

Utilizing Digital Solutions for Advancing Public Health Before, During, and After the Covid-19 Pandemic: The Case of Slovenia

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ABSTRACT

Background: Comprehensive digitalization of the Slovenian healthcare system and the use of national eHealth solutions could overcome numerous obstacles in accessing data and information relevant to quality healthcare for patients and healthcare professionals. For managers, it could enable better monitoring of healthcare institutions' operations and evidence-based decision-making. The pre-pandemic era witnessed Slovenia's proactive development of digital solutions, laying the foundation for a resilient eHealth system. During the peak of the Covid-19 crisis, the country adeptly employed technology to manage and mitigate the impact on public health. Post-pandemic, Slovenia continues to leverage digital advancements for ongoing healthcare improvements.

Methods: This article analyses the use of selected eHealth solutions before, during, and after the Covid-19 pandemic in Slovenia, which has sparked significant interest in the processes of digitalization and the use of eHealth solutions. The research applies a case study methodology based on a literature review, later supplemented by interviews with eHealth solution managers, and insights into actual statistical data from eHealth solutions' administrative and business intelligence modules.

Results: The results suggest that the Covid-19 pandemic may represent a turning point in the perception of digitalization. Thanks to its versatile utility, digitalization has emerged as a critical instrument for managing public health, fostering resilience, promoting healthcare system development, and empowering patients during national and international public health crises.

Conclusion: Recent developments have made it clear that modern digital solutions have a significant impact on public health management, providing essential support for decision-making, planning, and management processes in the healthcare system. This study offers insights into the successful implementation of national digital solutions, illuminating Slovenia's innovative practices and lessons learned.

Keywords: digitalization, public health, Covid-19 pandemic, eHealth, Slovenia.

INTRODUCTION

The public health system in Slovenia has faced numerous challenges in recent years due to various systemic, socio-economic circumstances, and unfavourable public health trends¹. The healthcare system grapples with management issues, resource shortages, and often outdated and inadequate legislation. To address these challenges and ensure the sustainability of the public healthcare system, significant and extensive changes to the current healthcare regulation are necessary. In this context, the digitalization process is crucial for innovation and the establishment of a more efficient and successful healthcare system. The term *digitalization* in this text is defined as the comprehensive implementation of information and communication technology (ICT) solutions into the operational and business processes of the healthcare system. In international strategic documents, ICT is considered a crucial tool for achieving improved patient care and timely monitoring of all parameters in the healthcare system's operation². The latest Slovenian strategic document, the Resolution on the National Health Care Plan 2016–2025, *Together for a Healthy Society*, outlines specific goals for ICT in healthcare³. In line with EU documents emphasizing the effectiveness, accessibility, and flexibility of healthcare systems, it highlights the implementation of unified and efficient digital solutions as a key strategic goal. Such digital solutions would provide relevant data for patient healthcare and support evidence-based managerial decision-making⁴. Reliable healthcare, financial, and managerial data would enhance planning and management for both individual

healthcare providers and the entire healthcare system^{5,6}. Successful healthcare digitalization projects are shown to have significant strategic importance for the further development of the healthcare system and a far-reaching impact on economic growth and social development⁷.

The Slovenian healthcare digitalization project (eHealth), following national, European, and World Health Organization directions, is a key long-term goal of the public sector in Slovenia^{8,9}. The eHealth system integrates a range of digital solutions for safer and more efficient healthcare services. The goal of eHealth is the introduction of effective and user-friendly digital solutions into the operation of the Slovenian healthcare system and the connection of local information systems into a functional national healthcare information system. This connection provides citizens and healthcare professionals with the ability to overcome numerous obstacles in accessing information relevant to the healthcare process, while enabling managers to better monitor the operations of healthcare institutions and improve decision-making processes¹⁰. With comprehensive healthcare system digitalization, Slovenian healthcare ensures opportunities for even higher quality and professional work with patients, rapid and secure management of healthcare information and data, further healthcare system development, and competitive integration into the European healthcare environment. Slovenian eHealth, in its current form, includes digital solutions such as electronic prescription (ePrescription), electronic ordering (eAppointment), electronic health record named Central Register of

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Patient Data (CRPD, containing specialist reports, microbiological reports, discharge letters, outpatient reports, vaccinations, and other patient records), and the zVEM Patient Portal, to name a few of the most important ones. Additionally, there is a whole range of backend infrastructure and network platforms that enable the use of eHealth solutions, but are not specifically oriented towards users and are not described in this text. Considering events since the publication of the first strategic document on healthcare digitalization in 2005, the implementation of eHealth solutions since 2016 represents a significant milestone in the history of Slovenian healthcare¹¹. In the context of these findings, the article focuses on analysing the use of ePrescription, eAppointment, CRPD, and the zVEM Patient Portal before, during, and after the Covid-19 pandemic in Slovenia.

METHODS

This article applies a case study methodology focused on leveraging digital solutions for the promotion of public health before, during, and after the Covid-19 pandemic in Slovenia. The case study includes different data collection techniques, including an in-depth analysis of the use of selected eHealth solutions (ePrescription, eAppointment, zVEM Patient Portal, and CRPD) and a wide-ranging review of the literature and different sources containing the materials related to eHealth solutions and their utilization in the field of public health^{12,13}. To validate and refine the findings, the in-depth analysis of the use of selected eHealth solutions was complemented by interviews with 15 competent and experienced professionals from the National Institute of Public Health (NIJZ), who are involved in managing eHealth solutions. Their expert opinions were corroborated by actual statistical data on the utilization of these solutions obtained from their administrative and business intelligence modules¹⁴. The selection of the research method was guided by the distinctive characteristics of the research subject, the availability of evidence, and the fact that healthcare digitalization in Slovenia remains at a relatively early stage, with only a limited number of experts possessing appropriate knowledge and experience in the field^{15,16}. Considering all these factors, the chosen research approach emerges as the most favourable option.

This methodological approach allowed insight into both the theoretical foundations of the outlined digital solutions and an empirical review of the use of selected solutions in the Slovenian healthcare system¹⁷. Collaborating with experts from the NIJZ not only provided insight into the technological, statistical, and managerial aspects of eHealth solutions, but also facilitated a critical and thorough understanding of the user aspects of these solutions. NIJZ experts are well-informed about the user experiences of both patients and healthcare professionals in the field, as solution managers actively engage in resolving requests and answering queries through the User Support Service. In recent years, this service has handled hundreds of thousands of requests from eHealth users nationwide. The greatest need for support was recorded in 2021, when the number of requests exceeded 100,000. The substantial increase in the number of requests or questions in 2021 is mainly attributed to the significant interest of citizens in ordering Covid-19 vaccinations and obtaining digital Covid-19 certificates. Given that NIJZ experts contribute to handling and resolving such a large number of requests and questions from users annually, they can provide a relatively reliable and objective assessment of both user experience and the technological adequacy and quality of eHealth solutions. The study was conducted from September 2023 to January 2024. Structured interviews with NIJZ experts and the acquirement of statistical data from business intelligence and administrative modules were conducted in December 2023 and January 2024. The article focuses on selected eHealth solutions primarily due to their usefulness and importance for both patients and healthcare professionals and the

significant progress in the last 5 years. The application of an appropriate methodological framework, which included a combination of various approaches and data collection techniques, was crucial for the successful implementation of the study^{18,19}. The synthesis of findings from literature, statistical reports, and the viewpoints of NIJZ experts facilitated the formulation of credible conclusions based on verifiable data concerning the research objectives. A comprehensive analysis of data obtained from diverse sources and structured interviews with NIJZ experts served as a fundamental basis for interpreting data and drawing coherent conclusions regarding the research subject at hand.

RESULT

There has been significant progress in the implementation and use of individual eHealth solutions since 2016. Considering the dynamics of events since the publication of the first Slovenian strategic document on healthcare digitalization in 2005, the implementation of the outlined eHealth solutions has yielded numerous benefits and represents an important turning point for all stakeholders involved. The architecture of Slovenian eHealth comprehensively encompasses all infrastructural, network, and system components, as well as application solutions for users (both patients and healthcare professionals). It also involves central ecosystem stakeholders and defines key activities and tasks in strategic, operational, and international fields (Figure 1). The evaluation of the Ministry of Public Administration for the period 2016–2018 indicates that the use of eHealth solutions (ePrescription and eAppointment) has triggered significant savings in the healthcare system. The Ministry of Public Administration estimates that the total savings amount to approximately EUR 40 million²⁰. The Digital Economy and Society Index (DESI) of the European Commission is a composite index that includes relevant indicators of the performance of digital service implementation and monitors the development of digital competitiveness in EU Member States. The DESI 2019 report marks a significant breakthrough in the development and use of eHealth services in Slovenia, ranking Slovenia 6th in the EU²¹. Slovenia's position is considerably above the EU28 average and is also better than many countries with comparable GDP (or even higher). In the years preceding the pandemic, there was a gradual yet steady growth in the utilization of all the discussed eHealth solutions. A significant leap is noticeable specifically between 2016 and 2017, given that 2016 marked the initial roll-out of national eHealth solutions (Table 1). The introduction of eHealth solutions in the pre-COVID-19 period demanded substantial time and effort, advocacy, promotion, and encouragement for users, encompassing both patients and healthcare professionals.

However, with the onset of the pandemic, the situation swiftly evolved, leading to a rapid acceleration in the implementation and adoption rate of eHealth solutions. The daily functioning of the healthcare system came to a halt during the pandemic, with exceptions being emergency procedures and the treatment of oncology patients. The work of healthcare professionals was exceptionally challenging due to new treatment protocols and the risk of infection. Meanwhile, patients, due to the fear of infection and the various restrictions imposed by healthcare institutions, attempted to minimize personal visits to healthcare facilities as much as possible. The outlined eHealth solutions (ePrescription, eAppointment, zVEM Patient Portal, CRPD) suddenly became the only way to ensure fast, efficient, and safe healthcare services and enable adequate communication, both among healthcare professionals and between healthcare professionals and patients^{22,23}. After the initial shock of the pandemic, the interest of healthcare professionals and patients in using eHealth solutions increased overnight, and the learning curve quickly flattened. Consequently, data on the utilization of eHealth solutions showed a rapid increase in both 2020 and 2021 (Table 1). Due to exceptional circumstances

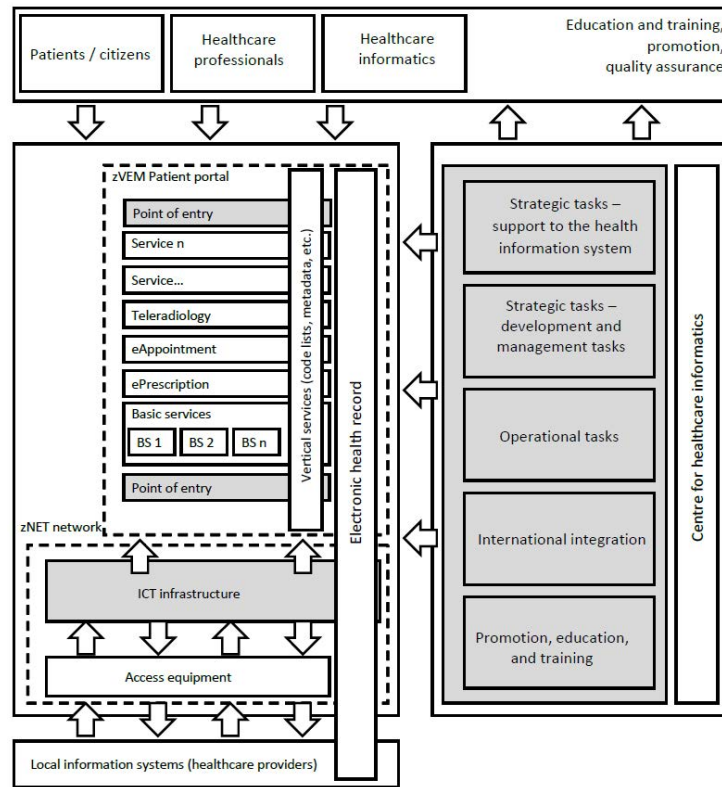
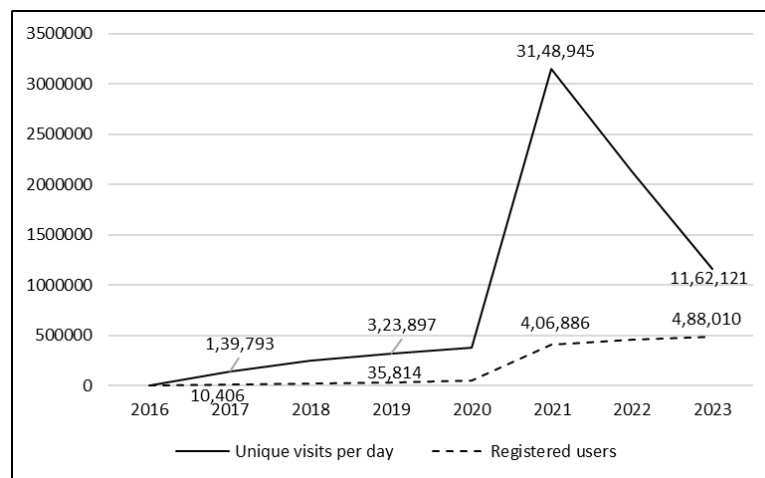


Figure 1. Architecture of the Slovenian eHealth



Graph 1. Increase in the number of registered users and the number of unique visits per day of the zVEM Patient Portal over the years

Table 1. Annual growth in the use of eHealth solutions in Slovenia, 2016–2023

		2016	2017	2018	2019	2020	2021	2022	2023
eAppointment	Number of eReferrals	241.379	2.509.518	3.564.993	3.946.878	3.273.719	3.871.269	4.257.788	4.460.303
	% of all referrals	42,96	84,71	95,11	93,92	94,97	95,99	94,85	96,46
ePrescription	Number of ePrescriptions	12.326.845	13.095.808	13.867.192	13.895.517	13.790.000	14.060.730	15.006.001	15.677.770
	% of all prescriptions	87,23	88,73	92,33	93,47	95,63	96,06	96,32	96,72
CRPD	Number of documents	3.180.704	9.617.604	19.028.736	34.230.045	53.294.237	129.010.388	182.173.650	227.626.748
CRPD	Number of microbiological reports	not yet established	not yet established	not yet established	3.657	799.081	2.615.982	7.877.350	8.704.629

and the pressure from patients, healthcare professionals began to use eHealth solutions more intensively. On the other hand, patients showed the greatest interest in monitoring their health and well-being through health records accessible via the zVEM Patient Portal and CRPD.

The growth in the use of eHealth solutions continued at a reduced rate after the Covid-19 pandemic (Table 1). Apart from financial savings, the analysis also unveiled other systemic benefits of ePrescription and eAppointment. These include simplified and more efficient patient treatment, streamlined procedures for patients, increased standardization, quality and security of collected health data, consultations between general practitioners and specialists, lower administrative costs, data accessibility for analysis and research. Since 2016, there has been a consistent increase in the adoption of eHealth solutions, and it is probable that this trend will persist in the upcoming period. This growth is likely to carry on, particularly if we continue to effectively promote the use of eHealth solutions, provide digital solutions that are beneficial to users, and sustain the development momentum established in recent years. Table 1 shows the cumulative growth in the use of eHealth solutions in Slovenia on an annual basis from their introduction into the healthcare system in 2016 until the end of 2023.

Statistical data support the above qualitative findings. In particular, the zVEM Patient Portal and CRPD experienced a significant increase in usage during the period of societal closure and immediately afterward (Graph 1 and Table 1). Despite the highly restrictive operation of the healthcare system in most areas and limited acceptance of patients, other eHealth solutions maintained a relatively stable level of usage or even saw growth, confirming their critical importance for patient treatments and the overall functioning of the entire healthcare system.

Experiences from the Covid-19 pandemic have underscored the crucial role of eHealth solutions in such scenarios. Statistical data on usage clearly indicate that healthcare professionals and patients increasingly recognize the numerous benefits of eHealth, especially in unexpected and crisis situations affecting the healthcare system and its operations. Furthermore, it has been revealed that eHealth solutions have even greater utility value for healthcare professionals and patients in such circumstances compared to *normal* conditions. During this period, users - both healthcare professionals and patients - have shown particular interest in accessing and obtaining microbiological findings, vaccination certificates, test results, or information about past illnesses, along with EU digital Covid-19 certificates, as confirmed by research in other countries^{24,25}.

Operational activities within eHealth are guided by a robust national and EU legislation, ensuring that personal data is processed lawfully, individuals are informed about data processing whenever possible or required, individuals have the opportunity to exercise their rights related to data protection under the General Data Protection Regulation, and data is appropriately secured against unauthorized processing through organizational, technical, and logical measures^{26,27}.

DISCUSSION

The number of compelling and in-depth studies dealing with direct analyses of the impacts of eHealth services on various aspects of the healthcare system is relatively small. This is despite the growing interest of the research and academic spheres in healthcare digitalization over the past two decades and the increasing number of national projects striving for healthcare digitalization worldwide. Existing research predominantly focuses on specific narrower segments of healthcare digitalization projects^{28,29}. Consequently, there

has been a lack of observation or evaluation regarding the potential benefits of eHealth solutions within the context of a pandemic. Interestingly, numerous aspects of the development and utilization of digital healthcare solutions have been scrutinized, including those of peripheral significance, which may sometimes seem to have only marginal relevance for legitimate research interest. Nevertheless, there appears to be a noticeable dearth of research attention in such a critical area as the potential benefits of digital solutions during infectious disease outbreaks or situations like the Covid-19 pandemic. Examining the impacts and roles of digitalization from numerous partial and often isolated perspectives hinders a comprehensive and critical evaluation of the potential effects of digitalization on public health management³⁰. In practice, this often manifests as an inability to plan the long-term development of healthcare systems on one hand, and on the other, digitalization projects frequently face significant challenges in securing political support, financial resources, and suffer from poor organization, management, and coordination, prolonging implementation times and increasing costs.

In general, scientific literature attributes a significant role to ICT in the future development of healthcare³¹⁻³³. It emphasizes that digitalization is one of the fundamental steps for a comprehensive reform of healthcare systems, aiming to provide higher quality healthcare on one side, and ensure more efficient management and operation of healthcare systems on the other. The World Health Organization (WHO) has recognized the digitalization of healthcare systems as a key factor in improving global health conditions in a series of significant studies over the last few years. The WHO's guidelines from 2019 directly linked the use of digital tools to improvements in health management, highlighting the greatest obstacle to more effective healthcare system development as the lack of information support³⁴. Research confirms that health information systems undeniably have great potential; however, the practical construction of these systems and the collection, organization, analysis, and presentation of health data face significant challenges^{35,36}. Collected data, due to their incompleteness, inaccuracy, obsolescence, and lack of connection to healthcare professionals' priorities and functions, often become unusable and do not support quality decision-making by health management^{37,38}. Hence, in an era where healthcare systems confront mounting user demands amidst increasingly limited resources, the necessity for enhanced efficiency becomes progressively important. In this context, effective digitalization, facilitating comprehensive, quality, and relevant health data, assumes a more significant role every day across all areas and levels of the healthcare system.

Despite encountering certain issues arising from the technological characteristics of existing health information systems, uncoordinated development in the initial years of implementing information systems, and a deficiency in political support, it can be asserted that the rapid growth in the use of eHealth solutions attests to the growing recognition among users and decision-makers. They increasingly acknowledge that ICT in healthcare holds significant practical value and developmental potential. These findings should serve as a foundation for future research in the field of eHealth, aiming to comprehensively and accurately define and evaluate its implications on the health, financial, organizational, and management aspects of healthcare systems.

The recent events serve as undeniable evidence of increased engagement and commitment from healthcare policymakers who, in the past, allocated relatively little attention to the eHealth project. The successful implementation and high usage rate of the CRPD, zVEM Patient Portal, eAppointment, ePrescription, and other eHealth solutions demonstrates that the requirements and interests of most important stakeholders within the healthcare system were recognized and successfully aligned.

This has resulted in a beneficial consensus regarding the functionality of digital solutions. Furthermore, the effective introduction of digital solutions confirms improved collaboration and coordination between healthcare institutions, NIJZ, the Ministry of Health, and external providers of digital services. It represents a successful example of overcoming and surpassing many substantive and technical challenges, which were the result of the uncoordinated development of healthcare digitalization before the eHealth project.

CONCLUSION

While various theoretical models and approaches address the acceleration of technological innovation adoption among users, it is evident that real-life necessity serves as the most effective catalyst for the use of digital solutions, particularly in the healthcare sector. This assertion is clearly illustrated in this study, encompassing the periods before, during, and after the Covid-19 pandemic in Slovenia. In this regard, we hope that recent developments have made it clear that modern digital solutions have a significant impact on public health management, providing essential support for decision-making, planning, and management processes in the healthcare system. This is supported by statistical data and evaluations conducted by national and international institutions. This study offers insights into the successful implementation of national digital solutions, illuminating Slovenia's innovative practices and lessons learned. Exploring this case study facilitates a deeper understanding of how digital solutions can contribute to the overall advancement of public health, fostering resilience against national health system challenges and global pandemic threats.

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