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Information System Implementation in Healthcare: Case Study of Croatia

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Abstract

Background: In today's environment, health professionals are overwhelmed by the rapid pace of advancement in both information technology and medical practice. **Objectives:** This paper aims to point out the importance of developing an electronic health record system that will meet the needs of all stakeholders in healthcare, support health professionals' work, and enable continuous quality improvement at all levels and in all healthcare segments. **Methods/Approach:** Non-systematic literature review has been used to develop a discussion on the healthcare systems' usage. **Results:** Close cooperation of participants at all levels is essential for the quality implementation and application of digital solutions in healthcare. **Conclusions:** The paper highlights the factors that contribute to the acceptance of the public healthcare information system in the Republic of Croatia, which is being developed according to the EU regulations.

Keywords: health information system; healthcare; organization and management in health; e-health in the EU; e-health in Croatia
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Introduction

In today's way of doing business, technology is a significant factor in shaping individual organizations. It is a generator of knowledge and innovation, and the level of technology development in a particular organization defines the competitiveness and position of the organization in the market. Technology can be viewed as an internal factor of an individual organization. Raising health services to a new level will not be possible without introducing new digital solutions. Their introduction will enable better health outcomes for patients, improve the efficiency of health systems and realize equal and inclusive access to health services for all. Improving people's health and quality of life and the more efficient organization and better implementation of health services are not possible without innovative digital solutions. Implemented e-health services improve the availability and speed of health services and the safety of patients and health professional's safety. A large amount of data is constantly collected in the health care system. Still, this data is not used regularly to make decisions on efficiency improvement, quality, and effectiveness of health care. Effective management of health data, using digital technologies, provides a quality, well-structured, standardized basis for further development of health services and achieving social solidarity.

The basic health information system of the Republic of Croatia is the Central Health Information System of Croatia, with more than 17,000 users together with a large number of separate information systems in hospitals. Healthcare professionals are the main users of the system. The importance of information and communication technology is expressed in everyday business through better control of the system's functionality as an aid in clinical decision making, resource management, patient management (reservations, appointments, invoicing), implementation, and monitoring of epidemiological sites, and more. An information system can be defined as any system used in business. Its task is to collect, sort, process, store, and distribute data. It does not necessarily have to be supported by a computer (Pavlić, 2011). The public health information system is also known as the health care planning system or the hospital information system. Its development dates back to 1960 when the system's main functions were limited to administrative management (Dezelic et al., 2014).

This paper aims to emphasize the importance of the health information system through its management potential that will result in a good business result. There are high expectations regarding the service they provide as they have to leave a great impression on stakeholders in these challenging times of constant change. In a competitive commercial healthcare environment, negative experiences and poor service indicate inefficiency, higher cost, lower quality of care, and a poor image of the overall healthcare system.

Methodology

Informatization in health care is a current topic that aims to analyze the application of innovative solutions to better and more efficient organization and management of this large system. The paper gives a brief overview of the application concept so far through several temporal features. Special attention is paid to the importance of health system informatization activities viewed through the prism of our country and the EU as a generator of many changes. We are all stakeholders and are viewed as active determinants of the concept. The paper is based on a systematic analysis of previously published relevant international scientific papers in health informatization, legislation, and the application of information and communication technologies. Methods of analyzing the temporal characteristics of a given topic and the impact

on further development through the applied aspect were used. The deduction method was used to conclude the importance of informatization in health care for business results and to determine the multiplicative effect of positive changes on society.

Healthcare information system

As the severity of patients' illnesses increases, medical staff must spend more time on care. The need to apply existing information technology to provide health care assistance has been introduced to improve the quality of healthcare services effectively. The creation of this system involves mainly a set of standards-based on health diagnostics, symptoms, cause, health goals, and measurements.

It is necessary to make certain changes in the system and take strategic steps. Changes should be well defined and gradually implemented, and it is necessary to have an appropriate strategy, clearly defined instructions, and certain foundations for implementing the guidelines. Implementing the guidelines is modern and efficient healthcare available to all, which will be characterized by mobility and openness.

Implementation of the guidelines should include: changing hardware, changing standards, changing protocols, changing platforms, changing codes, changing interfaces, changing portals, changing publications, changing registries, and changing telemedicine streaming. Intensive work is being done to consolidate the institutional framework, strengthen the capacity for rapid primary response (especially in the case of bioterrorism and the like), and better coordinate health promotion and disease prevention.

The combination of the business process through informatization is a health information system that aims to more efficient information management, security of data use, archiving and stored information, and connecting health care institutions. The public health information system mainly implies a set of standards based on health diagnostics, symptoms, cause, health goals, and measurements. Such computerized programs provide nurses with the necessary content, health care plans, and additional functions, including addition, revision, query, and printing (Kern et al., 2017). To obtain a more efficient information infrastructure system, users are offered all professional information. In contrast, within one hospital, they are offered access to specific information and knowledge bases that are important for the specific activity of a specific hospital system. The system also offers an infrastructure for the organization of e-learning systems (Galijačević 2004). Factors influencing the development of information system services are organizational, financial, and market (Wang et al., 2005). The health information system plays a major role in coordination between health system participants and patients.

Suppose state institutions cannot effectively allocate the resources and services. In that case, they provide to citizens, the situation in health care can be further aggravated through the example of the prevalence of corruption in health care (Mihaljek, 2006). There are high expectations in terms of the service provided by organizations as they have to leave a great impression on every user. The health sector consists of a dozen markets in health care and treatment, various insurance forms, medicines; medical equipment; labor market for medical staff, etc. In most of these markets, there is a so-called. Market failures include unfavorable choices, asymmetric information, growing returns, and moral hazards (Mihaljek, 2006).

The concept of the health care system has changed over time. The earliest concept of the health system is the transition from paper to computer data processing. The constant growth of new technologies allows for a constant computing environment and sensor technologies for health monitoring. Implemented information systems

reduce the need for the physical presence of employees, hierarchical control of superiors over subordinates, and direct integration mechanisms, taking into account the fact that they are realized through electronic connectivity. The creation of virtual networks and systems is contributed by a quality management information system that also improves the range of control while reducing the number of hierarchical levels in the organization. Reducing hierarchical levels in an organization is called a shallower organization. The practical application of information and communication technology points to the fact that it encourages development and change in the organization's structure (Cunliffe, 2008).

There are three data sets: electronic health record, electronic medical record, and electronic personal health record (Kern et al., 2017):

- Electronic health record IT module - processes data on the user's health status stored in the system and can be transmitted securely electronically, and their visibility is allowed to the user.
- Electronic medical record IT module - processes only the user's health data stored in the system that can be transmitted electronically in a secure manner.
- Electronic personal health record – the user's health status summarized in a set of data that the user creates and records. They are in electronic form and are freely available to users.

The electronic medical record (EMR), which is at the heart of every health information system, is important for integrating patient data in healthcare. EMR is a medical record in digital form, while electronic health record (EHR) refers to a medical record of an individual patient in digital format. Electronic personal record (EPR) is defined as electronically stored health data of a single unit, uniquely identified by an identifier. EHR systems coordinate the storage and retrieval of individual records. EPR technology includes the individual and comprehensive retrieval, storage, retrieval, transmission, and manipulation of healthcare-related data, particularly clinical, administrative, and biographical data (Borycki et al., 2011).

Due to their availability and easily acceptable form, digital tools have a great opportunity to spread scientific knowledge. People's interest and their active participation in health promotion, prevention, and care, together with rights, guide the development of information systems and give new tendencies. The trend is to involve patients or citizens in the source of information, decision-making, and awareness of responsibility for their health. Technology in the health system creates more efficient and better communication between the patient and the system. It provides quality support in changing lifestyles and taking a more active role in improving their health.

Further development towards an integrated health information system includes a holistic approach to personal habits, physical activities, spiritual and emotional activities, and social support and social networks that would become part of the system. The integration of technological solutions into health systems is especially evident in the configuration of new models of care and the use of health technology assessment to achieve higher quality and sustainability of health services. Through digital solutions and various applications for measuring health parameters, Demands for health services and care can make citizens actively involved in health promotion and manage chronic conditions on their own. The knowledge and skills that employees need to handle a particular technology mutually determine the degree of organization and technology and point to the technological imperative, i.e., the assumption that technology determines all other aspects of the organization (Hatch, 2006).

Development of e-health in the EU

The development of e-health is a program policy systematically implemented by the European Union to develop a new service branch called the e-health care industry. The e-health industry has great growth potential and could become the third industry whose revenues exceed 11 billion. Euro, or about 5% of the total health care budget (Commission of the European Communities, 2007). The European Union gives member states autonomy in creating a health care system under the Treaty of the European Union of Maastricht of 7 February 1992. The goal is to create a European area of e-health as a platform for joint actions in e-health and provide a favorable environment for its development and dissemination (Ostojić et al., 2012). In the European Union, e-health includes information systems in clinical work, information systems in the home care service, personalized health information systems, information health systems for remote patients, support information systems, e.g., billing systems, and integrated regional and national health information networks. Current European Union health policy is currently reflected in the five areas listed below (European Parliament, 2020):

- Health in all policy areas of the European Union - the "Field to Table" Strategy has been adopted, and the goal of the strategy is to produce sustainable and healthier food. A Zero Pollution Action Plan has been adopted to create a cleaner and healthier living space; Public health funding in EU Member States has been partially addressed through the European Social Fund Plus, which, together with other funds and programs (e.g., the European Regional Fund), will help address open health problems. The EU will fund projects to mitigate the effects of climate change, i.e., solving health problems caused or aggravated by climate change. Due to heatwaves and natural disasters, the number of deaths is undoubtedly rising. Current patterns of human infection have also changed, and it is thought to have been influenced by modes of disease transmission, such as vector insects or water as a medium.
- Disease prevention and health promotion - The EU has implemented joint activities to preserve and benefit mental health from 2013 to 2018. A uniform legal framework for mental health and well-being was created during the implementation of joint activities. The fight against cancer will also get its legal framework in the form of a Cancer Plan.
- Changes in society and demographic transition - following new demographic trends, increasing population aging was identified, and in 2016 an Action Plan was adopted, which includes the integration of citizens from third countries.
- Medicines - the EU-wide Regulation on Clinical Trials and other legislation on medicinal products and in vitro diagnostic medical devices has been in force since 2020. The European Union has monitored the application of these regulations to determine whether the expected results are being achieved. Join discussions on some important issues that have begun, such as the shortage of medicines and vaccines and access to more affordable medicines on the Health Committees.
- E-health - information and communication technologies address many health issues, including disease prevention, diagnosis, treatment, and health and lifestyle monitoring. The digitalization of the health sector belongs to the EU's digital single market strategy and has great potential. Several measures are implemented simultaneously so that the common market can function. In 2018, the communication on enabling digital transformation in the single digital market in health and care was adopted. This document defines the priorities of the digital healthcare market: secure access of citizens to health data, access to health data by citizens when they are outside their home countries and within

EU countries, and the implementation of personalized medicine through a common European data infrastructure. This allows for pooling in using resources by researchers and other health professionals. The use of shared resources should strengthen the position of citizens towards digital tools (e.g., mobile health solutions) and increase person-centered care - personalized medicine.

The European Health Information Initiative, set up by the World Health Organization (WHO), aims to improve information supporting health policies in the European region. It encourages international cooperation to support the exchange of expertise, capacity building, and harmonization of data collection and reporting processes. EHII operates in six key areas: (i) collecting and analyzing information that deepens the understanding of health and well-being, with an emphasis on indicators; (ii) improving access to and dissemination of health information; (iii) supporting the development of health information strategies; (iv) capacity building; (v) strengthening health information networks; (vi) communication and advocacy.

Development of e-health in Croatia

The informatization of the health care system in the Republic of Croatia began with the health care reform in 1993. The beginning of the integrated health care system began in 1994 under the organization of the Croatian Health Insurance Institute. The system called "e-Croatia" began at the beginning of the 21st century, and as part of this project, the e-health project came to life. The goals of the introduction of e-health were defined as improving the quality of health services for citizens while achieving significant financial savings. The reform provided several organizational solutions to improve the efficiency of the system and improve the quality of health care delivery, such as the informatization of primary health care, emergency care reform, the introduction of national waiting lists, and changes in primary health care payments, which should encourage quality and growth coverage of health services in primary health care (Broz et al., 2014). The computerization of the health care system started with the computerization of primary health care and hospitals. The implementation of the central primary health care information system based on the name NISHI (National Information System on Healthcare Infrastructure) was designed and developed by Ericsson Nikola.

In 2004, Croatia adopted an eHealth Action Plan. The Action Plan aims to implement e-health systems forms the EU system, define interoperability and its objectives, and use health records in electronic form (Barroso, 2015).

The National Health Development Strategy 2012-2020 published an analysis of the situation in the hospital, which states that about 45,000 employees were employed in Croatian hospitals in 2012, of which about 200 were IT, staff. In 2012, 36 hospital wards had separate IT departments, a hospital information system existed in 42 public hospitals, while in 20 public hospitals, there was no central information system (Ministry of Health, 2016).

In 2016, a project was implemented by the Croatian Health Insurance Institute and the Ministry of Health of the Republic of Croatia entitled Preparing a practical basis for building an e-HZZO (engl. Electronic Croatian Health Insurance Organization) system with the aim of better integrating cooperation with another state, interstate, regional and local stakeholders. Efforts were made to connect all stakeholders within the health system for more efficient management and more effective supervision, especially in the management and monitoring financial resources. Health information systems represent the interaction between people, processes, and technology to support management in providing essential information to improve the quality of health services (Ministry of Health, 2016).

The Agency for Quality and Accreditation in Health and Social Welfare existed in the Republic of Croatia until January 1, 2019 (Republic of Croatia, 2018). The purpose of its activities was to accreditation health services in health care and raised the quality of services in the health system through an advisory nature. After the termination of the Agency, its work is completely taken over by the Ministry of Health of the Republic of Croatia. The Agency was involved in an international study to determine the benefits and barriers to empowering patients in the chronically ill population. The term patient empowerment refers to how stakeholders in the health care system help the patients gain control over their own lives and increase the intensity of their actions in the area that is important to the patient. Communication is two-way, and patients have the opportunity to inform doctors by giving them feedback on their health. In the past, patients were passive observers of their treatment, while today, patients actively participate in their treatment and thus consume their rights and duties. The goal is for patients to become equal participants in the decision-making process.

Infrastructures e-health in Croatia

HZZO (engl. Croatian Health Insurance Organization) has created a database that contains data on all insured persons, taxpayers, and health care institutions. The database provides quality to doing business in the Republic of Croatia. The database enables real-time registration and check-out data monitoring and the creation of financial reports on paid sickness benefits, maternity benefits, etc.

The basic health information system of the Republic of Croatia is the Central Health Information System of Croatia (CEZIH). The Croatian Health Insurance Institute is the owner of CEZIH. The CEZIH system has several parts: the central information system and information subsystems of authorized health care providers in the Republic of Croatia. The program's purpose is to support the functioning of health processes in public health, implement special health care programs, and connect all other health information systems that represent an entity for themselves, all to provide appropriate health care to citizens of Croatia. HZO, as the owner of the health information system CEZIH, is an authorized issuer of digital certificates to users. In CEZIH, we distinguish two information systems. The first information system includes primary health care providers (family medicine clinics, polyclinics, pharmacies, etc.), i.e., the primary health care information system. The second system is the information system of secondary and tertiary health care, which refers to information systems in clinical hospital centers, hospitals, hospitals, and institutes. Every working day at CEZIH, all general family medicine clinics, pediatric surgeries, gynecological surgeries, dental surgeries, pharmacies, laboratories, school medicine surgeries, outpatient specialist-consultative health care, and the information system of the Croatian Health Insurance Institute are connected. More than 50 million recipes were recorded in one year. It is considered the central system of storage of health data and information in which standardized data processing is performed at all levels of health care.

NAJS is a national public health information system that provides information services of the Croatian Institute of Public Health and is connected to other institutions. It offers the possibility of managing information and processes in public health and serves to process health data and information in this narrow health segment. It is considered the central system of storage of health data and information in which standardized data processing is performed at all levels of health care.

BIS Hospital Information System 'Integrated Hospital Information System', so-called BIS. BIS has the most users because it has the most employees in hospitals and clinical hospital centers. The system keeps an e-card of patients with whom pharmacies,

laboratories, and the Croatian Health Insurance Fund are connected. Laboratory findings are available, an e-referral and e-prescription can be issued, the patient can be ordered for an examination, and an electronic prescription can be sent to pick up prescription therapy at any pharmacy in the Republic of Croatia (Poje et al., 2019).

HR-DRG – an information system that measures the efficiency of the hospital system, e-guidelines: integrated information system that integrates health guidelines into other e-systems and e-hospital – an integrated information system that is both standardized and interoperable in all public hospitals in the Republic Croatia (Republic of Croatia, 2020).

Obstacles in the further development of e-health

Incompatibility of digital solutions and non-support of data exchange within and outside national systems can be cited as an obstacle to further development of health system informatization. Hospitals, primary health care teams, institutes of emergency medicine, HZZO, etc., have information systems that are not interconnected. General hospitals, specialized hospitals, clinical hospitals, and clinical hospital centers are not interconnected with the hospital information system. In case of transfer of patients from one hospital to another, medical documentation is submitted in paper form. Hospital information systems of some hospitals are not connected to NICE either. Access to and use databases for research and innovation is limited, lacking financial resources and financial incentives. The main goals of health informatization are the following (Republic of Croatia, 2020): (i) improving connectivity and continuity in the health system; (ii) harmonizing and improving the quality of health care; (iii) increasing the efficiency and effectiveness of the health system; (iv) increasing the availability of health care and (v) improving the health indicators planned to be achieved through the implementation of an integrated program consisting of computerization of the central health system and the establishment of an e-hospital system.

The problem with introducing innovations is also a human factor because there are too few employees in the IT departments of health institutions who would identify the necessary innovations within the institution and their implementation. In health care institutions, the current problem is the obsolescence of devices and irregular servicing of devices. Since public health institutions are contracting authorities and subject to public procurement legislation, public procurement can be a health innovation and often a long and complex process involving health, legal, social, financial, and technical actors. The Ministry of Health of 2017 is conducting public procurement procedures. Joint procurement enables more efficient and economical spending of funds. So far, several procedures have been carried out for five procurement categories for 554 groups with a total value of over 1.2 billion kunas (Ministry of Health, 2021). The National Reform Plan sets out measures to improve the efficiency of management in the health care system, which consists of 3 objectives (Ministry of Health, 2021):

- improve the health care system in such a way that the application of information and communication technologies is systematic, efficient, and prudent and provides an effective way to control costs in health care, increase the availability and quality of health services; The activity required for the realization of this goal is the definition of a strategic framework for the development of e-health and the development of the National Health Development Plan from 2021 to 2027.
- raising the quality of health care, optimizing the resources of all hospital health systems, and ensuring the financial stability of the health system; activity for the

stated goal is the number of concluded agreements between hospitals on mutual functional integration, which is continuously implemented
- ensuring the financial sustainability of the health system; the activity for the stated goal is to make an analytical study and calculate the costs of major inefficiencies in the health system that have not yet been completed.

E-health and the Covid-19 pandemic

The current challenge facing all levels of health care institutions both in our country and in the world is the pandemic virus Covid-19, which has greatly changed the business. Hospitals have rapidly transformed and adapted their work to the new circumstances to reduce the likelihood of transmitting viral infection. Telemedicine came to life and realized the importance and readiness to invest in IT infrastructure and purchase software programs. The Covid 19 virus pandemic has intensified the application of already developed health information systems that can quickly be digitally transformed into the necessary applications with the required security levels. The Ministry of Health of the Republic of Croatia has published an application for Stop Covid-19. The purpose of using the application is to warn citizens that their contact, which the application has recorded, may be risky. HZZO has created a register of persons in isolation and self-isolation due to infection or exposure to the Covid-19 virus. A call center has been set up for people in self-isolation to get an answer to a question about their illness or status at any time.

The European Commission has adopted a Recommendation on a package of measures for applying technology and data to combat and overcome the crisis caused by the Covid-19 disease. The purpose of the Recommendation is to develop a pan-European approach to the application of mobile applications coordinated at the EU level, as a means to help citizens effectively limit social contacts and as a means to warn, prevent and monitor social contacts, to curb the spread of Covid-19. The European Commission has recommended the exclusive voluntary use of such applications without coercive measures. The European Union is providing a grant under the EU4Health project, i.e., the EU for health, from 2021 to 2027, with investments of 9.4 billion euros. The objectives are to improve the EU's preparedness for major cross-border health threats, to provide a stockpile of medical supplies for emergencies, to mobilize reserve health workers and experts who can be mobilized to respond to health crises anywhere in the EU, to strengthen health threat monitoring and systems to address epidemics and long-term challenges by encouraging disease prevention and health promotion in the context of an aging population, funding the digital transformation of health systems, ensuring access to health care for vulnerable groups and making medicines available and affordable, and affordability and availability of medical products, promoting the prudent and effective use of antimicrobials, promoting medical and pharmaceutical innovation and promoting green production (European Comission, 2021).

The ultimate goal of Croatian e-health is to improve management capacity through more efficient use of data as a basis for decision-making and policies. The selected data can be converted into health information with the appropriate algorithms based on which decisions will be made. Due to the new situation caused by the Covid-19 pandemic, the health care system faced challenges that led to a more intensive adaptation of the health information system to the real needs of the population.

Conclusion

This paper aims to review the development of the health care information system in the Republic of Croatia. The paper presents the principles of development of the information health system, its basic elements and purpose, and historical development. The policy of the European Union created further development of health services in the Republic of Croatia, all to provide comprehensive, timely, quality, and safe services. New digital and mobile applications can create a new future for patients by offering them personalized solutions to manage their health. Preventive health care will reduce the chances of developing potential diseases through protection and early detection to build people's quality of health and well-being.

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