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DIGITAL TRENDS AND ITS IMPLICATIONS ON THE HEALTH INFORMATION SYSTEMS FUNCTIONS DIVERSIFICATION[2]

Abstract

Improving the interoperability of healthcare organizations as the imperative of digitizing health services leads to the strengthening of an initiative for electronic health functions diversification. The focus is on the long-term economic, and above all the health benefits of using technologically advanced tools of health information systems. Digital trends tend to strive for high personalization, customization and patient-oriented information technolog solutions when implementing them in the health information system of a particular health organization. In view of this, the paper will monitor the evolution of digital trends in electronic healthcare and their impact on the functionality of health information systems, especially in terms of efficiency.

Keyword: *electronic health, information systems, trends, diversification*

JEL classification: C8, I15, O3

ДИГИТАЛНИ ТРЕНДОВИ И ЊИХОВЕ ИМПЛИКАЦИЈЕ НА ДИВЕРСИФИКАЦИЈУ ФУНКЦИЈА ЗДРАВСТВЕНОГ ИНФОРМАЦИОНОГ СИСТЕМА

Апстракт

Унапређење интероперабилности здравствених организација као императив дигитализације здравствених услуга, доводи до јачања иницијативе за диверсификацијом функција електронског здравства. У фокус се ставља дугорочни економски, а пре свега здравствени бенефит коришћења технолошки напредних алата здравствених информационих система. Дигитални трендови електронског здравства теже ка високој персонализацији, кастумизацији и пацијент - оријентацији информационо- технолошких решења приликом њихове имплементације у здравствени информациони систем одређене здравствене организације. С обзиром на то, у раду ће бити праћена еволуција дигиталних трендова електронског здравства и њихов утицај на функционалност здравствених информационих система нарочито по питању ефикасности.

Кључне речи: *електронско здравство, информациони системи, трендови, диверсификација*

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Introduction

Health information systems are information intensive, so their conceptual framework of functioning should be harmonized with the needs of consumeristic health care. The only way is to overcome the gap between technology and health and create a favorable atmosphere for the development of electronic health and the diversification of its functions. In order to integrate the technological development tendency with the needs of health, while respecting market trends in medical branches, health information systems must go through four dimensions of integration. The first dimension refers to the creation of information intensive health messages, their distribution through the communication channel, as well as the determination of the destination and the recipients of those messages. This dimension involves targeting stakeholders with important information about the patient's health status and the way they are transmitted through certain media.

In a broader context, the second dimension relates to the consumeristic perception of health information systems and familiarity with their wide range of functions, which provide information about health condition in real time. The third dimension refers to the ability of healthcare stakeholders to adapt to a new, virtual perspective of providing health care services with unchanged or improved efficiency and interoperability. The fourth dimension emphasizes the importance of an efficient allocation of medical resources, even by virtual ways, so that the economic effects of using health care information systems can be felt at the macro level.

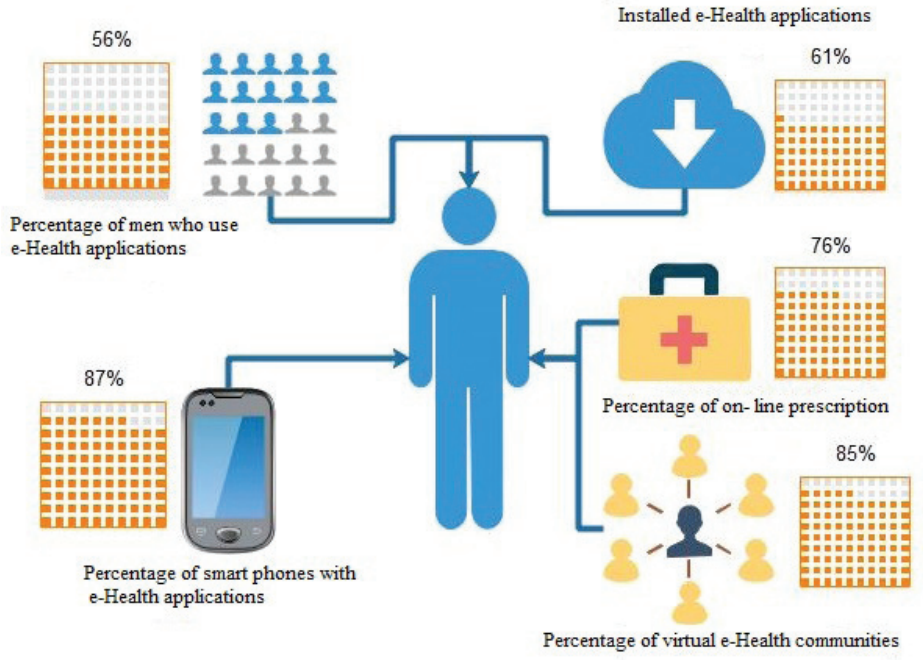
One of the growing trends within health care information systems is ability to work on the web. Namely, the Internet creates numerous opportunities for interaction between medical staff and patients. Telemedicine services can give a certain diagnosis regardless of geographical and temporal distance. Also, through e-mail you can get direct and quality advice from professional staff for current medical care, while by electronically filling in the form for taking medicine from the pharmacy, the waiting time in rows is reduced, as well as transport and administrative costs. Networking more than one medical institution, through a virtual medium, enables the creation of a consultative dimension of the health information system and a new trend in disease diagnosing. This way, information from the electronic health card can be exchanged, as well as the accompanying documents and analyzes, which informed staff about the patient health care condition. Thus, at no additional cost, a particular healthcare facility prepares for the reception of patients with an already known diagnosis, given therapy and general condition.

Applicative trends and interoperability tendencies in e- Health

Trends in the health information system sector are mutually conditioned and according to the aforementioned development possibilities, through electronic health, virtual communities of medical staff and patients are formed. This trend emerged as a reaction to virtual groups of patients who supported each other in cases of long-term treatment. Thus, electronic health creates an on-line community, which greatly facilitates the monitoring and analysis of the health care status of patients with the constant exchange of medical information. (Keselman et al., 2008)

The horizontal flow of medical information exchange, through electronic healthcare technology, has led to a fundamental change in the way of communication and interaction of the healthcare organizations stakeholders. This implies the diversification of electronic health care software functions across a range of applications that not only complement this information exchange, but contribute to the creation of trends in the medical virtual analysis of the patients health care status. Such a trend in the development of an applicative part of electronic health will lead to the emergence of m-Health.[3] Data show that in 2017 there was a significant increase in using of these e-health applications, particular through social networks, 85% (Figure 1).

Figure 1: Percentage of installed e- Health applications and e- Health users



Source: author, based on data from https://i.pinimg.com/736x/fa/a9/6c/faa96cb5542d674806213bc724c8c7a7--mobile-marketing-digital-marketing.jpg

The application trend in upgrading electronic health functions contributes to the digitization of the consultative aspect of medical services by forming the concept of "medicine from home". Namely, for information of the current state of health, scheduling examinations and mitigation of symptoms, patients can get from medical staff precisely through applications that reduce the costs of creating a "bottleneck" in the patients

[3] For example, through these applications, an increase in blood sugar may be monitored on a daily basis with the prognosis of the same for a shorter or longer period of time, whereby the obtained results can be directly entered into an electronic health record.

flow and speeds up the realization of emergency cases that are actually transported to a health institution. In other words, the creation of artificial crowds and waiting in queues reduces and gives priority to emergencies. Also, the information asymmetry about health condition on the patient-doctor relationship decreases with adequate management and redirection of information, at the patient's request. The application aspect of electronic health also allows the connection of patients with similar medical conditions and thus leads to an exchange of experiences. A telemedicine health service through a videoconferencing option provides direct, in real time, information to medical staff about the health care parameters of a given patient. That is, the patient can communicate their medical results in person, and may also have a virtual reminder of taking medication. (Esterle & Mathieu- Fritz, 2013)

Tendencies in further diversification of the functions of health information systems relate on improving the communication of users of electronic health services. It seeks to improve the communication part of the state of health in terms of a timely and realistic description of the current state of health by patients. In this way, standardized virtual communication between medical personnel and patients, can easily identify the symptoms of a potential illness and respond adequately to the situation. This reduces unnecessary administrative and operational costs, and improves the quality of services by more efficient communication. Given the heterogeneous character of the group of patients, standardization is essential in order for communication to be clear. Therefore, there is a trend of creating a template in the description of the health status through a specific application that is directly entered into the system and in an electronic health card where a computer prediction of the future situation is given, as well as a proposal for the care of patients. (Alahmadi et al., 2014)

Stakeholder value added information exchange in virtual health care services

Trends in electronic health go towards cost optimization and improvement of the organization's interoperability through the formation of the so-called Unified Medical Language System (UMLS). This systemic language has the task of unifying established medical service delivery schemes so that healthcare stakeholders can carry out the transmission of medical information in a uniform manner. The result of the formation of this type of system language is a better evaluation of health parameters introduced by patients electronically and preventive action without additional "steps" in transporting the patient to the institution if there is no need for it. This reduces "bottlenecks" in patients' flow and gives priority to emergencies with more effective monitoring. The multidisciplinary character of interactions between e-healthcare stakeholders in health organizations has influenced the emergence of new tendencies in the development of e-health software. These tendencies primarily concern the creation of additional value for certain stakeholders in the provision of healthcare through electronic health, which for the ultimate goal has the diversification of the functions of health information systems (Table 1).

Table 1: Stakeholder groups and their contribution to additional value of virtual health care services

Stakeholder group	Value added
Patient	-Virtual prescriptions. - Information portals for interactive communications. - Virtual patient triage. - Information availability. - Time reduction of waiting in a queue.
Medical stuff	- Decision support systems. - Virtual consultations. - Clinical databases. - Tools for analyzing healthcare indicators.
Managers	- Benchmarking -Brainstorming. - Budget planning. - Workflow planning.

Source: Keselman, A., Logan, R., Arnott- Smith, C., Leroy, G. & Zeng- Treitler, Q. (2008) Developing Informatics Tools and Strategies for Consumer- centered Health Communication, Journal of the American Medical Informatics Association, Vol.15, No.4., 473-483 str.

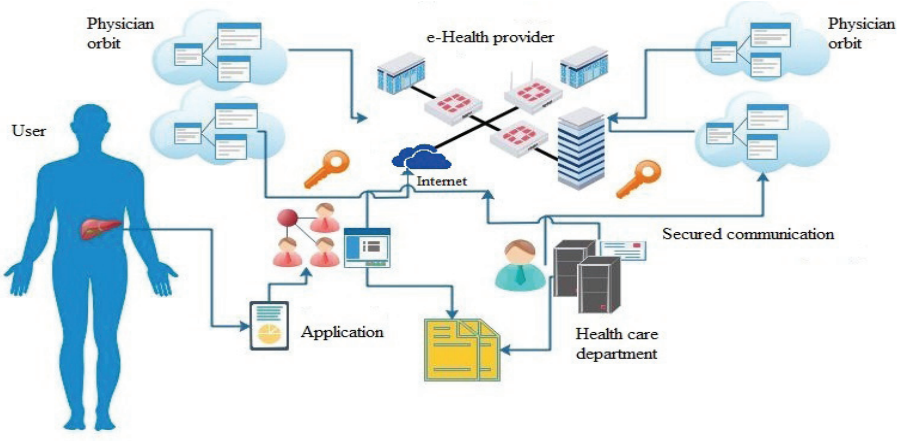
Stakeholder interactions within the health organization are not only related to the provision of health services, but also contain a large number of modalities, ranging from administrative exchange of information to business transactions. Therefore, in the digital health environment, it seeks to create such a user interface that will reduce the cost of complex interactions between users and providers of health services. On-line electronic healthcare services should, with their functions and a "user-friendly" atmosphere, reduce the level of complexity when it comes to healthcare stakeholder relationships, with the growth of interoperability and the connection of all departments of the health organization. The interface should be intuitive enough to provide information on health status or health parameters in real time.

Therefore, in the digital market of health information systems, there are initiatives to create such systems that will enable the balance between quality and cost efficiency in providing virtual health services. This implies full profitability of an investment in electronic healthcare, where, in order to achieve this, there must be a systematic and at the same time a holistic approach to the development and diversification of electronic health functions. Only this can be achieved one of the leading imperatives in the digital world, which is the self-evolving aspect of the information systems. This involves upgrading the existing information systems within each organization in accordance with

its characteristics and specific business characteristics, since each organization, including health, should be regarded as a kind of organism. It is clear that the aforementioned concept of self-upgrading of the organization's functions, according to its own needs, leads to the reengineering of business processes, in this case, the reengineering of the process of providing e-health services.

This new tendency in health information systems leads to the targeting of those phases in the process of providing health services that should be upgraded or eliminated, so as not to create a standstill in generating additional value by using e-Health functions. This refers primarily to the reengineering of certain clinical procedures in order to obtain these procedures in digital form, as well as to reengineering of certain phases in the health supply chain on the principle of "just-in-time", while respecting the principles of e-commerce.

Figure 2: Stakeholder communication channel and information exchange in e- Health network



Source: Author, based on available literature

As it has already been established, electronic healthcare services are an important component of the modern provision of health services. The medical profession emphasizes that in terms of service efficiency and cost reduction, the time of doctors is more important than the time of patients. It is therefore necessary to optimize the time for which a certain health service is provided and the waiting time for its execution. This is because the effective and effective use of medical resources leads to timely provision of health services and prevents the emergence of possible unwanted outcomes when it comes to patient health.

Waiting theory and its impact on e- Health service efficiency

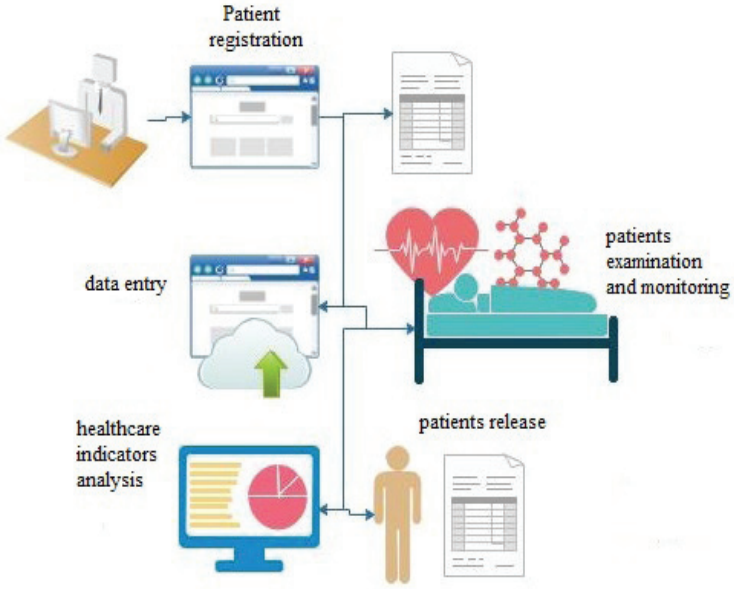
It is clear that health information systems have led health organizations to a higher evolutionary level, which primarily increases the dynamism and complexity of this type of service. The availability of diversification in the health sector, both scientifically and technologically, enables electronic healthcare to make a significant contribution when it

comes to maneuvers to which the organization is serving, to reduce costs to a reasonable level. The operational strategy of health organizations is therefore patient oriented and designed to ensure saving time for patients who wait for health care services by interacting with the following elements (Singh, 2006):

- Management of medical equipment and materials.
- Movement of medical and non-medical staff according to established "routines" within the health organization.
- Planning the capacity of a health organization, especially when it comes to emergency situations.
- Software monitoring for scheduling reviews, availability of capacity, availability of medical staff, equipment and medicines, as well as the collection, analysis and archiving of patient health information.

One of the best strategies for improving the provision of public health services is based on a waiting theory that ensures that waiting times are reduced by applying a one-channel multifaceted system model for waiting in healthcare institutions. This model is for increasing the efficiency of the operation of healthcare organizations provided by health information systems. Solving this problem is based on electronic tracking of patient flow through a regional healthcare organization and an electronic analysis of staffing capacities. This could reduce patient waiting and optimized the provision of health services with as much efficiency as possible.

Figure 3: Process of patient virtual registration and further medical treatment



Source: Author, based on available literature

An adequate screening system and regular electronic analytics of limited medical resources by the existing health care information system, in a specific health organization, helps to answer the following questions (Mardiah & Basri, 2013):

- How to optimally allocate medical supplies and staff to the current capacity and patient flow?
- How many hospital beds should be prepared at a given moment?
- How long should the average provision of health care for a given category of patients last, without compromising the health or financial aspect of the service?
- What factors cause a delay in providing health services?
- Is the provision of health services electronically fulfilled the minimum value of the norm, at the daily level, in terms of the number of scheduled examinations and the processed history of the disease from the electronic health card?
- Is there a potential for improving the use of medical equipment and materials, based on the software analysis carried out, the health information system?

When it comes to healthcare services supported by the health information system, the waiting time depends on the number of units or patients in the system and the order of their registration through the server of the health institution. Waiting in line is cost-priced both from the aspect of patients and from the aspect of a health institution, which uses certain medical resources for timely provision of services. Usually, each health care organization focuses on the first in-out concept of receiving and providing health services as the "safest" way for timely and continuous provision of health services registered through a systemic access to the health information system. Electronic health, accordingly, allows the organization to be cost-competitive by continuously monitoring patient flows, both clinical and operational.

Control and monitoring of patient flow as well as the balance of patient arrivals and provision of services is realized through a health information system that after a certain period of time forms the most frequent trajectories of patient movement through the process of medical care for a given health institution. All this is supported by the most commonly used indicators of the theory of waiting (Singh, 2006):

- Patient arrival rates (λ) - arrival of patients per hour during working hours taking into account the average number of visits per doctor on a daily basis.
- Service rate (μ) - the ratio between patient arrival rates and the average number of patients per doctor on a daily basis.
- Average server usage (P) - Average time for using a patient registration server and servicing their service.
- Average number of patients in line (Ls) - the average number of patients waiting for the health service after registration.
- Average number of patients in the system (Lq) - the average number of patients who are processed and registered in the system, as well as those who are still "on hold".
- Average waiting time in line. (Ws)
- The average time in the system (Wq) - the time spent on waiting for the registration and processing of the health information system users.

- Percentage of time for which the server is empty (P0) - the so-called "idle time" of the server, or the time for which the server does not register users or participates in the process of providing a health service.

Below (Table 2) are presented indicators of the theory of waiting on the example of the regional health center of the Republic of Serbia, which uses the health information system Heliant Health. Namely, the working hours of one change of medical and non-medical staff within a given health center is eight hours (t), with an average number of patients or a visit by a doctor 36 (δ) for the mentioned working time of one shift.

Table 2: Waiting theory and its indicators based on health information system Heliant Health

	Value
Patients arrival rate $\lambda = \frac{t-1}{\delta} x100$	**19**
Service rate $\mu = \frac{t}{\delta}$	**22**
Average server usage $P = \frac{\lambda}{\mu}$	**0,86 (86%)**
Average number of patients in line $L_s = \frac{\lambda}{\mu - \lambda}$	**5,46**
Average number of patients in a system $L_q = \frac{\lambda^2}{\mu(\mu-\lambda)}$	**6,37**
Average waiting time in line $W_s = \frac{1}{\mu - \lambda}$	**0,33**
Average time in a system $W_q = \frac{\lambda}{\mu(\mu-\lambda)}$	**0,28**
Percentage of time when the server is empty $P_0 = 1 - P$	**0,14 (14%)**

Source: Author, based on available data during research in regional health organizations in Republic of Serbia

From the previous table, it can be seen that the capacity of using server in providing health care services on the example of the regional health center is almost 90%, which shows only how much the health information system is important for patient flow monitoring. The average time for providing health care services with the help of the health information system is 22 minutes, while the waiting time is 0,33 hours or 19,8 minutes. From here, it can be concluded that there is significant efficiency in the work of a health center supported by electronic health, since the provision of services is less than 30 minutes per patient. This all supports the rapid systemic treatment of patients and the monitoring of his health condition, which is kept in the system for 16.8 minutes.

Conclusion

The benefits of electronic health are progressively increasing at the global level. New medical discoveries along with high quality medical services, supported by advanced technologies, lead to a significant improvement in people's health and prolonging life expectancy. In this way, the health condition of a certain population and in the genetic code improves in the long run. Modern technologies with their innovative medical analyzes and procedures have contributed to faster diagnosis and timely treatment. Software forecasting and health forecasting based on the collected data from the history of disease significantly reduces the costs of the health organization and optimizes the provision of health services with a high degree of interoperability. Reduction of administrative costs is also obtained at a time when it concerns the patient's health status and enables timely provision of health services

Virtual provision of health services through electronic health leads to the networking of all stakeholders of the health organization, which realizes the exchange of information about the patient's health status. In this way, virtual virtual medical orbits are formed, which create an effective interactive medical communication channel by the unique language of electronic health, the concept of electronic health record and application-based information gathering. This leads to early detection of signs of illness and better treatment of the patient, as well as optimal allocation of medical resources to urgent cases, leading to a significant reduction in operational, administrative and logistical costs. Timely making medical decisions based on software data processing about patient, collected through electronic health, priority is given to the most vulnerable group of patients and reduce unnecessary costs of transportation and use of medical equipment for other purposes. The benefits of e-health are increasingly reflected in the personalization of virtual medical tools to define in a more precise way the health condition of the patient and provide adequate medical services at no cost, with the continued growth of the added value of medical services.

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