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# Exploring Digital Transformation in Public Healthcare: Drivers, Success Factors, and Challenges

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SCHOOL OF SCIENCE & TECHNOLOGY

A thesis submitted for the degree of

*Master of Science (MSc) in e-business and digital marketing*

JANUARY 2022

THESSALONIKI – GREECE



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## **Abstract**

This thesis explores Digital Transformation (DT) in public healthcare and more specifically, drivers, success factors, and challenges. Based on the current literature, there is gap on the current topic. The ultimate purpose of this research is to gather all information relevant to the current topic in one place. This could help future researchers to find aggregated information as a starting point for their research journey.

Apostolos Palaskas

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## Introduction

This section describes a set of key terms which are related to the topic and are important for its further understanding. Additionally, the current research status on DT in healthcare is presented

## Digital Health

There is a close relation between DT in healthcare and Digital Health. Meskó et al. (2017) [1] define “Digital Health” as the cultural transformation which takes place when innovative, and of disruptive nature, technologies are implemented and adopted in the health sector. This transformation redefines the typical healthcare provider-receiver relation, leading to the democratization of care, access to data from all actors within the ecosystem, as well as participation in the decision-making process. The same authors also highlight the importance of understanding the users’ needs, which in our case are the patients. Based on the above definition, it can be deduced users, changes in how things are done, as well as in attitudes and stances is at the core of a transformative process. An example of innovative technologies with disruptive potential are Telemedicine, Artificial Intelligence, Internet of Things (IoT) Robotics, Genomics, Virtual Reality, and Augmented Reality. Odydq et al. (2020) define DT as a process of change facilitated by new technologies. They also identify a paradigm shift from a current state, which is institutional-based healthcare, to a new state, which is personalized, user-centric and distance-defying.

## Research Status on DT in Healthcare

Odydq et al. (2020) [2] performed a systematic literature review related to DT in Healthcare. Their findings are quite interesting regarding the status of research on this specific topic. Based on this literature review, DT in health is not being investigated as one would expect. There is a relatively large of theoretical papers, but a low volume of empirical research. Scholars that research this topic include engineers, IT scientist, medical and healthcare service researchers. There is a relatively low volume of researchers that belong to the fields of Information Systems and Business Economics respectively. The authors underline the need for more research, as well as more researchers that stem from various fields. This is due to the interdisciplinary nature of this specific topic, which in turns require a more holistic approach. Popular categories within the topic are

related to technology and implementation, strategic and government issues, digital technologies for enhancing service offerings, and finally, telemedicine and prevention in healthcare. Kraus et al. (2021) [3] highlight that the last 5 years there an increase of interest in research for DT in Healthcare, but the focus is on topics related to technology. Management and business of DT, as well as impact on various stakeholders within the ecosystem, does not attract many researchers. Consequently, there is a gap of research.

### Healthcare sector Characteristics

Cresswell, K., & Sheikh, A. (2013) [4] stress that healthcare, compared to other sectors, is relatively slow to adopt new technologies and innovations. A cause for this lies within the structure of healthcare and its complexity. Bureaucracy, sensitive patient data, strong regulation, existing legacy systems, authority and governance issues further augment the complexity of this sector. Consequently, a DT project in public health can be considered a challenging task.

### Stakeholders – Key actors

Nipa, N. S., Alam, M., & Haque, M. S. (2021) [5] conducted a systematic literature review and identified relevant stakeholders within the healthcare ecosystem. They define stakeholders as key-actors within an ecosystem of organizations that can influence or be influenced by aspects of performance and decision-making processes. Identifying stakeholders within an ecosystem is important for understanding the dynamics of power, as well as the needs of various groups within the ecosystem. These could prove useful later, during value creation activities. Stakeholders within the healthcare ecosystem are patients (and their families), healthcare professionals (doctors, nurses, administrators, employees, and hospital personal in general), health institutions, authorities, policy makers, researchers, service providers, consumer advocates.

### Systems in Healthcare

Karamachoski, J., & Gavrilovska, L. (2019) [6] analyze generations of systems used in healthcare. Their analysis starts from older systems, which are represented by independent and isolated networks and legacy systems, to newer generation systems which are more patient-centric and adopt mobile technologies, IoT, AI, Blockchain and 5G.

## Digital Transformation (DT)

Osmundsen, K., & Iden, J. (2018) [7] define DT a process that causes major changes in the way things work. It has a dynamic nature and is a continuous process with disruptive potential. They argue that this transformation occurs due to digitization and innovation.

Mergel et al. (2018) [8] provide their definition, stating that DT is the re-design of existing services with a user-centric mindset. Essentially, it is not just the digitization of existing and offline services, it is a paradigm shift.

### DT in public sector

Mergel et al. (2018) [8] interviewed experts from the public sector. They discovered useful insights on the reasons why DT occurs in the public sector. These reasons are divided in two main categories, describing the direction of the pressure for DT. There are reasons that stem from the external environment (exterior), and those from the internal environment (internal). Most of the experts (83%) argue that the main reasons for DT are exterior, and most notably include technological change, citizens' needs, political influences. The same authors identify what are the main objects of DT in public sector. The objects that prevail are transformation on existing processes (41,5%), relationships between stakeholders and actors within the ecosystem (24,6%), and services (23,1%). Finally, the authors argue that usually the results of DT are organizational change (27,2%), improved services (19,6%), Democratization (10,9%), and value creation (9,8%). Based on these findings, the authors define DT in Public Sector as a continuous process that is affected heavily by external environment, which results in improved relationships between the actors of the ecosystem, cultural and organizational change, shrinking of bureaucracy, and citizens' needs fulfillment. The same authors clarify the difference of three terms that sometimes are used interchangeably. These are: digitization, digitalization, digital transformation. Digitization is the transition for analog to digital. Digitalization represents a change in process and not just digitization. Digital transformation represents change in the culture, the processes, the relationships within the organization.



## Digital Transformation in Public Health

Iyamu et al. (2021) [9] on their research about Digital Public Health, define DT in Public Health. It is a multilayered process, characterized by a disruptive nature, which aims to transform the culture, the organizational structure, and the way public health services are offered. This process is centered around the needs of citizens that use these types of services.

## Methodology

The first step for this research was to search academic databases for existing papers related to DT in Public Health. The main keywords used for research are present on TABLE 1.

Main Keywords of Research
“Digital Transformation”; “Public Healthcare”; “Drivers”; “Success Factors”; “Challenges”

TABLE 1

It is important to clarify that these keywords were used combined in different search instances. For example: “Digital Transformation Public Healthcare” (or “Digital Transformation Public Health”), “Digital Transformation Public Health Drivers”, “Digital Transformation Public Health Success Factors”, “Digital Transformation Public Health Challenges”.

Google Scholar, a web engine of scholarly literature, was the starting point of research. Next, academic databases were searched for more specific results. These databases include IEEE, JMIR, ACM, BMC, SPRINGER. Papers published during the last 10 years were given priority, due to the dynamic nature of technology, as well as the slightly increased interest for the current topic from academic researchers.

The initial search results, after duplicates exclusion, were approximately 180 papers. The titles of these papers were then processed, based on their relevance to the topic. The outcome of this process led to the exclusion of 95 more papers. The remaining 85 papers were further processed by checking their abstracts and their relevance to the topic. Consequently, 61 more papers were excluded. The rest 24 papers were used for the purpose of this research. All these steps are depicted in TABLE 2.

Step 1	Search results after duplicates exclusion	180
Step 2	Topic relevance based on paper title	85
Step 3	Topic relevance based on paper abstract and content	24

TABLE 2

Mendeley Desktop App was the main tool used for studying all the papers that this research is based on. The same app was also used as a reference manager. Microsoft (MS) Excel & Word were used for organizing all relevant information and producing all related text. MS Sharepoint and Onedrive were used for backup and mobility. Communication with supervisors was facilitated through MS Teams communication platform and IHU elearning tools.

## Research Questions (RQ)

This research is based on three research questions:

1. RQ1: What are the key drivers for Digital Transformation in Public Healthcare?
2. RQ2: What are the success factors for Digital Transformation in Public Healthcare?
3. RQ3: What are the challenges for Digital Transformation in Public Healthcare?

The first RQ aims to explore factors that can drive DT in public healthcare. The second RQ focuses on factors that have a positive impact on the success of a DT project. Finally, the third RQ aims to shed some light on challenges during DT project in Public Health, which if left unattended may cause barriers and obstacles that jeopardize the success of the whole project.

## Results based on the literature

### RQ1: What are the key drivers for Digital Transformation in Public Healthcare?

Based on the studied literature there are interesting findings that can shed some light on RQ1. Various authors approach the matter using different perspectives, highlight different factors that qualify as key drivers for Digital Transformation(DT) in Public Healthcare.

Mesko et al. (2017) [1] emphasize the importance of a proper culture that facilitates change, as well as understanding end-user needs (in this case: patients). They argue that technology can provide solutions and better outcomes, only if specific cultural challenges are met, while on the same time adopting a patient-centric approach. They acknowledge the disruptive nature of specific technologies for medicine, for example AI, telemedicine, robotics, genomics, Virtual Reality, Augmented Reality, but accept as a driver a culture that must be cultivated within Public Healthcare for implementing and adopting technologies that will transform the current state to something more. It is important to mention that they also describe a new kind of patient, the “e-patient”, that is better informed, technologically more equipped, more skilled in new technologies, and more demanding. These demands push further the need for change and consequently, imply, that e-patient can be considered as an important actor within the healthcare ecosystem that drives DT.

Alt, R., & Zimmermann, H. D. (2021) [10] interviewed experts within healthcare industry and showcase that technology plays an important role for digital transformation, but not as a key driver, but as an enabler. They state that the healthcare ecosystem is a rather complex one, involving a lot of actors (government, doctors, patients, providers, insurance entities and various organizations) that can play an important role on driving DT or set obstacles. They also argue that corona pandemic, as factor of the external environment, will drive structural changes within the public healthcare sector, that will, in turn, drive DT efforts.

Dugstad et al. (2019) [11] point out that technology is not a driver for DT, but an enabler. Their research is based on field research examples, involving municipality DT healthcare services . Actors involved within the healthcare ecosystem, as well as a culture that supports change, are very important factors. Initiatives, a proper cultural environment, and a solid strategy can drive DT using new technologies.

Gleiss, A., & Lewandowski, S. (2021) [12] identify actors involved within the healthcare ecosystem, and technology itself, as key drivers for digital transformation. The actors involved set the ideal environment through initiatives and change, and technology provide tools with disruptive nature. It is quite clear that technology itself cannot lead to DT, but it is considered an important driver that push the limits further.

Wong et al. (2021) [13] in comparison to other authors, focus on one group of people within the healthcare ecosystem. A new generation of healthcare professionals that are digital natives. The authors argue that, among other factors, this group can become a driving force for digital transformation initiatives in the healthcare organizations that they belong to. Based on this approach, they propose a strategy that a government should build. This strategy has three main pillars at its center. The first pillar is training and education, through government support, infrastructure, frameworks, interdisciplinary approach, initiatives, and collaboration between ministries. The second pillar is about opportunities, through mentorship, co-design, and participation in the decision-making process. The third pillar is about ethics, through a proper data policy and regulation that eliminates algorithmic biases.

Meister, S., Burmann, A., & Deiters, W. (2019) [14] underline the importance of following a structured approach in DT and Innovation endeavors in public healthcare. They clarify that technology is not all that matters and identify a proper strategy and a clear vision as a key driver for DT. In addition, key actors within the ecosystem are also factors that drive DT, especially those that manage change.

Khashe, Y., & Tabibzadeh, M. (2021) [15] present technology as a driving force for digital transformation in healthcare. Technological advancements and the adoption of intelligent systems create a changing environment that makes DT a necessity. They also point-out that there are two more variables that can further facilitate or impede the process of change, the structure of an organization, and its people. Although technology is considered a driver for DT, changes in the organization's structure, as well as in people's skills and mindset, are essential during DT.

Granja, C., Janssen, W., & Johansen, M. A. (2018) [16] clearly state that factors within the external environment of a public healthcare entity drive the need for DT. They emphasize that demographic trends, for example an aging population and its need for long-term care, push the need for change through technology. Consequently, evolving needs of key actors within the healthcare ecosystem, press for changes.

Osmundsen, K., & Iden, J. (2018) [7] highlight drivers for DT in healthcare. More specific, they regard the needs and expectations of users involved, digital changes within the industry, the competitive landscape, as well as changes in the existing regulatory framework, key drivers for

DT. Again, key actors within the healthcare ecosystem (users, providers, regulators) and technology are driving change.

F. Seoane et al (2021) [17] argue that technology is not a driver for DT in public health, but an enabler. The authors underline the importance of having a strategy and clear goals when setting in motion a DT plan in public health. They identify strategy as an important driver for DT, as well as other factors related to demographic, social, and economic aspect. A growing population and the increase in life expectancy augments the need for better, in terms of quality, and long-term healthcare. This can be interpreted as a change in the needs and expectations of users within the healthcare ecosystem. Problems related to inequity in accessing healthcare also put pressure to governments for changes. Increase of healthcare costs for the state push the need for a more efficient and sustainable public healthcare. The authors also state that data is at the center of every attempt to transform public healthcare, thus it should be considered a driving force for DT.

## RQ2: What are the success factors for Digital Transformation in Public Healthcare?

Based on the literature reviewed, there is not a plethora of papers related to this topic, but a few. Despite this difficulty, some success factors for DT in Public Healthcare were identified.

Meskó et al. (2017) [1] argue that an important success factor is involving users in healthcare services design and decision-making process. Involvement and co-design are considered as the epitome of user-centered approach. A proper regulatory framework that understands what innovative and disruptive technologies are, while on the same time provide security and protection of sensitive data, is another success factor. The authors also highlight the importance of training and educating caregivers and every related stakeholder on how to implement and use new technologies.

Dugstad et al. (2019) [11] on their research for success factors related to DT in public health stressed the need for adopting a co-creation and collaboration methodology. They interpret co-creation as involving actors within the ecosystem into the whole DT process, from its inception to its implementation and adoption. Because DT in a dynamic process, collaboration between key actors is essential for positive results. Another success factor is proper training and education of actors involved, aiming to increase their IT competence.

Butler-Henderson, K., Gray, K., Day, K., & Grainger, R. (2020) [18] focus their research on a group of key actors within the healthcare ecosystem that they refer to as “Health Information Technology Specialists”. These are experts that have strong IT skills and can provide essential help when implementing and adopting disruptive technologies in public health. The proper training, education, and more career opportunities and pathways for these group of experts can be success factors for DT projects.

Gleiss, A., & Lewandowski, S. (2021) [12] suggest two important factors that can facilitate the successful implementation of a DT project in healthcare. Firstly, initiatives that help an organization change. They acknowledge the importance of change management, as well as the willingness of decision makers within the organization to cultivate an organization open to change initiatives, due to the dynamic nature of a DT process. Secondly, a data management platform that will mitigate technological barriers. The authors argue that a Hospital Data Management Platform can help mitigate many of these barriers which are related to technology. They based this result on a field experiment in a group of hospitals.

Wong et al. (2021) [13] also recognize the dynamic nature of a DT endeavor in public healthcare. Their research highlights a series of success factors. Two of them, Collaboration between actors involves and co-design are considered very important. Others important factors are also governmental support, and training and education of key players on new technologies and changes that occur during DT.

Lennon et al. (2017) [19] studied facilitators and barriers when implementing a DT program in public healthcare. They based their research on a program adopted by the National Health System of UK. They results are categorized under three main labels: “macro”, “meso”, “micro”. “Macro” is related to the exterior environment of a healthcare organization and includes government support and legislation. “Meso” is directly related to the internal environment of a healthcare organization and includes change management, support from top-management and initiative that cultivate a positive attitude towards DT. “Micro” is related to stakeholders of the healthcare ecosystem and how they interact to each other. Initiatives that promote collaboration between involved stakeholders can be considered a success factor under the “micro” domain.

Cresswell, K., & Sheikh, A. (2013) [4] conducted a systemic literature review related to healthcare innovation and DT. The aggregated success factors for DT under three main categories:

“technical”, “social”, “organizational”. “Technical” is related to technological success factors and include ease of use, interoperability with existing technology, ability to adapt and support changing needs. “Social” is related to key actors within the ecosystem and involves skills and IT literacy, attitude towards change and involvement. “Organizational” is related to the structure and hierarchy of the organization and include effective leadership, change management, top-management support, processes that support DT.

Meister, S., Burmann, A., & Deiters, W. (2019) [14] argue that due to the dynamic nature of DT, factors that can affect the success of project related to public healthcare are the level of change management, of technology, and the level of human-centered orientation. Efficient change management, technology that fits the vision and the overall strategy, and focus on user’s needs, co-design, involvement, education and training, important success factors.

Khashe, Y., & Tabibzadeh, M. (2021) [15] consider that the success of a DT project in public health has positive connection with the existence of an interoperability framework, a structured approach of the whole DT process, and organizational factors. These organization factors include a problem-solving attitude, emphasis on education and training of all key actors of the healthcare ecosystem.

Gochhait et al. (2020) [20] based their research on DT of public health in India. They argue that an important success factor is the existence of a structured framework with a central Information Management system at the center.

Granja, C., Janssen, W., & Johansen, M. A. (2018) [16] found that having a user-centered approach is one of the most important success factors for DT in healthcare, while another important factor is the perceived improvement of healthcare quality for actors within the healthcare ecosystem. This is because key actors play an important role for implementation and adoption of new technologies, workflows, processes etc.

Van Gemert-Pijnen et al. (2011) [21] argue that a holistic approach is required during a DT project in public health. An important aspect that should be taken under consideration is the interdependence between technology, people, the sociocultural and infrastructural environment of the healthcare organization. Success factors that they mention are change management, co-creation and participation from actors involved, advanced methods for data collection and analysis that aim

to assess the impact of change, proper value definition, education and training of key actors involved, activities for technology implementation and adoption in practice, prototyping, specific criteria for evaluation. The authors highlight the importance of a holistic and structured approach for the success of DT project.

Osmundsen, K., & Iden, J. (2018) [7] describe 6 main categories of success factors. A supportive organizational culture during a DT endeavor is of high importance for the project's success. This could be further analyzed to openness to change, open communication, a learning culture, tolerance to failure, open to risk-taking, and agility. Efficient management is another factor that can affect the success of DT project and is closely related to organizational culture. The third factor is the proper use of existing knowledge within the organization, especially knowledge acquired and related to key actors within the ecosystem (users, patients, doctors, etc.). Additionally, involvement for key actors, can have a positive impact on the success of the project. The authors also mention the importance of Information System capabilities, as well as the Dynamic capabilities of the organization. Information System capabilities are related to the level of the existing information system technology, while dynamic capabilities are related to change adaptation and agility. The higher the level of these, the better the odds for success. It is important to mention that the authors emphasize the importance of all factors mentioned above, under the umbrella of a strategic approach.

Benjamin, K., & Potts, H. W. (2018) [22] wrote extensively about success factors in DT of public health. They identify the following success factors: governmental support, transparency, user-centered approach, key-actors within the ecosystem that can influence the outcome of a DT project, leadership support within a healthcare organization, and an iterative, methodic approach.

### RQ3: What are the challenges for Digital Transformation in Public Healthcare?

Meskó et al. (2017) [1] underline specific challenges that policymakers need to face while undertaking a DT project. The first challenge is current regulation which in turn creates barriers for innovation providers. Technology plays an important role in DT, but if current regulation imposes restrictions to specific key areas, implementation efforts may face obstacles even during the planning phase. Healthcare sector is an area of strict regulatory frameworks. Another challenge that policymakers face is the rapid changes in the technological landscape. It is hard for public



sector to follow the pace of technological change, especially when bureaucracy and organizational structures have a complexity level that make decision making a more time-consuming task. The third challenge is related to how data provided by new technologies are managed, protected, and interpreted. Cyber security and sensitive data protection are vital for DT, due to importance of data for a DT endeavor. Additionally, misinterpretation of data can lead to misinformation and false knowledge. Finally, the authors highlight the challenge that educating and training key actors within the ecosystem. This is due to the dynamic nature of DT and the disruptive changes that may cause to existing processes, structures, and roles.

Alt, R., & Zimmermann, H. D. (2021) [10] describe some characteristics of the public healthcare sector that make DT a challenging task. These characteristics augment the complexity of this sector and are related to the bureaucratic structure of the healthcare organizations and paper-based systems that they usually still maintain, as well as different systems across the entire ecosystem that need to connect to each other. Also, healthcare sector operates under a strong regulatory framework, which means compliance is mandatory. The authors also argue that cybersecurity and data protection is another challenge that health organizations face during a DT project.

Odydq et al. (2020) [2] argue that a challenge during DT are problems that stem from the existing electronic health record IT systems. These problems are related to lack of interoperability and compatibility issues. These systems and how they could interact with new technologies should be considered during the planning phase.

Dugstad et al. (2019) [11] found that two important challenges during DT in Public Healthcare are IT infrastructure instability, and lack of involvement and motivation from key actors that can influence the results of the whole project.

Gleiss, A., & Lewandowski, S. (2021) [12] focus on six categories of challenges. Technological challenges, which are related to infrastructure and functionality. Infrastructure includes lack of interoperability between new and legacy systems, compatibility issues with current technologies, and poor data integrity. Functionality is about the complexity level of existing IT architecture, as well as the effort needed to organize it. Organizational challenges are related to an organizations structure and processes. Lack of leadership, poor change management, inefficient communication and cultural barriers are difficult challenges that need to be overcome during a DT project. Behavioral challenges are closely related to people within the organization and include lack of

motivation, negative attitudes towards change, and lack of proper training in new technologies and new ways to do things. Financial challenges are related to limited resources, especially funding, and unavailable proof of ROI due to the nature of the investment. Legal challenges are related to current regulation and data security. Usually, legal frameworks impose restrictions or require compliance. Structural challenges are related to the structure of the healthcare sector, due to the intense bureaucracy and complex authorization processes.

Lennon et al. (2017) [19] report challenges during a DT project in public health. These challenges include poor IT infrastructure, lack of interoperability, uncertainty around governance issues, pathogens within the healthcare sector that hinder collaboration, and conflicts between stakeholders. These challenges, if left without concern, could impose barriers, and jeopardize a DT project.

Cresswell, K., & Sheikh, A. (2013) [4] categorize the challenges related to DT in Healthcare in three main types: technical, social, and organizational. Technical is about interoperability of new technologies with existing systems, ease of use and responsiveness, cost reduction, advantages over existing technology and practices, ability to adapt to changing needs. Social is about IT literacy and skills, involvement of key stakeholders, and attitudes towards changes and innovation. Organizational is about organization's structure and hierarchy.

Milcent, C. (2018) [23] argue that a big challenge during a DT in public health is the way private patient data are handled. According to the author, data are at the center of DT of healthcare, but there are many restrictions and obstacles imposed by existing regulation. The challenge lies within the need for compliance, which in turn could lead to changes in the planning and implementation of innovative solution that transform the way things are done.

Karamachoski, J., & Gavrilovska, L. (2019) [6] underline that, innovative systems which can transform public health are based on 5G, AI and blockchain technologies. They briefly mention that a key challenge for a DT project using these technologies is data privacy and security.

Gochhait et al. (2020) [20] identify some challenges that need to be addressed. The first is related to digital literacy and how to train key actors on the use of new technologies. The second is the need for data unification and the use of a commons standard that promotes interoperability. The

third is related to data security concerns, due to the importance of data availability and analysis for new technologies.

Granja, C., Janssen, W., & Johansen, M. A. (2018) [16] argue that during a DT project in healthcare, a series of challenges may rise. Due to the disruptive outcomes of DT, current workflows may cease to exist or change completely. This could cause disturbances in the way existing stakeholders work, or skill gaps that require further attention. Another challenge is related to the stability of required financial resources. Bad management could lead to shortages, which in turn could halt the progress of a DT effort. The authors also highlight how important, and challenging, is to secure government support and policies that facilitate DT.

Nilsen et al (2016) [24] described four types of challenges during DT of public healthcare. These challenges are related to the resistance of specific aspect of the healthcare ecosystem to the disruptive nature of DT. Organizational resistance is about how DT affect established routines, lack of training and skill building, inefficient communication between actors involved, lack of involvement and participation. Culture resistance is about conflicts and cultural differences between actors involved, which could hinder a transformative process. Technological resistance is related to problematic IT infrastructure, and mistrust to innovative practices by the IT staff. Ethical resistance is related to moral concerns about security, privacy, accessibility, and equality issues.

Benjamin, K., & Potts, H. W. (2018) [22] highlight that an important challenge during a DT project is related to the complexity of public healthcare organizations. This complexity lies within the structure of these organizations, bureaucracy level, existing culture, number of stakeholders and governance issues. Additionally, risks related to patient's health, make the balance between product or service design and safety, a challenging task.

F. Seoane et al (2021) [17] argue that a challenge that DT in Public Health face are related to data. More specific, data management conflicts due to legislation (for example GDPR) and interoperability obstacles set by legacy systems. Another challenge is related to organizational readiness for digital adoption and transformation. When various aspects of an organization are not fully aligned to undertake a DT effort. Finally, inherent risks of AI form another challenge. These risks are related to bad data quality and algorithmic biases, which could lead to misinformation, exclusion, and bad decision-making.

## Discussion

### Key Drivers

Key Drivers for DT in Public Healthcare, based on the studied literature, are presented on this section. The table below summarizes the main drivers found.

<b>Key Drivers</b>
End-user needs
Organizational aspects
Actors within the ecosystem
Unpredictable factors
Technology
Proper strategy

#### Key drivers – Description

##### *End-user needs*

This driver is related to the changing needs of the user. Some authors highlight demographic trends, such as an aging population, and need for long-term care push further the need for change within the domain of public health. These evolving and changing needs, if combined with the rise of a better informed and digitally skilled patient, improve the position and the bargaining power of patients within the healthcare ecosystem. These circumstances lead to demands for a better healthcare system that adopts a user centric approach and new ways to fulfill existing or new needs.

##### *Organizational aspects*

The authors that mention organizational aspects as a key driver, usually focus on two main aspects. These are structure and culture. They consider a key driver an entity, or organization, that has a structure and a culture that facilitates changes and is open to new ways of doing things. These organizations are aware of the disruptive nature of new technologies and have the proper structural and cultural foundations to support implementation and adoption that lead to change and transformation. These organizations seek change, thus they drive DT.

### *Actors within the ecosystem*

As previously mentioned, the healthcare ecosystem has many key actors. These actors, through their influence, needs, or agendas, can facilitate or hinder a DT effort. Their stance can play an important role for implementation and adoption of new technologies, as well as initiatives for DT. An example of a key actor within the ecosystem is the government. A government can make plans for DT in public health, thus driving DT initiatives. Healthcare organizations can also be part of this by providing feedback or requesting initiatives from the state, due to the evolving needs of patients, as well as optimizing existing problematic processes or workflows.

### *Unpredictable factors*

These factors cannot be easily predicted. An example of this is the current pandemic. Some authors argue this situation pushed further the need for DT in Healthcare in many countries, acting as a key driver for further changes. It is important to comment, that although this argument is based on logical assumptions and government initiatives, a more skeptic approach is safer. Time will tell if the current pandemic is indeed a driving force for DT.

### *Technology*

Some authors argue that technology is a driver for DT, due to the changes that it causes within the healthcare industry, as well as the central role that it plays for DT. The same authors acknowledge that technology combined with organizational aspects and key actors can further drive DT.

### *Proper Strategy*

Many authors emphasize the importance of a structured approach during a DT effort. This can be interpreted as the existence of a vision, a strategy, and clear goals. A structured approach makes the whole process more focused, systematic, and easier to control. It also sets the foundation for future adapting to change, due to the dynamic nature of DT.

Based on all the above, we can assume that there is not just one driver for DT in public health. A multi-dimensional approach is required, due to the existence of many factors that drive DT. Healthcare is an ecosystem of high complexity, consequently, a one-sided approach is not advised.

## **Success Factors**

Factors which facilitate the successful outcome of a DT project in Public Health are presented on this section. The table below summarizes the success factors, based on the studied literature.

Success Factors
User-centered approach
Structured approach
Regulatory framework
Training & education
Organizational structure
Government support
Interoperability framework
Information System capabilities

Success Factors-Description

*User-centered approach*

Most of the authors underline the importance of a user-centered approach during a DT project. As mentioned before, user needs can drive DT. Placing the users at the center of the effort, signifies a constant attention to them. This takes shape through user-involvement, co-design, co-creation. Consequently, users are a vital part of the whole DT process.

*Structured Approach*

A structured approach not only drives DT, but it can also prove to be an important success factor. It sets the proper framework for initiating, implementing, and controlling the whole DT process.

*Regulatory Framework*

Based on the current literature, proper regulation can provide the proper framework for innovation and DT initiative. Consequently, a regulatory framework that supports DT project, can prove to be an important success factor. Regulation is also important for data protection and privacy, due to the important role of data during a DT endeavor, as well as the sensitive information provided by patient health records.

*Training & Education*

Again, most of the authors argue the importance of training and educating key actors within the healthcare ecosystem. Training and education can be a success factor during DT initiatives, especially when implementing and adopting new technologies, or new process and workflows. It is important that key actors within the healthcare ecosystem understand not only how to use new

tools, but also the value that is created, as well as the positive influence on their day-to-day work. This will make them more acceptable to change and value-driven.

#### *Organizational Structure*

The structure of an organization does not only drive DT, but it also plays an important role in the success of a DT project. Because, DT is a dynamic process, specific aspects of organizational structure can have a positive influence. These include, the level of change management, level of leadership, agility, tolerance to failure, openness, learning ability. The higher the level of these, the more positive the impact.

#### *Government Support*

As mentioned before, government is one of the key actors within the healthcare ecosystem. As a key actor it can drive DT initiatives, and it can also set the proper environment for more and more organization to start making changes. This can take shape through, regulatory frameworks, government support and financing. Especially in public healthcare, government support can make DT project flourish.

#### *Interoperability framework*

Since the healthcare ecosystem involves many key actors, the importance of an interoperability framework is high for the successful outcome of DT project. The existence of common standards, principles, policies, as well data interoperability is considered important for many authors. These facilitate collaboration, involvement, and communication between key actors. They also provide data integrity, due to a common standard and “language”.

#### *Information System capabilities*

Some authors argue that the existing Information System capabilities of healthcare organization can have a positive impact on the successful outcome of a DT project. The focus is mainly on data gathering and analysis tools, due to integral part that data play in DT. Systems with more sophisticated capabilities, can gather, process, and analyze larger volume of data, which in turn provide useful insights and knowledge that can help dynamic DT projects.

## Challenges

Challenges that rise during a DT endeavor in public healthcare are presented on this section. The table below summarizes the challenges identified in the literature.

Challenges
Legal
Characteristics of public healthcare sector
Data management & security
Rapid changes in technology
Motivation of key actors
Building Skills
Technical

Challenges-Description

*Legal*

Legal challenges stem from the existing regulation which may impose restrictions or barriers during a DT endeavor. Existing regulation may need modification to facilitate innovation and DT initiatives. Compliance is also a challenge related to existing regulation. Healthcare organizations operate under a strong regulatory framework, which means that compliance is mandatory.

*Characteristics of public healthcare sector*

Public healthcare sector has certain characteristics that can make DT a challenging task. These characteristics are related to the existing structure of public healthcare organizations which is complex and has a high level of bureaucracy. The complexity lies in the decision-making process, which usually can be a long process due to the structure and authoritative obstacles. These can make healthcare organizations resistant to change and innovation.

*Data management & security*

As already mentioned, data plays a pivotal role during a DT process. Data management can be a challenging task due to the volume of data, system requirements for analysis, and data quality. Poor data quality can have a tremendous impact on the decision-making process, while bad management can cause biases and security gaps.

*Rapid changes in technology*

The landscape of technology is considered of dynamic nature. Public healthcare sector, due to its characteristics, is usually unable to follow this dynamic state of rapid change. This can make



existing technology obsolete or inefficient. These challenges are closely related with the structural complexity and bureaucratic level of healthcare organizations.

#### *Motivation of key actors*

Key actors within the healthcare ecosystem can influence the outcome of a DT project. Lack of motivation from key actors can set obstacles to innovation initiatives and change efforts. The challenge rises when actors that drive DT need to convince, motivate, involve others that can influence the whole DT process.

#### *Building Skills*

This challenge rises when specific actors within the healthcare system need to be trained on new systems, processes, and workflows. Building digital skills can play an important role of innovation implementation and diffusion during a DT process. Education and training can be a challenging task, which requires time and resources, when people need to rethink existing processes and workflows using new technology and tools.

#### *Technical*

Technical challenges are related to existing technology. Legacy systems or existing IT infrastructure can set obstacles during a DT project. This is due to compatibility issues, lack of common standards and interoperability, as well as instabilities in existing technologies.

## Conclusions

The aim of this thesis is to explore DT in public health. Recently, there is an increase of interest for research on DT in public healthcare. This interest is focused on technological aspects of DT and not managerial or business aspects. Also, there is a gap on research related to the relations of stakeholders within the healthcare ecosystem, which in turn can have a possible impact on DT endeavors. This gap of research highlights that there is a need for wider approaches from researchers and a multidisciplinary mindset. Based on the studied literature, this paper tries to shorten this gap by aggregating essential information about drivers, success factors, and challenges related to DT in public health. It could be used as a starting point for further research.

Most authors argue that factors that drive DT in public healthcare are the changing and evolving needs of users, a structured strategy, key actors within the healthcare ecosystem, as well as organizational factors of organizations within this ecosystem. Some authors highlight that

technology also drives DT, but do not consider it as a standalone factor. These findings point out that DT is a process that is driven by multiple aspects which should be taken under consideration in terms of dynamics and influence.

There is a series of factors that can influence the successful outcome of a DT project in public health. User involvement in the DT process is important for supporting a user-centered perspective and creating solutions that consider real user problems and needs. A structured approach is important for building a strategy, as well as monitoring and controlling the whole DT process. A proper regulatory framework is important for setting the ideal environment for innovation and DT initiatives. Organizational structure that embraces change and innovation is also important for setting strong foundations when implementing a DT process. Training and education of key actors within the ecosystem is considered of high importance, due to the nature of DT which has a direct impact on how people or groups of people perform tasks and workflows. Government support is essential for initiating and funding DT projects in public health, as it operates under the domain of public sector. Interoperability is important for setting common standards between organizations within the healthcare ecosystem and enhancing collaboration and communication. The capabilities of Information Systems, especially those that analyze data and support the decision-making process, can have positive impact on DT initiatives.

There are also a series of challenges that may impose obstacles and barriers if left unattended. These challenges are related to existing regulation which may require compliance, leading to adjustment to the current DT plans. Additionally, characteristics of public healthcare sector such as complex structure and bureaucracy may cause potential problems during the implementation of DT process. Another challenge that organizations face is data management and security, which can influence data integrity and quality, or cause legal problems. Rapid changes in technology can turn existing technological solutions obsolete, especially if DT process follows a slow pace. Lack of motivation from key actors or organizations may set obstacles to DT projects. Motivation may prove to be a challenging task to cultivate due to time and resources required. The same applies, in terms of time and resources, for building proper digital skills of people or groups within the ecosystem. Lastly, there are technical challenges that need to be addressed, caused by existing legacy systems. These challenges are related to compatibility issues, instabilities, and lack of common standards.

## Future work

This thesis aggregates and highlights drivers, success factors, and challenges of DT in public healthcare. Potential future research could follow many directions, as each aspect (drivers, success factors, challenges) could be further analyzed separately. For example, drivers of DT in public health could be further studied to examine the weight of each one. The same could apply for the success factors and challenges.

A proposal for this could be interviews with focus groups that represent key actors within the healthcare ecosystem, as well as feedback from experts and decision makers experienced on DT projects. As already stated, there is a growing interest on research related to DT in public health. For now, this interest is focused on the technological aspect of DT. Consequently, other aspects of DT in public health (for example: management and business aspects) do not attract the same amount of interest. This gap could be seen as an opportunity for future researchers.

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