since 2020, Novo Nordisk's R&D expenditures have more than doubled (NOVO NORDISK ANNUAL REPORT, 2023).

The value proposition reflects the shift in paradigm, thus indicating the company is the first provider of a cure by leveraging scientific advancements for enhanced patient outcomes. Additionally, effective marketing strategies are essential to raise awareness, build trust, and drive adoption of the cure among healthcare professionals and patients. And patient engagement

initiatives and healthcare professional education are essential components of these strategies, ensuring that the benefits of the cure are clearly communicated and understood by all stakeholders.

Regarding revenue streams, the sources of income are essential for maintaining current efforts in manufacturing, distribution, and research as well as for fostering further growth and innovation. Considering only net profits, Novo Nordisk generated around 10.79 billion euros in 2023 (NOVO NORDISK ANNUAL REPORT, 2023). The Danish company Novo Nordisk serves an example considering its leading market position, but there are other example of pharma companies focusing on diabetes management and treatment.

Moreover, this methodology can ensure the sustainability of this transition by designing scalable strategies that can adapt to evolving scientific advancements, changing market dynamics, and shifting healthcare priorities. This adaptability allows organizations to optimize resource utilization by reallocating resources based on areas of high impact and need (OSTWALDER et PIGNEUER, 2010). By continuously refining strategies in response to changing circumstances, healthcare organizations can deliver care more effectively and with fewer resources, thus maximizing operational efficiency. Secondly, by ensuring cost-effectiveness of curative therapies through value-based pricing, cost-sharing arrangements, and efficient resource allocation (CHRISTENSEN et al., 2009). Through implementing value-based pricing strategies, organizations can align the cost of therapies with their demonstrated clinical benefits, ensuring that resources are allocated efficiently to treatments that provide the greatest value to patients. Finally, the long-term viability of curative treatments is assessed by reflecting characteristics such as treatment effect durability and illness recurrence risk. Healthcare organizations can make informed choices concerning the adoption and execution of curative medicines by considering aspects such as treatment efficacy and illness recurrence risk.

However, transitioning from a treatment-oriented approach to a curative one requires careful consideration of the broader socio-economic implications.

## 6.2. Is the business modeling innovation an effective approach to positively impact healthcare and management of T1D?

The pharmaceutical industry has faced numerous challenges over the years (BATES, 2022), including slow adoption of emerging technologies like gene therapy and gene-editing, reluctance

to embrace patient-centric approaches in marketing and treatment development, and struggles to navigate complex regulatory environments and shifting market demands.

These challenges are essentially four: failure to keep up with technological change, failure to understand and meet customer expectations, failure to adapt to market changes and slow to embrace new technologies (BATES, 2022).

The healthcare and pharmaceutical industry, including T1D management, must adapt to rapid technological advancements to remain relevant and effective, thus innovative business models can facilitate the integration of new technologies into healthcare practices, improving diagnosis, treatment, and patient outcomes related to T1D. Additionally, patient needs and preferences play a crucial role in healthcare delivery, and business models innovation could define steps to prioritize patient-centric approaches while enhancing patient satisfaction, engagement, and adherence to treatment regimens, ultimately improving T1D management outcomes.

Moreover, it operates within a dynamic market environment characterized by regulatory requirements, public opinion, and competitive pressures, and adaptable business models can help pharmaceutical companies navigate these challenges more effectively. Finally, there has been slow adoption of new technologies such as gene therapy and gene-editing, which have significant potential for advancing T1D treatment, meaning innovative business models can facilitate the integration of these technologies into pharmaceutical R&D processes, accelerating the development of novel therapies for T1D and improving patient outcomes.

Thus, leveraging business modeling innovation offers a promising avenue to positively impact healthcare and T1D management.

### 6.3. If so, would it be viable to apply this method for a shift in treatment-oriented approach to a curative-approach?

Conducting a cost-benefit analysis is crucial to comprehending the feasibility of this approach. This methodical process involves evaluating the possible advantages against the related expenses, facilitating the identification of the optimal course of action, and offering priceless insights into the financial sustainability and possible returns on investment.

The shift in treatment to a curative-approach holds significant social impact. When compared to Hepatitis C, which success rate is of 97%, the expectations are that a cure would decrease the prevalence rate of people with T1D, as long as they were correctly diagnosed. If the cure for T1D had the same success rate and remains constant over time, it would effectively reduce both diagnosed and non-diagnosed cases proportionally, thus representing 13,4% in 2025 and 13,1% in 2026. Moreover, it would decrease the number of deaths in which diabetes is the leading cause, as well as the amount of prevalence of complications related to a poor management of the disease, while increasing the quality of life of individuals and their families, thus explaining its social significance.

The shift also has an economic impact. Considering the projected public expenditures (TABLE 4), such development could cease to impose long-term financial strain on affected individuals. The United States of America (USA), for example, have estimated a total cost of diagnosed diabetes of \$412.9 billion in 2022, including \$306.6 billion in direct medical costs and \$106.3 billion in indirect costs attributable to diabetes (PARKER et al., 2024). Moreover, individuals with diabetes typically spend \$19,736 on medical expenses per year, of which \$12,022 is directly related to the disease (PARKER et al., 2024). In other words, the average person with diabetes spends 2.6 times as much on medical expenses as someone without the disease (PARKER et al., 2024). If considered the average life expectancy of 72 years for a person with T1D, and based on the values stated above, it corresponds to a medical lifetime expenditure of approximately \$1,556,846.40.

In addition, it is imperative that the financial analysis evaluate the potential returns on investment subsequent to the remedy being administered to the entire population. It is crucial to realize that the investment's initial needs should be in line with those of the local populace. The company might then think about growing internationally in order to reach more diabetics and possibly increase income.

Compared to the medical lifetime cost of around \$1,556,846.40 (or approximately 1,370,270.75 EUR based on the 0.88 EUR/USD exchange rate), it is clear that a business model's value proposition needs to go beyond simple financial investments. Considering the large amounts of money associated with healthcare costs, particularly when it comes to long-term illnesses like diabetes, the effectiveness and influence of any suggested business plan ought to significantly outweigh existing prices.

In conclusion, the data provided suggests that a successful cure for T1D, with a success rate comparable to that of Hepatitis C treatments, could significantly decrease the prevalence rate of the disease over time. This reduction in prevalence would not only lead to improved health outcomes but also alleviate the long-term financial strain on affected individuals and healthcare systems. Thus, it would be viable to apply the business modeling innovation method for a shift from a treatment-oriented approach to a curative approach for T1D. Therefore, transitioning from treatment to a curative solution through innovative business modeling approaches holds promise for positively impacting the management and eventual eradication of T1D.

6.4. Even if it is determined that it is not the most viable option, may any of the recommendations be adapted to the current business model to make it more cure-friendly?

The business model's profitability decreases if it fails to promote the discovery of a cure or fails to bring in investors. Still, there is room for improvement to foster a culture that is more receptive to a curative-approach.

Feedback from our interviews suggests valuable insights that could be integrated, particularly regarding collaboration with insurance companies and individuals with diabetes. Establishing such collaborations would foster a feedback loop – or feedback mechanisms - between business development efforts and customers, enhancing the model's responsiveness to market needs.

Resource reallocation could facilitate the allocation of funds towards research and development aimed at improving treatments for complications of T1D, which significantly impact quality of life. For instance, funds could be directed towards finding a cure for diabetic retinopathy, or even increasing the quality of current treatments.

6.5. Limitation of business modeling in T1D

Despite the potential for groundbreaking advancements in diabetes treatment, several obstacles remain, including challenges related to regulatory approval, market penetration, cost-effectiveness, and scalability. These barriers emphasize the imperative for ongoing innovation and adaptation within the dynamic framework of refining the business model.

Furthermore, it's essential to recognize the limitations and negative impacts associated with the utilization of a business model canvas. While this framework offers valuable insights and structures

for the strategic planning process, its rigid format may constrain creativity and fail to account for nuanced complexities or emergent factors.

The development of a cure for diabetes, while transformative, may not directly mitigate the incidence rate of T1D. While it holds the potential to prevent complications and improve quality of life for affected individuals, sustained reductions in disease prevalence may be challenged by continued new case occurrences. This is because new cases may continue to arise annually. Therefore, a comprehensive approach that addresses both prevention and treatment strategies is necessary to effectively combat the complexities of diabetes and related chronic conditions, while working towards a cure.

Additionally, under the current business model, it's impractical to anticipate the investment value investors would be willing to commit. Consequently, estimating the number of individuals who would benefit from the cure, or whether this number justifies the investment, becomes unfeasible — potentially paving the way to extend the cure beyond geographical borders.

These insights underscore the multifaceted nature of addressing diabetes and underscore the need for comprehensive, adaptable strategies that integrate diverse perspectives and prioritize long-term sustainability in combating this pervasive health issue.

## 7. Conclusions

The concept of a business model is characterized by several interpretations and contextual nuances, and no single, widely recognized definition exists. Scholars support continual investigation and research to broaden this complex idea rather than aiming for a clear definition, which is encouraging and endorses the ongoing theorization.

In healthcare, business models aim to align organizational components and activities with the Triple Aim of enhancing care quality, improving population health, and reducing costs. However, the healthcare landscape presents unique challenges, including fragmented care, regulatory hurdles, and reimbursement complexities, necessitating innovative strategies to drive positive change. Particularly in the case of diabetes, the escalating prevalence and incidence rates, coupled with the management of associated complications, impose a significant economic burden on public services. And while the premise of a cure is still on hold, investigators and scientists have been working on “curative” or potentially curative solutions, such as immunotherapy, beta cell replacement and transplantation, and stem cell research, which would require a paradigm shift in the market. Accepting this change means questioning assumptions, looking into new directions, and promoting multidisciplinary cooperation. To maximize total well-being, a paradigm shift in healthcare necessitates a fundamental rethinking of systems to promote proactive, individualized, and preventive care.

Some examples of companies that managed to successfully promote this transition are the cases of Tesla, Netflix, Hepatitis C, thus drawing attention to the transformative impact of innovative business models and scientific advancements, including the development of the concept itself. Three factors these businesses have in common with T1D are innovation and redefinition, efficiency and efficacy, and a patient-centric approach. This also means that, by embracing change and investing in research and innovation, organizations and governments can address complex challenges and pave the way for a healthier and more sustainable future.

Regarding T1D, it presents a complex challenge for individuals, healthcare systems, and governments alike. With rising prevalence, incidence and mortality rates and substantial economic burdens, there is an urgent need to prioritize research and innovation towards finding a cure.

Furthermore, addressing the psychological and social aspects of managing the condition is essential in improving overall patient outcomes and quality of life. Which is why it is important to make cost-benefit analysis to assess the feasibility of transitioning to a curative approach for T1D. The data provided suggests that a successful cure for T1D, with a success rate comparable to that of Hepatitis C treatments, could significantly decrease the prevalence rate of the disease over time.

The escalating costs associated with diabetes underscore the importance of finding a cure to alleviate the financial burden on healthcare systems. With significant government expenditure allocated to diabetes treatment, there is a pressing need to redirect resources towards research and innovation. Through case scenarios, we have illustrated that individuals with advanced complications necessitate more intensive medical interventions and healthcare resources, resulting in heightened financial expenditures for both patients and providers. Addressing the underlying cause of diabetes with innovative treatments such as a potential cure holds the promise of not only relieving the personal suffering endured by patients but also alleviating the substantial economic strain imposed by the condition on healthcare systems and society.

. Individuals with diabetes faced considerable annual medical expenses, predominantly attributable to the disease itself, which accumulated over their lifetimes. Any proposed business model addressing this issue must demonstrate clear economic benefits surpassing existing costs, with a focus on local needs before expanding globally. While a cure for Type 1 diabetes may not solve all diabetes-related complications in patients that have them, it could impact on these in early diagnosed patients releasing resources from Type 1 management towards finding cures for other chronic diseases which in turn could lead to other health or efficiency gains.

Moreover, leveraging innovative business models can facilitate the development of cures for complications related to T1D, thus addressing a wider spectrum of healthcare needs. For instance, strategic partnerships between pharmaceutical companies and research institutions can focus on developing targeted therapies for diabetic retinopathy, neuropathy, or cardiovascular complications associated with T1D. Additionally, value-based pricing models and outcome-based reimbursement strategies can incentivize investments in research and development aimed at addressing specific complications of T1D, thereby fostering innovation, and advancing patient care. By integrating business models with healthcare initiatives, we can not only pursue cures for T1D but also mitigate

the burden of its associated complications, ultimately leading to comprehensive improvements in diabetes management and overall healthcare outcomes.

The business model's final prototype serves as an essential guide for starting the process of creating a treatment for T1D. Important insights could be obtained into the complex terrain involved in developing a treatment for T1D through rigorous business model analysis. However, it's essential to recognize that while the business model provides a structured framework and strategic direction, it does not directly lead to the discovery of a cure. Rather, it serves as a guiding tool, offering clarity and direction to stakeholders involved in the pursuit of finding a cure.

Adopting a business model that highlights innovation and collaboration is crucial for organizations seeking to pioneer breakthroughs and trials in the pursuit of a cure for diabetes. By leading research and development efforts to find a cure, such companies not only improve the quality of life for people living from the disease, but also guarantee long-term profitability. This method involves finding a careful balance between pursuing medical advancements and ensuring financial stability. Sustaining remaining research and development projects is critical for taking the solution to the next level, especially given the changing landscape of the healthcare business.

This analysis underscores the importance of collaboration, innovation, and a patient-centric approach in navigating the complexities of finding a solution for diabetes. By fostering partnerships, leveraging innovative technologies, and keeping the needs of patients at the forefront, companies can overcome challenges more effectively. Embracing a patient-centric mindset ensures that efforts remain focused on addressing the real-world needs of individuals living with diabetes, thereby driving meaningful progress in the quest for a cure.

## References

1. Amit, R., & Zott, C. (2001). Value creation in E-business. *Strategic Management Journal*, 614. DOI: <https://doi.org/10.1002/smj.187>
2. Aronson, J. K., Ferner, R. E., & Hughes, D. A. (2012). Defining rewardable innovation in drug therapy. *Nature Reviews Drug Discovery*, 11(4), 253-254. DOI: <https://doi.org/10.1038/nrd3715>
3. Bresson, D., & von Herrath, M. (2009). Immunotherapy for the prevention and treatment of type 1 diabetes: optimizing the path from bench to bedside. *Diabetes care*, 32(10), 1753–1768.
4. Brunner-La Rocca, H. P., Fleischhacker, L., Golubnitschaja, O., Heemskerk, F., Helms, T., Hoedemakers, T., Allianses, S. H., Jaarsma, T., Kinkorova, J., Ramaekers, J., Ruff, P., Schnur, I., Vanoli, E., Verdu, J., & Zippel-Schultz, B. (2016). Challenges in personalised management of chronic diseases-heart failure as prominent example to advance the care process. *The EPMA journal*, 7(1), 2. DOI: <https://doi.org/10.1186/s13167-016-0051-9>
5. Carvalho, A. P. V., Neiva, L. C., Souza, M. P. R. de, & Araújo, A. H. I. M. de. (2022). Desafios no enfrentamento da diabetes mellitus tipo 1 em crianças e adolescentes: revisão de literatura. *Revista JRG de Estudos Acadêmicos*, 5(11), 456-470. DOI: <https://doi.org/10.5281/zenodo.7382427>
6. Casadesus-Masanell, R., & Ricart, J. E. (2010). From strategy to business models and to tactics. *Long Range Planning*, 43, 195-215.
7. Casadesus-Masanell, R., & Ricart, J. E. (2011). How to design a winning business model. *Harvard Business Review*, 89(1/2), 101-107.
8. Charmaz, K. (2003). Grounded theory: Objectivist and constructivist methods. In N. K. Denzin & Y. S. Lincoln (Eds.), *Grounded theory: Objectivist and constructivist methods* (pp. 249-291).
9. Chen, C., Song, J., Xu, X., Zhou, L., Wang, Y., & Chen, H. (2020). Analysis of influencing factors of economic burden and medical service utilization of diabetic patients in China. *PloS one*, 15(10), e0239844.
10. Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*, 11(3), 529-555.

11. Christensen, C., Grossman, J., & Hwang, J. (2009). *The Innovator's Prescription: A Disruptive Solution for Health Care*. New York: McGraw-Hill.  
DOI: <https://doi.org/10.1371/journal.pone.0239844>
12. DiMeglio, L. A., Evans-Molina, C., & Oram, R. A. (2018). Type 1 diabetes. *Lancet*.
13. Durrani, A. (2024, February 2). Top Streaming Statistics In 2024. Forbes Home.  
<https://www.forbes.com/home-improvement/internet/streaming-stats/>
14. Foss, N., & Saebi, T. (2016). Fifteen Years of Research on Business Model Innovation: How Far Have We Come, and Where Should We Go?. *Journal of Management*, 43.  
DOI: <https://doi.org/10.1177/0149206316675927>
15. Fredriksson, J. J., Mazzocato, P., Muhammed, R., & Savage, C. (2017). Business model framework applications in health care: A systematic review. *Health Services Management Research*, 30(4), 219-226.  
DOI: <https://doi.org/10.1177/0951484817726918>
16. Hayes, A. (2022, December 2). What Is a Paradigm Shift? Definition, Example, and Meaning.
17. Hwang, J., & Christensen, C. M. (2008). Disruptive Innovation in Health Care Delivery: A Framework for Business-Model Innovation. *Health Affairs*, 27(5), 1329-1335.
18. IDF Diabetes Atlas 2021 | IDF Diabetes Atlas. (n.d.). Copyright © IDF Diabetes Atlas 2024. All Rights Reserved.
19. Johnson, M. W., Christensen, C. M., & Kagermann, H. (2008). Reinventing Your Business Model. *Harvard Business Review*, December 2008 issue.
20. Kavadias, S., Ladas, K., & Loch, C. (2016). The Transformative Business Model: How to Tell if You Have One. *Harvard Business Review*, October 2016 issue.
21. Keymeulen, B., De Groot, K., Jacobs-Tulleneers-Thevissen, D., Thompson, D. M., Bellin, M. D., Kroon, E. J., Daniels, M., Wang, R., Jaiman, M., Kieffer, T. J., Foyt, H. L., & Pipeleers, D. (2023). Encapsulated stem cell-derived  $\beta$  cells exert glucose control in patients with type 1 diabetes. *Nature biotechnology*, 10.1038/s41587-023-02055-5. Advance online publication.  
DOI: <https://doi.org/10.1038/s41587-023-02055-5>
22. Kotter, J. P. (1996). *Leading Change*. Boston: Harvard Business School Press.
23. Lestand, G. (2018, March 8). Key questions to be answered when you fill up a business model canvas.

24. Laugi H. (2020). Discovery of Hepatitis C Virus: 2020 Nobel Prize in Medicine. *Euroasian Journal of Hepato-Gastroenterology*, 10(2), 105–108.
25. Magretta, J. (2002). Why business model matter. *Harvard Business Review*, 80(5), 86-92.
26. Mendes, D. (2010, 13 de janeiro). Diabetes custa mil milhões/ano. *Diário de Notícias*.
27. Moghadam, Y. H., Zeinaly, Z., & Alhani, F. (2022). How mothers of a child with type 1 diabetes cope with the burden of care: A qualitative study. *BMC Endocrine Disorders*, 22, 129. DOI: <https://doi.org/10.1186/s12902-022-01045-z>
28. Morris, M., Schindehutte, M., & Allen, J. (2005). The entrepreneur's business model toward a unified perspective. *Journal of Business Research*, 58, 726-735.
29. Mitchell, C. (2022, April 30). New Paradigm: What it is, How it Works, Examples. Investopedia.
30. Mulvaney, S. A., Hood, K. K., Schlundt, D. G., et al. (2011). Development and initial validation of the barriers to diabetes adherence measure for adolescents. *Diabetes Research and Clinical Practice*, 94(1), 77-83.
31. Nash, J. (2013). *Diabetes and Wellbeing: Managing the Psychological and Emotional Challenges of Diabetes Types 1 and 2*.
32. Ndisang, J. F., Vannacci, A., & Rastogi, S. (2017). Insulin Resistance, Type 1 and Type 2 Diabetes, and Related Complications 2017. *Journal of diabetes research*, 2017, 1478294. DOI: <https://doi.org/10.1155/2017/1478294>
33. Observatório Nacional da Diabetes. (2009). *Diabetes: Factos e Números*
34. Observatório Nacional da Diabetes. (2018). *Diabetes: Factos e Números*
35. Observatório Nacional da Diabetes. (2023). *Diabetes: Factos e Números – O Ano de 2019, 2020 e 2021. Relatório Anual do Observatório Nacional da Diabetes*.
36. OECD. (2020). *Economic Survey of Portugal*
37. OECD. (2023, June 15). *Economic Survey of Portugal*
38. Osterwalder, A. & Pigneur, Y. (2010). *Business model generation*. New Jersey: John Wiley and Sons.
39. Osterwalder, A., Pigneur, Y., Smith, A., & Etienne, F. (2020). *The Inevitable Company*. John Wiley & Sons.

40. Parker, E. D., Lin, J., Mahoney, T., Ume, N., Yang, G., Gabbay, R. A., ElSayed, N. A., & Bannuru, R. R. (2024). Economic Costs of Diabetes in the U.S. in 2022. *Diabetes care*, 47(1), 26–43.  
DOI: <https://doi.org/10.2337/dci23-0085>
41. Pandey, S. (2023, April 27). Netflix's Market Share Decline Continues In 2023: Analysis Of Leading Streaming Platforms.
42. Paschou, S. A., et al. (2018). On type 1 diabetes mellitus pathogenesis. *Endocrine Connections*.
43. Prevalence and Incidence Defined. (2012, October 21). *Obesity Prevention Source*.  
<https://www.hsph.harvard.edu/obesity-prevention-source/prevalence-incidence/> Pedro, M. (2021). Hepatite C em Portugal: Estaremos a caminho da erradicação?
44. Richard I.G. Holt, J. Hans DeVries, Amy Hess-Fischl, Irl B. Hirsch, M. Sue Kirkman, Tomasz Klupa, Barbara Ludwig, Kirsten Nørgaard, Jeremy Pettus, Eric Renard, Jay S. Skyler, Frank J. Snoek, Ruth S. Weinstock, Anne L. Peters; The Management of Type 1 Diabetes in Adults. A Consensus Report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care* 1 November 2021; 44 (11): 2589–2625.
45. Sams-Dodd, F. (2013). *Drug Discovery Today*, 18(5–6), 211-217.  
DOI: <https://doi.org/10.1016/j.drudis.2012.10.010>
46. Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, 43(2-3), 172- 194.
47. Timmers, P. (1998). Business models for electronic markets. *Electronic Markets*, 8, 3-8.  
DOI: <http://dx.doi.org/10.1080/10196789800000016>
48. Velosa, J., & Macedo, G. (2020). Elimination of Hepatitis C in Portugal: An Urban Legend? *GE - Portuguese Journal of Gastroenterology*, 27(3), 166–171.  
DOI: <https://doi.org/10.1159/000505582>
49. Voigt, K. I., Buliga, O., & Michl, K. (2016, July 28). *Business Model Pioneers*. Springer.
50. Wan, X. X., Zhang, D. Y., Khan, M. A., Zheng, S. Y., Hu, X. M., Zhang, Q., Yang, R. H., & Xiong, K. (2022). Stem Cell Transplantation in the Treatment of Type 1 Diabetes Mellitus: From Insulin Replacement to Beta-Cell Replacement. *Frontiers in endocrinology*, 13, 859638.  
DOI: <https://doi.org/10.3389/fendo.2022.859638>

51. Williamson, Kirsty. (2018). Questionnaires, individual interviews and focus group interviews. In Kirsty Williamson & Graeme Johanson, *Research Methods* (Second Edition), Chandos Publishing.  
DOI: <https://doi.org/10.1016/B978-0-08-102220-7.00016-9>
52. World Health Organization. (2016). *Global report on diabetes* (Publication No. ISBN 978 92 4 156525 7). World Health Organization. Borus, J. S., & Laffel, L. (2010). Adherence challenges in the management of type 1 diabetes in adolescents: Prevention and intervention. *Current Opinion in Pediatrics*, 22(4), 405-411.

# Appendix

## APPENDIX 1

KEY PARTNERS	KEY ACTIVITIES	VALUE PROPOSITIONS	CUSTOMER RELATIONSHIPS	CUSTOMER SEGMENTS
	KEY RESOURCES		CHANNELS	
COST STRUCTURE			REVENUE STREAMS	

Business model canvas template. Source: Osterwalder and Pigneur, 2010

## APPENDIX 2



### APPENDIX 3

<b>Key Partners</b> R&D and supply alliances, for instance with Panasonic and Daimler	<b>Key Activities</b> Broad array in-house activities: R&D and design, sourcing and production, sales and after-sales services  Built-to-order, on demand vehicle production	<b>Value Proposition</b> Electric, high-performance vehicles (including limousines and a sports model), which redefines electric mobility  Worldwide largest fast charging network, offering free charging  B2B: electric vehicle powertrain components	<b>Customer Relationships</b> Direct and consistent customer relationships with extensive personal assistance	<b>Customer Segments</b> Customer market: ecofriendly individuals High-end sports car market Mass market consumers B2B market OEMs
	<b>Key Resources</b> State of the art manufacturing facilities Expertise and intellectual property, however, open licenses	<b>Channels</b> Direct sales approach via own Tesla Stores and online, as opposed to the established dealership model		
<b>Cost Structures</b> Highly value-driven cost structure (state of the art R&D and manufacturing) Minimized inventories through built-to-order principle, yet rising manufacturing and R&D costs, resulting from the rising demand for its Model S		<b>Revenue Streams</b> Automotive sales (amounting to about 99.8 % of total sales, including vehicle, options and related sales, as well as powertrain components) Development services (amounting to about 0.2 % of total sales, including sales of powertrain components and systems for partner OEMs)		

Initial Business Model of Tesla, 2003 Source: Osterwalder and Pigneur, 2010

### APPENDIX 4

<b>Key Partners</b> Supplier alliance for the chassis production with Lotus  Engineering Licensing of the powertrain technology of AC Propulsion	<b>Key Activities</b> Developing, designing, manufacturing and optimizing the employed technologies for the Roadster model	<b>Value Proposition</b> Electric, high-performance sports vehicle, which redefines electric mobility	<b>Customer Relationships</b> Intention: Direct and consistent customer relationships	<b>Customer Segments</b> High-end sports cars enthusiasts wanting to make a statement about the environment
	<b>Key Resources</b> License for the powertrain technology		<b>Channels</b> Intention of solely direct sales via own Tesla Stores and online, as opposed to the established dealership model	
<b>Cost Structures</b> High value-driven cost structure		<b>Revenue Streams</b> No own revenues until 2008 (funded solely through venture capital and additional investors)		

Current Tesla's business model, 2021. Source: Osterwalder and Pigneur, 2010

## APPENDIX 5

<b>Key Partners</b> US postal service  DVD player manufacturers such as Sony and Toshiba	<b>Key Activities</b> Selecting the movie offer and strengthening the value proposition Warehouse management and continuous process improvement Website operation and development	<b>Value Proposition</b> State-of-the-art home movie experience due to DVD technology  Convenient movie rental with home ordering and delivery  Fast delivery and convenient return via direct mail  Substantial palette of movies	<b>Customer Relationships</b> Self-service via the Netflix website	<b>Customer Segments</b> Online-literate, convenience-seeking U.S. residents
	<b>Key Resources</b> DVD library of around 900 titles Warehousing and distribution center		<b>Channels</b> Company website (for customer registration, ordering and rating) Direct mail (for delivery and return)	
<b>Cost Structures</b> DVD acquisition costs Handling costs (packaging and mailing costs) Warehouse operation costs		<b>Revenue Streams</b> Pay-per-rental revenue model		

Netflix Business model – 1997. Source: VOIGT et al., 2017

## APPENDIX 6

Category	Portugal		
	2019	2020	2021
Outpatient Medication – Total**	355.1	386.7	423.8
Outpatient Medication - National Health Service (SNS)	351.6	382.8	419.6
Diabetes Monitoring Devices	67.3	72.0	76.8
Diabetes Monitoring Devices - National Health Service (SNS)	57.2	61.2	65.2
Hospitalization - Total Diabetes	265.7	284.3	310.0
Hospitalization - Diabetes Diagnosis (GDH's)	18.6	19.9	21.7
Hospitalization - Stroke + Diabetes (GDH's)	25.4	26.9	27.7
Hospitalization - Heart Attack + Diabetes (GDH's)	13.5	12.6	13.0
Insulin Infusion Pumps and Supplies	3.0	3.3	3.5

\* Values in million euros

\*\* Source: FONTE: BIMH – Dashboard da Diabetes – ACSS; Infarmed; MS; DGS; Tratamento OND