Adoption of Automation Technologies in Public Organizations: The Perception of Healthcare Professionals in Greece

Alexandra Daikou*, Ioanna Tamouridou**, Evangelos Kalampokis***, Konstantinos Tarabanis****

*424 Military Hospital, Thessaloniki, Greece, mhm19016@uom.edu.gr
**University of Macedonia, Thessaloniki, Greece, mhm19031@uom.edu.gr
***Centre for Research & Technology - Hellas and University of Macedonia, Thessaloniki Greece, ekal@uom.gr
****Centre for Research & Technology - Hellas and University of Macedonia, Thessaloniki, Greece, kat@uom.edu.gr

Abstract: The purpose of this study was to investigate the beliefs and perceptions of Greek healthcare professionals working in public hospitals about the new automation technologies in health services. Focus was placed on two representative examples, namely, the Automated Decision-Making and the Robotic Process Automation systems. Towards this goal, and in order to acquire a holistic viewpoint, we interviewed personnel from different positions, with different hierarchical duties and with variable working experience. Most of the participants were not aware of the two aforementioned technologies and, as a result, did not use any related tool in everyday practice. However, they were positive to be educated and trained in programs that specifically relate to their duties. The central criteria for adopting the new technology were the reduction in effort and time for accomplishing a work, the increase in reliability and efficiency as well as the lower levels of anxiety when a program could serve as a "checklist" add-on. Key issues, such as the improvement of the already available software to follow the modern systems and the initiation of educational programs to address the "electronic illiteracy" of the staff were emphasized. Finally, concerns about the implementation of these technologies were expressed, such as the potential lack of trust from patients to healthcare professionals, the complacency of younger colleagues and the low applicability of these tools in cases of manual work or dynamic conditions.

1. Introduction

The current state in health services around the world urgently necessitates innovative actions and developments. In fact, it has been estimated that by 2050, the older population (>60 years old) will be approximately 2 billion or, put differently, 900 million more than in 2015 (WHO). Taking also into account that the patients suffering from chronic diseases or disabilities live typically longer compared to previous decades, it becomes clear that increasing working productivity and putting less strain on health services represent two "grand" challenges for the present and the forthcoming decades (Buntin et al, 2011). A promising solution to address the aforementioned challenges is the development and implementation of novel tools exploiting information and communication technologies. These tools include, among others, the Automated Decision Making (ADM), the Robotic Process Automation (RPA), the Digital Health Systems (DHS), the Electronic Health Record (EHR), the Mobile Health Services and Applications (M-HEALTH), Data Analytics, Telemedicine and Artificial Intelligence. Therefore, the traditional paper-based medical systems are increasingly replaced by modern digital systems based on automation technologies, that facilitate better management and advanced handling of patient's information and treatment (Buntin et al, 2011, Hillestad et al, 2005).

In light of the above, the broad adoption of such "next-generation" approaches seems to be the way ahead regarding the processing of data in the healthcare services. However, the adoption of a new technological innovation has always been a challenging task, at any time in the history, and at all aspects of human activity (Alam et al, 2020, Khoja et al, 2017). The long-held belief that the progress of technology is exclusively safe and offers only benefits to humans has been put into a vigorous test and has been boldly questioned. Some certain innovations in health services have caused a lot of discussion and criticism compared to others. The most important criteria commonly used by the general public in adopting an innovation in health services relate to the survival rate and quality of life, the potential iatrogenic consequences and, predominantly, the diverse ethical issues (Calnan et al, 2005). As a result, some technologies have been smoothly accepted by the general public (e.g., hip replacement), while others (e.g., "tube" children) seem to have "triggered" or even contradicted some established perceptions and ethical codes. Regarding healthcare professionals, along with the ethical issues mentioned above, some factors that determine the adoption of a new technology include the feasibility of the implementation of the new technology in the clinical setting and the userfriendly interface of the application/software (Secginli et al, 2014). Despite the existing reservations, the majority of both the general public and healthcare professionals support the development of new technologies in health services. Of course, this does not mean that they underappreciate the use of "classic" medicine; rather, they recognize this innovation as a useful complementary tool (Hillestad et al, 2005). Regarding Greece, the vast majority of the new automation technologies is of limited use and the whole field could be generally characterized as "immature" in the applied settings. In particular, only few of the aforementioned technologies are utilized predominantly in private healthcare sectors, whereas the public sectors suffer from diverse operational and technological drawbacks that limit their usage, such as the low applicability due to lack of adequate implementation policies, poor staff capabilities, skills and knowledge to use the systems, underfunding as well as inadequate official training programs.

On this basis, the purpose of the present exploratory study was to investigate the beliefs and perceptions of healthcare professionals working in two Greek general public hospitals about this topic. We particularly focused on the Automated Decision-Making and the Robotic Process Automation. To this end, and in order to acquire a more holistic viewpoint, we recruited a heterogenous personnel from different professional positions, with different hierarchical duties and with variable working experience. The rest of this paper is organized as follows: Section 2 presents the research approach that we followed to achieve the objective of the study. In Section 3 we present the findings of our study, while in Section 4 we discuss these outcomes in relation to other countries and other automated technologies. Finally, in Section 5 we summarize in brief the main messages of our work.

2. Research Approach

The present work was designed as an exploratory case study to investigate the perception of healthcare professionals working in public hospitals in Greece about the adoption of automation technologies. An exploratory case study is a useful design to gain insights about a phenomenon that is under-studied and to construct a new theory or to provide suggestions about the phenomenon (Yin, 2014). We collected qualitative data from semi-structured interviews conducted in two different public hospitals and we recruited a heterogenous population in order to acquire a more representative sample.

2.1 Automated Decision-Making

Automated decision-making is the process of making a decision by automated means without any human involvement. These decisions can be based on factual data, as well as on digitally created profiles or inferred data. Ten (n=10) healthcare professionals participated in this part of our study regarding the Automated Decision-Making (Table 1). For the purposes of the present study, interviews were chosen as the source of primary data.

# Interview	Professional position
1	Male Nurse with 20 years working experience in public and private health sectors
2	Female Registered Nurse with 18 years working experience
3	Female Registered Head-nurse with 30 years working experience
4	Male worker in the technical support department of the hospital with 15 years working experience
5	Male worker from the administration staff with 3 years working experience
6	Female pharmacist with 12 years working experience
7	Male Intern Physician with 5 years working experience
8	Female Intern Hematologist with 7 years working experience
9	Male Hematologist with 15 years working experience
10	Male Oncologist with 16 years working experience

Table 1: Characteristics of the participants

The interviews (performed between September and November 2020) included open-ended questions and the participants were asked to provide their beliefs and perceptions on the topic by answering 7 specific questions (Table 2). A qualitative analysis was subsequently performed.

#	Question
1	Do you know what the Automated Decision-Making systems are?
2	Do you know if Automated Decision-Making systems exist in relation to your work/duties?
3	Are you open to this kind of technology? And for what reasons?
4	What type of decisions do you make in your position? Are they structured, semi-structured or unstructured? Could they be possibly obtained from an automated system?
5	Do you think that the use of this technology would affect patients' views on this type of health services?
6	Which do you think are the benefits and the shortcomings of such technologies? What are your thoughts on the reliability of such applications?
7	Do you think that the adoption of this technology would affect (either positively or negatively) health professionals in terms of seeking knowledge and promoting their personal development?

Table 2: The 7 research questions of the study

2.2 **Robotic Process Automation**

Robotic Process Automation is an application of technology, governed by business logic and structured inputs, aimed at automating business processes. Six (n=6) healthcare professionals participated in this part of our study regarding the Robotic Process Automation (Table 3). For the purposes of the present study, interviews were chosen as the source of primary data.

# Interview	Professional position
1	Female Registered Head-nurse with 15 years working experience
2	Male Head of the 2nd Nursing Department with 15 years working experience
3	Male Orthopaedic surgeon with 10 years working experience
4	Female Secretariat in the Nursing Services Directorate with 10 years working experience
5	Female Payroll Manager with 13 years working experience
6	Female Emergency Room Registered Nurse with 8 years working experience

Table 3: Characteristics of the participants

The interviews (performed between October and December 2020) included open-ended questions and the participants were asked to provide their beliefs and perceptions on the topic by answering 4 specific questions (Table 4). A qualitative analysis was subsequently performed.

#	Question
1	Do you know what the Robotic Process Automation technology is? Do you find it useful in general?
2	Do you use the Robotic Process Automation in your work/current position? If yes, please clarify in which routine processes.
3	Which processes do you think could be automated in your work to save time and avoid mistakes?
4	What do you think will be the complications and what the benefits of applying Robotic Process Automation in your work??

Table 4: The 4 research questions of the study

3. Results

3.1 Automated Decision-Making

The majority of the participants were not aware of the Automated Decision-Making concept and did not use any related program or process in their positions. Nevertheless, contrary to their perception, few of them actually used software that exploits this technology, but did not consider them in this category. The participants who were aware of this technology either used this extensively in their routine everyday clinical practice via software or applications in their mobile phones and computers (e.g., "Up to date", "Sanford guide", "NCCN", "Manage anticoag", "medcalc.gr") or participated in postgraduate educational programs in relevant fields (e.g., MSc in Healthcare Management). Despite the fact that most of the participants did not know these options in everyday practice, all of them were receptive to be educated and trained in programs that specifically relate to their duties. The central criteria for adopting this new technology were the reduction in effort and time for accomplishing a particular work, the increase in reliability and efficiency as well as the lower levels of anxiety in cases where an Automated Decision-Making program would serve as a "checklist" addon.

Of course, most of the participants underlined some issues that have to be addressed before adopting this new technology. More specifically, those who already use such programs or applications argued that the already existing options in the hospital should be updated or even advanced to become more efficient and user-friendly in order to follow the modern systems. The rest of the participants were cautious about their ability to use these programs and emphasized the need to be trained and supported for a short initial time before integrating these processes in everyday practice officially. Noteworthy, two of them referred to the term "electronic illiteracy" signifying the fact that they most probably already acknowledge this issue in other aspects of their life as well. Finally, some concerns were expressed by the participants. First, the extensive use of such technologies may lead the patients to believe that the staff is of low quality and largely depends on these programs (lack of trust). However, some participants disagree with this concern, because the use of these programs shows that the professionals follow the latest guidelines. Second, professionals with greater work experience stated that this easy access to "ready-to-use" information may lead younger colleagues to complacency and produce "low-achievers". Third, a preliminary period before full adoption should be established in order to clarify if these technologies are indeed less effort- and time-consuming in everyday practice for individuals naive to electronic and computational tools. Fourth, a major concern among the professionals in the lower administrative hierarchy levels was the applicability of these technologies in their work, which is predominantly manual and not office-based and/or is characterized by dynamic and unpredicted changes throughout a day or week (e.g., ER nurse, technical support staff). Thus, semi-structured or unstructured decisions in a healthcare sector cannot always be performed or supported by an Automated Decision-Making system. Fifth, a universal concern among all participants was the role of the human in this process. All agreed that the staff should always confirm the last step of the automated processes as a last check and in order to be able to obtain feedback and report on possible pitfalls or misfunctions as well as to "enrich" the program in specific steps.

3.2 Robotic Process Automation

Most of the participants reported that they were aware of the Robotic Process Automation and consider it particularly useful. Moreover, they even argue that a more optimal, advanced or updated form of it would facilitate the improvement in the operational efficiency of the hospital. Regarding the use of Robotic Process Automation from the participants of the study, the answers varied given that each specialty encounters this technology in different cases and from a different perspective. For instance, the Head-nurse argued that there is a program in run in the hospital that is close to the concept of the Robotic Process Automation and is associated with diverse processes, such as ordering drugs and introducing new treatments in patient's file; however, the currently used program requires major improvement to perform to the maximum. The Emergency Room nurse stated that the Robotic Process Automation is mainly used during the admission of the patient to the hospital as well as during the discharge. In particular, dyring admission the Social Security Registration Number is typed in the system and the patient's card is immediately displayed to the employee. At the discharge, the standard instructions to the patient are inserted through this system by the medical doctor and given to the patient. The doctor stated that he uses such a program at a very preliminary stage in the outpatient clinics of the hospital. In this program the patients are listed daily and they are checked when attended. It becomes clear that the benefits of this technology are many and multifaceted, allowing healthcare professionals to use their time more productively, devoting more time to patients and offering better services.

Subsequently, each of the participants provided some ideas and suggestions about this technology, according to his/her duties. In particular, a participant working as administrative secretariat underlined the need to make the patient's registration process automated, as well as the archiving of incoming and outgoing documents and the report of the number of the patients of each ward in a common electronic system. Currently, they are recorded either by phone or electronically via email, by each clinic separately. It is obviously a demanding and time consuming process, yet more than necessary for the smooth running of the hospital. The medical doctor pinpointed the 9 importance of automation in private sectors as well, as regards to the optimal operation of the office including record of the appointments, ready-to-use instruction forms that the patient will receive after the examination or postoperatively depending on the surgery. The head-nurse highlighted the time-consuming manual procedures so far, such as the staff schedule, the department's orders and the discard of old materials. In this part of the interview, the Payroll manager, having served in various positions in the hospital, expressed various suggestions. These suggestions included: scheduled follow-ups to review outpatients postoperatively, reprogramming in case of cancellation, scheduling injections of chemotherapy regimens for cancer patients, remuneration of staff, payment of overtime and on-call compensation, information on transition to a higher salary scale and corresponding salary reward, monitoring of the hospital contracts for the supply of materials and services and timely announcement of the tender when the expiration of the previous contract is approaching, monitoring of human resource management, automated monitoring and updating of scheduled maintenance of medical equipment and forecast of annual necessary budget. Finally, regarding the benefits and the drawbacks of the Robotic Process Automation use, the participants highighted the time and costs savings as well as the reduction in malpractices and omissions as the

main benefits, while the adoption of the process by the employees, their training and the cost for the installation of the software were thought the main barriers.

4. Discussion

One of the greatest challenges regarding the use of new technologies in the healthcare systems is the adoption of these tools from the health professionals. During the last approximately 50 years, 5 different theories have been developed that analyze how users (typically workers) react to a new technology. These theories are: the Theory of Reasoned Action (Fishbein and Ajzen 1975), the Theory of Planned Behavior (Ajzen, 1991), the Perceived Usefulness, Perceived Ease of Use, and User Acceptance of 10 Information Technology Model (Davis, 1989), the Diffusion of Innovation Theory (Rogers, 2003) and the Unified Theory of Acceptance and Use of Technology (Venkatesh, 2003). To the best of our knowledge, this is the very first study that investigated the beliefs and perceptions of Greek healthcare professionals working in public hospitals about the new technologies in health services. We recruited a heterogenous population of professionals in terms of position and work experience and specifically focused on the Automated Decision-Making and the Robotic Process Automation systems. According to the interviews conducted towards this goal, the majority of the participants reported that they were not aware of these technologies and did not use any related program. However, some of them actually used certain applications close to the concept of the two aforementioned technologies, but could not identify and link these ideas. Only few of them were aware and used relevant applications or software in their personal computer or mobile phone. In particular, programs or online platforms for calculating drug doses and assessing biomarker diagnostics are widely used among this cohort. On the bright side, all of them irrespective of the position or the current use of these technologies in their hospital were positive to be educated and to exploit this option in the future. Of course, some issues were stressed, such as the need for formal education and support as well as the existence of a test period to check the real applicability and feasibility of the programs. In the same context, some concerns about the humancentric idea, the trust of the patients and the potential complacency of younger workers were underlined. Finally, some suggestions according to the position of each participant were proposed.

The findings of our study are generally in line with previous studies from other countries, which also underlined the necessity for implementing analogous technological advances and the need to properly prepare and educate the workers to use them (for example (Muinga et al, 2020)). Relevant studies have also been published that investigated the perception and adoption of new technologies from healthcare professionals, and in particular, as regards to Humanoid Robots (Papadopoulos, 2020), Mobile-Health applications (Immonen et al, 2018), Artificial Intelligence (Xiang et al, 2020), Telemedicine (Kamal et al, 2020) and the Automated Decision-Making processes (Edwards et al, 2017). The authors of the latter study, which partially related to our study, argued that: i) the Automated Decision-Making systems, in a secondary role, are effective for operational decisions, but have some key limitations at a strategic level; ii) these systems can support users make better decisions, but their effectiveness is achieved only through their users; iii) such supportive systems do not necessarily provide the user with working time, but when it replaces the user it really improves the decision-making process and iv) users of these systems do not believe that they had acquired novel knowledge by using these systems. The participants of our study totally agreed with

the first two conclusions mentioned above. However, regarding the third conclusion and according to their duties, our participants strongly believe that new technologies will certainly ensure much working time. Finally, some of the participants not only agreed with the fourth conclusion of Edwards colleagues, but also stressed the scenario some users to exclusively rely on these technologies.

Apparently, there are some limitations that should be acknowledged in the context of the present study. First, despite the fact that we tried to cover a wide spectrum of different professionals, the total number of participants is limited and does not necessarily permit us to extrapolate our findings to the entire healthcare staff. Thus, our work mostly serves as a preliminary and proof-of-concept study on the topic in Greece. Second, we used a low number of questions (especially in the second study), while all of them were open-ended questions. Thus, a more complex combination of different type of questions would have provided more holistic and detailed view on the topic. Third, our information refers to only 2 public hospitals. As a result, the private sector is not represented in this work, while even public hospitals with more developed automation technology systems are not included.

5. Conclusion

The present study investigated the beliefs and perceptions of healthcare professionals working in two Greek public hospitals about two automation technologies, namely, the Automated Decision-Making and the Robotic Process Automation systems. Most of the participants were not aware of the two aforementioned technologies and, as a result, did not use any related tool in everyday practice. However, they were positive to be educated and trained in programs that specifically relate to their duties. The central criteria for adopting the new technology were 12 the reduction in effort and time for accomplishing a particular work, the increase in reliability and efficiency as well as the lower levels of anxiety when a program could serve as a "checklist" add-on. Key issues, such as the improvement of the already available software to follow the modern systems and the initiation of educational programs to address the "electronic illiteracy" of the staff were emphasized. Some concerns about the implementation and the applicability of these technologies in everyday practice were expressed.

References

Ajzen, I.: The theory of planned behavior. Organizational Behavior and Human Decision Processes 50(2), 179-211 (1991).

Alam, M.Z., Hoque, M.R., Hu W., et al.: Factors influencing the adoption of mHealth services in a developing country: A patient-centric study, Int J Inf Manage, 50:128-143 (2020).

Buntin, M.B., Burke, M.F., Hoaglin, M.C., et al.: The benefits of health information technology: a review of the recent literature shows predominantly positive results. Health Aff 30, 464-71 (2011).

Calnan, M., Montaner, D., Horne, R.: How acceptable are innovative health-care technologies? A survey of public beliefs and attitudes in England and Wales. Soc Sci Med 60(9):1937-1948 (2005).

Davis, F.D.: Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. MIS Quarterly 13(3), 319-340 (1989).

Edwards, L., Veale, M.: Slave to the Algorithm? Why a 'Right to an Explanation' Is Probably Not the Remedy You Are Looking For. Duke Law & Technology Review 18 (2017)

Fishbein, M., Ajzen, I.: Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research. Addison-Wesley, Reading Massachusetts (1975).

Hillestad, R., Bigelow, J., Bower, A., et al.: Can electronic medical record systems transform health care? potential health benefits, savings, and costs. Health Aff 24, 1103– 1117 (2005).

Immonen, M., Koivuniemi, J.: Self-service technologies in health-care: Exploring drivers for adoption. Computers in Human Behavior 88:18-27 (2018).13

Kamal, S.A., Shafiq, M., Kakria, P.: Investigating acceptance of telemedicine services through an extended technology acceptance model (TAM). Technology in Society 60:101212 (2020).

Khoja, T., Rawaf, S., Qidwai, W., et al.: Health Care in Gulf Cooperation Council Countries: A Review of Challenges and Opportunities. Cureus 9(8):e1586 (2017).

Muinga, N., Magare, S., Monda, J., et al.: Digital health Systems in Kenyan Public Hospitals: a mixed-methods survey. BMC Med Inform Decis Mak 20(1), 2 (2020).

Papadopoulos, I., Koulouglioti, C., Lazzarino, R., et al.: Enablers and barriers to the implementation of socially assistive humanoid robots in health and social care: A systematic review. BMJ Open 10(1): e033096 (2020).

Rogers, E.: Diffusion of Innovations. 5th edn. Free Press, New York (2003).

Secginli, S., Erdogan, S., Monsen, K.A.: Attitudes of health professionals towards electronic health records in primary health care settings: a questionnaire survey. Inform Health Soc Care 39(1):15-32 (2014).

Venkatesh, V., Morris, M.G., Davis, G.B., et al.: User Acceptance of Information Technology: Toward a Unified View. MIS Quarterly 27(3), 425-478 (2003).

World Health Organization Homepage, https://www.who.int/news-room/factsheets/detail/ageing-and-health, last accessed 2021/03/18.

Xiang, Y., Zhao, L., Liu, Z., et al.: Implementation of artificial intelligence in medicine: Status analysis and development suggestions. Artificial Intelligence in Medicine 102:101780 (2020).

Yin, R.K.: Case study research. Design and methods. 5th edn. Sage Publications, London (2014).

About the Authors

Alexandra Daikou

Alexandra Daikou is a registered nurse for the last 19 years and she is currently working in 424 Military Hospital of Thessaloniki. She has worked in a various departments such as the ICU, the ER, the Orthopedic dept and the Oncology ward. Alexandra has graduated from the Master in Health Care Management at the University of Macedonia, Greece.

Ioanna Tamouridou

Ioanna Tamouridou has recently graduated from the Master in Health Care Management at the University of Macedonia, Greece. She has also worked in the administrative department of a public hospital in Thessaloniki, Greece.

Evangelos Kalampokis

Evangelos N. Kalampokis is a research fellow with CERTH/ITI and an Adjunct Lecturer at the Business Administration Dept. of the University of Macedonia, Greece. His main research interests include Information Systems, Semantic Web, Artificial Intelligence, Open Data and eGovernment.

Konstantinos Tarabanis

Konstantinos A. Tarabanis is Professor of Information Systems at the Department of Business Administration of the University of Macedonia, Thessaloniki, Greece, where he has taught since 1994, and the Director of the Information Systems Laboratory at the same university conducting research in the fields of electronic government, electronic learning and electronic business. He is also the head of a Research team at CERTH/ITI's e-Services, e-Learning and e-Government Lab.