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The drivers of the digital transformation in the healthcare industry: An empirical analysis in Italian hospitals

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ABSTRACT
In recent years, driven by the spread of the COVID-19 pandemic, digital transformation in the healthcare sector is becoming increasingly important. Digital healthcare technologies, if adopted in a targeted manner and implemented in a cost-effective way, make it possible to reduce healthcare inequalities, improve the quality of healthcare provided and increase the well-being of citizens. The importance of digital transformation in healthcare is also attracting interest from academics. However, at present, there are few studies aimed at examining the degree of digital transformation in healthcare and the drivers of the adoption and implementation of digital solutions by healthcare facilities. This study aims to fill this gap by analysing the level of digital transformation of Italian hospitals and the factors that can affect this level of digital transformation. The analysis, conducted on a sample of 103 hospitals, shows a positive and significant impact of the hospital size, hospital age and hospital teaching status on the level of digital transformation. Furthermore, in relation to hospital complexity, it shows a positive effect of the presence of the emergency room and a non-significant influence of the number of hospital departments on the level of digital transformation.

1. Introduction
In recent years, digital transformation has been evolving the business models of companies operating in all sectors globally. It represents “a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies” (Vial, 2019, p. 118). The pervasive characteristics of digital technologies are changing the way businesses and organizations of all sizes are produced, traded and communicated (Rippa and Secundo, 2019; Elia et al., 2020; Raimo et al., 2021; Verhoef et al., 2021). In this regard, the changes brought about by digital transformation represent important and powerful driving forces of the current economic system (Cohen et al., 2017; Nambisan, 2017; Vitolla et al., 2020; Salvi et al., 2021).

Within the various sectors, digital transformation has taken on a particularly important role in healthcare and, more specifically, in hospitals (Agarwal et al., 2010; Sousa et al., 2019; Marques and Ferreira, 2020; Kraus et al., 2021; Massaro, 2021). An important push towards the digital transformation of hospitals was represented by the spread of the COVID-19 pandemic (Cobianchi et al., 2020a, 2020b; Drago et al., 2021; Madhavan et al., 2021; Tortorella et al., 2021). In this regard, according to a report drawn up by Deloitte (2020), about 65% of healthcare organizations have increased the adoption of digital technologies following the spread of this pandemic in order to support working methods and provide assistance to patients. Digital transformation is considered one of the most effective responses to face the pressures of stakeholders, improve the quality of health services and reduce costs (Locatelli et al., 2010, 2012; Secundo et al., 2018; Saifudin et al., 2021). Furthermore, digital health solutions such as electronic health records, monitoring equipment, tele-health, electronic communications, data analysis, and web and cloud-based tools, if implemented in a targeted manner, have the potential to reduce health inequalities and increase well-being of users through a substantial change in the way in which care and health services are provided to patients (Or et al., 2014; Mihailescu and Mihailescu, 2018; Spano et al., 2021; Cerchione et al., 2022).

In this regard, for example, the digitalisation of health records, understood as the conversion from paper format into computerized form, has consequently improved the overall quality of health care provided, also leading to an increase in the provision of care and patient safety (Car et al., 2008).

The importance of digital transformation in the healthcare sector has led to the emergence of numerous policies, programs, regulations and

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directives aimed at supporting the digitalisation of healthcare systems. These interventions mainly concerned the European context. In particular, in 2018, the European Commission published a final communication that detailed the previous actions taken to promote the digitalisation of health and a series of further commitments to further promote digital transformation (Deloitte, 2020).

However, despite the political interventions, the path towards the digital transformation of hospitals still presents some problems. First, most digitalisation projects have not lived up to expectations (Preko and Boateng, 2020). In this regard, Agarwal et al. (2010) found that health care improvements related to digital transformation often fail to materialize. Other authors have instead highlighted problems in the use of electronic health records (Lorens et al., 2008; Preko and Boateng, 2020) related to delays, safety and costs (Avison and Young, 2007; Mihailescu and Mihailescu, 2018). A second problem is instead connected to the different levels of digital maturity of health facilities not only between different European countries but also within individual countries (Deloitte, 2020). The contradictory results in relation to the digital transformation of healthcare and the different levels of digital maturity of healthcare facilities have attracted the attention of academics (Reis et al., 2018; Kraus et al., 2021). In this regard, a recent systematic literature review conducted by Marques and Ferreira (2020) highlighted a sharp increase in the last twenty years of studies on the topic of digital transformation in healthcare. However, the authors highlighted that these studies focused mainly on specific issues such as integrated management, medical images, electronic medical records and virtual services. The contributions that dealt with the digital transformation of healthcare organizations from a broader perspective focused mainly on the identification of the different digital technologies implemented, on the advantages and benefits deriving from the implementation of digital technologies and on the barriers and challenges associated with the implementation of these technologies (Tortorella et al., 2020a). However, there is an important gap in the academic literature since only a limited number of studies have examined the factors capable of influencing the level of digital transformation of healthcare organizations. Furthermore, these studies focused only on emerging economies (Tortorella et al., 2020a) and on African countries (Preko and Boateng, 2020).

This study aims to fill this important gap in the literature by analyzing the level of digital transformation of the healthcare organizations and the factors that can affect this level of digital transformation. In particular, this study aims to answer the following research question:

RQ: What are the factors that influence the level of digital transformation of hospitals?

To answer the research question, this study adopts a contingency theory perspective, focusing attention on the impact of the internal factors represented by the hospitals’ characteristics. More specifically, this study examines the impact of hospital size, hospital complexity, hospital age and hospital teaching status on the level of digital transformation of Italian hospitals. The focus on the Italian context is dictated, on the one hand, by the important efforts that the national government is making in order to ensure that digital health solutions integrate and improve the delivery models of existing health services, and on the other hand, by the strong disparity in the degree of digital transformation of healthcare structures due to the still heterogeneous implementation of regulatory interventions among the Italian regions (Odome et al., 2018). The strong commitment of the national government demonstrated by interventions such as the “2014–2020 Strategy for Digital Growth” and the “2017–2019 Plan for Information Technology in Public Administration” which have provided a boost towards the digitalisation of the healthcare system through the introduction of electronic health records, telemedicine services and centralized health services booking systems (Odome et al., 2018). The strong disparity in the level of digital transformation between the different health facilities is instead demonstrated by the different choices of the Italian regions in relation to the adoption of electronic health records (Odome et al., 2018).

The reminder of this study is organized as follows: Section 2 presents the background of this study, while Section 3 introduces the research hypotheses. Section 4 describes the research design, while Section 5 and Section 6 respectively present and discuss the results. Finally, Section 7 draws conclusions.

2. Background

2.1. Digital transformation in healthcare

The concept of digital transformation is understood as the transition from structures that communicate through non-digital tools to structures that use digital tools. Digital transformation, however, does not represent the only technical process of converting information from paper to digital formats, but also requires a socio-technical change of digital tools and the way in which they are used (Yoo et al., 2010). To better understand this step, it is useful to analyse it from two different points of view (Preko and Boateng, 2020). The first is linked to a substantial split in the digitalisation process from a purely technical point of view and from a socio-technical point of view in which the digital technologies and that of the people who have to use it is defined so that their respective contributions lead to the efficiency of the process (Sawyer and Jarrahi, 2014). The second concerns the material and social aspects of digitalisation that enable and force people to interact with digital tools to pursue the set objectives (Leonardi, 2013).

In the healthcare sector, the digital transformation of processes and services has become particularly relevant and popular and is gradually taking root both in local policies and in the strategic decisions of international healthcare organizations (Barea-Slapski, 2016; Preko and Boateng, 2020; Biancone et al., 2021). Digital technologies have played a central role in healthcare organizations since 1990 when the term ‘e-health’ was coined (Aceto et al., 2018; Tortorella et al., 2020a). The implementation of digital technologies within hospitals has increased more and more as they have become smaller, more accessible and capable of handling a greater amount of data (Ancarani et al., 2016; Gonzalez et al., 2016; Tortorella et al., 2020a).

According to Tortorella et al. (2020b), academic studies on the topic of digital transformation in healthcare organizations have mainly examined three aspects: 1) the identification of the different digital technologies implemented; 2) the advantages and benefits deriving from the implementation of digital technologies; 3) the barriers and challenges associated with the implementation of digital technologies.

In relation to the first aspect, there seems to be no unanimous consensus regarding the digital technologies implemented within healthcare organizations. According to Tortorella et al. (2020b), academic studies have identified nine major digital technologies. Among these, biomedical/digital sensors and Cloud computing seem to be those cited by the largest number of academic studies (Garai et al., 2017; Zhang et al., 2017; Ali et al., 2018; Elhosney et al., 2018; Hamidi, 2019; Munzer et al., 2019; Pace et al., 2019; Sannino et al., 2019), followed by the Internet of Things (Garai et al., 2017; Zhang et al., 2017; Elhosney et al., 2018; Hamidi, 2019; Munzer et al., 2019; Pace et al., 2019; Sannino et al., 2019) and big data (Zhang et al., 2017; Elhosney et al., 2018; Hamidi, 2019; Pace et al., 2019; Sannino et al., 2019). Other digital technologies recognized by academic studies are remote control or monitoring (Zhang et al., 2017; Hamidi, 2019; Pace et al., 2019), machine/deep learning (Zhang et al., 2017; Elhosney et al., 2018; Hamidi, 2019), augmented reality/simulation (Zhang et al., 2017; Munzer et al., 2019), 3D printing (Zhang et al., 2017), and collaborative robots (Zhang et al., 2017). Such technologies, according to Tortorella et al. (2020b) were used both for health treatments and to support administrative processes.

In relation to the second aspect, academic studies have identified various advantages and benefits related to the implementation of digital technologies within healthcare organizations. In general, the implementation of digital solutions has increased the level of automation and
interconnectivity by improving the efficiency of patient care and administrative processes (Yang, 2015; Tortorella et al., 2020a, 2022).

More in detail, a first benefit connected to the implementation of digital technologies in healthcare organizations is represented by the reduction of costs (e.g. Sakr and Elgammal, 2016; Aceto et al., 2018; Ali et al., 2018; Chen et al., 2018; Elhoseny et al., 2018; Wang et al., 2018; Amato et al., 2019; Munzer et al., 2019; Onasanya and Elshakankiri, 2021). Other important benefits are connected to an improvement in diagnosis and patient care (e.g. Aceto et al., 2018; Ali et al., 2018; Wang et al., 2018; Pace et al., 2019; Sannino et al., 2019), to greater personalization of health and real-time patient care (e.g. Garai et al., 2017; Thuemmler and Bai, 2017; Aceto et al., 2018; Ali et al., 2018; Pace et al., 2019; Sannino et al., 2019), to a reduction in waiting and delivery times (e.g. Ali et al., 2018; Pan et al., 2018; Wang et al., 2018; Pace et al., 2019; Munzer et al., 2019), to an improvement in collaborative health care (e.g. Guha & Kumar, 2018; Pan et al., 2018; Wang et al., 2018; Abdellatif et al., 2019; Albesher, 2019; Pace et al., 2019) and to an increased support for training and education (e.g. Guha & Kumar, 2018; Qi et al., 2018; Pan et al., 2018; Albesher, 2019; Munzer et al., 2019).

In relation to the third aspect, academic studies have identified a series of barriers and challenges related to the implementation of digital technologies in healthcare organizations. Among these, information security risks (e.g. Ali et al., 2018; Almuhim et al., 2019; Sannino et al., 2019; Pace et al., 2019; Wang et al., 2019), patents, price ceilings and lack of partnerships (e.g. Aceto et al., 2018; Ali et al., 2018; Pan et al., 2018; Hamidi, 2019; Munzer et al., 2019; Sannino et al., 2019), lack of information and communication technologies’ skills (e.g. Ali et al., 2018; Manogaran et al., 2018; Mutlag et al., 2019; Pace et al., 2019; Wang et al., 2019) and implementation costs (e.g. Ali et al., 2018; Guha & Kumar, 2018; Pan et al., 2018; Hamidi, 2019; Pace et al., 2019; Wang et al., 2019) seem to represent the main obstacles. However, academic studies have also identified further barriers such as regulatory changes (e.g. Ali et al., 2018; Kumari et al., 2018; Hamidi, 2019), poor information and communication technologies infrastructure (e.g. Ali et al., 2018; Elhoseny et al., 2018; Guha & Kumar, 2018; Rajan & Rajan, 2018; Munzer et al., 2019), the misalignment between the adoption of digital technologies and the strategy of the healthcare organization (e.g. Almuhim et al., 2019; Hamidi, 2019; Sannino et al., 2019; Wang et al., 2019) and devices/systems heterogeneity (e.g. Guha & Kumar, 2018; Saxena and Raychoudhury, 2017; Abdellatif et al., 2019; Mutlag et al., 2019).

Going beyond the three aspects previously examined, another part of the studies analysed the factors that can influence the digital transformation of healthcare organizations. In this regard, Tortorella et al. (2020a), examining a sample of 16 hospitals located in Brazil, India, Mexico and Argentina, found that hospital’s ownership and hospital functionality represent important drivers of the implementation of digital technologies with public hospitals and non-teaching hospitals that appear to be ahead of the private and teaching ones in digital transformation processes. According to the authors, the age of hospitals represents an additional factor that can influence the digital transformation. In fact, they have found a greater propensity towards the implementation of digital technologies by newer hospitals than older ones. Finally, the authors found conflicting results in relation to the impact of the hospital size on the degree of implementation of digital technologies by virtue of the different proxies used. Preko and Boateng (2020) on the other hand, examining the Ghanaian hospitals, have identified five generative mechanisms of digital transformation represented by standardization, financial transparency, storage systems, convergence and connectivity, and data security.

These studies represent the first attempts to examine the drivers of the implementation of digital technologies by healthcare organizations. However, there is a clear need for further empirical studies aimed at identifying additional drivers of the digital transformation of healthcare organizations and analysing this phenomenon also in other geographical contexts. This study aims to respond to these needs by analysing the effect of the hospitals’ characteristics on the level of digital transformation in the Italian context.

2.2. The process towards the digital transformation of the Italian healthcare system

In Italy, the process towards the digital transformation of healthcare started several years ago. This slow process began, in the first period, with the digitization of document processes (electronic health records, online payments, digital prescriptions, etc.) and subsequently involved the introduction of other more complex and innovative digital technologies such as artificial intelligence, virtual reality, and cloud computing.

The first regulatory references in this direction were defined at European level, by the Treaty on the Functioning of the European Union (Domenichiello, 2015). This concerned the responsibility of the Member States to define health policies for the organization of the provision of health services. Since 2000, the eEurope 2002 project aimed at enhancing the internet for electronic access to public services and specifically to health information. In 2004, the European Commission launched the first Action Plan for Europe on eHealth for the adoption of tools and services that use information and communication technologies for prevention, diagnosis, monitoring and management. This action plan was renewed in the following years to identify, in a strategic key, the use of these technologies as fundamental tools for the creation of effective and efficient public services in all member countries, especially in the health system (Domenichiello, 2015). However, each individual member country was able to define its own strategy to pursue these objectives (Domenichiello, 2015).

This circumstance makes it necessary to analyse the Italian context on the basis also of European guidelines. Since 2001, the institutional management system of the healthcare industry in Italy has changed, with a substantial realignment of responsibilities to the Government and the Regions. Since 2004, the eHealth Board has been introduced which, together with the Regions, the Ministry of Health and the Ministry of Innovation and Public Administration, has the task of defining policies on eHealth issues and monitoring the implementation of the national and regional action plans. To date, the main activities carried out by the eHealth Board are the “Shared Policy for eHealth”, which adopted the objectives of the European e-Health Action Plan 2004 and the “Architectural Strategy for e-Health”, which constitutes a general guideline on the issues of national architecture design for e-Health. The areas of implementation most affected by the Board are: access to health services, availability of the patient’s clinical history, innovation in primary care, redesign of the health services network through telemedicine (Domenichiello, 2015). Each region independently manages appointments for treatment through the Local health authorities and hospitals. Citizens can make reservations either directly at the hospital or through local unified booking centers. In 2008, a survey was carried out by the Ministry of Health aimed at showing the degree of diffusion of healthcare booking systems and electronic health record systems. A heterogeneous diffusion emerged at the level of the single region and this made it necessary, in 2010, to define national guidelines for the implementation of the healthcare booking systems. In 2011, on the other hand, guidelines were defined for the electronic health record systems which governed the summary information relating to the patient, the security of sensitive data for the purposes of protecting privacy. Furthermore, at the end of 2012 a law on electronic health record systems was definitively approved at national level (L.221 of 17/12/2012) which required the Regions and Autonomous Provinces to adopt these systems by June 30, 2015 (Domenichiello, 2015).

Since 2010, the transmission of sickness certificates has also been revolutionized. In fact, it is carried out online by doctors both to the employer and to the National Social Security Institute through technological infrastructures capable of transferring documents through regional gateways in full respect of privacy (Domenichiello, 2015).
Furthermore, in 2014 the guidelines governing telemedicine and the strategy with which it will be possible to place these services, models, processes and integration paths in clinical practice were defined. In order to strengthen the development of eHealth in Italy, other measures have been taken at a national level such as the online payment of health services and the telematic transmission of reports via the Web, certified e-mail or any other electronic means (Domenichiello, 2015).

After focusing the eHealth measures on the digitization of document processes in recent years, the “2014–2020 Strategy for Digital Growth” and the “2017–2019 Plan for Information Technology in Public Administration” have extended the focus also on the implementation of advanced digital technologies such as artificial intelligence and cloud computing in healthcare (Odone et al., 2018). However, the path towards a complete digital transformation of Italian healthcare system still seems long (Odone et al., 2018).

3. Theoretical background and hypotheses development

In line with other contributions on the topic (Tortorella et al., 2020a; Proksch et al., 2021), this study uses contingency theory to frame the digital transformation of hospitals. According to this theory, there is no single best way that leads to the success of organizations. According to Scott (1981, p. 114) “the best way to organize depends on the nature of the environment to which the organization must relate”. In other words, the best way to manage organizations depends on internal and external contingencies (Sheppard and Houglund, 1978; Donaldson, 2001). In particular, due to the complexity of healthcare systems, the management methods of organizations derive from external factors such as the culture and socio-economic context of the region, country and geographical area and from internal factors such as the characteristics and internal processes of individual organizations (Tortorella et al., 2020a). In relation to external factors, it is evident that elements such as the level of per capita income (Bedir, 2016) and the development of the local economy (Visconti et al., 2017) can influence the strategies and performance of healthcare organizations. Instead, in relation to internal factors, elements such as the number of beds and employees, functionality and age influence the dynamics of healthcare organizations (Kimberly and Evanisko, 1981; Sjetne et al., 2007; Theokary and Justin Ren, 2011; Moores, 2012; Zhang et al., 2017; Tortorella et al., 2020a).

This study focuses on the impact of internal factors on the level of digital transformation of hospitals. The impact of external factors was in fact mitigated by the focus on the Italian context alone, which leads to the exclusion of the effect of the socio-economic context at the region and country level. More in detail, this study examines the impact of the following characteristics of hospitals: size, complexity, age, and teaching status. The individual research hypotheses are developed below.

3.1. Hospital size

The size of the organizations, according to the academic literature, represents one of the main drivers of the adoption and implementation of new technologies (Bayo-Moriones and Lera-Lopez, 2007). In particular, academic contributions have provided several reasons why larger organizations are more likely to adopt and implement new digital solutions. Larger organizations enjoy greater capital and resources to be allocated to digital innovations (Hwang et al., 2004; Bayo-Moriones and Lera-Lopez, 2007). The greater availability of financial resources that distinguishes larger organizations not only allows greater investments in digital solutions but also increases the ability to absorb the risks associated with the uncertainty relating to the adoption and implementation of new digital technologies (Premkumar and Roberts, 1999). Larger organizations also have a greater chance of spreading fixed costs because of their larger scale of operations (Lind et al., 1989; Rahab and Hartono, 2012). Furthermore, in addition to having greater financial resources, they also enjoy greater human resources, sometimes even more qualified (Raimo et al., 2020). In light of this, there is a greater likelihood that within larger organizations there are human resources possessing digital skills capable of facilitating the adoption and implementation of digital solutions (Morgan et al., 2006). These reasons, valid for the different types of organizations, can also be considered sound for hospitals. In fact, academic literature has shown that larger hospitals enjoy greater financial resources and greater benefits deriving from economies of scale (Kimberly and Evanisko, 1981; Dewar and Dutton, 1986; Goldstein et al., 2002; Goldstein and Schweikhart, 2002). In addition, past studies have also pointed out that larger hospitals include more human resources, sometimes more qualified, not only in the medical but also in the information technology field (Yoon et al., 2016). In this regard, Alpar and Reeves (1999) highlighted the greater capacity of larger institutions to hire professionals such as technicians and physicians capable of promoting process innovation.

The reasons set out could also favour digital transformation processes. In this study, following Starkweather (1970), hospital size is expressed in number of beds. Therefore, in light of the above, it is possible to introduce the following hypothesis:

H1. Digital transformation is positively influenced by the number of hospital beds

3.2. Hospital complexity

The complexity of organizations, according to academic literature, represents another possible driver of the adoption and implementation of new technologies (Bayo-Moriones and Lera-Lopez, 2007). In fact, more complex organizations may have a greater need to innovate and digitalise processes (Salvi et al., 2021). These organizations have greater coordination problems due to the presence of units located in different places (Galliano et al., 2001) which leads to a greater need to digitalise the entire information flow (Dasgupta et al., 1999; Bayo-Moriones and Lera-Lopez, 2007; Arora and Rathi, 2019). In the context of hospitals, a broader functional differentiation increases the complexity of the hospital and the medical service offered (Damanpour, 1991; Young et al., 2001; Firiz et al., 2010). According to Damanpour (1991), this functional differentiation strongly influences the adoption of innovative solutions. In fact, greater functional differentiation leads to a greater number of interest groups and a greater demand for technological solutions capable of further advancing the hospital’s degree of innovation (Kimberly and Evanisko, 1981; Weng et al., 2011). Furthermore, according to Lo (2005), a more complex hospital enjoys greater resources and capabilities and is therefore able to improve its level of technological innovation. Finally, in relation to human resources, Damanpour (1996) and Yang (2015) underlined that in a more complex hospital there may be several specialists able to offer more diversified knowledge bases to improve the exchange and dissemination of creative ideas and the adoption of technological solutions.

The reasons set out could also favour digital transformation processes. In this study, hospital complexity is expressed in the number of departments (Capkun et al., 2012), and in terms of the presence of the emergency room. Therefore, in light of the above, it is possible to introduce the following hypotheses:

H2. Digital transformation is positively influenced by the number of hospital departments

H3. Digital transformation is positively influenced by the presence of the emergency room

3.3. Hospital age

The age of organizations, according to academic literature, represents another possible driver of the adoption and implementation of new technologies (Karshenas and Stoneman, 1995; Alderete and Gutierrez, 2014). However, the theoretical arguments about the direction of the effect of the age of organizations on the degree of technological
innovation are not conclusive (Hollenstein, 2004). In fact, some studies argue that the age of organizations can favour the adoption and implementation of technologies (Karsenhas and Stoneman, 1995; Aldere and Gutiérrez, 2014; Sebastian et al., 2017) while others argue that it can represent an obstacle in terms of resistance to change and experience in adopting advanced technologies (Dunne, 1994).

On the one hand, older organizations tend to enjoy a greater productive and functional knowledge base which can increase their capacity for innovation (Cohen and Levinthal, 1990). In this regards, older organizations have usually perfected the structures, incentive programs, routines and other infrastructures necessary for the adoption and implementation of new technologies (Sørensen and Stuart, 2000). They also usually face fewer financial constraints than younger organizations and therefore have greater potential for adoption and implementation of new technologies (OECD, 2019).

On the other hand, it has been argued that older organizations could potentially have additional difficulties as they may not have the sophisticated information and communication technology infrastructures necessary for the implementation of digital technologies (Garai et al., 2017; Zhang et al., 2017; Elhoseiny et al., 2018). In this regard, younger organizations whose information and communication technology infrastructure has been designed and built more recently may have a more favourable environment for the adoption and implementation of digital technologies.

Despite the presence of conflicting opinions about the effect of the age of organizations on the degree of technological innovation, Tortorella et al. (2020a) showed a greater propensity towards the implementation of digital technologies by newer hospitals than older ones and therefore this circumstance leads us to prefer the theoretical arguments according to which age represents an obstacle to digital innovation.

In this study the hospital age, following Weng et al. (2011), is expressed in number of years. Therefore, in light of the above, it is possible to introduce the following hypothesis:

**H4.** Digital transformation is negatively influenced by the number of hospital years

### 3.4. Hospital teaching status

The teaching status of hospitals, according to academic literature, represents another possible driver of the adoption and implementation of new technologies (D’Sa et al., 1994; Weng et al., 2011). There are important differences between teaching and non-teaching hospitals by virtue of the different educational and health care roles (D’Sa et al., 1994). Teaching hospitals offer their facilities to doctors, health personnel and medical students for medical training and education (Weng et al., 2006). These hospitals therefore provide higher level teaching and are more research-oriented (Weng et al., 2011). The greater focus on research increases the absorptive capacity (Cohen and Levinthal, 1990) of teaching hospitals which in turn enriches the technological knowledge resources (Chen, 2004). This technological knowledge allows a better understanding of the technologies and procedures for their implementation (Damanpour, 1991), favouring the innovation of teaching hospitals (Keller, 1996). Furthermore, the presence of specialized personnel with specific knowledge able to use new technologies allows teaching hospitals to obtain greater cost efficiency, thus favouring innovation processes (D’Sa et al., 1994). Furthermore, teaching hospitals may have a greater need to innovate processes and adopt new technological solutions due to the greater spectrum of clinical problems than non-teaching hospitals (D’Sa et al., 1994). Finally, teaching hospitals usually enjoy greater resources to be allocated to the adoption and implementation of new technologies (D’Sa et al., 1994). In this regard, Weng et al. (2011) highlighted that teaching hospitals are much more technological than non-teaching ones.

The reasons set out could also favour digital transformation processes. In this study, the hospital teaching status, following Weng et al. (2011), is expressed in terms of affiliation with the university. Therefore, in light of the above, it is possible to introduce the following hypothesis:

**H5.** Digital transformation is positively influenced by hospital/university affiliation

### 4. Research design

The empirical analysis conducted in this study is based on data collected through a questionnaire aimed at examining the level of digital transformation of Italian hospitals. This questionnaire was sent to the different Italian hospitals, selected from the list of hospital facilities provided by the Italian National Health Service. The questionnaire was administered in the period ranging from May to June 2021. The choice of short times eliminates the possible anomalies that could derive from the administration of the questionnaire in very long periods. As regards the method of sending, it was preferred to use e-mail and therefore forward the questionnaire to the address indicated on the official website of the hospital. In addition, to maximize the response rate, a telephone appointment was also set with the hospitals in order to inform them about the purpose of the research and to assure them of the anonymity of the data collected. This circumstance allowed us to obtain a good response rate to the questionnaire also taking into account the difficult period experienced by hospitals due to the spread of the COVID-19 pandemic.

Following Tortorella et al. (2020a), we addressed the questionnaire to subjects holding key leadership roles (senior or middle management) within the hospital. The administration of the questionnaire to these subjects ensured adequate validity of the answers considering that the senior or middle management should be fully aware of the dynamics of the hospital and its specificities also in relation to digital transformation. Furthermore, in order to increase the reliability and internal validity of the study, mitigating the issues connected to single respondent bias (Brewer and Crano, 2006; Tabachnick et al., 2007; Hair et al., 2014; Tortorella et al., 2020a), we requested a second answer to the questionnaire from subjects operating in the information and communication technology department. The administration of the questionnaire to these subjects has in fact further increased the validity of the answers considering that they should have specific knowledge about the implementation of digital technologies by the hospital. The comparison of the results of the questionnaires completed by the senior or middle management and by the subjects operating in the information and communication technology department confirmed a high reliability of the answers.

The final sample on which the econometric analysis is conducted includes the 103 Italian hospitals that responded to the questionnaire. These hospitals present an adequate differentiation in terms of size, complexity, ownership and geographical location.

In order to test the research hypotheses, this study uses an ordinary least squares (OLS) regression model, based on the variables described below.

The dependent variable of this study is represented by the digital transformation level (DTL) of Italian hospitals. It was measured through the use of a questionnaire based on 18 elements corresponding to as many different digital health technologies (summarized in Table 1). The consideration of different elements is supported by the academic literature (Salvi et al., 2021) which suggests the impossibility of describing a large and complex phenomenon such as digital transformation through a single item. For the identification of the elements concerning the digital transformation of hospitals, an important professional document drawn up by Deloitte (2020) was used. This document precisely identifies 18 different types of digital health technologies that can be implemented in hospitals. Within the questionnaire, a question was provided for each digital technology, which can be evaluated through a scale ranged from 0 to 5. This scale aims at an in-depth evaluation of the use of the different digital health technologies with 0 corresponding to an absence of the
specify digital solutions. This choice derives from the desire to assign the same importance to each digital health technology without identifying more important digital solutions for hospitals. Thus, in light of this, the dependent variable of this study can range from 0 to 100.

In order to ensure content validity, the set of digital health technologies and the entire questionnaire were reviewed by a group of six well-informed experts on the topic of the digital transformation of hospitals. These experts held in fact the position of general manager in Italian hospitals, one holds a top position in an Italian local health board, while the other two experts hold an executive master in digital health transformation. These experts examined the formulation of the questions and the possible need to include additional questions related to additional digital solutions that can be implemented in hospitals. Unanimously they agreed on the correct formulation of the questions and the completeness of the survey, thus excluding the possibility of including further questions.

The independent variables of this study are: hospital size, hospital complexity, hospital age, and hospital teaching status. Hospital size, following Starkweather (1970), was measured through the natural logarithm of the number of beds in the hospital (HBEDS). Hospital complexity provides for two different operationalizations. A first operationalization in fact, following Capkun et al. (2012), concerns the number of departments of the hospital (HDEP). A second operationalization concerns the presence of the emergency room inside the hospital (ER). This variable has a dichotomous nature and assumes a value of 1 if the hospital provides for the presence of an emergency room and a value of 0 if the hospital does not have an emergency room. The number of hospital beds (HBEDS) and the level of digital transformation at p < 0.005. This result demonstrates a greater propensity of larger hospitals to undertake digital transformation processes.

As regards the impact of hospital complexity, the results are conflicting. In fact, they support hypothesis 3 (H3) but do not support hypothesis 2 (H2). More specifically, they show a positive and significant relationship between the presence of the emergency room and the level of digital transformation at p = 0.049 and a non-significant relationship between the number of departments and the level of digital transformation. These results show that the existence of an emergency room represents a push towards the digital transformation process, while the number of departments does not significantly influence the adoption of digital solutions.

As regards the impact of hospital age, the results do not confirm hypothesis 4 (H4) showing a positive and significant relationship between the hospital years and the level of digital transformation at p = 0.058. This result, contrary to expectations, demonstrates a greater propensity of longer-lived hospitals to undertake digital transformation processes.

Finally, as regards the impact of hospital teaching status, the results confirm hypothesis 5 (H5) and show a positive and significant relationship between the hospital’s affiliation with a university and the level of digital transformation at p = 0.005. This result demonstrates a greater propensity for hospitals that have an affiliation with a university to undertake digital transformation processes.
Table 2
Descriptive statistics, VIFs and correlation analysis.

| Variables | Mean | S.D. | VIF | DTL | HBEDS | HDEP | ER | HYEARS | HUA | GVIS | FEMGM | GMYEARS | NORTH |
|-----------|------|------|-----|-----|-------|------|----|--------|-----|------|-------|---------|-------|
| DTL       | 38.95| 14.02| 1   | 1   |       |      |    |        |     |      |       |         |       |
| HBEDS     | 5.60 | 1.27 | 2.61| 0.502***| 1 |      |    |      |      |      |       |         |       |
| HDEP      | 31.36| 27.34| 2.08| 0.387***| 0.561***| 1 |    |      |      |      |       |         |       |
| ER        | 0.91 | 0.28 | 1.31| 0.415***| 0.372***| 0.242**| 1 |      |      |      |       |         |       |
| HYEARS    | 73.91| 132.89| 1.30| 0.347***| 0.265***| 0.338***| 0.095| 1 |      |      |      |         |       |
| HUA       | 0.32 | 0.46 | 1.69| 0.492***| 0.536***| 0.435***| 0.138| 0.406***| 1 |    |      |         |       |
| GVIS      | 11.31| 1.77 | 1.36| 0.378***| 0.350***| 0.111| 0.346***| 0.010 | 0.140 | 0.036 | 0.034   | 0.034 | 1    |
| FEMGM     | 0.07 | 0.18 | 1.64| 0.087| 0.128| 0.091| 0.142| 0.036 | 0.034 | 0.034 | 0.034   | 0.034 | 1    |
| GMYEARS   | 53.74| 8.82 | 1.72| 0.034| 0.034| 0.034| 0.034| 0.034 | 0.034 | 0.034 | 0.034   | 0.034 | 1    |
| NORTH     | 0.44 | 0.49 | 1.64| 0.034| 0.034| 0.034| 0.034| 0.034 | 0.034 | 0.034 | 0.034   | 0.034 | 1    |

Note: \( n = 103 \). S.D. = Standard Deviation. *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

Table 3
Regression model results.

| Variables | Baseline Model | Complete Model |
|-----------|----------------|----------------|
|           | \( \beta \) (SE) | p-value | \( \beta \) (SE) | p-value |
| HBEDS     | 4.012 (1.263) | 0.002   | 4.012 (1.263) | 0.002   |
| HDEP      | 0.057 (0.052) | 0.276   | 0.057 (0.052) | 0.276   |
| ER        | 7.937 (4.022) | 0.049   | 7.937 (4.022) | 0.049   |
| HYEARS    | 0.016 (0.008) | 0.058   | 0.016 (0.008) | 0.058   |
| HUA       | 7.977 (2.768) | 0.005   | 7.977 (2.768) | 0.005   |
| GVIS      | 1.462 (0.642) | 0.076   | 1.148 (0.657) | 0.086   |
| FEMGM     | -2.791 (3.516) | 0.373  | -2.353 (3.430) | 0.494   |
| GMYEARS   | -0.168 (0.136) | 0.283  | -0.151 (0.144) | 0.299   |
| NORTH     | 6.894 (2.375) | 0.014   | 5.694 (2.366) | 0.018   |
| Cons      | 0.412 (0.277) | 0.003   | 0.450 (0.351) | 0.000   |

\( ^a \) Significant at the 10% level.
\( ^b \) Significant at the 5% level.
\( ^c \) Significant at the 1% level.

6. Discussion

The results obtained demonstrate the relevance of the hospitals’ characteristics in digital transformation processes. In particular, they show a positive and significant impact of the size, age and teaching status of hospitals and a partial positive effect of hospital complexity (connected only to the presence of the emergency room) on the level of digital transformation. In a contingency theory key, these elements represent the internal factors capable of influencing the digital transformation policies and strategies of Italian hospitals. Moving on to a more detailed analysis of the results obtained, this study first of all demonstrates a strong positive influence of the size of hospitals on the degree of digital transformation. This result can be explained, on the one hand, by the greater financial resources enjoyed by larger hospitals and by the greater advantages deriving from economies of scale (Kimberly and Evanisko, 1981; Dewar and Dutton, 1986; Goldstein et al., 2002; Goldstein and Schweikhart, 2002) and, on the other hand, by the availability of more qualified human resources also in possession of digital skills (Yoon et al., 2016). These elements are in fact able to facilitate the adoption and implementation of digital technologies within hospitals. The results obtained in relation to the impact of the hospital size on the degree of digital transformation clarify what was found in the study by Tortorella et al. (2020a) which by examining the emerging economies had obtained conflicting results by virtue of the different proxies used.

The results are instead contrasting in relation to the impact of hospital complexity on the degree of digital transformation. In fact, on the one hand they demonstrate a positive impact of the presence of the emergency room and, on the other hand, they demonstrate a non-significant effect of the number of departments. The positive impact of the presence of the emergency room on the degree of digital transformation can be explained by the need to digitalise the processes resulting from the provision of first aid by the hospitals (Heldt et al., 2021). In fact, the presence of an emergency room requires digital solutions both to speed up the entry processes of new patients and to improve the care provided and the tracking of healthcare traces carried out. In addition, the positive effect of the presence of the emergency room on the degree of digital transformation can also be explained by the greater availability of monetary resources available to hospitals that include this department. The non-significant effect of the number of departments is a surprising result which, however, can be explained by the low need in some specific departments to adopt digital solutions. The results obtained in relation to the impact of hospital complexity on the degree of digital transformation provide an important contribution to the academic literature since to the best of our knowledge, no previous study had examined the impact of this variable.
This study also demonstrates a positive impact of hospital age on the degree of digital transformation. Although this is a contrary result compared to expectations, it can still be explained, on the one hand, by the availability of a well-defined resource base by the older hospitals to be allocated to digitalisation and, on the other hand, by the greater propensity of these hospitals to adopt digital technologies in order to insuring their status in the reference community (Kimberly and Evanisko, 1981). The results obtained in relation to the impact of hospital age on the degree of digital transformation are contrary to what was found by Tortorella et al. (2020a) through a study conducted on emerging economies.

Finally, this study demonstrates a positive impact of hospital teaching status on the degree of digital transformation. This result can be explained, on the one hand, by the greater digital knowledge of teaching hospitals staff, connected to the focus on research (Weng et al., 2006, 2011), and, on the other hand, by the greater need for such hospitals to digitalise processes due to the greater spectrum of clinical problems (D’Sa et al., 1994). In addition, a further explanation may be related to the greater availability of monetary resources by teaching hospitals to be also allocated to the adoption and implementation of digital solutions (D’Sa et al., 1994). The results obtained in relation to the impact of hospital teaching status on the degree of digital transformation are contrary to what was found by Tortorella et al. (2020a) through a study conducted on emerging economies.

The results of this study, in part contrary to what was found by Tortorella et al. (2020a), further confirm the goodness of contingency theory as a theoretical perspective to frame the digital transformation of hospitals. The dynamics relating to the digital transformation of healthcare organizations, according to the contingency theory, are the result not only of internal factors such as the characteristics of hospitals but also of external factors such as the culture and socio-economic context of the country. In light of this, it is therefore possible to obtain different results in different geographical contexts.

7. Conclusions

This study aimed to analyse the level of digital transformation of Italian hospitals and the factors that can affect this level of digital transformation. In particular, in the context of the different types of determinants, this study aimed to examine the impact of hospitals’ characteristics on the level of digital transformation. The results show a full relevance of the size, age and teaching status of hospitals and a partial importance of hospital complexity in digital transformation processes. More specifically, the results showed a positive impact of the number of beds, presence of the emergency room, age, and affiliation with a university on the level of digital transformation of Italian hospitals. In addition, they showed a non-significant effect of the number of departments on the adoption and implementation of digital solutions by Italian hospitals.

This study contributes to enriching academic literature in different ways. Firstly, it provides a new methodology for measuring the level of digital transformation of hospitals that can be used by future research. Secondly, it extends the field of application of contingency theory which is still little used to explain the dynamics connected to the digital transformation of healthcare organizations. Third, this study provides information on the effective use of digital technologies by Italian hospitals. Finally, this study contributes to the knowledge of the drivers of the adoption and implementation of digital solutions by healthcare organizations, showing the role played by the hospitals’ characteristics.

The results obtained also offer important implications for policy makers. In recent years, the growth rate of the digitalisation of some aspects of health care has increased significantly, also driven by the spread of the COVID-19 pandemic. However, this study demonstrated the need for further efforts to achieve full and complete digitalisation of health services. In light of this, policy makers should encourage the digital transformation of hospitals through specific regulations and a new approach to funding ground on value-based outcomes in order to ensure an efficient and cost-effective future with a focus on prevention, reduction of health inequalities and on improving the health and well-being of the population. In this perspective, encouraging digital transformation and the adoption and implementation of digital technologies could guarantee the healthcare system a preventive, predictive, participatory and personalized future. To this end, policy makers should also pay attention to citizens’ digital skills in order to support a wider spread of digital health technologies. In fact, the adoption and implementation of specific digital technologies to access health care such as online appointment booking, virtual health consultancy and apps to manage health remotely could be useless in the presence of citizens with little digital knowledge. Bridging the gap in digital health literacy is particularly relevant also because digital knowledge gaps usually concern those (for example, elderly people) who are in greatest need of health care.

However, this study is not without limitations. The main limitation is related to the sample size which includes only 103 Italian hospitals. However, this limitation does not reduce the overall quality of this study and offers important insights for future research. In fact, they will be able to extend the sample size using different methods for sending the questionnaire to Italian hospitals. Furthermore, future research will be able to replicate this study in the coming years in order to verify the effective push provided by the COVID-19 pandemic to the digital transformation processes of Italian hospitals. Finally, future studies will be able to extend the analysis to hospitals located in other countries of the world in order to make comparisons of the level of digital transformation between Italian and foreign hospitals.

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