

Enhancing the Performance of Healthcare Organizations: An Applied Analysis of Digital Technologies and Sustainability

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Abstract

Over the last two decades, scholars attempted to implement models to evaluate the effectiveness of digital technologies management in healthcare organizations balanced by its compliance with sustainability. However, a managerial framework for assessing digital technologies' contribution to healthcare organizations' performance is still lacking. Evidence-based research on digital and mobile technologies applied in the daily life environments of people over 65 in Italy has been implemented. Results were investigated by a) SWOT analysis and b) identifying the key performance indicators to evaluate the performance of healthcare organizations by following the implementation of digital technologies in healthcare processes in a sustainable perspective. The analysis reveals that some weaknesses can be overcome (e.g., the availability of GPs to be involved in the enrollment of the patients) while others cannot (e.g., systematic limitations of digital methodologies). At the same time, some threats can be tackled (e.g., users' and operators' difficulty adapting to technological developments) while others can only approximately be solved. Evidenced key performance indicators can be leveraged to carry out standardized assessments related to the digital practices implemented by healthcare organizations to achieve a fully developed sustainable relational ecosystem and generate a more efficient and effective healthcare organization system.

Keywords: healthcare organization, management of digital technologies, business performance, sustainability

1. Introduction

The world of healthcare organizations is experiencing an essential third-millennium communication revolution that the web has already anticipated at the end of the 90s (Marzaleh et al., 2022; Kickbusch & Reddy, 2015). The confluence of global economic and welfare system crises has underscored the critical significance of electronic and multimedia communication networks in the restructuring efforts of both public and private healthcare organizations. In response to these crises, healthcare entities are increasingly recognizing the pivotal role of digital communication platforms in facilitating organizational adaptation and resilience. These communication networks serve as indispensable tools for enhancing collaboration, disseminating crucial information, and optimizing resource allocation within the healthcare sector. As organizations navigate the complexities of the current landscape, the strategic utilization of electronic and multimedia communication networks emerges as a fundamental imperative for fostering agility, responsiveness, and sustainability amidst ongoing challenges and transformations (Marzaleh et al., 2022; Rathee et al., 2020).

In the presence of a plurality of political and managerial strategies for rationalizing public spending (Ginter et al., 2018), it is necessary to develop a new and more advanced level of communication and interaction between the organization that produces and delivers healthcare services and the "citizen-user," to obtain greater efficiency, effectiveness, equity of access, and personalization of the healthcare service.

The utilization of web services has consistently demonstrated its efficacy in facilitating enhanced communication channels and optimizing managerial and operational dynamics within healthcare organizations and communities. By mitigating the inherent imbalance in the traditional "physician-patient" relationship, web services have played a crucial role in fostering more equitable interactions and empowering individuals to actively engage in

their healthcare journey. Through streamlined access to information, resources, and support systems, web-based platforms have contributed to greater transparency, collaboration, and patient-centered care delivery models. This evolution in communication paradigms underscores the transformative potential of web services in reshaping the dynamics of healthcare delivery and promoting more inclusive and participatory healthcare ecosystems (Kalliainen & Lichtman, 2010; Dyck, 2017; Wan et al., 2021).

The “network” composition, as identified by Sheaff et al. (2016), helps to understand the fundamental interactions that make-up the dynamic whole in which healthcare organizations and citizens relate (Elrod & Fortenberry, 2017; Williams, 2021). Precisely, by following a managerial perspective, the network that best identifies the interactions of a healthcare organization consists of a graph made up of nodes, hubs, and links, in which dynamically, the organizational nodes (healthcare organizations) and the environmental nodes (citizens/users of health services) are powered by a hub (powered node inside or outside the organization) and, by interacting with each other, they create a powerful communicative information flow called “micro-macro link” (Sheaff & Schofield, 2016; Shahid et al., 2019).

In this way, the clinical data sharing between physicians, managers, and healthcare professionals, the transfer of processed data to the citizen through the Electronic Health Record (EHR), and the implementation of home-care programs through digital technology services, such as telemedicine, contribute to configuring the new more sustainable, effective, and efficient E-Health and E-Welfare (Coorevits et al., 2013; Lehoux, 2004; Whitten et al., 2010; Harjula et al., 2022).

The Italian National Health Service (INHS) marked the country’s transition from the compulsory social insurance healthcare model to the public service model (Macinati & Anessi Pessina, 2014). According to the literature, the general model adoption was motivated by adherence to social and solidarity principles, summarized in the citizen's right to free access (financed by the public budget) to the healthcare services necessary to protect and re-store health (Macinati & Anessi Pessina, 2014; France & Taroni, 2005). Several reasons supported the adoption of the public health model: economic motivations, such as concern about the growing weight of mandatory social security contributions on the cost of labor, and socio-political motivations, such as the concern of trade union organizations to satisfy workers’ expectations.

Furthermore, Italian National Institute of Statistics (ISTAT) recognized as “disabled” those who have severe difficulties in carrying out at least one out of four activities of daily life; individual confinement, difficulty in movement, disability in functions, of sight, hearing, and speech (ISTAT, 2021). This substantial proportion of the population, older adults with disabilities or chronic diseases, and also young patients suffering from acute episodes, make it urgent to experiment and apply a healthcare system equipped with innovative, modern, and sustainable organizational models. The recognition of these characteristics of the healthcare service delivery model allows for meeting the patient’s needs better since they facilitate the transfer of skills and digital technologies outside the hospital and towards small structures, such as in small hospitals situated in disadvantaged or rural areas, or at the patient’s home (Lehoux, 2004; Bhuvana & Vasantha, 2020; Domenichiello, 2015).

Therefore, developing care models based on E-Health and adopting digital technologies in healthcare will aim to pursue the objectives of effectiveness, efficiency, equity, and sustainability of the NHS shortly.

This study is primarily aimed at experimenting with a managerial framework capable of enhancing the contribution of digital technologies to the healthcare organization’s performance. In this perspective, a multi-methodological approach was used. First, a SWOT analysis was conducted on the results obtained from evidence-based research in different European countries, including Italy. Secondly, on the results of the SWOT analysis, key performance indicators (KPI) have been defined to assess how much digital technologies in healthcare are of practical support to the management of a healthcare organization and its performance following a sustainability vision.

The paper is structured as follows: after an initial introduction on using digital technologies in healthcare, the main benefits of digital tools in healthcare organizations will be described. Subsequently, evidence-based research will be presented, specifically identifying what has been implemented in Italy. The following section will detail the methodology adopted, and finally, the results, discussions, and conclusions will be presented.

2. The Digital Technologies Used in Healthcare: The Deal for Digital Healthcare, an Italian Application

The Deal for Digital Health (literally: *Patto per la Sanità Digitale*) was drawn up in Italy by the Presidency of the Council of Ministers in 2016 and constituted the main unitary and shared strategic plan within the State and Regions Conference, for the achievement of the objectives of efficiency, transparency, and sustainability of the

NHS, through the systematic use of digital innovation in healthcare (Ministero della Salute, 2016). This plan has identified: the strategic objectives to be achieved, the process to be adopted, the actors involved, the priorities for action, the governance, and the activities to be carried out.

The definition of the Deal for Digital Health is part of a context of the necessary reorganization of the healthcare network to reconcile the growing demand for health with the budget constraints placed on healthcare organizations. In this situation, digital innovation appears to be an enabling and, in some cases, the decisive factor for creating welfare and organizational models that meet new needs (Schiffhauer & Seelmeyer, 2021; OECD, 2016).

To systematically promote digital and sustainable innovation and keep it from being carried out in a sporadic, partial, non-replicable, and non-compliant way with healthcare needs, the preparation of a strategic plan is necessary (Ziadlou, 2021; Bello, 2023).

Such a strategic digital health plan should be based on creating platforms and organizational solutions that develop the processes of continuity of care, improving care management, de-hospitalization, and full cooperation between the subjects involved in the healthcare supply chain, without requiring new ones or more excellent economic resources.

The objective of the Deal for Digital Health is to favor those initiatives involving areas of the country that, due to their geographical position, have difficulty obtaining healthcare services comparable to the rest of the national community. In particular, the main aim is to support the Regions in creating and disseminating the EHR, sharing data on the territory according to the interoperability of the EHR, and identifying the EHR as a facilitator of integrated processes between the territory and healthcare organizations (Domenichiello, 2015; Botsis et al., 2010). Furthermore, the Deal for Digital Health intends to develop innovative models of continuity of care: Integrated “hospital-territory” Diagnostic Therapeutic Assistance Pathways (DTAP), use of digital technologies as a clever way of taking charge of the chronic patient with the remote transmission of clinical parameters managed by healthcare professionals within an individual care plan; use of tele-consultation, teleporting, telediagnosis and telemedicine and integration with EHR; guidelines definition relating to the EHR use and preparation of services in “Shared Service” mode with centrally predefined methods (e.g., Single Booking Centre, dematerialization of services, reports via the Internet) (Ministero della Salute, 2016; Crespo-Gonzalez et al., 2020; Locatelli et al., 2012).

Therefore, the Deal confirms and reiterates the need for better use of digital technological supports aimed at achieving strategic objectives, including an overall efficiency improvement of the NHS, greater system transparency, an improved level of accountability, the development of new awareness and empowerment of the patient and caregivers, the launch of online services capable of promoting positive lifestyles and full involvement of stakeholders.

In this context, technological innovation can contribute to a reorganization of healthcare by supporting the shift of the focus of healthcare from the hospital to the community and providing support for the development of a Sustainable Relational Ecosystem through the implementation of innovative care models focused on the citizen and facilitating access to healthcare services (Paul & Princey, 2023).

Ultimately, such an organization of healthcare services that boasts the support of digital technologies would be essential to contribute and ensure equity in access to treatment for populations residing in remote territories, support for the management of chronic conditions, a channel of facilitated access to high specialization, better continuity of care through multidisciplinary comparison and a total aid for emergency-urgency services.

3. The Benefits of Digital Technologies in Healthcare Organizations

At an international level, there are many initiatives to study new digital technologies and telemedicine, which too often lead back to experiments, prototypes, and projects characterized by limited cases and high mortality of the initiative. At the European level, there are many examples where telemedicine is widely used; for example, in Sweden, where in 2008, more than 100 applications were surveyed in over 75% of hospitals, or in Norway, where different e-health solutions and development of digital technologies have been developed (Doupi et al., 2010; Grisot et al., 2017).

There are many applications in use in Spain. In the last 15 years, the Regional Health Systems have focused their attention on E-health, initiating some shared lines of action, including developing systems based on highly efficient digital implementations (Mahou et al., 2021). Recently, in the UK, the Department of Health financed a vast Teleassistance and Telehealth program, the Whole System Demonstrator (WSD) Programme, aimed at frail people and the chronically ill, involving over 6,000 patients and 200 doctors in 2 years (Hendy et al., 2012).

Specifically, the opportunities offered by the development of digital technologies in healthcare make it possible to find new answers to traditional problems of clinical treatments and create new opportunities for improving the healthcare service through greater collaboration between various healthcare professionals, healthcare managers, and patients.

The main motivations and benefits that lead to developing and adopting digital technologies in healthcare organizations can be summarized below.

- **Equity of access to healthcare treatments:** The equity and availability of qualified healthcare treatments in remote areas can be exponentially increased thanks to digital technologies in healthcare organizations (Locatelli et al., 2012; Brewer et al., 2020).
- **Better quality of care to ensure continuity of care:** Digital technologies in healthcare aim to bring the care service directly to the patient's residence without the physician leaving his office and without the patient himself being forced to move. The treatment of chronic diseases can represent a priority area for the application of digital technologies. Telemonitoring, for example, can improve the quality of life of chronic patients through remote self-management and monitoring solutions, even for early de-hospitalization (Hopstaken et al., 2021).
- **Improved effectiveness, efficiency, and appropriateness of healthcare treatments:** The challenge of healthcare systems in the coming years, linked to the aging of the population and the prevalence of chronic diseases over acute conditions, must also be faced through better use of the system, supported by Information and Communication Technology. The introduction of digital technologies in healthcare as an innovative organizational method has the immediate consequence of making communication between the various players usable and continuous and directing providers towards an appropriate use of resources, reducing the risks associated with complications, reducing the recourse to hospitalization, reducing waiting times and optimizing the use of resources available in the healthcare company. The availability of timely and synchronous information also allows measuring and evaluating healthcare processes through process and outcome indicators (Ziadlou, 2021; Kaplan, 2023).
- **Reduction in expenses:** The use of digital technologies in healthcare can no longer be considered an application in its own right, but rather as a specialization in the broader sector of e-health. The latter includes using ICT to support the entire range of operational functions and processes involving the healthcare sector. The EHR indeed represents the most advanced and innovative tool, progressively impacting international and national reality (Ekman, 2018; Tortorella et al., 2022).

According to the literature, one of the main advantages of the new organizational models based on digital health technologies is represented by a potential rationalization of social and healthcare processes with a possible impact on cost containment, reducing the social cost of pathologies. If properly implemented and managed within the healthcare organization, digital healthcare services can efficiently contribute to transforming the healthcare sector and substantially change the business models implemented in healthcare organizations (Gauthier et al., 2018). Considering the previous observations, it is clear how the availability of services offered by digital technologies for disadvantaged patients could reduce expenses, increase system efficiency, digital support for hospital discharge, and less recourse to hospitalizations nursing homes for the elderly.

The fundamental areas of application of digital technologies include the continuity of care and “hospital-territory” integration (Pietrantonio et al., 2021). The management of chronicity and the continuity of care assistance make substantial use of the contribution of innovative technologies to ensure the creation of an operating network method that involves the institutional and non-institutional actors responsible for patients’ taking charge. In particular, in the new healthcare organizational forms, Telemedicine and Teleassistance represent examples of how technology can support the effective operation of these forms and manage chronicity.

As reported in various studies, experiences of the application of digital technologies have been carried out in treatment pathways in many sectors of medical and surgical pathology, from cardiovascular and cerebrovascular pathologies to respiratory diseases, from diabetes to psychiatric pathology, in acute and in chronicity, in pediatrics, in adults and the frail elderly up to rehabilitation (Williams, 2021; Domenichiello, 2015). Among the objectives to be pursued, the need to implement the use of digital technologies is consistently recognized as a means of promoting a better level of interaction between the territory and the reference structures, thus making the service as sustainable as possible and defining the basis for the creation of a sustainable relational ecosystem.

4. Digital Technology in Healthcare: An Evidence-Based European Study

As part of evidence-based research of digital and mobile technologies applied in the daily life environments of people over 65, a European study lasting three years was conducted involving seven European countries (Italy,

Greece, Finland, Spain, France, United Kingdom, Germany), 49 partners, 7200 people affected including 6000 elderly people and 1200 caregivers.

The main objective of the multicenter and large-scale study was to improve the health of the elderly and promote an active and independent lifestyle even in old age.

Faced with the recognition of a gradual and constant aging of the population, the study wanted to contribute not only to an improvement in the lives of older adults but also to the economic, social, organizational and functional sustainability of healthcare organizations, with concrete answers for caregivers, healthcare professionals, and managers.

Medical devices and digital technologies were used to remind one to take a drug, controlled home security, daily mobility, night rest and relationships with family members: these are just a few examples helpful in understanding the potential and opportunities of the applications technologies in the healthcare context. The devices had various fields of application: some directly concerned the patient, such as the progress of the disease, behavior inside and outside one's home, changes linked to aging and socialization. Others, however, concerned the patient's environment, such as safety, comfort, and the activation of emergency systems in homes. The data collected by the technological systems were sent via web and entered into the EHR to give visibility to the patient and the caregiver and to inform the physician of the regular implementation of the therapy.

The study achieved the aims of reducing the number of hospitalizations, the use of the emergency room, and of checking the stability of the clinical picture—results obtained through the use of digital technologies.

In Italy, particularly in the Emilia-Romagna Region, the project envisaged the application of digital technologies on people over 65 after stroke, with moderate consequences on health. The objectives that had to be achieved in Emilia-Romagna Region were: (1) preventing the person affected by a stroke from having a limitation of their residual motor skills to carry out the essential activities of daily life and primary living conditions and (2) limiting isolation as regards the expressions of one's personality and stimulating relational and communicative activities. While the endpoints to which the project aimed were: 1. the reduction of hospitalization and the use of resources by detecting essential daily activities for the achievement of the primary objectives, and 2. the detection of the essential elements for maintaining a lifetime relationship and communication such as to be active in the social context.

From the final data, it emerged that, for greater awareness of the therapy and greater adherence to the treatment objectives, the service implemented through digital technology had met the interest of people with pathology. The stabilization of the clinical picture occurred more in cases where digital technology was regular.

In conclusion, the project highlighted the need to develop not only an objective evaluation technique from a managerial perspective, but also key performance indicators to identify the contribution that the digital technologies involved in healthcare procedures give to the healthcare organization.

5. Methodology

Based on the results of the previous described evidence-based research, the first applied methodology was the SWOT analysis. It was helpful in identifying which elements needed to be improved given the sustainable development of the relational eco-system promoted by the healthcare organization.

SWOT analysis identifies the strengths, weaknesses, opportunities, and threats of a specific project, study, or reality under investigation (Learned et al., 1965). Each of these factors should be carefully examined to plan for the adequate organization growth. The analysis, therefore, plays the role of a strategic planning tool used to evaluate any situation in which an organization should decide to achieve an objective. The analysis concerns the internal environment (by analyzing strengths and weaknesses) and the external environment (by analyzing threats and opportunities) (Table 1).

Table 1. Illustrative diagram of a SWOT matrix

SWOT ANALYSIS	Qualities useful for the achievement of objectives	Qualities harmful to the achievement of objectives
Internal elements (recognized as constituting the organization under analysis)	Strengths	Weaknesses
External elements (recognized within the context under analysis)	Opportunities	Threats

Over time, the literature has highlighted that the SWOT analysis lays its basis on achieving the desired orientations of organizational variables or issues. By identifying positive and negative external matters in the four areas of a SWOT analysis Cartesian plan, managers can better manage how to stress the strengths to achieve favorable circumstances and understand how weaknesses can negatively influence progress or amplify organizational threats (Learned et al., 1965; Helms and Nixon, 2010).

Using the diagram shown in Table 1 and the primary identification of the SWOT elements, KPIs were subsequently identified, which were helpful in understanding how much digital technologies in healthcare are of effective support to the management of a healthcare organization and its performance by following a sustainability perspective. The KPIs identified and correlated to European evidence-based research should represent the primary tool for analyzing the influences generated by the use of digital technologies in relation to:

- The patient's quality of life.
- Sustainability.
- Innovation in the technological field.

6. Results

From a managerial perspective this study is primarily aimed at evaluating a framework capable of enhancing the contribution of digital technologies to the performance of healthcare organizations. In this perspective, the SWOT analysis in the first place, and the identification of the indicators, in the second place, have made it possible to provide valuable indications regarding the standardization of assessments that could also be used in different healthcare organization contexts.

The SWOT analysis has identified the internal and external factors influencing the investigated process. Specifically, in the present case, the impact generated by evidence-based research conducted on a European scale on the performance detected in healthcare organizations following the implementation of digital technologies in healthcare processes was investigated.

The elements reported in Table 2 indicate the results deriving from analyzing strengths, weaknesses, threats, and opportunities applied to the evidence-based research. The detected items are described individually in the following areas.

Table 2. SWOT analysis results.

SWOT analysis	Qualities useful for the achievement of objectives	Qualities harmful to the achievement of objectives
Internal elements (recognized as constituting the organization under analysis)	Strengths	Weaknesses
	<ul style="list-style-type: none"> • Natural integration with regional infrastructures. • Users, professionals and technicians, already know the user interface. • Sensors produced by project partners. • Assessment of risk factors that can lead to re-hospitalization. • Better organization of home care. • Greater control and continuous contact with caregivers or home health assistants. 	<ul style="list-style-type: none"> • Wi-Fi sensors not readily available on the market. • Involvement of general practitioners. • Target users want constant follow-up and personal interaction. • Knowledge of technology and digital technological tools is not yet so widespread both in terms of culture and practice.
External elements (recognized	Opportunities	Threats

within the context under analysis)	<ul style="list-style-type: none"> •Continuous monitoring of patients with chronic conditions. •Improvement of the physician-patient relationship. • COVID-19 emergency and other emergencies have significantly increased the need to use digital technologies in care processes. •Lead the market towards the production of products adapted to the needs of patients with chronic diseases. 	<ul style="list-style-type: none"> •New products on the market that can be user-friendly while clarifying legal and safety responsibilities. •Difficulty of users and operators to adapt to technological developments. •Resistance in the public health institution to adopt innovative solutions that involve an initial increase in costs, organizational changes and legal liabilities related to privacy. •Cybersecurity threats.
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Strengths

As identified by the results reported in Table 2, the strengths related to the introduction of digital technologies in care processes are partly related to the advantages that a new technology can bring to a care process and partly related to the continuous contact that can ensure only a communication in which there are no physical barriers of obstacle.

Digital technologies in healthcare have increased the potential of healthcare organizations' performance evaluation systems, making it possible to improve, make more reliable and consolidate data availability, thus facilitating organizations and healthcare networks in achieving their institutional goals.

Furthermore, digital technologies have enormous potential for improving training, communication and cooperation between professionals, integrating health data, and communicating, and involving people regardless of their health status. These abilities have a specific dimension in the new model of taking charge of the citizen built around the word "proximity," as well as that "strengthening of home care so that the home can become the privileged place of assistance" (Groop et al., 2017).

In general, the SWOT analysis results make it possible to identify strengths related to the adoption of digital technologies in healthcare, a clear improvement in the organization of home care, greater control and better relationships with caregivers and patients.

Opportunities

To increase accessibility to healthcare organizations, reduce inequalities in access to care and guarantee an approach as homogeneous as possible throughout the national territory, it is necessary to create a standardized infrastructure for data collection and integration, which is currently highly heterogeneous in the various territorial realities.

Among the opportunities identified by digital technologies in healthcare, the continuous monitoring of patients with chronic diseases is of great importance due to the multiple challenges that the system has to face about these types of patients, i.e. achieving the effectiveness and medical appropriateness of services, improve access to services, ensure professional job satisfaction and adequate treatment for patients. These are increasingly difficult objectives to achieve, especially for the general economic sustainability of the National Health Service.

Furthermore, the spread of COVID-19 and subsequent emergencies have overwhelmingly increased the need to use digital technologies in healthcare processes and spur the market toward the production of tools designed to meet the needs of patients especially with chronic pathologies (Wang et al., 2021).

Therefore, the SWOT analysis highlighted that the foremost opportunity relating to the use of digital technologies in healthcare has led, and will lead in the future, to the use of adequate tools to measure more and more carefully the central performances of healthcare processes, both in terms of the effectiveness of medical treatments and efficient allocation of economic-financial resources.

Weaknesses

One of the main weaknesses was undoubtedly the great stress suffered by the hospital organizations involved in the implementation of digital technologies since, in some cases, the territory has not managed to sufficiently remediate the substantial increase in the demand for health services and, above all, it is not collected to quickly create an efficient "dialogue" between patients and digital technologies. Furthermore, it is essential to recognize that the healthcare facilities experimenting with these instruments had to rely on sensors and medical devices widespread on the market whose manufacturing companies did not always respond with appropriate and valuable instruments for these specific purposes.

The role that the corporate IT function has played in the hospital environment, in correlation with the other corporate functions, to quickly organize an adequate response, was a critical element which, however, failed to fill the predominant knowledge gap relating to the lack of knowledge not only of technology itself but also of the technological digital tools to be used in the therapeutic process. The opening was manifested by the patients and the health professionals who admitted that they had not received appropriate training in this regard.

Threats

The pandemic emergency is determining the need to redesign health services through careful digitization governance. The acceleration of the regulatory and application process for the implementation of digital healthcare is understood as the sum of highly sophisticated projects and tools up to the development of artificial intelligence applied to medical activities.

All of this has an impact on the introduction of new tools on the market that could be easy to use if the legal and safety responsibilities were clarified.

Indeed, a significant critical issue to be managed about healthcare assistance provided through digital technologies is represented by the need to ensure the protection of health data. These methods, including in the IoT, provide for the movement of health data through the internet, their custody in the cloud, and their use in electronic format.

The EU legislator, aware of the change and of the associated risks, has taken care to regulate personal data in an incisive way through the issuing of the European Regulation relating to the protection of natural persons with regard to the processing of personal data, as well as to the free circulation of data which repeals the previous European directive 95/46/EC (European Commission, 1995).

GDPR (General Data Protection Regulation) 2016/679 also imposes that the data processing can only occur in the presence of specific conditions and compliance with certain principles: the principle of lawfulness, which always requires the patient's consent (European Commission, 2016).

A further difficulty experienced by users and operators is adapting quickly to technological developments. The lack of speed of adaptation to the digital technologies used in healthcare organizations limits the diffusion of a sustainable relational ecosystem. It is facilitated by the feeling of resistance experienced by healthcare organizations in adopting innovative solutions that imply an initial increase in costs and subsequent organizational and responsibility changes related to privacy issues.

Furthermore, as healthcare organizations rely more heavily on digital technologies, they become more vulnerable to cyber threats such as data breaches, ransomware attacks, and other forms of cybercrime. This can compromise patient data privacy and safety, as well as damage the reputation of the organization. The adoption of digital technologies can be disruptive to traditional healthcare workflows, as it requires staff to adapt to new systems and processes. This can result in decreased productivity and a need for additional training and support.

It is essential for healthcare organizations to consider these potential threats when adopting new digital technologies carefully. By proactively addressing these challenges, healthcare organizations can ensure that the benefits of digital technologies outweigh the potential risks.

Key Performance Indicators

Based on the results obtained in detecting the strengths, opportunities, weaknesses, and threats, the Key Performance Indicators (KPIs) have been defined. KPIs are tools for measuring the benefit of the solutions proposed by the previously described European evidence-based research. What the KPIs wanted to estimate were the influences that digital technologies have generated on:

- The patient's quality of life.
- Sustainability.
- Innovation in the healthcare technology field.

Influence on the Patient's Quality of Life

4 KPIs have been defined (Table 3):

- The first related to the measurement of adverse events related to comorbidity, using the data entered in the cloud and in the EMR online available to the healthcare organizations as a measurement tool.
- The second related to estimating active participation in care processes, using the "Kane" scale as a measurement tool to evaluate social interaction.

- The third indicator helpful in estimating a possible improvement in the interaction model through the use of two questionnaires: one aimed at analyzing the user experience and the other at mental status (SPMSQ).
- The fourth indicator helpful in estimating a possible improvement in physical well-being through the use of tools such as the Barthel scale and two questionnaires relating to monitoring daily activities (ADL and IADL).

Table 3. KPIs related to the patient's quality of life

KPIs	EVALUATION TOOLS
Measurement of comorbidity-related adverse events	Data comparison included in cloud and EMR
Estimate of active participation in healthcare processes	Evaluation of social interaction (Kane scale)
Improved interaction model	User experience questionnaire; SPMSQ extension
Improved physical well-being	Barthel scale, ADL, IADL

Sustainability

5 KPIs have been defined (Table 4):

- The first related to the measurement of hospital admissions, using the data included in the Hospital Discharge Forms (HDF) as a measurement tool.
- The second relates to estimating the frequency of access to the emergency room, using the number of visits as a survey and measurement tool.
- The third indicator helpful in estimating a possible improvement (and therefore a reduction) in rehospitalization events through the use of different tools: HDF and questionnaires for Integrated Home Care (IHC) and Survey of the Degree of User Satisfaction (SDUS).
- The fourth indicator relates to measuring the number of days of absence from work recorded by caregivers. These were monitored through the CarerQol questionnaire.
- The latest indicator helpful in estimating and monitoring the consumption of prosthetic devices. The monitoring action took place through prosthetic assistance, and the reference target is the reduction in the purchase of prostheses at the healthcare organization level.

Table 4. KPIs related to the sustainability of healthcare processes.

KPIs	EVALUATION TOOLS
Measurement of hospital admissions	HDF
Measurement of the frequency of access to the emergency room	Emergency room
Measurement of re-hospitalization events	HDF, IHC, SDUS
Measurement of days of absence from work (caregiver)	CarerQol questionnaire
Monitoring of prosthetic device consumption	Prosthetic assistance
Measurement of hospital admissions	HDF

Innovation in the Healthcare Technology Field

3 KPIs have been defined (Table 5):

- The first related to measuring the number of "open source" documents available. The survey and measurement tool used was the number of accessible publications pertaining to the topic.
- The second indicator refers to enabling new care services implemented through digital technologies in healthcare. The survey and measurement tool used is a questionnaire designed to investigate the development of new services.
- The last indicator relates to the measurement of the spin-offs' size, expressed in the number of new employees hired. The assumed survey tool estimates the number of new contracts closed for hiring new staff in the spin-offs.

Table 5. KPIs related to the benefits generated by the introduction of innovation in healthcare technology field.

KPIs	EVALUATION TOOLS
Number of open-source scientific documents available	Number of publications on the topic
New healthcare services connected to the IOT	Survey
Spin-off size estimation (hiring new employees)	Verification of new employee contracts

7. Discussion and Conclusions

In recent international debates it is widely known that the healthcare model based on the inclusion of digital technology services in the healthcare pathways provided by healthcare organizations imposes a necessary radical organizational change of the NHS which cannot be limited to the mere shift of economic resources on the front of technology investment.

Reducing the potential of digital technology services in healthcare to a different method of delivery of clinical services by replacing "presence" services with "remote" services would be an extremely reductive and limiting action (Kaplan, 2023; Mair et al., 2007). The digital model in healthcare imposes a significant change of strategic vision with respect to the assistance currently provided to meet the new requests deriving from the definition of a sustainable relational ecosystem (Mair et al., 2007; Haddad & Wickramasinghe, 2014).

As the objective of this research, it has been observed that the results obtained through SWOT analysis have facilitated the identification of some KPIs useful to evaluate the performance of healthcare organizations following the implementation of digital technologies in healthcare processes from a sustainability perspective.

Indeed, as revealed by the SWOT analysis' results, digital technologies promote a multidimensional approach and direct comparison between professionals, favor accessibility to services, promote patient care and continuity of care. In other words, they allow for the creation of the so-called "vertical clinical networks" between the hospital and the territory and the "horizontal clinical networks" between services located at a territorial level (Paul & Princey, 2023; Robinson & Casalino, 1996).

The healthcare model based on digital technologies shifts its attention from the resources allocated and the services produced to the modification of the satisfaction of people's need for care. As such, the introduction of digital technology in healthcare will have to be accompanied by performance assessment tools with respect to which positions of responsibility will have to be identified and formalized no longer built according to the "organ pipe" model which does not facilitate intra-disciplinary, but of a "horizontal type" focused on segmenting the population in relation to the pathology detected and, consequently, on implementing the right technological digital healthcare service (Pietrantonio et al., 2021; Free et al., 2013).

Another aspect of relevance indicated by the SWOT analysis is represented by the identification of a subject who will have to manage the patient's care. As seen, the technological digital services applied in healthcare organizations must aim at promoting global patient care by ensuring interaction between professionals and managers and the creation of clinical networks and by identifying a structure that is at a higher organizational level than the individual clinical specialist serves as a solid reference for the patient; for example, the Case Manager within the diagnostic therapeutic assistance pathways (De Luca et al., 2022).

Physiologically, any organizational change needs sufficient times and methods to ensure that the actors develop awareness of the positive value of the new model introduced by the digitization of services which is aimed at promoting the development of a sustainable relational ecosystem in healthcare (Polese et al., 2018; Lo Presti et al., 2019).

As such, digital technologies in healthcare can help create a sustainable relational ecosystem by improving communication, data sharing, remote monitoring, patient engagement, and research.

The use of digital tools can enhance communication between healthcare providers and patients, as well as among healthcare providers themselves. This can help to facilitate the exchange of information and support the coordination of care, leading to better health outcomes (Whitten et al., 2010; Locatelli et al., 2012). In this sense, digital technologies can enable the sharing of patient data between healthcare providers, which can help improve the continuity of care and reduce errors. This can also support the development of more personalized treatment plans that are tailored to the unique needs of each patient. By using digital tools to remotely monitor patients, healthcare providers can identify health issues before they become serious, reducing the need for hospitalization and other costly interventions, which can help make healthcare more sustainable (Salvioni et al., 2016, 2018; Burnes, 2004).

Moreover, digital technologies can help engage patients in their own health status by providing them with tools to track their health and receive personalized recommendations for healthy behaviors. This can lead to better health outcomes, as patients become more invested in their own care. More specifically, addressing the impact of digital technologies on patient outcomes, particularly in terms of patient satisfaction and health outcomes, is crucial for a comprehensive understanding of their role in healthcare delivery. Numerous studies have highlighted the potential benefits of digital technologies in improving patient outcomes.

For instance, research by Topol (2015) underscores the transformative potential of digital health technologies, including wearable devices and telemedicine, in enhancing patient engagement and empowerment, leading to improved health outcomes. Additionally, a study by Barello et al. (2016) emphasizes the positive correlation between patient satisfaction and the use of digital health tools, highlighting the importance of patient-centered approaches in healthcare delivery. Moreover, the implementation of digital technologies has been associated with improved clinical outcomes, as demonstrated by a meta-analysis conducted by Kruse et al. (2018), which found significant improvements in various health parameters, including blood pressure control and diabetes management, following the adoption of digital health interventions. These findings aim to provide a more comprehensive assessment of the impact of digital technologies on patient outcomes, thus contributing to the ongoing discourse on digital health innovation and its implications for healthcare delivery.

Also, digital technologies can support research into new treatments and therapies, which can help improve health outcomes and reduce the burden of disease. This can also support the development of more sustainable healthcare practices that are based on evidence-based research. In any case, it should be considered that change inevitably generates resistance which can be at an organizational, group or individual level (Crespo-Gonzalez et al., 2020; Fontana et al., 2015). In the theory of change, Lewin describes the existence of two main groups of forces: the first based on resistance to change, the second based on the push for change within the organization aimed at reducing resistance in order to implement the organizational structure resulting from action of change (Burnes et al., 2004).

In addressing the challenges associated with the implementation of digital technologies in healthcare, it is imperative to delve into the nuanced complexities that arise, particularly concerning resistance from healthcare professionals and the necessity for cultural shifts within organizations. To this end, it is possible to refer at numerous studies that have underscored the significant role played by healthcare professionals' attitudes and perceptions in the adoption and integration of digital technologies (Cresswell et al., 2013). Resistance to change among healthcare professionals often stems from concerns regarding the impact of digital technologies on their workflow, patient interactions, and overall quality of care (Dünnebeil et al., 2012). Moreover, the successful implementation of digital technologies necessitates profound cultural shifts within healthcare organizations, including changes in leadership styles, communication patterns, and organizational structures (Greenhalgh et al., 2017). Cultural factors, such as entrenched practices and norms, can act as barriers to the adoption of digital innovations, highlighting the need for strategic interventions to promote a culture conducive to technological advancement (Greenhalgh et al., 2019). By acknowledging and addressing these challenges, this study contributes to a more comprehensive understanding of the complexities inherent in the adoption and utilization of digital technologies in healthcare settings.

In this research, the main criticism detected as a result of the SWOT analysis was the low participation of physicians in evidence-based research in order to recruit users. The need to intervene with organizational-digital development techniques and through group and individual meetings, video conferences and communications in order to "engage" the physicians who represent the traditional reference for the patient has been emerged from the analysis.

Furthermore, to address the threats posed by the adoption of digital technologies in healthcare organizations, it is important to implement appropriate managerial procedures. In particular, healthcare organizations should establish robust cybersecurity protocols to protect patient data and other sensitive information. This may include regularly updating software, implementing firewalls and antivirus software, and providing staff training on best practices for data security (Tawalbeh et al., 2020). This action should be correlated with staff training and support. To ensure that staff members are equipped to use new digital technologies, healthcare organizations should provide comprehensive training and ongoing support. This may involve providing access to user manuals, offering technical support, and conducting regular training sessions to refresh staff members' skills.

Moreover, in order to limit the potential threats posed by digital technologies in healthcare, healthcare organizations should develop detailed plans for integrating new digital technologies into their existing infrastructure (De Luca et al., 2022). This may involve conducting a thorough analysis of current workflows and

identifying potential issues that could arise during implementation. Developing a well-structured implementation plan can help to minimize disruption and ensure that the technology is fully integrated and utilized to its fullest potential. In other words, healthcare organizations should strive to strike a balance between the use of digital technologies and face-to-face interaction with patients. This can help to ensure that the quality of care is not compromised by over-reliance on technology (Hopstaken et al., 2021; Leoni et al., 2021). It may involve setting guidelines for the appropriate use of digital technologies, as well as providing training to help staff members maintain effective communication with patients.

The results of the SWOT analysis have made it possible to develop some KPIs to estimate the influences that digital technologies generate on the patient's quality of life, sustainability, and innovation in the healthcare technology field.

In order to measure the impact of digital technologies on patient quality of life, KPIs can be used to track patient satisfaction and health outcomes. For example, KPIs can measure the number of patients who report improved health outcomes after using digital technologies, such as telemedicine or mobile health apps. KPIs can also measure the extent to which digital technologies enhance patient empowerment, and engagement in their own healthcare (Fitzgerald et al., 2014).

To measure the impact of digital technologies on sustainability, KPIs can be used to track the reduction of healthcare costs and resource consumption. For example, KPIs can measure the extent to which digital technologies reduce the need for hospitalization, which can reduce costs and environmental impacts associated with hospital stays. KPIs can also track the adoption of sustainable healthcare practices that are enabled by digital technologies, such as remote monitoring and virtual consultations (Molnar & Weerakkody, 2013).

In conclusion, to measure the impact of digital technologies on innovation in a healthcare organization, KPIs can be used to track the development and adoption of new technologies and practices. For example, KPIs can measure the rate of adoption of digital health tools among healthcare providers and patients. KPIs can also track the development of new healthcare technologies and the success of healthcare technology startups. As such, KPIs can be a useful tool for estimating the influences that digital technologies generate on patient's quality of life, sustainability, and innovation in the healthcare technology field. By measuring these factors and by managing these elements, healthcare providers and technology companies can work to develop and adopt digital technologies that have a positive impact on patient care and the environment, while promoting innovation in the healthcare industry (Leitão et al., 2018; Alonazi & Thomas, 2014).

The current work has a main limitation. This study has not considered the impact of COVID-19 on the evidence-based research ensuring the sustainability of healthcare organizations. Therefore, future research should be aimed at studying the main impact that the COVID-19 pandemic has generated on digital practices implemented by healthcare organizations to achieve a sustainable relational ecosystem. Future directions should be implemented in the policy-making process in order to stimulate the NHS to play an active role by supporting and providing benefits or lower duties to healthcare organizations that switch to environmentally friendly technologies and processes.

In conclusion, digital technology has made it possible for healthcare providers to communicate with patients, share information, and collaborate with other healthcare professionals and managers across different locations, creating a more efficient and effective healthcare system. This has led to better outcomes and a globally improved healthcare organization system.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal and publisher adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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