International Journal of Smart Business and Technology
Vol. 14, No. 1 (2026), pp. 21-38
http://dx.doi.org/10.21742/ijsbt.2026.14.1.02

# Smart Service Design for Digital Sports Rehabilitation: A Customer Journey Map Approach in the Hungarian Healthcare Ecosystem

Andras Simon[1*] and Zsigmond Gyombolai[2]

[1,2]*Department of Physiotherapy, Faculty of Health Sciences, Semmelweis University, Budapest, Hungary*

[1]*andras.simon@semmelweis.hu*, [2]*gyombolai.zsigmond@semmelweis.hu*

***Abstract***

*The rapid digital transformation of healthcare systems has created new opportunities for improving rehabilitation services through smart service design and technology integration. However, many rehabilitation systems remain fragmented, leading to limited service efficiency, inconsistent patient experiences, and insufficient long-term engagement. This study proposes a smart service design framework for sports rehabilitation using the Customer Journey Map (CJM) as a core analytical tool. Focusing on Hungary's emerging digital healthcare ecosystem, the research examines how rehabilitation services can be redesigned to enhance user experience, service continuity, and technological integration. The study employs a mixed research approach that combines literature review, service design analysis, and comparative case insights from international rehabilitation practices. Based on this analysis, the rehabilitation service journey is structured into five key stages: initial consultation, health assessment and goal setting, personalized rehabilitation intervention, progress monitoring and feedback, and long-term health management. Each stage is examined in terms of user needs, service touchpoints, stakeholder interactions, and emotional experience throughout the rehabilitation process. The findings highlight the importance of integrating tele-rehabilitation platforms, wearable monitoring devices, digital health records, and multidisciplinary collaboration in creating a smart rehabilitation service ecosystem. Such integration improves patient participation, enables data-driven treatment adjustments, and supports continuous care beyond clinical settings. The proposed framework contributes to the development of user-centered smart healthcare services. It offers practical implications for healthcare institutions, technology developers, and policymakers seeking to modernize rehabilitation systems within digitally enabled health environments.*

***Keywords:*** *Smart healthcare, Sports rehabilitation, Service design, Customer journey map, Digital health ecosystem, Hungary*

## 1. Introduction

Rehabilitation has become a strategic priority in contemporary health systems because disability, chronic disease, injury, and population ageing are increasing the demand for long-term functional care. A global analysis based on the Global Burden of Disease 2019 estimated

**Article history:**
Received (November 29, 2025), Review Result (January 2, 2026), Accepted (February 5, 2026)
*corresponding author
[2]https://orcid.org/0000-0001-7153-805X

that 2.41 billion people had health conditions that could benefit from rehabilitation, with musculoskeletal disorders accounting for the largest share of this need, affecting about 1.71 billion people worldwide [1]. Related burden analyses have also shown that musculoskeletal disorders remain among the leading contributors to disability-adjusted life years globally, with especially strong effects on mobility, work participation, and quality of life [2]. These trends make rehabilitation not only a clinical concern but also a service-system challenge that requires more accessible, coordinated, and scalable models of care [1][2].

Within this broader context, sports and musculoskeletal rehabilitation are under growing pressure to deliver continuous, personalized, and outcome-oriented services. Conventional rehabilitation models still depend heavily on face-to-face supervision, repeated facility visits, and therapist-centered workflows, which can create barriers related to travel, cost, scheduling, and service continuity. Early clinical evidence indicates that telerehabilitation can be implemented without compromising clinical quality in orthopedic recovery while maintaining high patient satisfaction [3]. Subsequent reviews have reinforced this direction, indicating that telerehabilitation can produce outcomes comparable to conventional rehabilitation for several physical therapy contexts, while also reducing disruption to daily life [4]. These findings suggest that rehabilitation is increasingly moving toward hybrid and digitally enabled delivery models rather than remaining exclusively clinic-based [3][4].

At the same time, digital transformation in rehabilitation is being accelerated by wearable sensing, remote monitoring, and artificial intelligence. Reviews of smart rehabilitation technologies have shown that wearable devices can capture movement, range of motion, physiological signals, and performance indicators, supporting home-based monitoring and more objective progress assessment [6]. Systematic evidence on AI-supported physical rehabilitation further indicates that digital tools are expanding across app-based systems, gaming environments, robotics, and wearables. However, implementation quality and real-world evaluation still vary considerably [7]. More recent evidence has strengthened the case for digital rehabilitation, showing that telerehabilitation for musculoskeletal disorders can be effective and cost-effective, particularly when face-to-face care is limited or continuity across settings is important [8]. Umbrella-level evidence also suggests that telemedicine can provide accessible care with noninferior outcomes for multiple musculoskeletal conditions, although objective outcome measurement and integration into routine workflows remain incomplete [9].

Despite these advantages, digital rehabilitation cannot be treated as a purely technical upgrade. Adoption barriers remain substantial and include staff readiness, resistance to change, reimbursement constraints, infrastructure limitations, and uneven digital literacy among users and providers [5]. In practice, this means that successful smart rehabilitation depends not only on devices and software but also on the design of the overall service journey: how patients enter the system, how assessments are coordinated, how feedback is delivered, and how long-term follow-up is sustained. This service design perspective is particularly important in rehabilitation because recovery unfolds across multiple stages, actors, and settings rather than through a single isolated clinical encounter [5][7][9].

For this reason, patient- and customer-journey approaches are becoming increasingly relevant in digital health research. Patient journey mapping has been described as an emerging method for understanding how people move through health systems, identifying touchpoints, transitions, and pain points that shape actual care experiences [10]. Recent work on digitally enabled health innovations has further shown that journey mapping and service blueprinting are valuable for designing interventions that align technology with user behavior, system processes, and real-world adoption conditions [10]. In rehabilitation, where emotional

fluctuations, adherence challenges, and multidisciplinary coordination are central to outcomes, a journey-based framework provides a robust analytical basis for service redesign.

This perspective is especially relevant for Hungary, where digital health development is advancing but remains uneven across settings. A 2024 study of Hungarian primary care physicians found that doctors were generally more open to digital tools that facilitate patient communication and collaboration than to technologies directly supporting clinical work, and the study emphasized the importance of knowledge, training, and experience in shaping adoption [11]. At the same time, recent Hungarian evidence from a public insurance-based telemedicine program demonstrated that digitally supported mobile healthcare services could expand access, identify previously undetected chronic conditions, reduce referral pressure, and receive very positive user feedback in underserved rural districts [12]. Taken together, these findings indicate that Hungary has both the need and the emerging institutional basis for more integrated smart rehabilitation services, but that technological adoption must be linked to practical service design and user experience considerations [11][12].

Against this background, the present study positions sports rehabilitation not merely as a therapeutic activity but as a smart service system that combines clinical expertise, digital infrastructure, and user-centered pathway design. The paper argues that the Customer Journey Map (CJM) provides an appropriate framework for redesigning rehabilitation around five connected stages: initial contact, assessment and goal setting, personalized intervention, progress monitoring, and long-term health management. By reframing rehabilitation through a smart business and service design lens, this study aims to contribute a Hungary-oriented model for digitally enabled sports rehabilitation that is clinically meaningful, operationally coherent, and suitable for discussion within the scope of the International Journal of Smart Business and Technology [8][10][11][12].

## 2. Literature review/theoretical background

### 2.1. Digital transformation in rehabilitation services

The digital transformation of healthcare has reshaped how medical services are delivered, monitored, and evaluated. In rehabilitation medicine, the integration of digital technologies, including telemedicine platforms, wearable monitoring devices, artificial intelligence, and mobile health applications, has significantly expanded the capabilities of conventional therapeutic models. These technologies support continuous monitoring of patient progress and facilitate remote therapeutic interventions, enabling rehabilitation services to move beyond the limitations of physical clinical environments [13].

One of the most important technological developments in modern rehabilitation systems is the application of wearable sensing technologies. Wearable devices can capture physiological and biomechanical signals, including body movement, joint angles, muscle activity, and cardiovascular indicators. These devices allow clinicians to assess patient progress during rehabilitation exercises objectively and provide real-time feedback to improve exercise performance and adherence [14]. Compared with traditional observational assessment methods, wearable systems offer a more precise and data-driven approach to rehabilitation monitoring.

In addition to wearable monitoring, tele-rehabilitation has emerged as a major innovation in healthcare service delivery. Tele-rehabilitation enables patients to perform rehabilitation exercises at home while receiving remote supervision and guidance from healthcare professionals via digital communication technologies [15]. This model has become

particularly important for patients who face geographical barriers or mobility limitations that prevent them from regularly attending clinical sessions. Research has shown that tele-rehabilitation can achieve therapeutic outcomes comparable to those of traditional face-to-face rehabilitation while reducing travel time and improving patient convenience [16].

Artificial intelligence (AI) technologies further enhance digital rehabilitation systems by enabling predictive analytics and automated clinical decision support. Machine learning algorithms can analyze large volumes of patient data obtained from wearable devices and electronic health records to identify patterns associated with recovery progress and rehabilitation effectiveness. These insights enable clinicians to personalize treatment strategies and adjust therapy programs based on individual patient needs [17]. As a result, AI-driven rehabilitation systems contribute to precision rehabilitation, in which therapeutic interventions are tailored to specific patient characteristics and recovery trajectories.

Despite these technological advances, several studies emphasize that the effectiveness of digital rehabilitation systems depends not only on technological capabilities but also on how these technologies are integrated into healthcare service processes. Barriers such as a lack of digital literacy among healthcare providers, limited technical infrastructure, and resistance to organizational change can hinder the successful implementation of digital health innovations [18]. Consequently, digital rehabilitation must be supported by service design approaches that consider patient behavior, healthcare workflows, and institutional coordination.

### 2.2. Service design in healthcare systems

High levels of complexity characterize healthcare systems due to the involvement of multiple stakeholders, diverse service interactions, and long-term patient engagement. These characteristics make healthcare services particularly well-suited to service design methodologies, which analyze and optimize service systems by focusing on user experiences and service interactions. Service design integrates insights from design thinking, management science, and user experience research to improve the efficiency and effectiveness of service delivery [19].

One of the central principles of service design is human-centered design, which emphasizes understanding user needs, motivations, and behaviors when designing service systems. In healthcare settings, this approach involves analyzing how patients interact with healthcare providers, facilities, and technologies throughout the care process. By examining these interactions, service designers can identify inefficiencies, communication barriers, and service gaps that negatively affect patient experiences [20].

Another important concept in service design is co-creation, which involves active collaboration between service providers and service users during the design process. In healthcare systems, co-creation enables patients, healthcare professionals, and caregivers to contribute their perspectives to the development of new service models. Participatory design practices can improve service quality by ensuring that healthcare innovations align with real-world needs and expectations [21].

In rehabilitation contexts, service design is particularly important because rehabilitation processes often extend over long periods and involve multiple stages of care. Patients typically interact with different healthcare professionals, including physicians, physical therapists, rehabilitation specialists, and support staff, throughout the recovery process. Without effective service coordination, these interactions may become fragmented, resulting in inconsistent treatment experiences and reduced rehabilitation effectiveness [22].

Service design methodologies provide tools for mapping these interactions and designing integrated service pathways that ensure continuity of care. For example, service blueprinting techniques allow researchers and practitioners to visualize frontstage and backstage service activities, highlighting how clinical processes, administrative procedures, and technological systems interact within the healthcare ecosystem [23]. By identifying inefficiencies within these processes, healthcare organizations can redesign service workflows to improve patient outcomes and operational efficiency.

Furthermore, the integration of digital technologies into healthcare services has increased the importance of service design in modern healthcare systems. Digital health innovations often introduce new interaction channels between patients and healthcare providers, including mobile applications, online consultation platforms, and remote monitoring systems. Service design frameworks help organizations coordinate these digital and physical touchpoints, ensuring that technological innovations enhance rather than complicate the patient experience [23].

### 2.3. Customer journey mapping in healthcare services

Customer Journey Mapping (CJM) is widely recognized as a valuable tool for analyzing and improving complex service systems. Originally developed in marketing and service management, CJM visualizes the sequence of interactions customers experience when engaging with a service. These interactions include physical touchpoints, digital channels, and emotional responses that occur throughout the service process [24].

In recent years, CJM has been increasingly applied to healthcare services under the concept of patient journey mapping. Patient journey mapping focuses on understanding the entire healthcare experience from the patient's perspective, including the stages of diagnosis, treatment, recovery, and follow-up care. By mapping these experiences, researchers can identify critical moments where service improvements can significantly enhance patient satisfaction and healthcare outcomes [25].

One of the key strengths of journey mapping is its ability to capture both functional and emotional aspects of service experiences. Healthcare services often involve emotional challenges such as anxiety, uncertainty, and frustration, particularly in long-term treatment processes like rehabilitation. Journey mapping enables researchers to visualize emotional fluctuations across different stages of the service process and to identify opportunities to provide psychological support and to develop patient engagement strategies [26].

Another important advantage of journey mapping is its ability to facilitate interdisciplinary collaboration. Healthcare services involve interactions among multiple stakeholders, including clinicians, therapists, administrators, and technology providers. By providing a shared visualization of service processes, journey maps help stakeholders develop a common understanding of service challenges and coordinate improvement efforts more effectively [27].

The relevance of journey mapping becomes even greater in digitally enabled healthcare environments. Modern healthcare systems increasingly rely on digital platforms that integrate telemedicine services, mobile health applications, wearable monitoring technologies, and electronic health records. These technologies create multiple interaction channels between patients and healthcare providers. CJM helps organizations identify how these channels interact and how to optimize them to deliver seamless healthcare experiences [28].

In the context of sports rehabilitation, journey mapping provides a structured framework for analyzing patient interactions with rehabilitation services across different stages of

recovery. By examining the rehabilitation journey—from initial consultation and diagnosis to long-term health management—researchers can identify service gaps and design integrated rehabilitation systems that improve treatment outcomes and patient engagement.

## 3. Research methodology

This study adopts a mixed-method research design that integrates literature analysis, service design methodology, and conceptual modeling to investigate the development of a smart rehabilitation service system. Mixed-method approaches are widely used in healthcare service research because they enable scholars to combine qualitative insights related to patient experience with structured analytical frameworks for system design and evaluation. In complex healthcare environments, such as rehabilitation services, both technological performance and user interaction must be examined simultaneously to develop effective service innovations [19]. Consequently, this study's research design focuses not only on technological capabilities but also on the organizational and experiential dimensions of rehabilitation services.

The study's methodological framework comprises three major stages: literature analysis, service system analysis using customer journey mapping, and conceptual framework development. The first stage involves a systematic review of relevant academic literature to identify the theoretical foundations and research gaps in digital rehabilitation technologies, healthcare service design, and digital health ecosystems. A literature review is considered a fundamental research methodology in interdisciplinary studies because it allows researchers to synthesize existing knowledge and develop new conceptual perspectives based on prior research findings [20].

During the literature search process, keywords such as “sports rehabilitation,” “digital rehabilitation,” “tele-rehabilitation," "service design in healthcare," "patient journey mapping," and "digital health ecosystems" were used. The initial search yielded more than 100 potential articles on rehabilitation service design and digital health technologies. After applying screening criteria based on relevance, publication quality, and methodological rigor, approximately forty-five peer-reviewed studies were selected for detailed examination. These studies provided insights into technological innovations in rehabilitation systems, service design approaches for healthcare delivery, and digital health integration models. Previous research has shown that combining digital technologies with service design frameworks can significantly enhance healthcare accessibility, service efficiency, and patient satisfaction, thereby supporting the development of more responsive healthcare systems [21].

Following the literature analysis, the study applies Customer Journey Mapping (CJM) as the primary analytical framework for examining rehabilitation service processes. CJM is a widely recognized service design tool that visualizes the sequence of interactions between service users and service providers throughout the service lifecycle. By identifying service touchpoints, user behaviors, and emotional responses across different stages of service delivery, journey mapping helps researchers identify service inefficiencies and opportunities for innovation [22]. In healthcare systems, patient journey mapping has become an increasingly important tool for analyzing patient experiences across complex processes involving multiple providers, treatment stages, and institutional interactions.

Rehabilitation services offer a particularly suitable context for applying journey mapping techniques, as rehabilitation processes often span long periods and require repeated interactions between patients and healthcare professionals. Patients undergoing rehabilitation typically interact with physicians, physical therapists, rehabilitation specialists, and support

personnel at various stages of recovery. These interactions form a service journey that includes diagnostic evaluation, treatment planning, exercise therapy, monitoring, and follow-up care. Mapping this journey enables researchers to identify potential service gaps, communication challenges, and inefficiencies that may negatively affect treatment outcomes [23]. Moreover, previous studies indicate that communication failures and unclear treatment guidance during rehabilitation processes can significantly reduce patient adherence and recovery effectiveness [24].

Based on insights derived from the literature review, this study conceptualizes rehabilitation services as a five-stage service journey. The first stage involves the initial contact and consultation phase, during which patients obtain information about rehabilitation services and communicate with healthcare providers to determine the suitability of treatment. The second stage consists of health assessment and goal setting, during which medical professionals conduct clinical evaluations and develop individualized rehabilitation plans tailored to each patient's needs. The third stage focuses on personalized rehabilitation intervention, during which patients participate in therapeutic exercises, physical therapy programs, and digitally supported rehabilitation activities. The fourth stage involves progress monitoring and feedback, during which clinicians evaluate treatment outcomes using clinical observations and digital monitoring technologies. The final stage encompasses long-term health management, which includes follow-up care, preventive health strategies, and lifestyle adjustments that support sustained recovery and reduce the risk of reinjury.

To systematically analyze these stages, the study employs a multidimensional analytical framework derived from service design research. This framework examines rehabilitation services from several complementary perspectives, including user needs, user behavior, organizational actions, stakeholder participation, service touchpoints, service outputs, and emotional experience. Analyzing healthcare services from these dimensions allows researchers to capture both operational processes and experiential factors that influence service effectiveness. In healthcare contexts, patient engagement and emotional well-being are closely linked to treatment adherence and recovery success, underscoring the need to examine both the functional and psychological aspects of rehabilitation services [25].

Furthermore, the analytical framework enables the identification of opportunities for integrating digital technologies into rehabilitation services. Modern rehabilitation systems increasingly rely on telemedicine platforms, wearable monitoring devices, electronic health records, and mobile health applications to support remote patient monitoring and data-driven clinical decision making. These digital technologies serve as critical service touchpoints, facilitating communication between patients and healthcare providers while improving treatment continuity and accessibility. Studies on digital health ecosystems highlight that the successful integration of such technologies requires coordination among healthcare providers, technology developers, and healthcare organizations within a broader service ecosystem [26].

Based on the insights obtained from the literature review and journey mapping analysis, the final stage of the research involves developing a conceptual framework for smart sports rehabilitation services. Conceptual modeling is frequently used in healthcare research to represent complex service systems and illustrate relationships among service components and stakeholders. Through conceptual modeling, researchers can propose structured frameworks that guide the design and implementation of innovative healthcare service systems [27]. In this study, the conceptual model integrates three major components: digital health infrastructure, service interaction systems, and healthcare ecosystem collaboration.

The digital health infrastructure includes tele-rehabilitation platforms, wearable monitoring devices, and electronic health information systems that enable data-driven rehabilitation

management. The service interaction system encompasses the communication and coordination processes among patients, therapists, and healthcare institutions during rehabilitation. Finally, the healthcare ecosystem component emphasizes collaboration among hospitals, rehabilitation centers, community healthcare providers, and technology organizations. Together, these components form a smart rehabilitation service ecosystem that enables continuous, personalized, and technology-supported rehabilitation services. Similar digital healthcare ecosystem frameworks have been proposed in recent studies examining how digital transformation reshapes healthcare service delivery and patient engagement [28].

## 4. Smart rehabilitation service model and case analysis

### 4.1. Conceptual structure of smart rehabilitation services

Based on the methodological framework described in Section 3, this study proposes a smart rehabilitation service model that integrates digital health technologies, service design principles, and patient-centered care pathways. Traditional rehabilitation services are often fragmented across multiple healthcare institutions and lack continuous monitoring mechanisms. Patients frequently experience disjointed service interactions when transitioning between diagnosis, therapy, and follow-up stages. The proposed model addresses these challenges by integrating clinical treatment, digital monitoring technologies, and coordinated service pathways into a unified rehabilitation ecosystem.

The conceptual model of the smart rehabilitation service system consists of three interrelated components: digital health infrastructure, service interaction mechanisms, and ecosystem-level collaboration. Digital health infrastructure includes tele-rehabilitation platforms, wearable monitoring devices, mobile health applications, and electronic health record systems that enable real-time data collection and communication between patients and healthcare providers. Service interaction mechanisms refer to the structured communication processes between patients, therapists, and healthcare institutions during rehabilitation treatment. Ecosystem-level collaboration involves coordination among hospitals, rehabilitation centers, technology providers, and community healthcare organizations to ensure continuity of care across the rehabilitation process.

The integration of these components forms a smart rehabilitation ecosystem that supports continuous patient monitoring, personalized therapy adjustments, and improved service coordination.

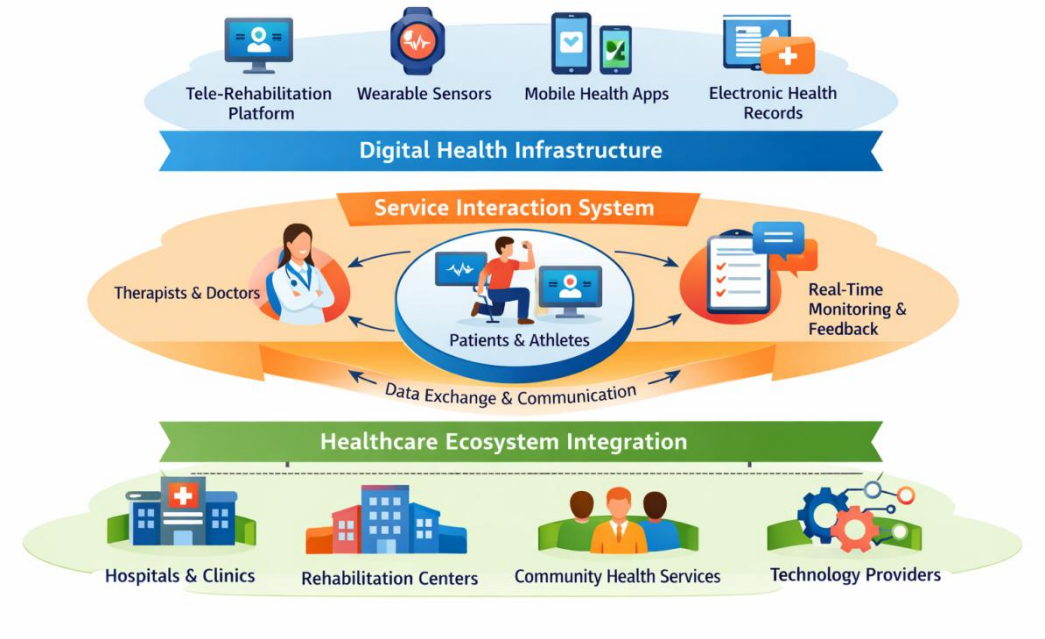


Figure 1. Smart rehabilitation service ecosystem architecture

Figure 1 shows the conceptual architecture of the smart rehabilitation ecosystem integrating digital infrastructure, healthcare providers, and patient-centered service interactions.

### 4.2. Digital infrastructure supporting rehabilitation services

Digital technologies play a central role in enabling the proposed smart rehabilitation service model. The integration of tele-rehabilitation platforms, wearable monitoring devices, and mobile health applications allows patients to perform rehabilitation exercises in remote environments while still receiving professional supervision from therapists. These technologies provide continuous data streams that support the monitoring of patient progress and enable therapists to make data-driven treatment decisions.

Wearable monitoring devices are particularly important in sports rehabilitation because they can measure physiological and biomechanical indicators such as joint motion, muscle activation, body posture, and movement performance during therapeutic exercises. These data allow healthcare providers to evaluate rehabilitation progress objectively rather than relying solely on patient self-reporting or periodic clinical assessments.

Tele-rehabilitation platforms further enhance service accessibility by enabling remote consultations, virtual therapy sessions, and digital communication between patients and healthcare professionals. Patients can access rehabilitation guidance through video consultations or digital exercise programs, while therapists can monitor performance through integrated monitoring systems. This hybrid model of rehabilitation services combines physical clinical treatment with digital healthcare support.

Electronic health record systems also play a critical role in the digital infrastructure of rehabilitation services. These systems enable the secure storage and exchange of patient health data across healthcare institutions, supporting coordinated treatment planning and interdisciplinary collaboration among healthcare providers.

### 4.3. Patient journey in smart rehabilitation services

To better understand how patients interact with rehabilitation services, this study applies the Customer Journey Map framework to analyze the patient rehabilitation experience. The rehabilitation service journey can be conceptualized as a sequence of five stages: initial contact and consultation, health assessment and goal setting, personalized rehabilitation intervention, progress monitoring and feedback, and long-term health management.

During the initial contact stage, patients seek information about rehabilitation services through healthcare websites, digital platforms, physician referrals, or community healthcare organizations. At this stage, patients often feel uncertain about treatment options and recovery expectations. Providing clear service information and accessible consultation channels is therefore essential for improving patient engagement.

In the health assessment stage, healthcare professionals conduct clinical evaluations to determine the patient's physical condition and rehabilitation needs. These assessments may include physical examinations, diagnostic imaging, and digital monitoring data obtained from wearable devices. Based on these evaluations, therapists develop personalized rehabilitation plans tailored to individual recovery goals.

The personalized rehabilitation stage involves implementing therapeutic interventions to restore physical function and mobility. These interventions may include physical therapy exercises, strength training programs, mobility training, and digitally supported rehabilitation activities. Tele-rehabilitation technologies enable patients to perform rehabilitation exercises remotely while maintaining communication with therapists.

The progress monitoring stage focuses on evaluating rehabilitation outcomes and adjusting treatment plans accordingly. Digital monitoring technologies allow therapists to track patient performance and recovery progress in real time. This data-driven feedback helps ensure that rehabilitation programs remain effective and responsive to patient needs.

Finally, the long-term health management stage emphasizes maintaining rehabilitation outcomes through continuous health monitoring and preventive care. Patients are encouraged to adopt healthy lifestyle habits, participate in follow-up assessments, and continue using digital health tools that support long-term physical well-being.

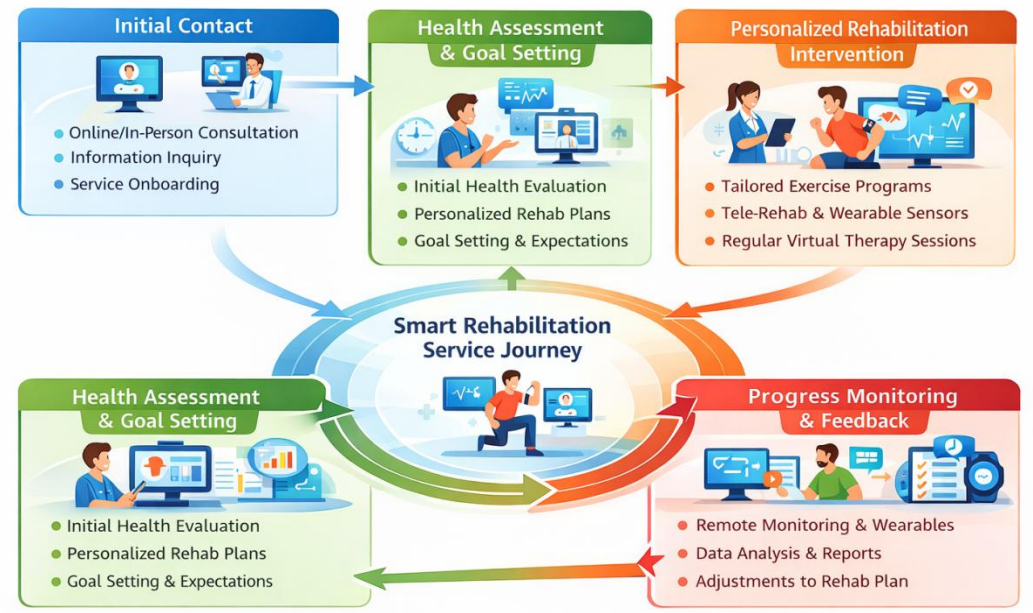


Figure 2. Customer journey map of smart rehabilitation services

Figure 2 shows the five-stage customer journey map illustrating patient interactions and service touchpoints throughout the rehabilitation process.

### 4.4. Case context: Smart rehabilitation services in Hungary

The Hungarian healthcare system provides a relevant context for examining the development of smart rehabilitation services. Hungary operates a publicly funded healthcare system supported by the National Health Insurance Fund Administration, which provides coverage for rehabilitation treatments through hospitals, specialized rehabilitation centers, and outpatient clinics. In recent years, Hungary has begun expanding its digital healthcare infrastructure to improve service accessibility and healthcare coordination.

Several initiatives have focused on introducing telemedicine services and mobile healthcare programs designed to reach patients in rural areas where healthcare resources are limited. Mobile healthcare units and teleconsultation platforms allow healthcare professionals to provide diagnostic services, health monitoring, and rehabilitation consultations remotely. These initiatives demonstrate the potential of digital health technologies to reduce healthcare disparities and expand access to rehabilitation services.

However, despite these technological developments, rehabilitation services in Hungary still face several challenges. These include fragmented service coordination across healthcare institutions, limited integration of digital monitoring technologies into rehabilitation programs, and insufficient continuity between clinical treatment and long-term health management. Addressing these challenges requires the development of integrated service models that combine digital technologies with coordinated healthcare service pathways.

### 4.5. Integrated smart rehabilitation service framework

Building upon the conceptual architecture and patient journey analysis presented in this study, an integrated smart rehabilitation service framework is proposed. The framework

emphasizes integrating digital technologies, multidisciplinary healthcare teams, and coordinated service pathways to support patient-centered rehabilitation.

The framework highlights three key principles for improving rehabilitation service delivery. First, digital technologies should be used to enhance continuous monitoring and communication between patients and healthcare providers. Second, rehabilitation services should be designed as coordinated service pathways that guide patients through different stages of recovery. Third, collaboration among healthcare institutions, technology providers, and community healthcare organizations should be strengthened to ensure continuity of care.

Implementing this framework can improve rehabilitation outcomes by enabling personalized treatment plans, enhancing patient engagement, and supporting long-term health management. Furthermore, integrating digital health technologies into rehabilitation services can help healthcare systems address the increasing demand for these services while maintaining service quality and efficiency.

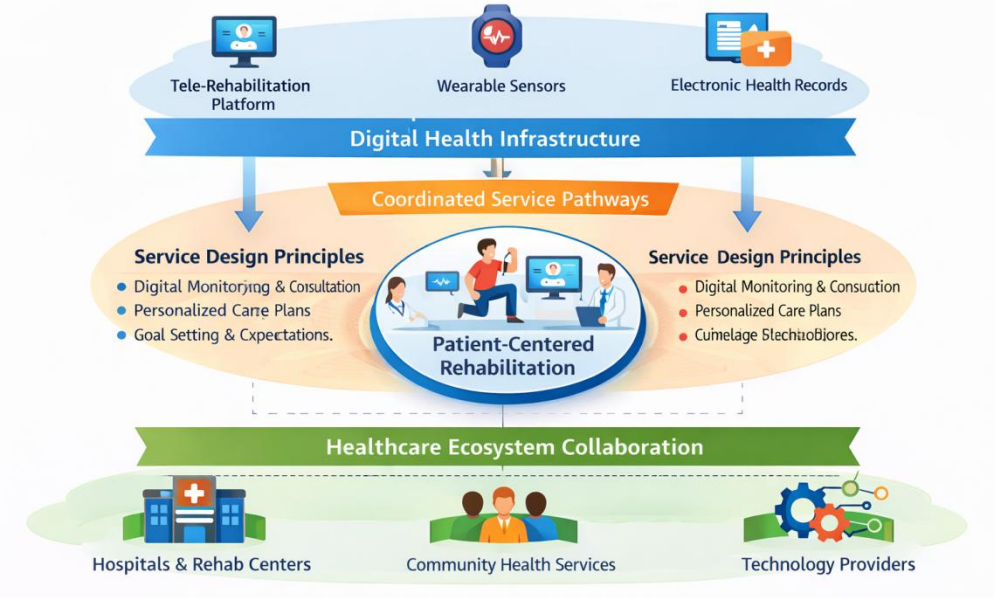


Figure 3. Integrated smart rehabilitation service framework

Figure 3 shows an integrated framework combining digital infrastructure, service design processes, and healthcare ecosystem collaboration.

## 5. Discussion

The results of this study demonstrate that integrating digital technologies with service design methodologies can significantly improve the structure and delivery of sports rehabilitation services. The proposed smart rehabilitation model emphasizes the importance of coordinated service pathways, digital health infrastructure, and ecosystem-level collaboration in developing patient-centered rehabilitation systems. By analyzing rehabilitation services through the Customer Journey Mapping framework, this research highlights how service interactions, technological tools, and organizational coordination collectively shape patient experiences and treatment outcomes.

One of the major insights from this research is that rehabilitation services should not be viewed solely as clinical treatment processes but rather as complex service ecosystems that involve multiple stakeholders and interaction channels. Traditional rehabilitation models typically rely on in-person therapy sessions delivered within hospital settings. While such approaches remain important, they often fail to provide continuous support throughout the rehabilitation journey. Patients frequently encounter gaps between treatment stages, particularly when transitioning from clinical therapy to home-based recovery. The smart rehabilitation model proposed in this study addresses these limitations by integrating digital technologies that enable remote monitoring, continuous communication, and personalized treatment adjustments.

Another important finding is the critical role of digital health technologies in improving the efficiency and accessibility of rehabilitation services. Tele-rehabilitation platforms, wearable monitoring devices, and electronic health record systems enable healthcare providers to monitor patient progress in real time and adjust rehabilitation programs accordingly. These technologies also allow patients to participate more actively in their recovery process by providing feedback, tracking performance metrics, and receiving guidance outside clinical environments. As a result, digital health technologies enhance patient engagement and improve rehabilitation outcomes.

However, technological innovation alone cannot guarantee improvements in healthcare service delivery. Successful implementation of smart rehabilitation systems requires effective service design that aligns technological capabilities with patient needs and healthcare workflows. Without proper coordination, digital technologies may create additional complexity rather than improving service efficiency. Therefore, integrating service design principles, such as customer journey mapping and patient-centered care frameworks, is essential to ensuring that digital health innovations enhance the overall rehabilitation experience.

Furthermore, the findings indicate that rehabilitation services must be supported by collaborative healthcare ecosystems involving hospitals, rehabilitation centers, community health services, and technology providers. Healthcare institutions alone often lack the resources and technological expertise required to implement advanced digital health systems. Collaboration with technology companies and digital health developers is therefore necessary to develop scalable and sustainable rehabilitation service models.

To better understand the impact of smart rehabilitation systems, the key improvements offered by the proposed framework are summarized in Table 1.

Table 1. Comparison between traditional and smart rehabilitation service models

| Dimension | Traditional Rehabilitation Model | Smart Rehabilitation Model |
|---|---|---|
| Service Delivery | Primarily clinic-based therapy | Hybrid model combining physical and digital services |
| Monitoring Methods | Periodic clinical assessments | Continuous monitoring using wearable devices |
| Patient Engagement | Passive patient participation | Active patient involvement supported by digital tools |
| Communication | Limited interaction between visits | Continuous communication via telehealth platforms |
| Data Utilization | Minimal data collection | Data-driven treatment adjustment using digital monitoring |
| Service Continuity | Fragmented treatment stages | Integrated rehabilitation journey with long-term monitoring |

The comparison in Table 1 shows that smart rehabilitation services offer significant advantages over traditional rehabilitation systems. Digital monitoring technologies allow healthcare professionals to collect and analyze real-time patient data, enabling personalized treatment adjustments and early detection of potential complications. Additionally, tele-rehabilitation platforms expand access to rehabilitation services by allowing patients to receive professional guidance regardless of geographical constraints.

Another important aspect of the smart rehabilitation model is the role of service design in improving patient experience. Rehabilitation is not only a physical recovery process but also an emotional journey that involves uncertainty, motivation challenges, and psychological adaptation. By mapping the patient journey across different stages of rehabilitation, healthcare providers can better understand patient needs and develop services that address both functional and emotional aspects of recovery.

Table 2 summarizes the key service design elements identified in this study and their contributions to improving rehabilitation services.

Table 2. Key service design components in smart rehabilitation systems

| Service Design Component | Description | Impact on Rehabilitation Services |
|---|---|---|
| Customer Journey Mapping | Visualization of patient interactions across service stages | Identifies service gaps and improves care coordination |
| Digital Health Platforms | Telemedicine systems and mobile health applications | Enables remote therapy and patient monitoring |
| Wearable Monitoring Devices | Sensors tracking movement and physiological indicators | Provides real-time data for treatment evaluation |
| Personalized Treatment Planning | Individualized rehabilitation programs | Improves treatment effectiveness and patient satisfaction |
| Multidisciplinary Collaboration | Coordination among therapists, physicians, and technology providers | Enhances treatment quality and service integration |
| Long-Term Health Management | Continuous monitoring and follow-up care | Prevents reinjury and supports sustained recovery |

The analysis presented in Table 2 demonstrates that smart rehabilitation services rely on the integration of multiple service design components. Each component contributes to improving rehabilitation outcomes by enhancing communication, monitoring patient progress, and ensuring continuity of care throughout the recovery process.

In healthcare systems such as Hungary's, implementing smart rehabilitation models could help address several systemic challenges. For example, digital rehabilitation services could expand access to care in rural regions where specialized rehabilitation facilities are limited. Tele-rehabilitation programs could also reduce the burden on healthcare institutions by allowing certain rehabilitation services to be delivered remotely.

Despite these advantages, several challenges remain in implementing smart rehabilitation systems. These challenges include technological infrastructure limitations, healthcare professional training requirements, patient digital literacy barriers, and regulatory considerations related to digital health services. Addressing these challenges will require coordinated efforts from healthcare institutions, technology providers, and government policymakers.

Overall, this study's findings highlight the importance of combining digital health technologies with service design principles to create integrated rehabilitation service systems. By viewing rehabilitation services as smart healthcare ecosystems rather than isolated clinical treatments, healthcare providers can develop more efficient, accessible, and patient-centered rehabilitation models.

## 6. Conclusion

This study examined the development of smart rehabilitation service systems by integrating digital healthcare technologies with service design methodologies. As demand for rehabilitation services worldwide continues to grow, healthcare systems face increasing pressure to deliver more accessible, efficient, and patient-centered programs. Traditional rehabilitation models, which primarily rely on clinic-based therapy and periodic patient monitoring, often lack continuity and fail to support long-term patient engagement fully. In response to these challenges, this research proposed a smart rehabilitation service framework that combines digital health technologies, customer journey mapping, and coordinated healthcare ecosystems to improve the delivery of rehabilitation services.

The findings of this study demonstrate that digital technologies play a crucial role in enabling continuous and personalized rehabilitation services. Tele-rehabilitation platforms allow patients to participate in rehabilitation programs remotely, while wearable monitoring devices provide real-time data on patient performance and recovery progress. These technologies enhance communication between patients and healthcare providers and support data-driven treatment decisions. By integrating these technologies within a structured service design framework, healthcare providers can create more responsive and adaptive rehabilitation systems that address both clinical and experiential aspects of patient care.

Another important contribution of this study is the application of the Customer Journey Mapping approach to analyze rehabilitation services from a patient-centered perspective. Rehabilitation processes involve multiple stages of interaction between patients and healthcare providers, and understanding these interactions is essential for identifying service gaps and improving patient experiences. The journey mapping analysis conducted in this research revealed that effective rehabilitation services require coordinated service pathways that guide patients through the stages of consultation, diagnosis, therapy, monitoring, and long-term health management.

The study also highlights the importance of collaboration within the healthcare ecosystem for the development of smart rehabilitation systems. Hospitals, rehabilitation centers, community healthcare providers, and technology companies must work together to implement digital health solutions and ensure service continuity across care stages. Such collaboration is particularly relevant for healthcare systems such as Hungary, where digital health infrastructure is expanding, but service integration remains an ongoing challenge.

From a theoretical perspective, this research contributes to the growing literature on digital healthcare innovation and service design by proposing a conceptual framework for smart rehabilitation services. The study demonstrates how digital health technologies and service design principles can be integrated to support patient-centered healthcare systems. The proposed framework provides a foundation for future research on digital health ecosystems and smart healthcare service models.

From a practical standpoint, the findings of this research offer valuable insights for healthcare administrators, rehabilitation professionals, and technology developers seeking to modernize rehabilitation services. Implementing smart rehabilitation systems can improve healthcare accessibility, increase patient engagement, and enhance treatment outcomes while reducing the burden on healthcare institutions. Policymakers may also benefit from these insights when developing strategies to support digital health transformation and healthcare innovation.

Despite its contributions, this study has several limitations. The research is primarily conceptual and focuses on service design analysis rather than empirical evaluation of

rehabilitation programs. Future research could extend this work by conducting empirical case studies, piloting smart rehabilitation systems, or conducting quantitative evaluations of digital rehabilitation outcomes. Additionally, further research could explore how artificial intelligence and advanced analytics can support predictive rehabilitation models and personalized therapy planning.

In conclusion, integrating digital technologies and service design approaches offers significant potential to transform rehabilitation services into smart, patient-centered healthcare systems. By adopting digital health innovations and coordinated service frameworks, healthcare providers can create more efficient and accessible rehabilitation services that support long-term recovery and improve patients' quality of life. The smart rehabilitation service model proposed in this study provides a conceptual foundation for the future development of digitally enabled rehabilitation systems within modern healthcare ecosystems.

## References

[1] A. Cieza, K. Causey, K. Kamenov, S. Wulf Hanson, S. Chatterji, and T. Vos, "Global estimates of the need for rehabilitation based on the Global Burden of Disease study 2019: a systematic analysis for the Global Burden of Disease Study 2019," Lancet, vol. 396, no. 10267, pp. 2006–2017, 2021. DOI: 10.1016/S0140-6736(20)32340-0

[2] S. Safiri et al., "Prevalence, Deaths, and Disability-Adjusted Life Years Due to Musculoskeletal Disorders for 195 Countries and Territories 1990-2017," Arthritis & Rheumatology, vol. 73, no. 4, pp. 702–714, 2021. DOI: 10.1002/art.41571

[3] J. Kuether, A. Moore, J. Kahan, et al., "Telerehabilitation for Total Hip and Knee Arthroplasty Patients: A Pilot Series with High Patient Satisfaction," HSS Journal, **(2019)**

[4] L. Suso-Martí, R. M. La Touche, A. Herranz-Gómez, et al., "Effectiveness of Telerehabilitation in Physical Therapist Practice: An Umbrella and Mapping Review With Meta-Meta-Analysis," Physical Therapy, vol. 101, 2021. DOI: 10.1093/ptj/pzab075

[5] C. S. Kruse, P. Karem, K. Shifflett, L. Vegi, K. Ravi, and M. Brooks, "Evaluating barriers to adopting telemedicine worldwide: A systematic review," Journal of Telemedicine and Telecare, vol. 24, no. 1, pp. 4–12, 2018. DOI: 10.1177/1357633X16674087

[6] R. De Fazio, V. M. Mastronardi, M. De Vittorio, and P. Visconti, "Wearable Sensors and Smart Devices to Monitor Rehabilitation Parameters and Sports Performance: An Overview," Sensors, vol. 23, no. 4, p. 1856, 2023. DOI: 10.3390/s23041856

[7] J. Sumner, H. W. Lim, L. S. Chong, A. Bundele, A. Mukhopadhyay, and G. Kayambu, "Artificial intelligence in physical rehabilitation: A systematic review," Artificial Intelligence in Medicine, vol. 146, p. 102693, 2023. DOI: 10.1016/j.artmed.2023.102693

[8] P. Molina-Garcia, M. Mora-Traverso, R. Prieto-Moreno, et al., "Effectiveness and cost-effectiveness of telerehabilitation for musculoskeletal disorders: A systematic review and meta-analysis," Annals of Physical and Rehabilitation Medicine, vol. 67, no. 1, p. 101791, 2024. DOI: 10.1016/j.rehab.2023.101791

[9] S. Bargeri, G. Castellini, J. A. Vitale, et al., "Effectiveness of Telemedicine for Musculoskeletal Disorders: Umbrella Review," Journal of Medical Internet Research, vol. 26, e50090, 2024. DOI: 10.2196/50090

[10] L. N. Bulto, E. Davies, J. Kelly, and J. M. Hendriks, "Patient journey mapping: emerging methods for understanding and improving patient experiences of health systems and services," European Journal of Cardiovascular Nursing, vol. 23, no. 4, pp. 429–433, 2024. DOI: 10.1093/eurjcn/zvae012

[11] E. Girasek et al., "Exploring the attitudes and experiences of Hungarian primary care physicians on the utilisation of digital health solutions," BMC Primary Care, vol. 25, no. 1, p. 396, 2024. DOI: 10.1186/s12875-024-02642-8

[12] M. Virag, R. Kovacs, G. Marovics, et al., "Bridging healthcare gaps through specialized mobile healthcare services to improve healthcare access and outcomes in rural Hungary," Scientific Reports, vol. 15, no. 1, p. 12692, 2025. DOI: 10.1038/s41598-025-97447-9
[13] D. P. Sheehan et al., "Digital rehabilitation and the future of physical therapy," Journal of Medical Systems, **(2019)**
[14] S. Patel, H. Park, P. Bonato, L. Chan, and M. Rodgers, "A review of wearable sensors and systems for monitoring rehabilitation exercises," IEEE Reviews in Biomedical Engineering, **(2018)**
[15] A. Turolla et al., "Telerehabilitation for physical therapy: systematic review," Journal of Telemedicine and Telecare, **(2020)**
[16] M. Tenforde, J. Hefner, C. Kodish-Wachs, K. Iaccarino, and A. Paganoni, "Telehealth in physical medicine and rehabilitation," PM&R, **(2020)**
[17] H. L. Chen et al., "Artificial intelligence in rehabilitation medicine: current applications and future directions," Frontiers in Medicine, **(2021)**
[18] R. G. Peters, "Barriers to digital health adoption in rehabilitation services," Health Policy and Technology, **(2022)**
[19] M. Mager and B. Sung, "Service design in healthcare: improving patient experience," Design Journal, **(2018)**
[20] J. Bate and G. Robert, "Experience-based design in healthcare services," Quality in Health Care, **(2019)**
[21] S. Steen, "Co-creation and participatory design in healthcare innovation," Service Design Journal, **(2020)**
[22] P. Jones, "Designing patient-centered healthcare services," International Journal of Healthcare Management, **(2019)**
[23] R. C. Basole and J. Rouse, "Complexity of service ecosystems in digital healthcare," Service Science, **(2021)**
[24] J. Kalbach, Mapping Experiences: A Complete Guide to Customer Alignment Through Journeys, **(2020)**
[25] L. Trebble et al., "Process mapping the patient journey," BMJ, **(2019)**
[26] S. McCarthy, "Patient journey analysis in healthcare service improvement," Health Services Research, **(2022)**
[27] A. Stickdorn, M. Hormess, A. Lawrence, and J. Schneider, This is Service Design Doing, **(2018)**
[28] M. Lim and A. Maglio, "Service journey analytics in digital health ecosystems," Journal of Service Research, **(2024)**

***This page is empty my intension.***