

THE ADOPTION OF HEALTHCARE 4.0 IN POLISH HEALTHCARE SECTOR

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ABSTRACT

The intensive development of new technologies has brought about changes in the functioning of many organisations, the so-called Industry 4.0 includes, in general terms, changes concerning a significant increase in the automation and robotisation of production processes and the expansion of the use of internet information and computer data management systems in organisations. These changes also apply to the field of healthcare, where telemedicine, artificial intelligence, Big Data analytics, among others, are increasingly used and a megatrend called Healthcare 4.0 or Health 4.0 has emerged. The concept of Healthcare 4.0 is the result of research into the applicability of the concept. The use of Industry 4.0 in the healthcare field is a relatively new research direction. In order to realise the full potential of Healthcare 4.0, comprehensive governance models are needed that also allow for the early teasing out of flaws, limitations and their elimination. The ongoing research fits in with this demand. One of the barriers to wider implementation of the Healthcare 4.0 concept in the area of healthcare entity management may be insufficient acceptance of new technologies by their directors. The article presented here addresses precisely the problem of acceptance of modern technologies by hospital directors and their use in the process of strategic decision-making. A literature review was used as a research method.

Keywords: public management, health 4.0, health sector, decision making process

INTRODUCTION

Industry 4.0 is the common name for the development programme initiated by the German government in 2011. [1]. Industry 4.0 involves the technical integration of new technologies such as artificial intelligence (AI), cloud computing, cyber-physical systems and the internet of things into industrial production [1, 2, 3, 4]. The fourth technological revolution has also extended to the public sector, where technologies specific to Industry 4.0 are being used with increasing intensity, e.g. artificial intelligence in medicine, digitisation of social services provided. It is significant that the modernisation and thus improvement of the efficiency of public organisations does not apply to the operation of individual organisations that decide to do so, but to entire areas of public service provision through the implementation of relevant programmes at central or

regional level, thus realising the aspiration to transform the public sector towards Government 4.0. These changes also apply to the field of healthcare, where telemedicine, artificial intelligence, Big Data analytics, among others, are increasingly used and a megatrend called Healthcare 4.0 or Health 4.0 has emerged [5]. Chen [5] and his team described the changes taking place as 'The new brain and new hands in Healthcare 4.0'.

The concept of Healthcare 4.0 is the result of research into the applicability of the concept. The use of Industry 4.0 in the healthcare field is a relatively new research direction. As Cavallone and Palumbo [6] point out - Industry 4.0 in healthcare should not be seen as a self-absorbed innovation; rather, it should be carefully managed at both the policy-making and management levels. In order to realise the full potential of Healthcare 4.0, comprehensive governance models are needed that also allow for the early teasing out of flaws, limitations and their elimination. The ongoing research fits in with this demand. One of the barriers to wider implementation of the Healthcare 4.0 concept in the area of healthcare entity management may be insufficient acceptance of new technologies by their directors. The article addresses precisely the problem of acceptance of modern technologies by hospital directors and their use in the process of strategic decision-making. The article focuses on the consideration of the possibility of using the Unified Theory Of Acceptance And Use Of Technology (UTAUT) to assess the degree of acceptance of new technologies by hospital directors to improve decision-making. A literature review was used as a research method.

HEALTH 4.0 CONCEPT

The stages of penetration of modern IT solutions into the health services sector were presented in their work by Chanchaichujit, Tan, Meng and Eaimkhong [7]. Between 1970 and 1990, modular or siloed IT systems mainly geared towards paperless medical records based on simple automation (Healthcare 1.0) were developed. The next step was the networking of most IT systems, and the electronic health records (EHRs) generated began to integrate with clinical imaging, giving physicians a better perspective (Healthcare 2.0). Since 2000, the emergence and development of patient-worn devices and implants can be observed. There is an integration of all outcome data, along with electronic patient records on a network (Healthcare 3.0). There is an emerging problem of data incompatibility and resistance from healthcare providers. Currently, we are seeing the rapid development of Healthcare 4.0, the intention of which is to apply some of the elements of Industry 4.0 to the healthcare sector, including the Internet of Things, Big Data analytics, cyber-physical systems and cloud computing.

The development of the Healthcare 4.0 concept is shown in Table 1.

Table 1. *Transition from Healthcare 1.0 to Healthcare 4.0*

Destinctions	Healthcare 1.0	Healthcare 2.0	Healthcare 3.0	Healthcare 4.0
Main objectives	Improving efficiency and reducing paperwork	Improving information sharing and efficiency	Provision of patient-centred solutions	Provide solutions to monitor patient status and respond in real time
Focus	Simple automation	Liaison with other organisations	Inteaction with patient	Integrated real-time monitoring, AI-enabled diagnostics
Sharing information	With the organisation	Within the cluster of providers	In the country	As part of the global health supply chain
Key technologies	Administrative systems	Cloud computing	Big Data, mobile devices, optimisation systems	IoT, Blockchain, AI, data analytics
Restrictions	Single, isolated systems with limited functionality	Sharing only critical information but no interaction with patients	Different standards udes in a community with limited interoperability	New and untested technologies raising data security concerns

Source: [7]

The Internet of Things are technologies that enable any device to be connected to the internet, remotely access and manage these devices from anywhere with internet access. An example application of the IoT is monitoring health conditions remotely and performing medical procedures at home, which are possible in this way. As well as being used to remotely monitor a patient's health, the data obtained from biosensors can also aid scientific research. Cyber-physical systems are intelligent systems comprising machines, devices and software that operate autonomously or in a network, communicate over the internet and use web services, and make decisions in a decentralised manner or in collaboration with humans. These systems are used to monitor and control devices in the physical world and the processes in which these devices are used. The main application of cyber-physical systems in the healthcare sector is the modelling of therapeutic reality. Cloud technology allows data to be remotely stored and processed within secure servers. Sources of data can include medical records, laboratory test results, prescription data, wellbeing data, data generated by electronic gallantry and demographic factors such as postcode, local weather,

shopping habits. Cloud computing uses analytics and calculation systems to process data.

Current digital health technology is widely used, ranging from mobile health applications, or m-health, to decision support systems that use algorithms derived from mining clinical datasets, to biometric sensors such as continuous glucose monitoring, video-linked consultations ('telemedicine') and electronic personal health records. The implementation of these technologies has been a key driver of change in healthcare and has helped to bridge the divide between healthcare providers and patients through digital communication.

Reaping the full benefits of applying the technologies known to Industry 4.0 to the public sector, however, requires overcoming certain obstacles. One of these is the lack of acceptance of modern technologies among doctors, managers and other employees of healthcare providers [8], [9], [10]. Without an appropriate level of acceptance, it is not possible to effectively introduce modern technologies into the practice of medical entities. It seems that this problem is smaller among physicians and nurses, as they perceive the direct impact of modern technologies on improving the quality of provided health services or facilitating their work. Less acceptance of the use of modern technology may concern managers of healthcare entities, who may not perceive a direct link / or understand it / between modern technology and improved efficiency in the management area. One possible application of Industry 4.0 technology is to support decision-making processes using, among other things, Big Data analysis. However, the lack of sufficient managerial acceptance of modern technologies may hinder the process of implementing Industry 4.0 technologies in the management area of the healthcare entity, especially in the decision-making process.

The above justifies the need for a deeper analysis of the level of acceptance and use of modern technologies among the management staff of hospitals, especially with regard to the support of Industry 4.0 technologies for decision-making.

DECISION MAKING PROCESS IN PUBLIC ORGANIZATION

Modern Industry 4.0 technologies can significantly support the decision-making process in public healthcare entities, e.g. in the area of investment decisions or organisational risk management. At this point, however, it is important to point out the specifics of the decision-making process itself in public organisations.

Essentially, both in private and public organisations the management comes down to decision-making, however, it should be borne in mind that the decision-making process in public organizations differs fundamentally from the decision-making process in commercial organisations, both in terms of the process itself and its determinants [11].

The source literature indicates that private organizations have definitely smoother and quieter decision-making processes [12]. On the other hand, public organisations experience more turbulence, breaks, recirculation and conflicts. These differences are attributed by the researchers to the roles of public and private organisations in society. Commercial organisations act with the aim to make profit, while public organisations pursue goals of social importance, the hierarchy of which is changed from time to time and dependent on the currently prevailing political forces and electoral preferences.

The decision-making process in the public sector organisations is complex. The managers, when performing their tasks, are forced not only to strive to achieve economic efficiency, but also to consider social and political consequences of their actions [13].

The rules and regularities of general management are applicable in public management, however, referring them to the public organizations, it is necessary to take their specificity into account , i.a. [14]:

- the existence of many stakeholders, whose interests do not coincide and sometimes are disputatious,
- large impact of stakeholders that have a significant power,
- decision-making rarely performed in a rational way due to operation in a highly political environment,
- lack of profits as a measure of efficiency, evaluating, at the same time, political interests and legislative elections, from the point of view of citizens' preferences
- less susceptibility of the participants to financial incentives, and more focus on the mission of the organization, need to cross the organizational barriers in order to recognize various aspects of problem solving, relatively high public visibility and transparency of intra-organizational activities.

The differences in decision-making in the private and public sector organizations were also pointed out in the works of Nutt [12]:

- in public organizations decision-makers must recognize the market, because it is created by state authorities, and behaviour of buyers is the factor defining the market for private organizations;
- in public organizations, cooperation replaces competition;
- in public organizations, there is greater need for consensus and simultaneous pressure to understand the mandates and commitments, and the range of choices available is smaller. In private organizations autonomy and flexibility of an organization is limited only by law and internal needs of the organization;

- in public organizations more time is needed for balancing expectations of the users with the requirements of the authorities, which is a result of networks between the users and authorities;
- in public organizations the need for opening the processes of external participation is increasing, it is difficult to keep the decision-making in secret;
- in public organizations the need for determining public expectations regarding the way in which the service is provided is increasing because the citizens behave like shareholders and often impose their expectations concerning activities of the organization;
- in public organizations, clarity of selection criteria is decreasing, there is the need to take into account the soft criteria and the criteria that will ensure equal access to the services;
- in public organizations the need for bargaining over resources is increasing, decision-makers have less power enabling them to change the shape of organization, also the time to search for options for this change is more limited.

Industry 4.0 tools, including artificial intelligence (AI) or Big Data, provide decision support and even empower decision-making in different contexts. The change for Industry 4.0 tools is driven not only by the availability of massive amounts of data, but also by the shift from decision support to actual decision-making. Industry 4.0 tools may indeed be able to process a lot of data, even in real time, to come to conclusions that can be the basis for good decisions, thus freeing employees to think more strategically and/or abstractly. Modern technologies, their sophistication and their operation on large data sets in real time allow them to be more widely used as decision support for more complex problems, often of a strategic nature.

Research carried out by the author of this article [11] indicates that decision-making among managers of public healthcare entities is dominated by making decisions based on previously made decisions, the so-called historical model. These decisions are based on previous experiences and decisions made by managers and do not take into account the new context in which decisions are made, thus limiting the effectiveness of actions. Supporting the decision-making process with modern technology therefore seems fully justified to move towards a more innovative decision-making process.

However, as indicated earlier, one of the barriers to wider implementation of Industry 4.0 technologies in the practice of organisational functioning, including decision-making processes, is the lack of acceptance of modern technologies by managers. Therefore, it is reasonable to investigate more deeply the extent to which managers of public healthcare entities accept and use modern technologies. For this purpose, the Unified Theory Of Acceptance And Use Of Technology (UTAUT), recognised in the literature, can be used.

UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY (UTAUT)

UTAUT was proposed in 2003 by Venkatesh and his team [15]. It combines previous models of acceptance of modern technology and is now widely used in research on this phenomenon. The Unified Theory Of Acceptance And Use Of Technology model is shown in the figure below.

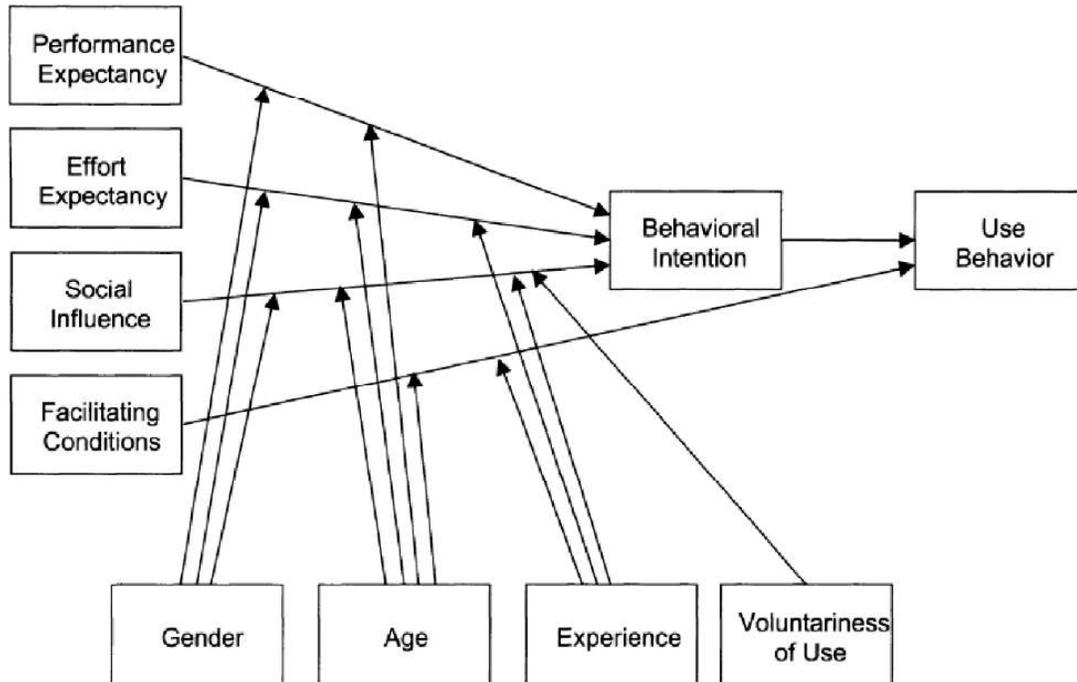


Fig. 1. Unified Theory Of Acceptance And Use Of Technology

Source: Venkatesh V., Morris M. G., Davis G. B., & Davis F. D., User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, 27(3), pp. 425–478, 2003.

The authors of the model propose the following independent variables: performance expectancy, effort expectancy, social influence and facilitating conditions. They influence the intention to use modern technologies and, consequently, their ultimate use. As moderating variables, the model authors proposed gender, age, experience and voluntariness from use.

Performance expectancy refers to the expected efficiency, productivity from the use of modern technology. It means that the use of ICT increases an employee's productivity, allows me to complete tasks faster; the belief that the use of ICT at work is useful, improves the quality of work.

Effort expectancy means that the effort involved in using modern technology.

Social influence is a variable that refers to the importance of the influence of the immediate environment as a determinant of acceptance of modern technology. For example, people who are important to me think that I should use ICT, people who influence my behaviour/actions think that I should use ICT, I get help from my manager when it comes to using ICT, I use ICT because of the percentage of my co-workers who also do so.

Facilitating conditions are expressed, for example, in access to equipment or training to acquire the appropriate knowledge and skills to use modern technology. Facilitating conditions also refer to knowledge sharing within the organisation itself, including access to people with the necessary knowledge and skills.

CONCLUSION

The above considerations clearly indicate the need for deeper research into the degree of acceptance of modern technologies by managers of public healthcare entities, who are active participants in the process of change - the transition to Health 4.0.

In the designed research, after the exploratory research, which has a qualitative character, the author of the article will move to the stage of quantitative research, the first stage of which will be the development of a research tool. The aim of the designed research is to ocean the degree of accpetation of modern technologies as a support for strategic decision-making by managers of public healthcare entities.

It should also be noted that Industry 4.0 and Health 4.0 not only promote improvements, technological progress, but above all promote transformation. The development of the Health 4.0 concept implies a fundamental change in the way health services are delivered, both for healthcare providers, medical professionals, but also for patients. In addition to triggering institutional, structural and cultural changes for healthcare organisations, Health 4.0 also aims to achieve greater patient and carer participation in the value creation process.

The growth of a population familiar with IT solutions, who are more aware of the importance of modern technology in their lives, including the provision of public services, and thus require better service from their healthcare providers. At the same time, healthcare providers themselves - diagnosticians, doctors, surgeons and hospitals as a whole - recognise that the increasing use of modern solutions specific to Industry 4.0 in healthcare improves their productivity and efficiency.

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