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# Care Pathway as the Basis for Collaborative Business Model Innovation in Healthcare

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**Abstract.** Digital transformation has disrupted various healthcare domains, yet we are just starting to witness the enrollment of digital solutions enabled by technologies such as artificial intelligence and machine learning. Stroke is one of the leading causes of death and permanent disability globally. Research evidence suggests a need for newer technology-enabled collaborative service models that will not only improve stroke care but are economically viable for stakeholders (i.e., service providers, patients, and payers). A new collaborative service model equally requires the development of new collaborative business models in the stroke care cycle. In a large-scale research ecosystem in Finland, the stroke care pathway is utilized to identify the scope of digitalization in early stroke diagnosis, treatment, rehabilitation, and secondary prevention. This study presents how the stroke care pathway has been used as the basis for new collaborative business models and healthcare service innovation.

**Keywords:** Collaborative business model, healthcare innovation, artificial intelligence, care pathway, stroke.

## 1 Introduction

The disruption caused by the use of data in the healthcare sector, e.g. the availability of biomedical data and the genetic makeup, has been compared with how information and communications technologies changed our society in the past decades [1]. Various forms of data and digital disruptions in healthcare help not only overcome existing long-term challenges in the domain (i.e., ageing population, growing non-communicable disease patient group) but also create novel vertical solutions [2], [3]. Furthermore, the immersion of ICT in the health sector has enabled people to acquire care outside hospitals and control and share their personal health information and user-generated content for more personalized care [4]. Nevertheless, we are only starting to witness the enrollment of digital solutions enabled by technologies such as artificial

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intelligence (AI) and machine learning (ML) [5]. One of the reasons for the inertia in embracing the possibilities of these new technologies is that the successful utilization of AI and ML technologies requires a holistic understanding of the implications of these technologies. The findings in Blomster and Koivumäki [6] suggest that the capability to understand the requirements for the data, the impact of the technology adoption on the service and business environment and rigorous business processes and management procedures to support data governance are the most crucial competencies of successful AI-based business model innovation.

AI-driven innovations are crucial for healthcare organizations in bridging the gap between future possibilities and healthcare delivery [4]. Especially innovations related to new approaches to preventing [7] and managing illness call for new technology-enabled solutions. Stroke is a medical condition caused by poor blood flow to the brain, and it is one of the leading causes of death and permanent disability globally. The scope of digitalization in stroke diagnosis, treatment, rehabilitation, and secondary prevention has different implications and needs for recovering patients and care providers. Therefore, we need to draw attention to patient care pathways and how digital solutions utilize data for the most optimal decision-making during the treatment continuum. Trans-ischemic attack (TIA) is called a “mini-stroke”, where the blood supply to the part of the brain is temporarily disrupted. TIA patients have a higher risk of having a stroke soon after TIA. On the other hand, usually, TIA patients do not have any symptoms after 24 hours of the attack, and they do not need any care or rehabilitation afterwards, only lifestyle changes and preventive medication. In this article, we focus only on the stroke care pathway.

Research evidence suggests [5] that there is a need for newer technology-enabled collaborative service models that will not only improve health care but are also economically viable for stakeholders (i.e., service providers, patients, and payers). This calls for the development of new collaborative business models in the care cycle that are based on patient care pathways. This single case study focuses on understanding “*how to use care pathway as a basis for collaborative business models in data-intensive healthcare innovation*”. This is done by examining the challenges and success factors when a care pathway is used as a baseline for business model innovation in the ecosystem that is collaborating to create a collaborative business with data-intensive innovations for stroke diagnosis, treatment, rehabilitation, and secondary prevention.

The research is structured as follows. First, the literature on patient care pathways is reviewed in connection with digitalization. Then, we will explore how business models are conceptualized in a collaborative healthcare setting. Then we will present our empirical case, explain the empirical findings and relate them to academic discussions in the final chapter.

## **2 Care Pathways and Patient Journey in Digital Health**

### **2.1 Care Pathways and the Patient Journey**

A patient care pathway acts as a template of the care to be offered to a specific group of patients; however, it is not intended to compromise clinical judgement. A care

pathway is a complex plan to support the mutual decision-making and organization of care processes for a well-defined group of patients, in most cases in a well-defined period [8]. One of the critical aims of building care pathways is to improve the quality of care across the treatment continuum. Care pathway has its roots in various management concepts and terms, such as the critical path method, the six sigma method, business process redesign and the theory of constraints [9]. However, works on care pathways have primarily focused on care “process” improvement and related innovation. Existing literature somewhat overlooks the need for improvement and innovation of care “products” and “systems” that can further improve the overall care pathway performance. Patient care pathways are often finalized as a formal document presenting steps in the care process, the period in each step that the treatment will require or even the period that needs to be elapsed before the next step can be started. Although formally organized care pathways become an integral part of the selected patient groups’ treatment once implemented, the unformalized care pathways can often be used as a tool for innovation and unit of analysis [10]. The concept of patient journey maps is closely tied to such unformalized patient care pathways. Patient journeys emphasize user centricism and how it could impact designing future care pathways and solutions for healthcare [11]. Patient engagement and input about patients’ expectations of solutions can enhance the acceptance of new medical and non-medical devices and systems [12]. In the scope of this paper, we use the terms patient care pathway and patient journey interchangeably.

## 2.2. Digitalization in Modern Healthcare

According to Standell and Wolff [13], the total number of people aged over 65 in the 28 EU states is expected to peak at 149.2 million in 2050 from 101.2 million in 2018. World Health Organization (WHO) [14] states that among six WHO regions, the European region has the highest number of patients affected by non-communicable diseases. Together, these five significant conditions account for 77% of diseases and 86% of deaths in the European region.

Data-intensive digitalization in healthcare focuses on solving problems for the ageing society and non-communicable diseases [2], [15]. Within this scope, data becomes a vital resource, which is available for collection, but in the healthcare domain, it is often unavailable for analysis, innovation, and commercialization purposes. Data analytics and visualization techniques help in better decision-making for individual patient treatment [16], [17] and can also help create better health policies for the population. AI capabilities and its application in healthcare as a medical device, still have different hurdles such as legitimacy, ethical use, standardization and regulatory approval. To enable AI deployment and governance for healthcare, a collaboration between policymakers, healthcare professionals, technology developers and researchers is needed, as well as international cooperation and coordination [18].

While low- and middle-income societies lack direct financial resources to be invested in the healthcare systems, higher-income societies also face a lack of other human and technological resources. Data can be used as resources for better-personalized healthcare services that help patients get better care and allow healthcare

professionals to organize their care. Automatic data collection and standardized interfaces are among key technological success factors for new services in healthcare [19]. To manage the various challenges in future healthcare, digital-intensive health solutions can be developed to optimize access, sharing, analysis and usage of collected data [15]. Future digital-intensive solutions are envisioned to bring together patients, doctors, nurses, and other healthcare professionals. The secure and proper data channeling between various stakeholders can be completed according to the MyData principle [20].

### **3 Towards Collaborative Business Models in Healthcare**

#### **3.1 Business Model Innovation**

Business models are often imposed by technological innovation that creates the need to bring discoveries to market and the opportunity to respond to unmet customer needs. Hwang and Christensen [21] claimed that disruptive technologies should match innovative business models. Christensen et al. [22] conceptualize business models to be made of four elements: 1) a value proposition for customers; 2) resources (e.g., people, money, technology); 3) the processes used by the organization to convert inputs to finished products or services; and 4) the profit formula dictating the margins, asset velocity, and scale required to achieve an attractive return [30, p33]. These elements are interdependent and must be compatible for the business model to function [22]. The business model needs to describe how the solution brings value to its customers in a profitable way and how this value is delivered to the customers.

The health sector has long been criticized for lacking innovation in the business models [21]. This resonates with academic research on business model innovation in the healthcare context. First, it is important to acknowledge that business models are not static descriptions of elements but evolve, requiring constant innovation and experimentation [23]. Adding to the complexity of business model innovation in healthcare, it is also important to note that creating business models for new ventures emphasizes a different focus than developing business models for more mature organizations. Therefore, business model innovation can be defined as the design of novel business models for newly formed ventures (BMD) or the reconfiguration (BMR) of existing business models [24] to explain the two types of business model innovation. While BMD refers to the entrepreneurial activities of creating, implementing, and validating; BMR involves reconfiguration requires shifting from an existing model to a new one through gradual to radical degrees of change in the new business model. In the case of business model reconfiguration, the innovation in the business model often has an epicentre. As the business model is assumed to have a customer side, a resource and capabilities side, a value proposition element, and a cost and revenue element, the business model innovation can be driven by any one or more of these “epicentres”.

### **3.2 Collaborative Business Models in Healthcare**

Traditionally, healthcare systems have suffered from fragmentation and a low innovation capacity, where challenges related to balancing the allocation of resources and performance [4], [25]. The innovation process in healthcare increasingly requires access and combinations of knowledge from different departments and sectors; innovators are pushed towards collaboration [4], [5] with various types of actors to overcome these challenges. However, how organizations manage this collaboration and co-develop their capabilities to build mutually beneficial relationships becomes a central question [26]. Complementarities in resources and alignment in objectives, opportunities and advantages can create a basis for collaboration in healthcare business ecosystems [3]. Also, complementary strategic goals, opportunities, and combined advantages allow collaborating business entities to co-create and co-capture greater value [27].

Newer conceptualizations of business models take the external environment and ecosystem into account and emphasize collaboration, synergy and compatibility [27]. Business models can be used as tools to bend the boundaries of organizations [28], where a collaboration of the focal organization with its network can be considered one of the main functions of the business model [29]. Therefore, understanding how business models can be utilized as tools for developing and streamlining collaboration, more specifically the co-creation, co-capture and co-development of capabilities, opportunities and eventually solutions, becomes central. The search for collaboration, synergy and compatibility puts even more pressure on innovators of healthcare solutions. In addition to internally matching the different business model elements, they also need to ensure their business model is compatible with the partners in the process. Therefore, this kind of interplay between the design and reconfiguration perspectives of business model innovation, coupled with collaboration, is of crucial importance to academic discussion on business models and practitioners.

## **4 Research Approach**

### **4.1 Stroke-Data Project**

The research data for this study is primarily collected from a Business Finland-funded Smart Life R&D project consortium titled “Stroke-Data”. The consortium comprises various stakeholders from industry and academia; five active industry partners are involved in the project, and three industry partners complement the project as affiliates. The overall setup of the industry partners has a mix of SMEs and larger organizations in the ecosystem. In addition, the research consortium includes three research organizations and three hospital organizations. Among the hospital organizations, two

tertiary level hospitals are responsible for population healthcare for large areas of the country. The third hospital organization involved in the project is a privately functioning rehabilitation hospital. Among the industry partners, different partners focus on digital health solution design and development, medical device production for clients, medical data platform creators, and remote monitoring device and service producers. Together, the stakeholders form a specialized data-intensive healthcare ecosystem, with a mutual goal to create ways to provide better patient care through the co-creation of novel data-intensive innovations for stroke identification, treatment, diagnosis, and rehabilitation.

While the R&D project primarily aims to create new data-intensive solutions for TIA and Stroke care to provide better care and save health costs, the consortium also creates an ecosystem of stakeholders working towards implementing research results for the future healthcare market. The R&D actions include business model ideation, business model innovation with partners, co-creation of solution ideas, and conceptualizing ecosystemic collaborative business models for Stroke-Data.

#### **4.2 Data Collection**

The co-creation of data-intensive innovations in healthcare requires clinical data. The project consortium initially aimed to obtain datasets from real-life situations along the care path of stroke and TIA patients. The data used for research and creating data-intensive innovations comes from a local birth cohort, the Northern Finland Birth Cohort (NFBC), and by collecting new data sets with various sensors and devices at two hospitals and one rehabilitation hospital. The data collection at hospitals happened, with patients' consent, after the patients had received the most acute treatment and were in the ward for follow-up. In addition, the collected data sets allowed the consortium to focus on co-creating solutions for the phases in the care path after stroke, such as rehabilitation.

This research was constructed as a qualitative single case study [30]. First, during the early stages of the joint effort, six semi-structured interview sessions with industry partners focused on Stroke-Data objectives, technical infrastructure, existing business models, and co-creation opportunities, among other topics. Further, a scenario mapping workshop was organized as a part of service ideation and innovation; this workshop was co-organized with medical professionals who are experts in the field of Stroke treatment and diagnosis, technology developers from multiple industry partners, and researchers. There were altogether 27 participants in this workshop. The results of the scenario workshop helped to identify the current state of technology, data utilization and the patient journey in the studied context and the preferable and probable scenarios for the future. Based on the workshop results, the needs and challenges of the current patient journey were identified, which helped draft an initial set of high-level requirements for the future preferable patient journey. From there, coupled with requirements and opinions from clinical experts, the research team in the Stroke-Data project started working on identifying a more detailed set of user needs and requirements, which were further validated in the project workshop.



Altogether, 157 high-level user needs were identified in this task that can be developed through software solutions. In addition, the second round of business model-focused interviews were conducted with all the industry partners that raised issues such as data security, privacy, access, innovation in healthcare, and collaborative activities within the ecosystem. Altogether 10 follow-up interviews were conducted in this phase. The follow-up interviews also covered challenges in inter-organizational collaboration, data-related issues in digital healthcare innovation, and validating the data collection approach.

## 5 Findings and Analysis

Stroke, one of the leading causes of permanent disability and death globally, has a broad impact on societies. The patient journey or the care pathway has been identified as a critical basis of service innovation in the context of this R&D project. However, it is understood from the research data that the contributors agree to observe the patient journey on a general level, which will enable service creation opportunities to be broader. The generic stroke patient journey can be perceived to have five stages where medical assistance can be provided to the patient: 1) the scene of the stroke event and the ER, 2) The intensive care and surgery facilities, 3) post-surgery care and Stroke ward, 4) rehabilitation in-hospital care, and 5) rehabilitation in home-care.

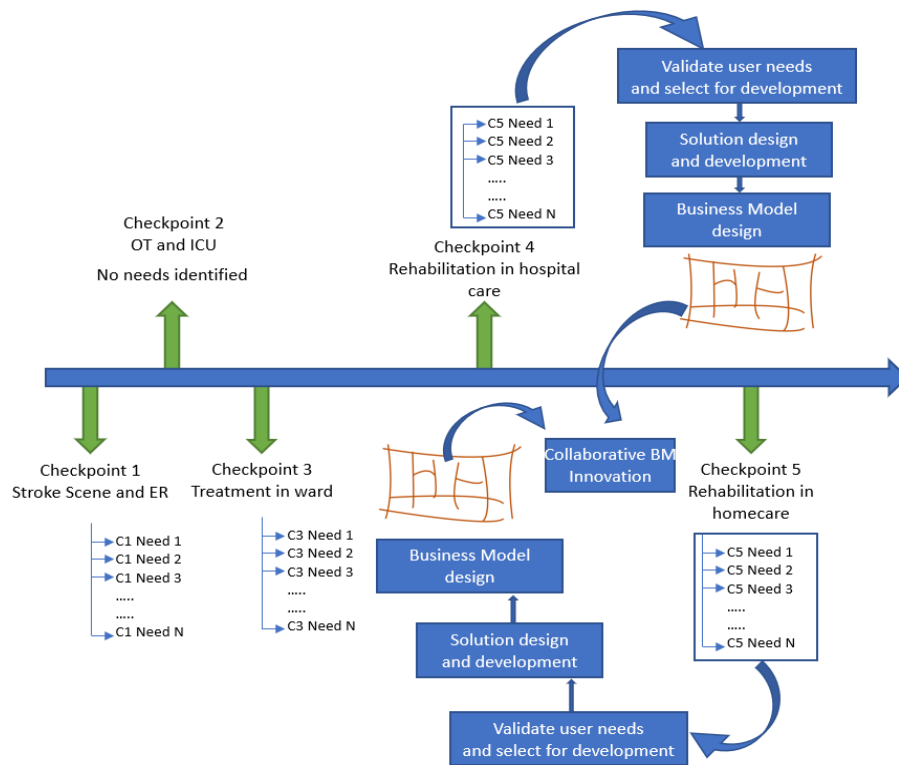
The 157 user needs covered the phases of prediction, emergency care, diagnosis, and rehabilitation of stroke patients. Further, these high-level user needs were defined for both users who are healthcare professionals and lay people.

Initial interviews revealed that among all the industry partners in the ecosystem, some had clear research and development plans in the domain of digital health, which contributes to the stroke patient care pathway. Some of the industry partners brought special skills and long-term goals aligned with the public research program's aims. In addition, the Small and Medium Enterprises (SME)s involvement in the project is for new solution development and validated references to their solutions. Most industry partners involved are not generic stroke or neuro care providers. Hence, the devices and services created in the program context significantly differ from the usual offerings for most industry partners. The same can be argued about the business models for each industry partner involved in the case.

The original objectives of the research project included clinical data collection and research of new services in four out of the five stages of the stroke patient journey. Data collection from the intensive care and surgery facilities was identified outside the scope of the project's onset. However, during the Covid-19 pandemic, clinical data collection using new devices for foundational research proved unfeasible, especially for stroke patients who are often highly vulnerable. Hence, the clinical data collection was planned to be reduced to stroke ward patients and rehabilitation hospital patients, besides data from control groups. While the clinical data is not the subject of this paper,

the clinical data collection and research on new services affect the co-creation and collaboration outcomes.

The industry partners in the stroke data project used the care pathway and business model workshops organized in the project as a baseline to identify the key focus areas of their stroke-related services and businesses in overall stroke care. One of the partners decided to focus on pre-hospital care. In contrast, two of the partners in the ecosystem concentrated their efforts more on the rehabilitation of stroke patients dividing their businesses into one vertical solution including two perspectives 1) rehabilitation decision support and 2) personalized data-intensive service innovation for the stroke rehabilitation patients. Although the two companies focusing on rehabilitation cases have a clear distinction in the offering or basic value proposition and customer segments they are serving; the partners agreed to co-create one “vertical solution” for the involved rehabilitation hospital having separate interfaces instead of creating two “horizontal solutions” which could potentially become competitors. The research data suggests that the decision to make one “vertical solution” was as much a “business model decision” as it was a “technology decision” by the industry partners involved in the case.



**Fig. 1.** The Stroke-Data process: from patient care pathways to collaborative business models.

From the collaborative business model perspective, we can observe that both partners targeted the same “phase/stage” of the stroke patient journey. However, their targeted end-users group are different but working together in such a way that these end-user groups are constantly connected for the whole care cycle to be completed is bringing them additional value compared to their competitors in the market. Further, from the value proposition elements, the partnering players identified complementarities in such a way by not only creating value for customers but also by reducing future competition among themselves. A coherent technology strategy means reduced technical infrastructure costs for both parties. Although the vertical solutions are closely integrated, they can also be sold as standalone systems to different customers where the need is such. However, the closely integrated solutions also bring the opportunity of “piggybacking” sales for both partnering players; a new sale made by one partner can bring new customers to the partner organization.

While looking closely at the collaboration between these two companies, a few essential continuous efforts have helped this collaboration succeed thus far. First, the partners have agreed on specific resource sharing between themselves. This indicates that both the partners are willing to identify the strength and expertise of the other side’s organization and utilize the collective strength. The resources not only include human or financial resources, but they can also include technology know-how, a specific skill set and expertise. Second, both partners have actively participated in customer case meetings to ideate, identify, and develop the solution on a regular schedule. Precise goal setting and following through with checkpoints have helped the collaboration smoother. Third, when it comes to solution testing, the organizations adopted an “open” strategy to allow the other party to test the solutions as standalone and build modular services. Fourth, seamless communication between partnering organizations has been identified as a key to inter-organizational collaboration. Fifth, although the companies are not yet in the commercialization phase, there are early discussions within the organizations on value-sharing models that can benefit both parties.

Data-intensive innovation in the healthcare domain in the current European market is challenging due to data protection regulations if the innovating organizations are looking to use actual patient data for development. The original aim of this collaborative solution for the Stroke-data rehabilitation case included data analytics and AI capabilities applied to actual patient data collected in the scope of the research project. However, current data protection regulations and the test use of the developed solution with actual patients meant that such analytics and AI capabilities could not be trialled in the first phase. In the current scope, the collaborating partners agreed the vertical solutions would create a seamless communication channel between rehabilitating Stroke patients and healthcare professionals to track their rehabilitation process digitally. The inclusion of data analytics, AI and ML capabilities will be done in the future phases of the collaboration.

Looking at the Stroke-Ward phase of the studied case, although the clinical data collection and data-oriented medical research are being conducted, they are currently conducted as foundation research only. Only public organization (University and

Hospital) researchers are permitted to access and analyze the collected clinical data for any potential ML or AI algorithms. Any personnel from organizations with commercial objectives will only be given access to an anonymized and aggregated data set with no identifiable variables available. This prolongs the product-to-market timeline for the participating partners in this phase.

## 6 Discussion and Conclusions

In this study, we looked at the Stroke-Data ecosystem, where multiple research organizations, hospitals and industry partners combined efforts to co-create data-intensive solutions to improve the current state of early stroke treatment, diagnosis, rehabilitation, and secondary prevention. From a business model innovation perspective, the case shows how a patient journey or care pathway can be used as a unit of analysis to locate the “epicentre of innovation”. Our findings suggest that collaborating partners not only utilized these “epicentres” for innovation but further deepened the collaboration between them. The complementarities of resources and alignment of objectives also enable creating such collaborative business models [26], [27]. We also observed in this case that the same epicentres could enable collaboration between multiple organizations. This collaboration can take various forms: resource sharing, skill and expertise exchange, business case development, and business model co-development, among other things. The care pathway approach for collaborative business model innovation is not only meant to identify the initial epicentre of collaboration but instead, continuously supports collaboration throughout the development cycle. This is important so that the developed solutions will address the needs of the “patient care pathway” besides the needs of the patient in the specific phase of the pathway.

Some of the identified benefits of this approach realized during this exercise include a clear and empirically validated value that the newly created solutions will have; as solutions developed in this approach are based on actual user needs and requirements, close cooperation means a faster development cycle, continuous customer feedback in the development cycle also improves the solution outcome. As one of the challenges of this approach, these activities seem to be individual-oriented. Changes in personnel in partnering organizations can impact collaboration. Also, organizational objectives, resources, and objectives are essential in addressing specific pathway needs. Another challenge in such activities is the strict regulations on data usage by commercial organizations and the lack of collaboration with healthcare professionals.

The identified limitations of this study include the research data is gathered from a single project. Although rich and diverse in qualitative terms, it is challenged by generalizability. Current data protection regulations stand, private organizations with commercial goals are not permitted to access and analyze personal data which are not “fully anonymized”. To develop such solutions, the innovating companies need to test the developing solutions with a “synthetic data set”. The result is that even digital solutions that require certification as a “medical device” will need to go through formal

clinical trials. Using a “synthetic data set” in the development rounds can end up being unrepresentative of the actual use case in various ways, resulting in unreliable trial attempts. Hence the cycle from idea to product to implementation can be significantly longer than expected. Future research is called on tackling how to speed up the commercialization of data-driven healthcare solutions and how collaborative methods can help validate especially personal data at an individual level and scale these solutions for broader industry use. We also need to increase our understanding of the companies’ challenges when making AI-driven innovations in the ecosystems creating certified medical solutions.

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