# The Business Model Framework for Digital Health Start-ups in Europe, based on the Innovation Landscape

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## ABSTRACT

**In today's fast-paced world, it is difficult to acquire the same quality level of healthcare efficiently. To achieve a similar quality of service in a shorter time, digital health solutions ranging from applications to online registration play a pivotal role in the lives of healthcare practitioners and more specifically patients.**

**The new digital health paradigms have shifted to be more patient-centric, preventive, predictive, and personalized to more accurately and precisely cater to the patient's needs. The dawn of novel innovative technologies revolutionizing the digital health sector across the globe has generated multiple value creations and research opportunities. The following research focuses on studying innovation diffusion in the digital health sector and its effect on the success of start-ups via analysis of the business models [1]. It is essential to understand the significant proportionality of innovation to the success of digital health startups in delivering quality care to users/patients without compromising quality or failing to create business value in the current competitive market.**

## KEYWORDS

**Digital health, entrepreneurship, business model innovation, open innovation, accelerators, incubators, success factors**

## 1. Introduction

The success of such digital health-related business models is based on multiple factors including market choice, technology used, value addition, and many more. The innovation landscape is getting wider and measuring its success concerning digital health start-ups in Germany has become highly important to understand the intricate causes of failure of a massive 90% of start-ups in their first 5 years of inception, roughly around 1 in 12 start-ups find it difficult to survive [2].

The creation of archetypes based on various significantly affecting factors would help to categorize current digital health start-ups [1].

In their study, Burström et al. [3] explored AI-enabled business model innovations by analyzing how AI transforms the mechanisms of value creation, delivery, and capture within organizations. They proposed a comprehensive framework illustrating that AI not only enhances existing business models but also enables the development of new, dynamic business models by integrating advanced data analytics and automation capabilities. The authors emphasize that these AI-driven innovations can significantly improve competitive advantage, particularly in sectors such as manufacturing, where digital transformation is still nascent. However, despite this potential, AI-based business models remain underexplored and insufficiently researched, especially regarding their implementation and ecosystem interactions. This gap underscores the urgent need for further investigation into innovative business models that leverage AI to drive digital transformation and sustainable growth in industrial contexts.

Similarly, Huckvale et al. [4] highlighted the critical role of the human factor in the design, development, and implementation of patient-centric digital health interventions. Their research emphasized the importance of a partnership model involving healthcare professionals, patients, and software systems to enhance decision-making processes. This collaborative approach is particularly vital in low- and middle-income countries, where digital health innovations must be tailored to local contexts and resource constraints. Huckvale and colleagues argue that the success of digital health solutions depends not only on technological advancements but also on the active engagement and alignment of all stakeholders involved, ensuring that digital tools effectively meet patient needs and improve health outcomes.

### 1. Goal and Objectives

**Goal** – To successfully analyze the implementation of innovative technologies in digital health start-ups and its effect on business models leading to the success of the start-ups in Europe by establishing the relevant knowledge of the success of the digital health start-ups.

**Objectives**

- **Objective 1** – To perform a scoping review of efforts to support the digital health entrepreneurship landscape until current advancements.
- **Objective 2** – To study the current digital health start-up scene in Europe and cluster the start-ups with similarities as individual archetypes focusing on innovations, with a minimum of three start-ups [1].
- **Objective 3** – To equate the correlating factors and differentiating factors facilitating each archetype that is contributing the most to the success of the start-ups.
- **Objective 4** – To be able to draw clear conclusions by connecting various factors involved in innovation that led to the success of the start-up archetypes via qualitative semi-structured interviews with the subject matter experts and start-up founders/representatives [1].

The research topic and methodology are designed to evaluate the success factors of digital health start-ups concerning the needs and expectations of digital health consumers, market penetration/access, business innovation and technology frameworks, etc.

## 2. Methodology

### 2.1 Systematic Literature Search

To gain a comprehensive understanding of both current research and previously established literature, a rigorous systematic structured literature review was conducted across multiple reputable academic databases and search engines. These included Google Scholar, PubMed, ABI Inform/ProQuest, EBSCO/Business Source Premier, JSTOR, MENDELEY, ScienceDirect, Scopus, SpringerLink, and Web of Science.

This systematic approach ensured a thorough review of relevant literature, enabling the synthesis of existing knowledge on the identified topics and contributing to scholarly discourse in the field.

Snowballing Method: Snowballing is an iterative and complementary method to systematic literature research to include articles that may have slipped the attention of the researcher. There are two types of snowballing – forward and backward snowballing [5].

### 2.2 Primary and Secondary Data Collection Methods

This research employed in-depth semi-structured interviews to gather primary data from subject matter experts within the industry and representatives of digital health start-up companies. The selection criteria for participants included considerations such as geographical location, educational background, professional experience, and affiliation with digital health start-ups or relevant industry entities such as hubs, accelerators, or incubators. Each interview was meticulously recorded and transcribed verbatim using Microsoft Teams, with participant anonymity safeguarded through the use of pseudonyms. Following data collection, a rigorous simultaneous coding process was undertaken to identify and categorize key themes and patterns within the interview transcripts.

Subsequently, these overarching themes were analyzed to develop archetype-specific system dynamic models, such as causal loop diagrams, and archetype-specific business and conceptual frameworks. The thematic analysis facilitated a deeper understanding of the nuances and complexities inherent in the digital health innovation landscape, shedding light on the interplay between various factors and stakeholders within the industry. By synthesizing insights from diverse sources, this study aims to contribute to the development of robust theoretical frameworks and practical strategies to navigate the evolving landscape of digital health innovation [1].

The start-ups examined in this research study were characterized as operational entities with a functional history ranging from 1 to 5 years. Their primary products or service offerings were required to be within the digital health domain, featuring relevant innovations such as artificial intelligence (AI), natural language processing (NLP), or virtual/augmented reality (AR/VR) technologies.

Incubators specialize in nurturing early-stage start-ups that are primarily focused on product development and have yet to establish a fully developed business model. Conversely, accelerators are geared towards expediting the growth of established companies that have already developed a minimum viable product (MVP) and demonstrated traction among early adopters, with a proven product-market fit [6].

This distinction between incubators and accelerators underscores their respective roles in supporting start-ups at different stages of development within the digital health innovation ecosystem. By elucidating these distinctions, this study provides valuable insights into the diverse pathways available to start-ups seeking support and growth opportunities in the dynamic landscape of digital health entrepreneurship.

The criteria for inclusion and exclusion were clearly defined for prospective interview participants in this study:

**Inclusion Criteria:**

- Residency within the European Union (EU), the United Kingdom (UK), or the European Economic Area (EEA).
- Affiliation with either a digital health start-up for the start-up representative cohort or involvement with an accelerator or incubator for the subject matter experts' cohort.
- Proficiency in English communication, as evidenced by exposure to international environments through prior educational or professional experiences.

**Exclusion Criteria:**

- Lack of involvement in the digital health innovation landscape for both experts and start-ups.
- Participants residing outside of the European Union, the UK, or the European Economic Area were excluded from participation.

These criteria were established to ensure that interview participants possessed relevant experience and perspectives within the context of digital health innovation in the specified geographical regions.

**Stratified Sampling Method**

Stratified sampling stands as a method of probability sampling commonly deployed in sample surveys. It entails dividing the elements of the target population into distinct groups or strata, where elements within each stratum share similarities regarding certain key characteristics pertinent to the survey. The stratification process serves not only to enhance the efficiency of sample design in terms of survey costs and estimator accuracy but also to refine the precision of estimations. This article delves into the foundational principles of stratified sampling within the context of simple random sampling. Key areas of discussion encompass the delineation of strata formation and the optimal distribution of samples among these strata. Furthermore, practical considerations in implementing stratified sampling are explored, encompassing methodologies such as systematic sampling, implicit stratification, and the utilization of contemporary software for strata construction. The significance of employing stratified sampling in practical research settings is underscored by its widespread application in five major large-scale health surveys conducted in both the United States and the United Kingdom [7].

There were two cohorts or subgroups in this research first cohort as subject matter experts who were employed or directly associated with digital health innovations carried out in accelerators or incubators based in the European region. The second cohort consisted of founders, co-founders, or active long-term employees of a digital health start-up based in Europe.

While acknowledging that qualitative research, particularly in the form of small-scale interview-based studies, is deliberately conceptual in its approach, the resulting findings inevitably carry an element of speculation as they are not intended to be final but rather suggestive. This characteristic aligns with the exploratory nature of such research, which aims to propose ideas rather than definitively prove them, thus diverging from the reliance on representativeness and large sample sizes typically associated with verification-oriented studies. It is essential to emphasize that rigor in both methodology and argumentation remains paramount in exploratory research, even more so than in verification-focused investigations, as the latter often lacks the familiar markers of assurance. Nevertheless, within a realist framework, the hypothetical nature of concepts emerging from exploratory studies does not fundamentally differ from the results of research aiming for truth-claiming conclusions. In the broader context of science, all knowledge remains contingent on ongoing developments, characterized by provisional designations of symbols, myths, or theories [8].

The study involved a sample size comprising five participants from each cohort, totalling ten interview participants across both cohorts. However, due to time limitations, only eight interviews (3 + 5) were conducted in practice. Pre-designed questionnaires, delineating the allotted time duration for each section, were developed for both cohorts.

**Semantic Approach**

The method of simultaneous coding involves using multiple coding techniques ranging from a pre-defined coding system, i. e. Priori coding, to descriptive coding. In the analysis of this research question, interview transcripts were coded mainly in two types: 1 In-vivo coding, the codes that emerged from the direct quotes of the interviewee, while Descriptive coding allows the researcher to use their own subject knowledge for describing the terminology or scenario. This combination of codes is complementary and inclusive of two diverse perspectives. As described by Braun and Clarke [9], their research suggested

that semantic codes are explicit and grounded in the surface meanings of the data, allowing researchers to stay close to the participants' actual words while still applying analytical interpretation.

**Thematic Analysis**

Thematic analysis, sometimes referred to as template analysis, offers a broad spectrum of creative possibilities. Researchers have the flexibility to apply coding techniques across multiple levels without rigid constraints. This method allows for the exploration of various layers of meaning within qualitative data, facilitating a nuanced understanding of complex phenomena. By employing thematic analysis, researchers can uncover rich insights and patterns embedded within the data, thereby enhancing the depth and comprehensiveness of their findings. This approach encourages an iterative and exploratory process, empowering researchers to delve deeply into the intricacies of their data and extract meaningful themes and patterns. Ultimately, thematic analysis serves as a versatile and powerful tool for uncovering and interpreting the underlying narratives and structures present in qualitative data. This method of qualitative analysis should be the backbone as it helps to surface known themes and in result novel theories reshaping the newer avenues of research [9, 10].

The depth and breadth of qualitative thematic analysis allow researchers to capture the complexity of the research topic; however, validating such research remains a challenge. In Canada, Nowell et al. [11] conducted mixed methods research aimed at establishing the trustworthiness and rigor of thematic research designs. Building on Koch's [12] assertion, maintaining detailed documentation of the interview process and its nuances provides a systematic approach that enhances the replicability of qualitative studies, allowing subsequent researchers to arrive at similar, though not identical, conclusions. Nowell et al. [11] further demonstrated that audit trails—comprehensive records of qualitative data collection and analysis—contribute significantly to systematizing the research process, thereby enhancing the overall trustworthiness and rigor of qualitative research models [13]. The audit trail of the semi-structured interview process performed in this research is depicted below (Figure 1):

1. Audit Trail

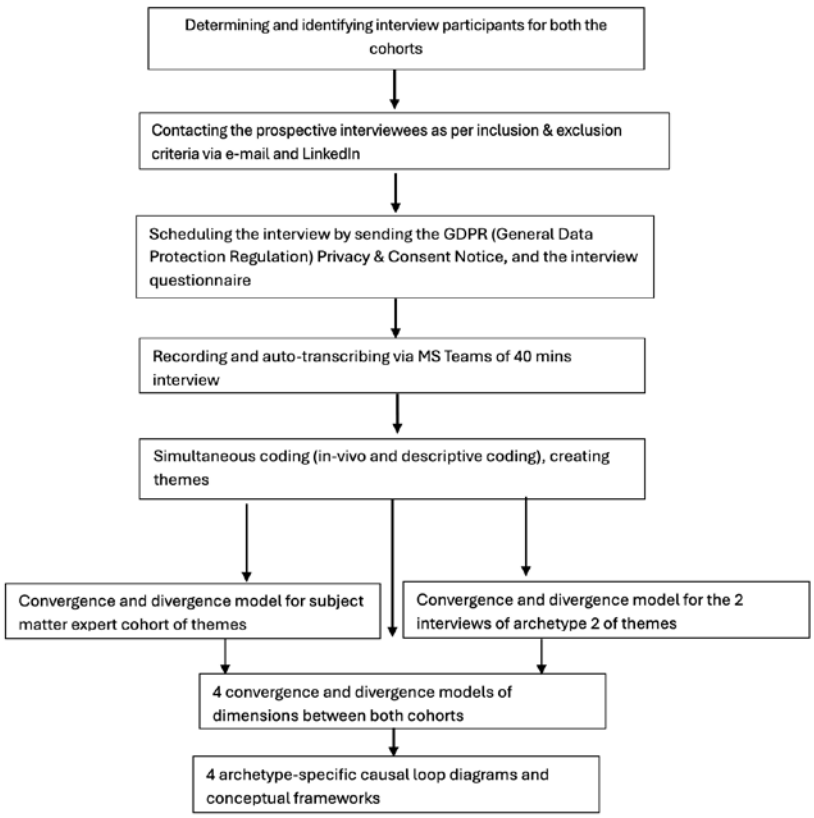


Figure 1: Audit trail.

**2. Expert's Validation**

An additional approach to validate the study design involves iteratively seeking expert opinions on the conceptual framework or model generation. In the research conducted for this study, three subject matter experts were consulted, and one of them provided iterative advice, resulting in subsequent adjustments to the framework. This iterative process of expert consultation ensured the refinement and enhancement of the conceptual framework, thereby bolstering the robustness and credibility of the study design. The insights gleaned from expert input facilitated a more nuanced understanding of the research context and contributed to the development of a comprehensive and well-founded conceptual model.

**Literature Review**

The seminal research work functioning as the backbone research for this study is elaborated in Table 1.

The search terms utilized encompassed key concepts related to start-ups, new ventures, small firms, and digital health, among others. Terms such as "start-up", "new venture", "small firm", "digital health", "mhealth", "ehealth", "medtech", "success", "successful", "market", and "factors" were combined using AND and OR conditions across various combinations.

Table 1: Collection of seminal work

| Title | Author/ reference | Finding | Focus | Summary |
|---|---|---|---|---|
| Success Factors for Market Entry of Mobile Health Startups | Lux and Kempf [14] | Study concludes that while the success factors identified could aid start-ups in avoiding mistakes and achieving successful market entry, they do not guarantee success. | Success factor for mHealth start-ups in market entry | Although the research focused on identifying success factors, it acknowledged that the diversity of business models makes it difficult to generalize the results. |
| Health-tech start-ups in healthcare service delivery: A scoping review | Chakraborty et al. [15] | 5 out of 76 articles could focus on the status of health tech start-ups | Research gap in business framework | The business model framework in digital health has not been explored. |
| Critical success factors of startups in the e-health domain | Chakraborty et al. [16] | The study underscores the significance of identifying (critical success factors (CSFs) for health tech start-up success in a rapidly evolving healthcare landscape. Findings offer valuable guidance for stakeholders and suggest avenues for future research to strengthen success trajectories in the health tech sector. | Success factors for health tech start-ups in India | The STOF (Service-Technology-Organization-Finance) framework helps to identify the CSFs for health tech start-up success in a rapidly evolving healthcare landscape. |

| | | | | |
|---|---|---|---|---|
| **International aspects of growth management in eHealth service start-ups** | Saarela et al. [17] | The results indicate that international factors are integral to growth management. Key areas of management priority associated with internationalization include focus, strategic management, and service development and delivery. | Growth management in the international environment | In summary, incorporating internationalization aspects as fundamental components of business growth management could enhance the stages of growth perspective. |
| Key components and critical factors for developing a telehealth business framework: a qualitative study. | Velayati et al. [18] | Results revealed four main themes: key components for developing a telehealth business framework, success factors, challenges, and barriers. Key components identified included value creation, resources, activities, partnerships, licenses, pricing, revenue, marketing, support services, and customer feedback. Success factors included support from individuals and organizations, along with economic benefits. | Success factors in telehealth industry | The study underscores the importance of a telehealth business framework in facilitating commercialization and sustainability in a competitive market. |
| The 4P telehealth business framework for Iran. | Velayati et al. [19] | 68 out of 74 components proposed in the initial framework were approved across four major dimensions: prerequisites, production, payments and costs, and post-production services. The developed framework is expected to facilitate the commercialization of telehealth technologies, aid in business planning, and enhance the success of telehealth start-ups in a competitive market. | Framework for telehealth businesses | The research employed a mixed methods approach, combining systematic review, qualitative research, expert panel review, and Delphi method validation. The framework underwent refinement based on the input from a panel of telehealth experts and subsequent validation through the Delphi method across three rounds. |

| | | | | |
|---|---|---|---|---|
| Management priorities of digital health service start-ups in California | Muhos et al. [20] | Meta-analysis, ser vice-based businesses typically have the following manage-ment priority areas: focus, power, HR, marketing, decision making, strategic management and growth management, etc. | Analysis of US-based digital health service industry | Through a multiple case study, qualitative and contextual characteristics of growth are identified, leading to the formation of a management priori-ties framework. Network management emerges as a key priority for start-ups aiming to introduce radical innovations to complex markets, where fundrais-ing plays a crucial role in success. |

Due to the geographical limitation of the study, the last research article was excluded.
These six articles collectively offer insights into the success factors, challenges, and frameworks pertinent to start-ups within the health tech and telehealth sectors.

Lux and Kempf [14] emphasize the identification of success factors for market entry of mobile health start-ups, highlighting the significance of avoiding mistakes, but caution that success is not guaranteed. Meanwhile, Velayati et al. [18] and Velayati et al. [19] delve into the development of telehealth business frameworks, identifying key components and critical factors for commercialization and sustainability, with the latter focusing specifically on the Iranian context.

In contrast, Chakraborty et al. [15] and Chakraborty et al. [16] explore critical success factors for start-ups in the healthtech and e-health domains, respectively. While Chakraborty et al. [15] point out a research gap in business frameworks and models within digital health, Chakraborty et al. [16] highlight the significance of identifying success factors and offer guidance for stakeholders in a rapidly evolving healthcare landscape.

Saarela et al. [17] examine international aspects of growth management in e-health service start-ups, stressing the importance of incorporating internationalization aspects into business growth management for enhanced perspectives on growth stages.

In summary, these studies collectively underscore the complexity and significance of success factors, frameworks, and international considerations in fostering the growth and sustainability of start-ups within the health tech and telehealth industries.

**Business Model and Value Proposition**

The Business Model Canvas (BMC) serves as a comprehensive framework for entrepreneurs and businesses to visually represent and analyze their business models. Developed by Alexander Osterwalder and Yves Pigneur, the BMC provides a structured approach to understanding the fundamental components of a business, including key activities, resources, partners, customer segments, revenue streams, and cost structure. This tool enables stakeholders to gain a holistic view of their venture, facilitating strategic decision-making, innovation, and communication across teams and stakeholders. By condensing complex business concepts into a concise format, the BMC fosters clarity and alignment, empowering organizations to iteratively refine and optimize their business models in response to market dynamics and customer needs [21].

Central to the Business Model Canvas is the concept of value proposition, which encapsulates the unique value that a product or service delivers to its target customers. A compelling value proposition articulates how a company's offering addresses customer needs, solves pain points, or fulfills desires in a distinctive and superior manner compared to alternatives in the market. By focusing on the value created for customers, businesses can differentiate themselves, attract and retain customers, and drive revenue growth. Moreover, the Value Proposition Canvas (VPC), an extension of the BMC, provides a structured framework for systematically designing, testing, and refining value propositions by understanding customer jobs to be done, pains, and gains, thereby enhancing product-market fit and competitiveness in dynamic business environments [22].

In this research study, the questionnaires were segmented into 10 sections, with each section demonstrating direct interconnectivity attributable to its influence on both the BMC and the VPC. Therefore, the ensuing illusion of interlinking is evident.

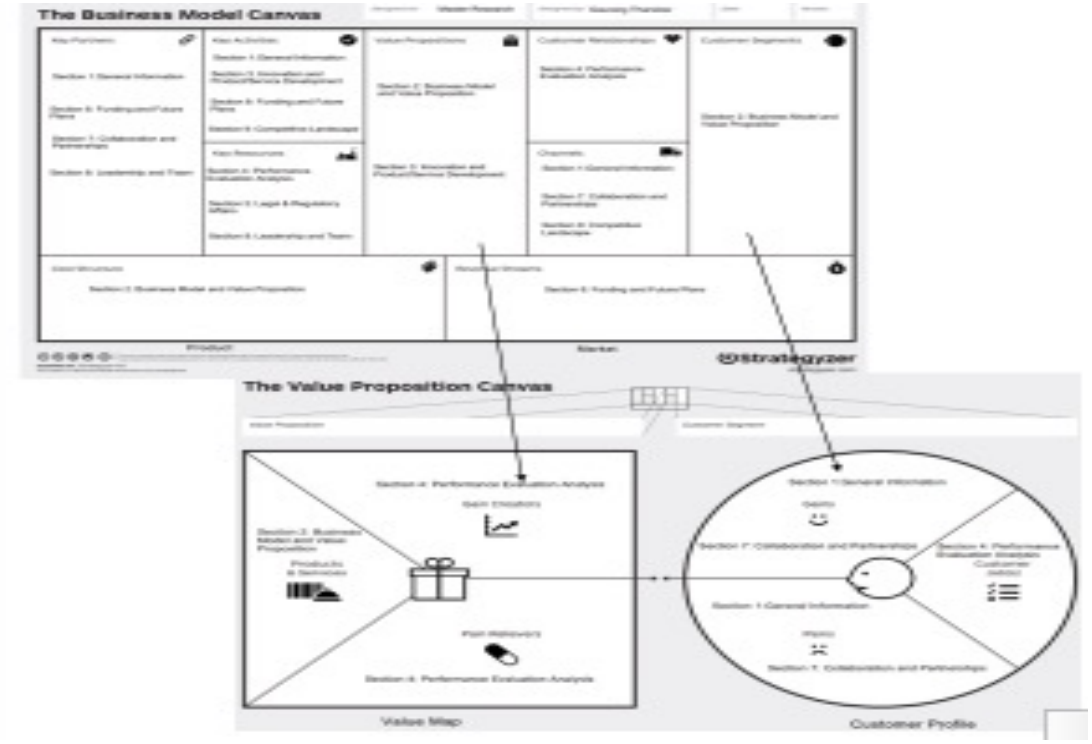


Figure 2: Business Model Canvas – Download the official template. (n. d.). (Source: https://www.strategyzer.com/library/the-business-model-canvas; Creative Commons Attribution-ShareAlike 3.0 Unported License [CC BY-SA 3.0] [23]).

**Types of the Business Models**

Business models represent the foundational framework upon which businesses operate and generate value. They define how a company creates, delivers, and captures value within its ecosystem. Various types of business models exist, each tailored to suit different industries, markets, and organizational objectives. Traditional business models include the manufacturer model, where products are produced and sold directly to consumers, and the distributor model, where products are sourced from manufacturers and distributed to retailers. Service-based business models focus on delivering intangible services instead of physical products, such as consulting firms or subscription-based services like streaming platforms. Another prevalent model is the platform model, which facilitates transactions or interactions between multiple parties, often leveraging network effects to scale rapidly. Additionally, the subscription model offers recurring revenue streams through periodic payments for access to products or services. More contemporary models include the freemium model, which provides basic services for free while charging for premium features, and the sharing economy model, which connects individuals to share resources or services. These diverse business models highlight the versatility and adaptability required for success in today's dynamic business landscape [24].

## 3. Results

The results of qualitative and quantitative data were collected and analyzed for emerging codes (first order), sub-themes and overarching themes (second order), and lastly aggregate dimensions and insights. The dimensions of the subject matter expert cohort were compared with each archetype-specific dimension, as a result forming various convergence and divergence models. The secondary quantitative data collated from reputed reports and articles were triangulated for validation of the research.

**Thematic Analytical Planning**

Table 2: Details about cohort and Interviews

| Actual cohorts | Actual interviews conducted | Actual time required | Actual geographical outreach |
|---|---|---|---|
| Subject matter experts | 3 | Around 40 mins | Western Europe including the UK and Southern Europe |
| Start-up representatives | 5 | Around 40 mins | Western Europe and Southern Europe |

For the thematic analysis, five interviews for each of the two cohorts, namely subject matter experts and start-up representatives (current employees of the start-up) were planned, in total 10 interviews with a duration of around 40 minutes. The geographical boundaries for the data collection were envisioned to be the EU including the UK and EEA.
The results were found to be that a total of eight interviews were conducted: three of subject matter experts and five of start-up representatives. The duration of the interviews happened to be approximately 40 minutes each. The actual regions that participated in the interviewing process were Western Europe, the UK, and Southern Europe with significant participation from Spain.

**Start-up details related to the archetypes:**

Table 3: Information of the Start-ups archetypes with commercialization model

| Start-up represented by | Archetype | Founding year | Operational year | Commercialization model | Headquarter |
|---|---|---|---|---|---|
| SR1 | Personalized Chronic Disease Management Platform | 2018 | 2020 | Business-to-Customer model | Netherlands |
| SR 2 & SR 3 | Integrated Multi-Omics Imaging Platform | 2012 | 2020 | Business-to-Business model | Spain |
| SR 4 | Global Medical Tourism Platform | 2023 | 2023 | Business-to-Customer model | Germany |
| SR5 | AI-Powered Biologics Discovery Platform | 2022 | 2023 | Business-to-Business model | Germany |

Table 3 depicts the diverse nature of each start-up based on its geographical location, founding and operations years, and commercialization model implemented for the European market. The two start-ups were in operation for 1 year while the other two start-ups were operating for 3 years. This data supported the categorization of these start-ups based on their operational maturity levels.

**The Outcome of Comparative Thematic Analysis**

All three interviews with subject matter experts were conducted, coded, and analyzed resulting in convergence and divergence of the themes.

**Thematic Convergence and Divergence Model**

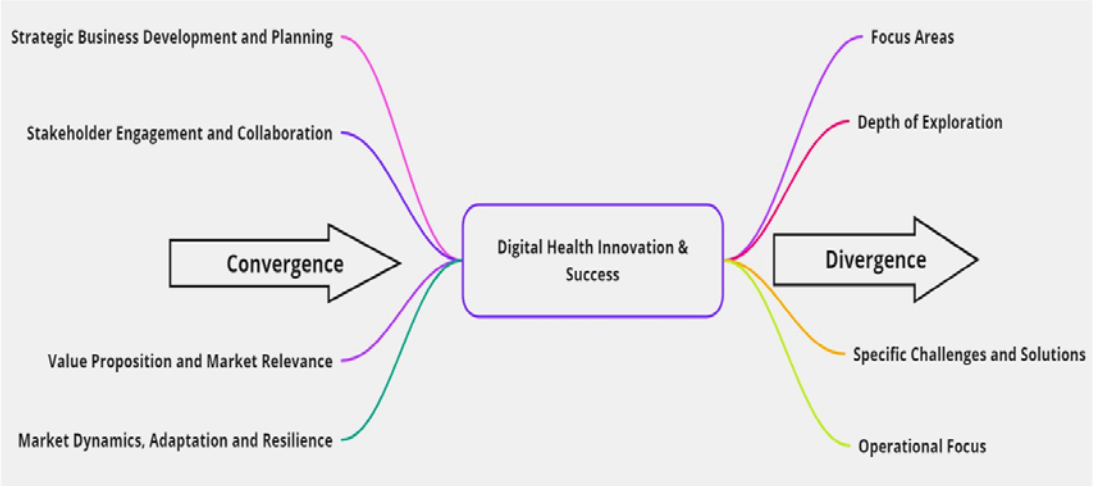


Figure 3: Overall Convergence and Divergence model.

A thorough convergence and divergence model was formulated from the emerged themes. The following is a detailed analysis of the similarities and differences across the three interviews:

**Convergence of Themes:**

**1. Strategic Business Development and Planning:**

- All three interviews emphasized strategic planning, development, and resource management as crucial for business success.
- Themes such as strategic planning and development, strategic implementation and customization, and strategic business development aligned across all interviews.
- All three interviews addressed strategic business development, emphasizing the importance of planning, resource management, collaboration, and partnerships for success.

**2. Stakeholder Engagement and Collaboration:**

- The importance of stakeholder engagement, collaboration, and partnerships was highlighted consistently in all interviews.
- - Themes related to stakeholder engagement, networking, and collaborative growth were common across the interviews.
- - Stakeholder engagement was a recurring theme across all interviews, highlighting the significance of collaborating with stakeholders for innovation, validation, and market penetration.

**3. Value Proposition and Market Relevance:**

- Recurring themes were understanding market needs, developing a strong value proposition, and ensuring market relevance.
- Themes such as value proposition development, market analysis and segmentation, and value creation aligned across the interviews.
- The importance of developing a strong value proposition and ensuring market relevance was evident in all interviews, focusing on understanding market needs, adapting to market dynamics, and creating value for customers.

**4. Market Dynamics, Adaptation and Resilience:**

- Adapting to dynamic markets and regulatory environments was emphasized across all interviews.
- Themes related to market dynamics, adaptation, and regulatory challenges converged in all interviews.
- Adaptation and resilience emerged as key themes in all interviews, emphasizing the need for start-ups to adapt to changes in the market, regulatory landscape, and operational challenges.

**Divergence of Themes:**

**1. Focus Areas:**

- Each interview had its unique focus areas and sub-themes. For example, while the first interview (SME 1) emphasized ecosystem engagement and entrepreneurial attributes, the second interview (SME 2) focused more on strategic business model innovation and market engagement.

**2. Depth of Exploration:**

- Some interviews dived deeper into certain topics than others. For instance, the third interview (SME 3) explored strategic team development and value proposition validation more extensively than the other interviews.

**3. Specific Challenges and Solutions:**

- Different interviews addressed specific challenges and solutions based on the context and perspectives of the interviewees. For example, the second interview (SME 2) discussed regulatory compliance and operational strategy in detail, while the third interview (SME 3) focused on continuous innovation and stakeholder engagement.

**4. Operational Focus:**

- While all interviews touched upon operational aspects, the depth of coverage varies. Some interviews, like the third one (SME 3), dove deeper into operational challenges and solutions.

**Divergence by interviews:**

1. Interview of SME 1: Emphasized diverse themes such as social responsibility, trustworthiness organizational dynamics, and inclusion.
2. Interview of SME 2: Focused on holistic market engagement, strategic business model innovation, and operational challenges.
3. Interview of SME 3: Highlighted themes related to team development, dynamic markets, continuous innovation, and resource-intensive market entry.

## 4. Aggregate Dimensions and Insights

### Aggregate Dimensions and Insights of Subject Matter Expert Cohort

The insights from expert interviews were categorized based on overarching themes, sub-themes, and their correlation with the Business Model Canvas (BMC) and Value Proposition Canvas (VPC). Key aggregated dimensions include:

Table 4: Aggregate Dimensions with the Business Model Canvas (BMC) and Value Proposition Canvas (VPC)

| Dimension | Key Focus Areas | Impact |
|---|---|---|
| Strategic Business Development & Planning | Strategic planning, market segmentation, differentiation | Aligns business strategies with cost structures, refining value propositions and customer focus |
| Market Ecosystem Engagement & Customer Focus | Market engagement, user-centric customization, stakeholder interactions | Enhances business success through refined value propositions and user engagement |
| Innovation & Adaptability | Continuous innovation, integration, strategic adaptation | Ensures competitiveness through market feedback-driven innovation |
| Regulatory Compliance & Risk Management | Regulatory navigation, operational risk mitigation | Ensures sustainability by adhering to compliance standards |
| Resource Management & Funding | Resource allocation, investment, financial constraints | Secures funding and demonstrates investor value through clear revenue strategies |
| Collaboration & Networking | Partnerships, networking, ecosystem synergy | Strengthens value propositions through collaborative growth |
| Team Development & Organizational Culture | Team building, human resources (HR) management, entrepreneurial mindset | Enhances innovation and customer engagement via a strong organizational culture |
| Value Proposition & Business Model Innovation | Refining value propositions, business models | Ensures market relevance and competitive advantage through customer insights |
| Performance Evaluation & Metrics | key performance indicators (KPIs), performance monitoring | Aligns value propositions with success metrics for customer satisfaction |
| Adaptation & Resilience | Start-up challenges, dynamic market navigation | Ensures sustainability by adapting business models to evolving conditions |

These dimensions aimed to capture the essence of the interviews while providing a framework for analysing the data in a more aggregated manner. They encompassed a wide range of factors that influence the success and growth of digital health start-ups within accelerator/incubator programs in Europe.

### Aggregate Dimensions and Insights of Start-up Representative Cohort

The insights from expert interviews were categorized based on overarching themes, sub-themes, and their correlation with the Business Model Canvas (BMC) and Value Proposition Canvas (VPC). Key aggregated dimensions include:

Given the diverse range of themes and sub-themes across the interviews, the following are the aggregate dimensions and insights into the broader purview:

### 1. Personalized Chronic Disease Management (B2C) Platform

Table 5: Aggregate Dimensions of the Personalized Chronic Disease Management (B2C)

| Dimension | Key Focus Areas | Impact |
|---|---|---|
| Regulatory Compliance & Market Expansion | Navigating regulations, ensuring compliance, cost implications | Facilitates market expansion and innovation within legal frameworks |
| Strategic Resource Management & Innovation | Business model innovation, resource optimization, product development | Enhances efficiency and growth through strategic innovation |
| Patient-Centric Innovation & Solution Validation | Meeting patient needs, technological advancement, performance validation | Ensures that solutions align with patient requirements and effectiveness |
| Strategic Planning & Market Entry | Market entry validation, investment acquisition, partnerships | Strengthens market penetration through strategic decision-making |
| Cost Management & Regulatory Challenges | Financial constraints, regulatory compliance, fostering innovation | Balances cost efficiency with compliance for sustainable growth |
| Strategic Partnership & Intellectual Property Management | Collaborative partnerships, intellectual property (IP) rights, business model innovation | Leverages partnerships for business development and market advantage |
| Cultural & Personal Attributes in Entrepreneurship | Diversity, leadership, team dynamics, entrepreneurial mindset | Cultivates a supportive and innovative entrepreneurial culture |
| Tailored Solutions & Market Alignment | Customization, market fit, unique value proposition | Enhances stakeholder value through aligned product offerings |
| Understanding Market Needs & Proposition Development | Market analysis, value proposition refinement, business model alignment | Drives business success through targeted market strategies |
| User Engagement & Satisfaction | User feedback analysis, experience enhancement, performance monitoring | Ensures continuous improvement and customer-centric growth |

### 2. Integrated Multi-Omics Imaging (B2B) Platform

The insights from expert interviews were categorized based on overarching themes, sub-themes, and their correlation with the Business Model Canvas (BMC) and Value Proposition Canvas (VPC). Key aggregated dimensions include:

Table 6: Aggregate Dimensions of the Integrated Multi-Omics Imaging (B2B) Platform

| Dimension | Key Focus Areas | Impact |
|---|---|---|
| Regulatory Compliance & Market Expansion | Navigating regulatory challenges, compliance, adaptability, market expansion | Ensures adherence to legal requirements while exploring new market opportunities |
| Strategic Resource Management & Innovation | Business model development, scientific advancement, resource management | Aligns resource allocation with innovative business models for value creation |
| Patient-Centric Innovation & Solution Validation | Strategic product development, regulatory compliance, technological validation | Meets patient needs while addressing regulatory hurdles |

| Dimension | Key Focus Areas | Impact |
|---|---|---|
| Strategic Planning & Market Entry | Market entry validation, stakeholder engagement, strategic funding | Optimizes value propositions for successful market penetration |
| Cost Management & Regulatory Challenges | Cost constraints, regulatory landscape, operational efficiency | Balances cost management with compliance in healthcare markets |
| Strategic Partnership & Intellectual Property Management | Collaboration, IP management, revenue models | Strengthens business sustainability and competitive advantage |
| Cultural & Personal Attributes in Entrepreneurship | Diversity, entrepreneurial characteristics, innovation culture | Fosters an inclusive entrepreneurial environment for innovation and growth |
| Tailored Solutions & Market Alignment | Customization, market readiness, stakeholder engagement | Ensures alignment with target customer segments for optimized value delivery |
| Understanding Market Needs & Proposition Development | Market analysis, competitive positioning, value proposition refinement | Develops compelling value propositions that address customer pain points |
| User Engagement & Satisfaction | Stakeholder engagement, performance evaluation, customer experience | Drives customer retention and loyalty through enhanced user satisfaction |

## 3. Global Medical Tourism (B2C) Platform

Table 7: Aggregate Dimensions of the Global Medical Tourism (B2C) Platform

| Dimension | Key Focus Areas | Impact |
|---|---|---|
| Stakeholder Engagement & Collaborative Strategy | Partnerships, collaborations, stakeholder engagement | Drives innovation and ensures start-up success through strong relationships and aligned goals |
| Financial Management & Resource Allocation | Cost structure optimization, revenue diversification, funding acquisition | Ensures sustainability and supports expansion and innovation efforts |
| Patient-Centered Innovation & Experience Enhancement | Understanding patient needs, addressing pain points, experience improvement | Enhances healthcare outcomes and patient satisfaction |
| Operational Excellence & Infrastructure Development | Process optimization, technology investment, continuous improvement | Ensures seamless service delivery and high-quality digital health operations |
| Strategic Planning & Market Expansion | Market analysis, growth opportunities, competitive differentiation | Supports successful market entry and sustained business growth |
| Collaborative Innovation & Knowledge Exchange | Open innovation, shared expertise, continuous learning | Fosters creative problem-solving and healthcare innovation |
| Trustworthy Execution & Market Engagement | Regulatory compliance, transparency, credibility building | Strengthens market trust and promotes adoption of digital health solutions |

## 4. AI-Powered Biologics Discovery (B2B) Platform

Table 8: Aggregate Dimensions of the AI-Powered Biologics Discovery (B2B) Platform

| Dimension | Key Focus Areas | Impact |
|---|---|---|
| Strategic Market Engagement & Business Model Innovation | Market dynamics, stakeholder engagement, business model innovation | Enhances market understanding and develops innovative business models to address unmet needs |

| Dimension | Key Focus Areas | Impact |
|---|---|---|
| Customer Acquisition Efficiency & Revenue Optimization | Customer acquisition, revenue cycles, funding, performance evaluation | Optimizes acquisition processes and revenue cycles for sustainable business growth |
| Pilot Project Implementation & Assessment | Pilot testing, product validation, service evaluation | Ensures the feasibility and effectiveness of new solutions through pilot projects |
| Regulatory & Intellectual Property Management Complexity | Regulatory navigation, intellectual property rights, compliance challenges | Addresses legal and IP complexities to sustain competitive advantage |
| Strategic Market Expansion & Cost Management | Market growth, cost management, competitive landscape | Facilitates expansion while maintaining cost efficiency and market positioning |
| Cultivating a Diverse, Stakeholder-Centric Environment | Diversity, stakeholder collaboration, leadership dynamics | Fosters an inclusive and collaborative environment to drive innovation and success |
| Strategic Alignment with Unmet Needs for Optimal Product-Market Fit | Market alignment, value proposition, customer insights | Ensures that solutions align with market needs for a strong product-market fit |
| Strategic Entrepreneurship in Competitive Environments | Entrepreneurial strategy, competitive positioning, leadership | Strengthens start-up resilience and adaptability in competitive markets |

### 1.1.1 Archetype-specific Convergence and Divergence Models

The convergence and divergence of dimensions depict the commonalities and differences of attributes between the subject matter experts' views and start-up representatives' understandings.

### 1. Personalized Chronic Disease Management (B2C) Platform

To create a convergence and divergence model between the two cohorts—subject matter experts and start-up representatives—let us first outline the aggregate dimensions of each cohort, identify overlaps and unique elements, and then delve into the specifics of how these dimensions have converged and diverged.

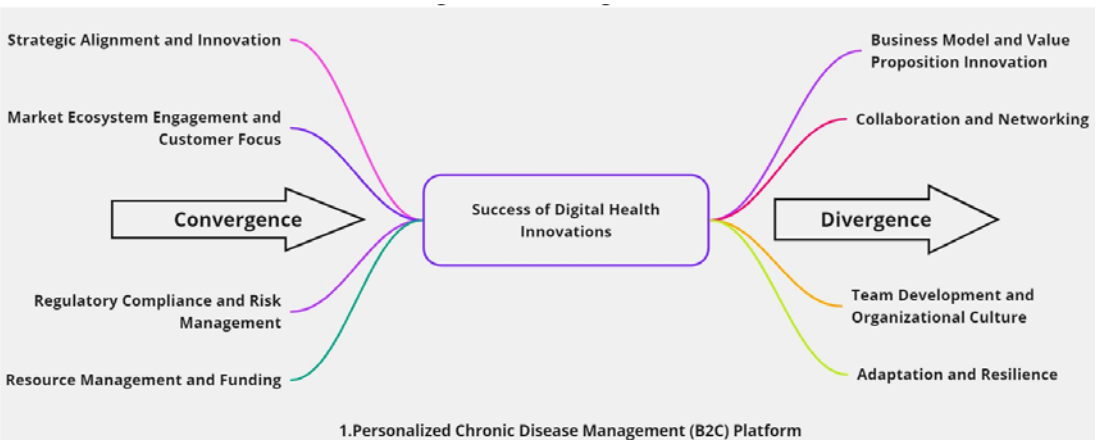


Figure 4: Convergence and Divergence model for Personalized Chronic Disease Management (B2C) Platform.

**Convergence Model**

**1. Strategic Alignment and Innovation:**
Both cohorts emphasized the critical role of strategic alignment between business development, market entry, and innovation efforts. Subject matter experts focused on strategic business development, planning, and innovation as foundational elements. This paralleled the start-up representative's emphasis on strategic resource management and innovation, as well as patient-centric innovation for solution validation. There was a clear convergence in the understanding that strategic planning and continuous innovation were paramount for navigating market dynamics and sustaining competitive advantage.

**2. Market Ecosystem Engagement and Customer Focus:**
The convergence was evident in the shared emphasis on market ecosystem engagement and maintaining a customer-centric approach. Subject matter experts' dimensions of market ecosystem engagement closely aligned with start-up representatives' focus on understanding market needs and developing tailored solutions. Both cohorts recognized the importance of engaging with market ecosystems, understanding customer needs, and refining value propositions to enhance user engagement and drive business success.

**3. Regulatory Compliance and Risk Management:**
Both groups underscored the significance of navigating regulatory challenges and managing operational risks. Subject matter experts and start-up representatives highlighted regulatory compliance as a critical dimension, integrating it with market expansion strategies and innovation processes. This alignment illustrated a common understanding that compliance and risk management were integral to operational efficiency and market viability.

**4. Resource Management and Funding:**
Efficient resource management and securing funding were focal points for both cohorts. Subject matter experts' emphasis on resource management and funding found a counterpart in start-up representative's strategic resource management and innovation. The collective insight was that managing resources efficiently and securing appropriate funding were essential for supporting business operations, growth, and innovation.

**Divergence Model**

**1. Business Model and Value Proposition Innovation:**
While both cohorts focused on value proposition and business model innovation, subject matter experts provided a more structured approach to integrating these innovations within broader business development strategies and frameworks like the BMC and VPC. In contrast, start-up representatives appeared to focus more on the practical implications of tailoring solutions to market needs and aligning value propositions with customer segments.

**2. Collaboration and Networking:**
Subject matter experts placed a strong emphasis on the importance of collaboration and networking within the ecosystem, viewing it as a strategic asset for business growth and innovation. Start-up representatives, while acknowledging the importance of strategic partnerships, especially in the context of intellectual property management, seemed to view collaboration more to an end rather than an integral part of the ecosystem engagement.

**3. Team Development and Organizational Culture:**
The dimension of team development and fostering a positive organizational culture was more explicitly addressed by subject matter experts, highlighting the strategic importance of human resources in driving business success. Start-up representatives touched on cultural and personal attributes in entrepreneurship, suggesting a divergence in the level of emphasis placed on organizational culture and team development as strategic assets.

**4. Adaptation and Resilience:**
Both cohorts recognized the importance of adaptation and resilience; however, subject matter experts provided a broader perspective on strategic engagement and navigating dynamic markets as part of fostering adaptability. In contrast, start-up representatives focused more on specific strategies such as market alignment and solution validation in response to market needs and regulatory challenges.

**2. Integrated Multi-Omics Imaging (B2B) Platform**
The convergence and divergence model based on the dimensions provided from both the subject matter expert and start-up representative interviews, with explanations for each convergence and divergence, is depicted in Figure 5:

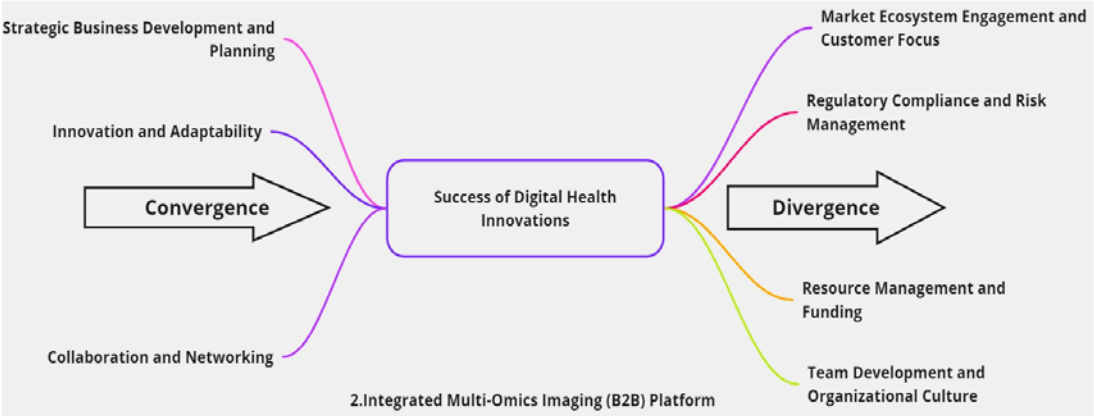


Figure 5: Convergence and Divergence model for Integrated Multi-Omics Imaging (B2B) Platform.

**Convergence Model**

**1. Strategic Business Development and Planning (SBDP):**
Both cohorts converged on the importance of strategic planning and development to drive business success. They emphasized aligning business strategies with operational activities and refining value propositions based on strategic planning insights. This alignment ensures efficient resource allocation and enhances customer segmentation and targeting strategies.

**2. Innovation and Adaptability (IA):**
Both cohorts recognized the significance of continuous innovation and adaptation to market dynamics. They integrated innovation into business processes and iterated value propositions based on market feedback and trends. This convergence fosters agility and competitiveness in responding to evolving customer demands and industry changes.

**3. Collaboration and Networking (CN):**
Collaboration and networking emerged as crucial elements endorsed by both cohorts. They highlighted the importance of building strategic partnerships and networks to enhance value propositions and support business growth. This convergence fosters a collaborative ecosystem that addresses customer needs and explores market opportunities effectively.

**Divergence Model:**

**1. Market Ecosystem Engagement and Customer Focus (MECF**):
While both cohorts emphasized understanding market needs and enhancing user engagement, the subject matter experts placed more emphasis on holistic market engagement and user-centric customization. In contrast, start-up representatives focused more on strategic market alignment and optimizing customer acquisition processes. This slight divergence highlights nuanced perspectives on market engagement strategies.

**2. Regulatory Compliance and Risk Management (RCRM):**
The subject matter experts and start-up representatives diverged slightly in their emphasis within this dimension. While both acknowledged the importance of regulatory compliance, subject matter experts focused more on navigating regulatory challenges and ensuring sustainability. In contrast, start-up representatives highlighted the complexity of managing intellectual property rights alongside regulatory requirements. This divergence underscores varied priorities in addressing regulatory and risk management complexities.

**3. Resource Management and Funding (RMF):**
There was a slight divergence between the two cohorts regarding resource management and funding strategies. While both emphasized optimizing resource allocation and securing funding, subject matter experts focused more on demonstrating value to investors through clear value propositions and revenue streams. In contrast, start-up representatives emphasized the importance of efficient resource management and strategic resource mobilization for sustainable growth. This discrepancy reflects nuanced perspectives on funding and resource allocation strategies.

**4. Team Development and Organizational Culture (TDOC):**
The cohorts exhibited a slight divergence in their emphasis on team development and organizational culture. While both recognized the importance of fostering a positive organizational culture, subject matter experts focused more on developing team expertise and driving innovation. In contrast, start-up representatives emphasized indirectly influencing team dynamics through strategic decisions impacting customer relationships and revenue streams. This divergence highlights varying perspectives on the role of organizational culture in driving innovation and success.

**3. Global Medical Tourism (B2C) Platform**

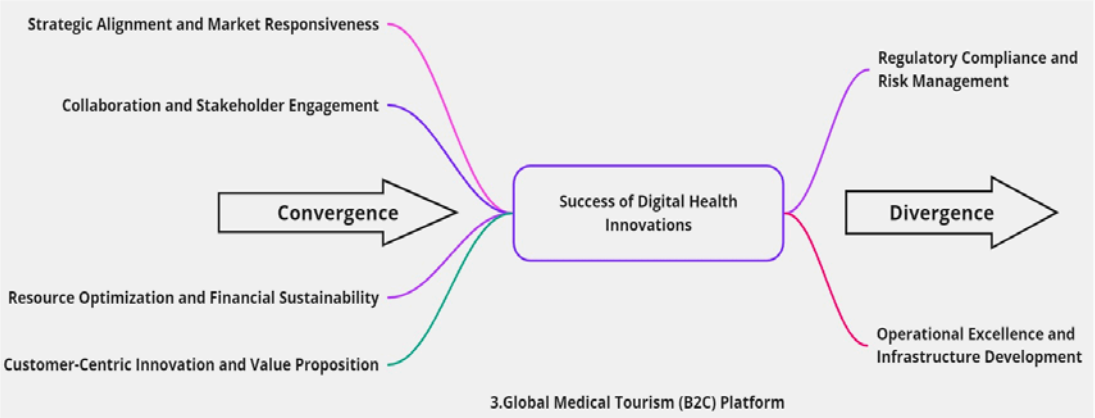


Figure 6: Convergence and Divergence model for Global Medical Tourism (B2C) Platform.

**Convergence Model:**

The convergence model identified common dimensions and areas where the insights from both cohorts aligned, suggesting a unified approach to navigating the digital health startup ecosystem.

**1. Strategic Alignment and Market Responsiveness (SAMR):**
Both cohorts emphasized the importance of strategic planning, market analysis, and adaptation to market dynamics. This converged on the need for continuous innovation and strategic flexibility to respond to market needs and competitive pressures.

**2. Collaboration and Stakeholder Engagement (CSE):**
The emphasis on collaboration, networking, and stakeholder engagement across both cohorts highlighted

the importance of building strategic partnerships and leveraging collective expertise for innovation and market expansion.

**3. Resource Optimization and Financial Sustainability (ROFS):**
Efficient management of resources and securing funding were critical themes, underscoring the importance of financial sustainability and strategic resource allocation for growth and innovation.

**4. Customer-Centric Innovation and Value Proposition (C-CIVP)**:
Prioritizing customer needs and experiences to drive innovation and enhance value propositions was a common thread, emphasizing the importance of patient-centered approaches in developing digital health solutions.

**Divergence Model**

The divergence model explored each cohort's unique perspectives and focuses, highlighting the diverse approaches within the digital health start-up ecosystem.

1. **Regulatory Compliance and Risk Management (RCRM)** (subject matter expert cohort):
A focus on navigating regulatory challenges and managing operational risks was more pronounced in the subject matter expert cohort, reflecting a broader concern for ensuring compliance and sustainability.

2. **Operational Excellence and Infrastructure Development (OEID)** (start-up representative cohort):
The start-up representative cohort strongly emphasized optimizing processes and infrastructure development, indicating a hands-on approach to ensuring quality and efficiency in service delivery.

**4. AI-Powered Biologics Discovery (B2B) Platform**

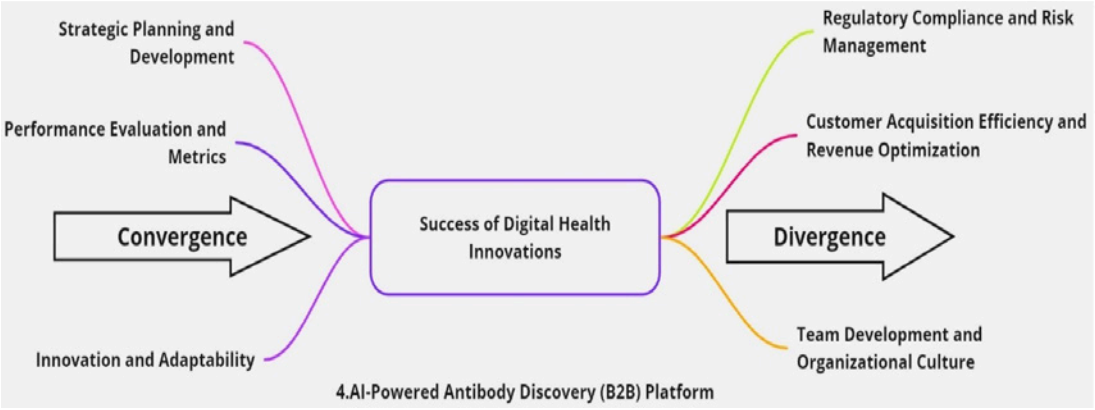


Figure 7: Convergence and Divergence model for AI-Powered Biologics Discovery (B2B) Platform.Platform.

**Convergence Model:**

**1. Strategic Planning and Development (SPD):**
- Both cohorts emphasized strategic planning and development, albeit with different focuses (start-up representatives on market dynamics and subject matter experts on business strategies).
- Integration Point: Aligning strategic planning with market dynamics for optimal business development.

**2. Innovation and Adaptability (IA):**

- Both cohorts acknowledged the importance of innovation and adaptation in response to market changes.
- Integration Point: Incorporating market insights from start-up representatives into strategic adaptation strategies suggested by subject matter experts.

**3. Performance Evaluation and Metrics (PEM):**

- Both cohorts highlighted the significance of performance evaluation and metrics in assessing business success.
- Integration Point: Establishing common KPIs and metrics that align with both strategic objectives and startup performance goals.

**Divergence Model:**

**1. Regulatory Compliance and Risk Management (RCRM):**

- While subject matter experts focused on regulatory compliance, start-up representatives emphasized intellectual property management and regulatory challenges.
- Divergence: Different priorities in regulatory aspects suggested a need for separate strategies in this dimension.

**2. Customer Acquisition Efficiency and Revenue Optimization (CAERO):**

- Start-up representatives prioritized customer acquisition efficiency and revenue optimization, while subject matter experts emphasized market engagement and differentiation.
- Divergence: Different emphases suggested separate strategies to be pursued in customer-centric approaches versus market-driven differentiation.

**3. Team Development and Organizational Culture (TDOC):**

- Subject matter experts emphasized team development and organizational culture, while start-up representatives focused on stakeholder-centric environments and soft skills development.
- Divergence: Different focuses suggested distinct strategies for fostering organizational culture versus stakeholder engagement.

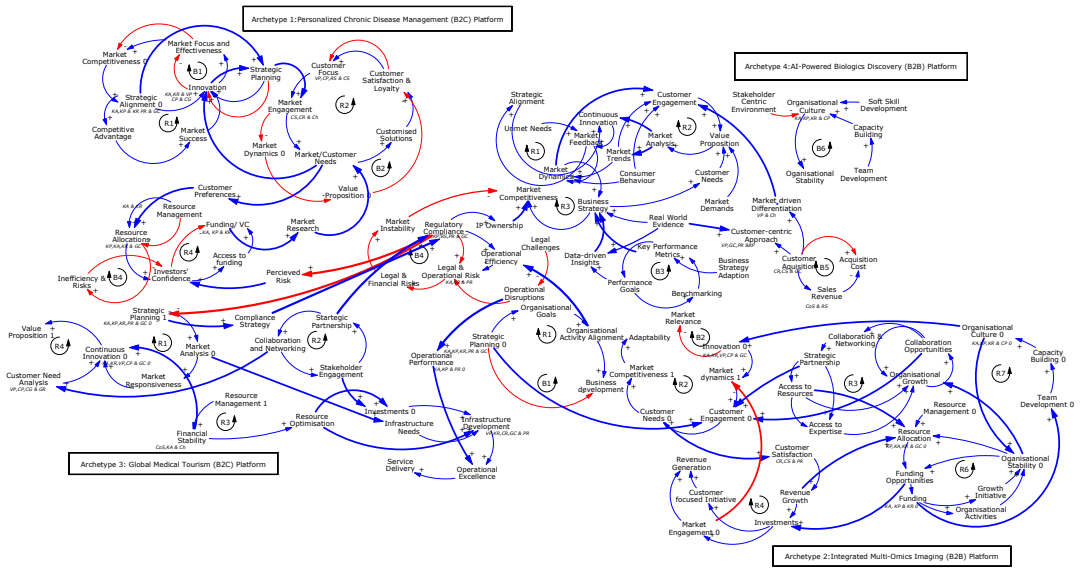


Figure 8: Canvas of the Archetype-Specific Research of Digital Health Landscape.

# 4. Conclusions

The research on "archetype-specific research of digital health landscape" across different platforms reveals a comprehensive exploration of the systemic interactions that drive success in various business contexts. The research smartly decomposes complex business ecosystems into interconnected feedback loops, identifying both reinforcing and balancing dynamics that underlie the operations of B2C and B2B platforms [1]. Here is an integrated analysis:

**Common Themes Across Platforms**

**1. Strategic Alignment and Innovation:** Across the platforms, there is a unanimous emphasis on the synergy between strategic planning and innovation. The iterative relationship between these elements serves as a backbone for sustainable competitive advantage, irrespective of the business model (B2C or B2B) or industry (healthcare, biotech, etc.).

**2. Market Dynamics and Customer Focus:** The diagrams underscore the necessity of understanding and engaging with market dynamics and customer needs. This engagement is not just a driver of product or service development but also a critical factor in regulatory compliance, resource allocation, and strategic direction.

**3. Regulatory Compliance and Risk Management:** Particularly prominent in sectors like healthcare and biotech, regulatory compliance is both a loop and a critical intersection point with other loops. It impacts and is impacted by strategic planning, market engagement, and resource management, emphasizing the need for agility and foresight in navigating legal landscapes.

**4. Resource Management and Funding:** Efficiency in using available resources and securing additional funding is depicted as crucial for both operational stability and strategic ventures. This loop interacts closely with market engagement, strategic alignment, and regulatory compliance, highlighting the interconnectedness of financial health and strategic objectives.

**5. Feedback Mechanisms:** The causal loop diagrams illustrate the existence of both positive and negative feedback mechanisms within and across the loops. These mechanisms ensure that the system can self-regulate and adapt, underlining the importance of feedback in strategic decision-making.

**Unique Insights**

Table 9: Key Insights of each Archetype

| Archetype | Key Insights |
|---|---|
| Personalized Chronic Disease Management (B2C) | Emphasizes "Strategic Alignment and Innovation Loop" and "Market Engagement and Customer Focus Loop," ensuring continuous innovation and customer-centric strategies. |
| Integrated Multi-Omics Imaging (B2B) | Highlights "Strategic Business Development and Planning Loop" and "Innovation and Adaptability Loop," focusing on aligning strategic initiatives with market demands and leveraging partnerships for growth. |
| Global Medical Tourism (B2C) | Underscores "Strategic Alignment and Market Responsiveness" and "Collaboration and Stakeholder Engagement," showcasing agility and external collaborations to meet diverse global market needs. |
| AI-Powered Biologics Discovery (B2B) | Stresses "Strategic Planning and Development" and "Regulatory Compliance and Risk Management" as critical in navigating the evolving biotech landscape. |

### Conclusions of Strategic Implications

Table 10: Robust Strategic Implications

| Strategic Insight | Implication |
|---|---|
| Holistic Management | Success demands an integrated approach, considering the dynamic interplay between feedback loops. Ignoring one loop may lead to unintended consequences. |
| Agility and Adaptation | Rapid adaptation to market dynamics and regulatory shifts is crucial for sustained growth. |
| Collaboration Across Ecosystems | Particularly vital for B2B platforms, fostering partnerships enables access to new markets, resources, and innovations. |
| Customer-Centric Innovation | Across all platforms, understanding and anticipating customer needs remain central to driving innovation and market success. |

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## 7. Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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