POLITECNICO DI MILANO

DEPARTMENT OF MANAGEMENT, ECONOMICS AND INDUSTRIAL ENGINEERING

DOCTORAL PROGRAMME IN MANAGEMENT ENGINEERING

DIGITAL INNOVATION IN HOSPITALS: INDIVIDUAL AND INSTITUTIONAL DETERMINANTS OF ACCEPTANCE

Doctoral Dissertation of:
Anna De Benedictis | ID. 840433

Supervisor:
Prof. Emanuele Lettieri

Chair of the Doctoral Program:
Prof. Paolo Trucco

XXX Cycle
February 2020

La gloria di Colui che tutto move
per l'universo penetra, e risplende
in una parte più e meno altrove.

Dante Alighieri

To my Family

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

ABSTRACT

Healthcare is the most complex and fast moving industry that exists. New digital technologies are constantly being developed, all with the potential to support clinical practice by bringing many advantages into the healthcare sector (Barlow, 2017). Nevertheless, the healthcare industry has lagged behind in comparison with other sectors in the adoption of information technology in the workplace (Rudin et al., 2016). Some studies have analyzed both individual and institutional factors that affect the acceptance and implementation of information technology (Oliveira and Martins, 2011; Venkatesh and Davis, 2000) but they have generated mixed results (Holden and Karsh, 2010). Indeed, the mechanisms driving the adoption and implementation of information technology in hospitals remain unclear. Organizational Studies conceive organizations as strongly institutionalized settings in which individual behaviours are influenced by regulations, social norms and cultural systems (Scott and Davis, 2008; Gastaldi et al., 2019). In contrast, Information Science has mostly adopted user acceptance models, which emphasise individuals' rational and volitional assessment of the costs and benefits they would obtain from a new digital technology (Gastaldi et al., 2019). Only a few studies have tested both explanations (institutional and individual) in an integrative framework (Lewis et al., 2003; Gastaldi et al., 2019) to explain the behaviour of hospital professionals (Mignerat and Rivard, 2009; Messerschmidt and Hinz, 2013) and comparing different types of digital technology.

Following these considerations, this doctoral dissertation aimed to integrate these theories even more. Given the strength of the institutional forces in healthcare and the uniqueness of the hospital setting, the study viewed acceptance of technology as an effect of both individual and institutional forces, and it aimed to investigated the interplay between the institutional and the individual factors through experimentation with a new theoretical model, which combine different determinants coming from User Acceptance Models and from Institutional Theory. Another important aim was to evaluate whether and how to belonging to different professions (e.g. nurses and physicians) and the use of different types of digital technology - in particular management-led types and those introduced by hospital professionals - explain the behaviours of hospital professionals and their acceptance of technology. Two theoretical frameworks have been realized, one for each digital technology

considered: Electronic Medical Record, as an example of technology management-led, and WhatsApp, considered as a type of technology introduced by professionals.

A quantitative study was designed and performed in a medium-size Italian University Hospital, including surveys and interviews. Hospital professionals (nurses and physicians), IT staff and hospital executives were selected as participants in the project. Furthermore, two systematic literature reviews have been carried out. The research project is detailed and described in the five appended papers. Paper I summarizes the results of a systematic literature review focused on the determinants of Electronic Medical Record acceptance in hospitals. Paper II explores the state-of-the-art, the key determinants and the strength of recommendations of WhatsApp usage in hospitals. Paper III studies the interplay between individual and institutional determinants of the intention to use Electronic Medical Record, which is an example of digital technology management-led, using an original theoretical framework that combines Technology Acceptance Model and Institutional Theory. Paper IV studies the interplay between individual and institutional determinants using a similar theoretical framework, but applied to the use of WhatsApp to support clinical processes, considering WhatsApp an example of digital technology introduced by professionals. Paper V is the psychometric evaluation of an original questionnaire about the determinants of WhatsApp acceptance and usage by hospital professionals.

From an academic viewpoint, the study offers an original perspective with a new theoretical framework, and it provides academics with at least three main contributions. First, the results confirm the importance of individual determinants, not only as directly related to the acceptance of digital technology, but also as important mediators between institutional determinants and acceptance of technology. Second, even if the data are preliminary, the study is one of the first to compare the professionals' behaviours towards two different types of technologies, those who are management-led - and that require at least a careful process of adoption, design and implementation -, and those who are introduced by hospital professionals without any planning or prevision of impact on processes, quality and safety of care. Third, the findings show significant correlations, which are worthy to be better explored, between being nurse or physician and the perceived ease of use and intention to use different types of digital technology in hospitals. From a managerial perspective, the research offers a novel insight for hospital executives, middle managers and hospital professionals since it provides several important insights into which levers can be used to improve the acceptance of digital technology, both in the case of technology management-led or introduced by professionals. For hospital executives, the results shed a new light on the role of normative factors (e.g. peer influence) in promoting the acceptance of new technology. More specifically, mimetic forces influence the perceived usefulness of the two different types of digital technology.

One of the main limitations of the study relates to the generalizability of results, as the research design is based on a single case study. Further research should consider a multi-centre design, to increase the generalizability of results.

Keywords: Digital Innovation, Hospital, Technology Acceptance Model, Institutional Theory, Electronic Medical Record, WhatsApp.

LIST OF APPENDED PAPERS

Paper I **When Hospitals meet Information Technology Innovation: State-of-the-Art of key determinants of the intention to use Electronic Medical Records.**

De Benedictis A., Lettieri E., Masella C., Tartaglini D.

Under Review. Submitted to the Academic Journal "PLoS One" (Journal impact: Q1; IF = 2.776).

An earlier draft of this paper was presented as oral communication:

- at the *2nd Annual EDIM PhD Conference*, Milan, Italy, 10th June, 2015;
- at the *17th International CINet Conference*, Turin, Italy, 11-13 September, 2016.

Paper II **WhatsApp in Hospitals: Poison or Medicine? Insights from a Systematic Review.**

De Benedictis A., Lettieri E., C. Pensieri; R. Alloni; Tartaglini D.

Under review. Submitted to the Academic Journal "BMJ Open" (Journal impact: Q1; IF: 2.376)

Paper III **Electronic Medical Record implementation in Hospital: An empirical investigation of individual and organizational determinants.**

De Benedictis A., Lettieri E., Gastaldi L., Masella C., Urgu A., Tartaglini D.

Under Review. Submitted to the Academic Journal "PLoS One" (Journal impact: Q1; IF = 2.776)

An earlier draft of this paper was presented as oral oral communication:

- at the *European Health Management Association (EHMA) 2017 Annual Conference "Health Futures*", Milan, Italy, 13 - 15 June 2017;
- at the *R&D Management Conference "R&Designing Innovation"* Milan, Italy, 2 - 4 July 2018.

Paper IV   **WhatsApp in Hospital? An empirical investigation of individual and organizational determinants to use.**

De Benedictis A., Lettieri E., Masella C., Gastaldi L., Macchini G., Santu C., Tartaglini D.

Published. PLoS One. 2019, Jan 11; 14(1): e0209873. doi: 10.1371/journal.pone.0209873. (Journal impact: Q1; IF = 2.776)

This paper was presented as oral oral communication:

- at the *European Health Management Association (EHMA) 2017 Annual Conference "Health Futures"*, Milan, Italy, 13 - 15 June 2017;
- at the *R&D Management Conference "R&Designing Innovation"* Milan, Italy, 2 - 4 July 2018.

Paper V   **Development and psychometric testing of a new measure of determinants that influence the adoption of WhatsApp in Hospitals.**

De Benedictis A., Lettieri E., Piredda M., Tartaglini D.

Under Review. Submitted to the Academic Journal "BMC Health Service Research" (Journal impact: Q1; IF: 1.9)

1. INTRODUCTION

Medicine is the most humane of sciences, the most empiric of arts, and the most scientific of humanities (Pellegrino, 1979). The use of Information Technology in healthcare should be guided by such definition.

1.1 BACKGROUND

Healthcare is the most complex and fast-moving industry that exists. New digital technologies are constantly being developed, all with the potential to support clinical practice by bringing many advantages into the healthcare sector (Barlow, 2017). Nevertheless, the healthcare industry has lagged behind other sectors in the adoption of Information Technology (IT) in the workplace (Rudin et al., 2016). For example, Electronic Medical Record (EMR) has long been considered a key factor for improving healthcare quality and safety, reducing adverse events for patients, decreasing costs, optimizing processes, improving clinical research and obtaining best clinical performances (e.g. Hillestad et al., 2005; Cowie et al., 2017; Goldstein et al., 2017; Scott et al., 2018). However, the pace of the adoption of EMR in healthcare continues to lag (Hillestad et al., 2005; Rudin et al., 2016), and hospitals continue to experience resistance from professionals to accepting digital technology (Safi et al, 2018). Though many research and development programs exist and venture capital investment has been growing, successful IT projects in healthcare continue to be rare, and a plan to accelerate innovation is needed beginning with a diagnosis of the problem (Rudin et al., 2016). Some studies analyzed both individual and institutional factors that affect the acceptance and implementation of digital technology (Oliveira and Martins, 2011; Venkatesh, 2000), but they have generated mixed results (Holden and Karsh, 2010), and the mechanisms that drive the adoption and implementation of IT in hospitals remain unclear. Organizational Studies conceive organizations as strongly institutionalized settings in which individual behaviours are influenced by regulations, social norms and

cultural systems (Scott and Davis, 2008; Gastaldi et al., 2019). In contrast, Information Science has mostly adopted user acceptance models, which emphasise individuals' rational and volitional assessment of the costs and benefits they would attain from the new digital technology (Gastaldi et al., 2019).

Hospitals are highly institutionalized and regulated contexts, in terms of regulatory oversight and professional roles, and are operationally and technically complex (Scott et al., 2000). Physicians and nurses have a high level of professionalism[1] and they often affiliate within their own specialties via professional training and participation in specialty-focused organizations (Sherer et al., 2016). Successful adoption or perceived usefulness of EMR by others within their own specialties may influence hospital professionals' decisions, particularly if they are uncertain about individual benefits. Nevertheless, the majority of academic research in IT adoption in healthcare has focused on the individual level (Cao et al., 2014). The most widely used model to explore issues related to the acceptance of technology is the Technology Acceptance Model (TAM)[2] (Davis, 1989), which identifies two main antecedents, the perceived usefulness and the perceived ease of use of technology. The TAM has been validated in multiple settings (e.g. Davis, 1989; Venkatesh et al., 2003; Lankton et al., 2014; Walsh, 2014). In its basic framework the end user's attitudes and perceptions regarding the use of new technology determine the user's behavioural intention to use it.[3]

Institutional theory, instead, is based on the assumption that individual behaviours are modelled by regulations, social norms and meaning systems and that institutions embodied in routines rely on automatic cognition and uncritical processing of existing schemata and privilege consistency with stereotypes and speed over accuracy (Lawrence et al., 2009). Thus, in this theory normative, regulative and cultural conditions are co-determinants of the adoption of new technologies (Scott, 2003). The use of institutional theory in Information Science is rare compared to other fields such as organization science (Weerakkody et al., 2009). However, several studies have used an institutional approach for exploring the adoption of technology, considering institutional forces as crucial to shaping organizational actions and the opinions of the decision makers (Oliveira and Martins, 2011; Mignerat and Rivard, 2009; Sherer et al., 2016).

Both Institutional Theory and user acceptance models have independently tried to incorporate elements of the other theory to enrich their explanatory power (Gastaldi et al., 2019). User acceptance models have incorporated the direct effects of social influences and organizational conditions on individuals' behavioural intention (Venkatesh et al., 2003; Chang et al., 2007), and institutional studies have demonstrated that even when professionals are subject to institutional influences, their self-determination plays an important role even in highly-institutionalized and regulated settings such as hospitals (Holm, 1995; Leca et al., 2008). Previous studies about technology acceptance and adoption

---

[1] The professionalism competency is *"the ability to align personal and organizational conduct with ethical and professional standards that include a responsibility to the patient and community, a service orientation, and a commitment to lifelong learning and improvement"*. In: Garman A.N., Evans R., Krause M.K., Anfossi J. (2006) Professionalism. *Journal of Healthcare Management* 51(4): 219-222.
[2] Insights are reported in Papers I and II.
[3] The theoretical models and theories are described in depth in Chapter 2.

compared individual and social levels including environmental factors (Oliveira and Martins, 2011; Abdekhoda et al., 2016; Rasmi et al., 2018; Abdekhoda et al., 2019), typically based on the diffusion of innovation theory (Rogers, 1995) or the TOE (technology, organization, and environment) framework (Tornatzky and Fleischer 1990). Moreover, only a few studies have tested both explanations (institutional and individual) in an integrative framework (Lewis et al., 2003; Mignerat and Rivard, 2009; Gastaldi et al., 2019) to explain the behaviour of organizations. [4]

Following these considerations, this doctoral dissertation aimed to integrate these theories even more. Given the strength of the institutional forces in healthcare and the uniqueness of the healthcare setting, this study viewed acceptance of technology as an effect of both individual and institutional forces, and it aimed to explain how these different determinants interact and affect the acceptance of different types of digital technology in hospitals. A model has been developed and tested which hypothesized that individual factors are mediators between institutional determinants and users' acceptance of technology. In particular, we considered some institutional determinants, coming from institutional pillars, as antecedents of the individual factors that explain the acceptance of digital technology. This rationale is consistent with recent views of institutional theory, according to which professionals within organizations subject to greater institutional forces are more likely to perceive the usefulness and the ease of use of a new technology, while maintaining its own practical consciousness in order to rationalize the adoption (Lawrence and Suddaby, 2006; Gastaldi et al., 2019). We hypothesized that perceived regulative and normative factors affect professionals' acceptance of new digital technology, influencing the perceived usefulness and the perceived ease of use of such techology. In particular, regulative factors tend to outline which behaviors professionals must perform to support management in achieving its goals. As such, in the case of the acceptance and adoption of new digital technology, regulative factors should include relevant information about the benefits that certain digital technology can bring in professional practice, therefore influencing perceived usefulness and perceived ease of use. Similarly, normative factors, in particular 'peer influence', can impact on professionals' perceived usefulness of a new digital technology, since professionals can indirectly prove and consider the benefits deriving from the use of this technology trought their colleagues' experience (Gastaldi et al., 2019). The study focused on the 'perception' of hospital professionals about individual factors and inter-hospital normative and regulative forces that might influence digital technology acceptance.

Moreover, the study aimed to understand whether and how belonging to different professions (e.g. nurses and physicians) and the use of different types of digital technology explain hospital professionals' behaviours and their acceptance of technology. In fact, while most types of digital technology are strategically implemented and guided by the hospital executives (Mohr, 1969), as the case of an EMR, others are brought in by professionals and sometimes they are introduced into clinical practice without any formalized evaluation (Buxton, 1987). This is the case, for instance, of certain smartphone applications adopted in healthcare to support clinical and care processes (Windrum, 2008). In the case of

---

[4] Insights are reported in Paper I.

strategically introduced innovations, a single figure, the top management, makes all the decisions and exercises its power for them to be implemented by all the dependent hierarchies. This model prioritizes decision-making so that it will be more effective and efficient in achieving the objectives. By contrast, the employee-driven model prioritizes the innovative capacity of an organization and its individual members.

This doctoral dissertation is based on a research project that includes two different studies performed in the same organizational and clinical setting. The choice of a single case study offers the opportunity to eliminate potentially confusing factors due to the heterogeneity – in terms of strategy, legacy, professionals' behaviours and technology infrastructure – that different hospitals might show. Moreover, the choice of investigating a single case allows attention to be focused on those individual and institutional factors that might facilitate/inhibit the implementation of digital technology in hospitals, revealing the potential interplay among them. We selected the Campus Bio-Medico (CBM) University Hospital in Rome (Italy) as an appropriate setting for investigating our research questions. This hospital is a medium-sized (around 300 beds), multi-disciplinary teaching hospital. The study was approved by the General Management and by the Ethics Board[5] of the Campus Bio-Medico University.

The research project is detailed and described in the five appended papers. Paper I summarizes the results of a literature review focused on the EMR' determinants of acceptance in hospitals, considering EMR as an example of digital technology driven by hospital executives. Paper II explores the state-of-the-art, the key determinants and the strength of recommendations of WhatsApp usage in hospitals, considering WhatsApp as an example of digital technology introduced by hospital professionals. Paper III studies the interplay between individual and institutional determinants of the intention to use EMR in hospitals, considering EMR as an example of digital technology introduced by hospital executives, and using an original theoretical framework that combines Technology Acceptance Theory and determinants coming from institutional pillars. Paper IV explores the interplay between individual and institutional determinants using a similar theoretical framework, but applied to the use of WhatsApp to support clinical processes in hospitals, considering WhatsApp as an example of digital technology introduced by professionals. Paper V reports the psychometric evaluation of an original questionnaire about the determinants of WhatsApp usage in hospitals by nurses and physicians.

1.1.1 THE ACCEPTANCE OF DIGITAL TECHNOLOGY

The term "acceptance" appeared the first time in the Technology Acceptance Model proposed by Davis (1989); since then this concept has been widely used in the body of literature about Information Science. Over the years, some authors tried to go more in depth in the effort to explain and understand the meaning of acceptance, and Schwarz and Chin (2007) analyzed the different main dimensions of this concept (Table 1). The authors

---

[5] The study has been approved by the Ethics Board of the University Campus Bio-Medico (Approval number: 61/16 OSS ComEt CBM). A written consent has been obtained by professionals involved in the study.

proposed an etymological analysis of the term acceptance, which relates to the Latin word *accepto*, or *acceptio*, meaning "the action or result of the action", and they explained how it does not occur only during the initial adoption process, "but throughout the lifecycle of usage" (Schwarz and Chin, 2007).

In this doctoral dissertation, we consider the acceptance as a result of "an holistic conjunction of a user's behavioural interaction with the digital technology over time and the psychological understanding/willingness or resistance/acceptance that develops within a specific social/environmental/organizational setting." (Schwarz and Chin, 2007).

In the appended papers, the acceptance is considered in the *be given* dimension, that is "the psychological state of an individual willing to adapt his/her routines to what was required by the technology" (Table 1). Moreover, depending on different stady of digital technology implementation - not yet in use or already in use - acceptance takes on meaning of *actual use* or *behavioral intention to use,* that is the "motivational factors that influence a given behavior where the stronger the intention to perform the behaviour, the more likely the behavior will be performed" (Ajzen, 1991).

Table 1. Summary of Dimensions of Acceptance and Similar Concepts
(Schwarz and Chin, 2007)

Dimension	Dimension Definition
Receive	The psychological state of taking the technology without question.
Grasp	The psychological state of fully comprehending the intentionality (e.g. functionality and design) of the technology.
Assess	The psychological state of evaluating the value and desirability of the technology to me.
Be given	The psychological state of an individual willing to adapt his/her routines to what was required by the technology.
Submit	The psychological state of the individual surrendering to the intentionality of the technology.

1.1.2 ELECTRONIC MEDICAL RECORD (EMR)

EMR is one of the most common example of digital technology applied in health care, which is designed to improve the care delivery process, by creating legible and organized recordings of patient information and by managing both the distribution and processing of information (Laerum and Faxvaag, 2004). Although the terms EMR, Electronic Health Records (EHRs), Personal Health Record (PHR) or Health Information Exchange (HIE) are often used interchangeably as being synonymous, they actually refer to different systems. In this doctoral dissertation the following definitions have been adopted, from the National Alliance for Health Information Technology (NAHIT, 2008):

- *Electronic Medical Record (EMR)* – An electronic record of health-related information on an individual that can be created, gathered, managed, and consulted by authorized clinicians and staff within one health care organization.
- *Electronic Health Record (EHR)* – An electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that

can be created, managed, and consulted by authorized clinicians and staff across more than one health care organization.

- *Personal Health Record (PHR)* – An electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be drawn from multiple sources while being managed, shared, and controlled by the individual.
- *Health Information Exchange (HIE)* – The electronic movement of health-related information among organizations according to nationally recognized standards.
- *Health Information Organization (HIO)* – An organization that oversees and governs the exchange of health-related information among organizations according to nationally recognized standards.

In this doctoral dissertation EMR was defined "an electronic record of health-related information on an individual that can be created, gathered, managed, and consulted by authorized clinicians and staff within one health care organization" (NAHIT, 2008), and it was considered as an example of digital technology management-led.

1.1.3 THE USE OF WHATSAPP IN HOSPITALS

In healthcare context, the growing use of apps to support clinical and care processes and to communicate between peers and with patients has been documented (Mobasheri et al., 2015). There is currently a large number of mHealth apps available and useful to empower patients to manage disease conditions, and there is also an increasing number of apps designed specifically for healthcare professionals use in the clinical environment to enhance efficiency around work-related tasks (Mobasheri et al., 2015). Although much has been written about mHealth and the use of mobile phone applications for medicine, there is not much evidences about applications that - even if not been specifically developed for this reason - are increasingly used in healthcare, as the case of WhatsApp, to support clinical and care processes. A growing number of healthcare professionals use WhatsApp in their daily work with peers and patients and for different reasons (Johnston et al., 2015; Wani et al., 2013; Giordano et al., 2015; Astarcioglu et al., 2015; Giordano et al., 2017). Past research has highlighted the advantages and disadvantages of WhatsApp usage in healthcare. In this regard, two main positions exist in the scientific debate (Giordano V et al., 2017): those (e.g. Lee et al., 2008; Johnston et al., 2015; Gulacti et al. 2016; Kaliyadan et al. 2016; Raiman et al., 2017) that underline all of the advantages (e.g: improvement of communication; best surgery performances and reduction of consultation time), and those who highlight also the disadvantages (e.g. Jagannathan, 2013; Pandian et al., 2014; Choudhari, 2014; Khanna et al., 2015; Dhuvad et al., 2015) including, for instance, an increase in workload, disparity in the sense of urgency, worsening of professional relationships and risk of unprofessional behavior; possible issues of privacy and data protection; clinical information not being included in medical records. Hospitals are increasingly looking to evaluate the impact of WhatsApp usage on care delivery (Astarcioglu et al., 2015); however, there is still limited evidence regarding whether and how individual and institutional determinants influence this phenomenon, and about the strength of recommendations for a safe use of WhatsApp in hospitals for specific clinical, research and education activities. In this doctoral

dissertation WhatsApp was considered as an example of innovation introduced by professionals.

1.2 PURPOSE

The main purpose of this doctoral dissertation was to explore the main determinants of hospital professionals' acceptance of digital technology, through experimentation with a new theoretical model including User Acceptance Models and Insitutional Theory. By combining these theories, this study investigates the interplay between institutional and individual factors, thus offering novel insights on the determinants of hospital professionals' acceptance of digital technology and pointing out how and to what extent the interplay between individual and institutional determinants might trigger or inhibit acceptance of digital technology. Moreover, the study compare different digital technology and different professions' behaviours toward the acceptance of two different types of digital technology, management-led or introduced by professionals.

1.3 RESEARCH QUESTIONS

The main research objectives and continuous reflection during the research process, led to the identification of the following three focused research questions:

RQ1 **Does an interplay exist between individual and institutional determinants in explaining hospital professionals' acceptance of digital technology?**

RQ2 **Do differences in digital technology influence hospital professionals' acceptance of digital technology?**

RQ3 **Does to belonging to different hospital professions influence the acceptance of digital technology?**

Accordingly, the papers included in this doctoral dissertation contribute as shown below:

Paper I - **When Hospitals meet Information Technology Innovation: State-of-the-Art of key determinants of the intention to use Electronic Medical Records.**

A literature review identified the state of the art of the determinants of the intention to use EMR in hospitals, and it verified whether an interplay exists between institutional and individual factors. Moreover, the study explored whether and how theories coming from Organizational Studies and from Information Science have been combined to explain the phenomenon under study.

Paper II - **WhatsApp in Hospitals: Poison or Medicine? Insights from a Systematic Review.**

A literature review explored the current use of WhatsApp and the key institutional and individual determinants of its usage in hospitals. Moreover, the study explored whether and how theories coming from Organizational Studies and from Information Science have been combined to explain the phenomenon under study, and the strength of recommendations for WhatsApp usage with patients and between hospital professionals.

Paper III - **Electronic Medical Record implementation in Hospital: An empirical investigation of individual and institutional determinants.**

A Survey in a hospital explored the institutional and individual determinants of the intention to use EMR and the interplay between them. Moreover, the study tested a new model in which Technology Acceptance Model and determinants coming from institutional pillars interact and influence the intention to use EMR.

Paper IV - **WhatsApp in Hospital? An empirical investigation of individual and institutional determinants to use.**

A Survey in a hospital explored the institutional and individual determinants of WhatsApp acceptance and the interplay between them. Moreover, the study tested a new model in which Technology Acceptance Model and determinants coming from institutional pillars are combined to explore the phenomenon of WhatsApp usage in hospitals.

Paper V - **Development and psychometric testing of a new measure of the determinants that influence the adoption of WhatsApp in Hospitals.**

The questionnaire 'Digital Innovation Adoption in Hospitals' (DIAH) was developed and psychometrically tested. DIAH is a measure of the individual and institutional factors that influence the adoption of WhatsApp in hospitals as perceived by nurses and physicians.

This doctoral dissertation was designed and structured driven by the research questions, which have been analyzed in the five appended papers, as shown in Figure 1. The first four papers simultaneously explored the three research questions; the paper five refers especially to the second research question.

Figure 1. Summary of the contributions of the papers to the research questions
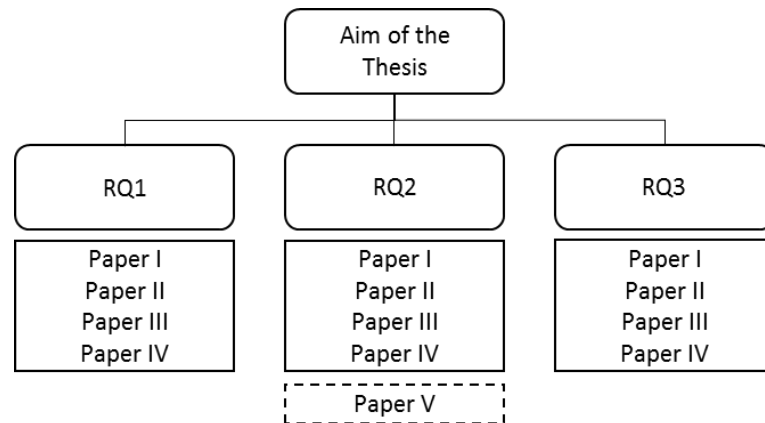
1.4 OUTLINE OF THE DOCTORAL DISSERTATION

The doctoral dissertation is driven by the research questions and it develops in the following way:

Chapter 1   Describes the research background, purpose, and research questions.

Chapter 2   Provides a theoretical framework including previous research and concepts relevant to the doctoral dissertation.

Chapter 3   Describes the research design and the methods used for generating and analyzing the empirical material.

Chapter 4   Gives a summary of the papers appended to the doctoral dissertation.

Chapter 5   Discusses the relation between the appended papers and the results of the research in terms of the theoretical, practical and methodological implications.

Chapter 6   Concludes the findings.

Chapter 7   Provides ideas for future research.

These chapters are followed by the list of references, and the appended papers.

2. THEORETICAL FRAMEWORK

The following section explains the theoretical framework of the doctoral dissertation.

Organizational Studies conceive organizations as a strongly institutionalized settings in which individual behaviours are influenced by regulations, social norms and cultural systems (Scott and Davis, 2008); while Information Science, has mostly adopted User Acceptance Models, which emphasise individuals' rational and volitional assessment of the costs and benefits they would attain from the new technologies. In this research project we proposed an integration of these two theories, particularly by testing the roles of individual and institutional factors as determinants of hospital professionals' acceptance of digital technology, and by exploring the interplay between different determinants.

2.1 USER ACCEPTANCE MODELS

Davis introduced the TAM model for the first time in 1989 (Davis, 1989). The main problem that the author posed was to understand what leads people to accept or reject Information Technology. He proposed two main determinants: perceived usefulness and perceived ease of use. The first one stimulates potential users to adopt a certain technology as it enables them to obtain better results in their work; ease of use, on the other hand, stimulates potential users to adopt a certain technology, because with a low energy expenditure many advantages are gained.

Originally, the factors determining the acceptance of technologies were taken mostly from other theories (e.g. the Theory of Reasoned Action). TAM has undergone a number of modifications that originated different models, such as the TAM2, which adds a variable about the social influence towards adoption of a technology; or the Unified Theory of Acceptance and Use of Technology (UTAUT), which reasons about the influence of performance expectancy. For the sake of our study, we rely on the original model, which is

still the most commonly used and consistently proved as effective. Additionally, the potential role of social influence is already captured by the inclusion of institutional factors.

2.1.1 THEORY OF REASONED ACTION

The Theory of Reasoned Action (TRA) (Figure 2) was proposed by Fishbein and Ajzen (1975) and focuses on the 'intention'. The model consists of three main constructs: the 'behavioral intention', the 'attitude toward behaviour' and the 'subjective norms'. In particular, 'behavioural intention' is the "motivational factor that influence a given behavior where the stronger the intention to perform the behaviour, the more likely the behavior will be performed" (Ajzen, 1991). The behavioural intention depends on the other two elements and measures a person's ability to maintain a certain behaviour. The 'attitude toward behaviour' is "an individual's positive or negative evaluation of self-performance of the particular behavior" (Ajzen, 1991); and the 'subjective norm' is "the person's perception that most people who are important to him think he should or should not perform the behavior in question" (Ajzen, 1991; Davis, 1989).

Figure 2. Theory of Reasoned Action (TRA)
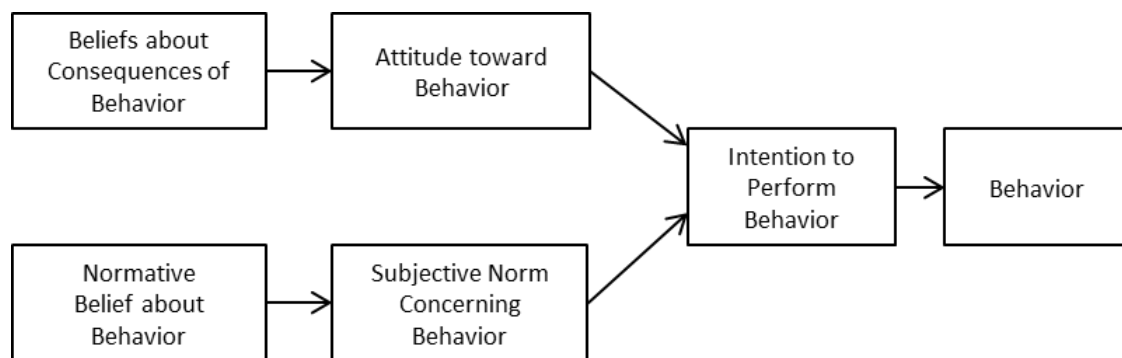
The original TRA (Fishbein and Ajzen, 1975) postulated that intentions are the immediate antecedents of any behaviour that is under voluntary control and are assumed to capture the motivational influences on behaviour. Intentions are in turn, determined by attitudes towards the behaviour, i.e. a personal factor, and by a social factor: subjective norms (SN). The former determines the relative strength of the intention of an individual to perform a specific behaviour. Therefore, the individual is more likely to perform the specific behaviour if he owns a stronger degree of intention. The latter refers to the belief that an important person or group of people will approve and support a particular behaviour, which implies the importance of the influences coming from the social environment. SN is determined by the perceived social pressure from others for an individual to behave in a certain manner and by the motivation to comply with those people's view. Attitudes and subjective norms, according to the model, are also influenced by other factors. Attitudes are determined by beliefs about the outcomes of performing any behaviour and the perceived importance of that outcome for the individual. In this sense, attitudes are the strongly dependent on the idea of the individual that a behaviour will result in an outcome and, on

the evaluation of that outcome. Similarly, subjective norms depend on the importance given by the individual to the opinion of others, and on his or her level of motivation to comply with them. However, the model has been criticized for trying to explain only intentional behaviours, excluding a wide range of behaviours such as spontaneous, impulsive and born of desire.

2.1.2 THEORY OF PLANNED BEHAVIOR

The Theory of Planned Behaviour (TPB) is an extension of the TRA. As in the TRA, the central element of the TPB is the *intention*, which depends on the 'attitude toward behaviour', the 'subjective norms' and the 'perceived behavioural control'. Behavioural control is the new element of this model and is defined as "an individual's perceived ease or difficulty of performing the particular behavior" (Ajzen, 1991). Some studies have shown that behavioural intention does not always lead to actual behaviour. That is, the intention cannot be the exclusive determinant of behaviour when the individual's control over his or her behaviour is incomplete. Therefore, Ajzen (1991) introduced 'perceived behavioural control', in such a way as to cover non-voluntary behaviours as well, in predicting behavioural intentions and actual behaviour (Figure 3). Despite the improvements made, the model has limitations. For example, variables such as fear and past experiences, which can influence behaviour, are underestimated. Even environmental and economic factors are not considered, since the behaviour of an individual is seen as the result of a linear decision-making process, which does not change over time.

Figure 3. Theory of Planned Behaviour (TPB)
(Ajzen, 1991)
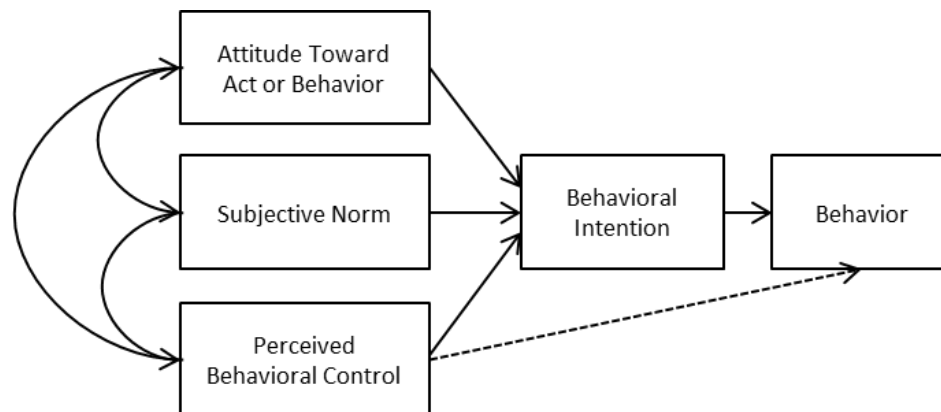
2.1.3 TECHNOLOGY ACCEPTANCE MODEL (TAM)

The TRA explanation can be considered preparatory to the introduction of TAM. Indeed, there was the need to adapt this theory to new contexts and preliminary studies were held to investigate the appropriate variables that could have explained IT use behaviour. The TAM was first introduced by Davis in 1989 (Davis, 1989). In the basic TAM (Figure 4) the IT use is determined by the behavioural intention to use (BI) variable, which is preceded by the attitude of the individual toward using the IT (ATT), defined as "a learned predisposition

to respond to an object or class of objects in a consistently favourable or unfavourable way" (Davis, 1989). The latter, in turn, has two antecedents: "perceived usefulness" and "perceived ease of use". "Perceived usefulness" (U) measures "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). Davis explains that the more the person perceives the item to be able to enhance his or her performance, the more willing he or she will be to adopt and use it. "Ease of Use" (EOU) measures "the degree to which a person believes that using a system would be free of effort" (Davis, 1989).

Figure 4. Technology Acceptance Model (TAM)
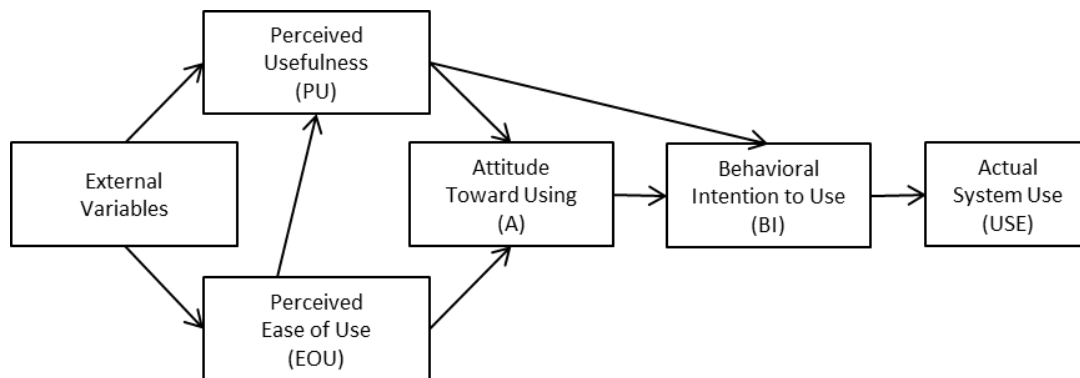
This means that the use implies for the user freedom from complexities and complications. Consequently, an item that is perceived as easy to be used is generally accepted and adopted by a wider number of people. Furthermore, the model considers perceived ease of use to have a direct influence on perceived usefulness, given the fact that easier usage lead to increased job performance. Finally, according to the model, the belief towards a system can be affected by other factors referred to as external variables.

Figure 5. Final version of Technology Acceptance Model (TAM)
(Venkatesh and Davis, 1996)
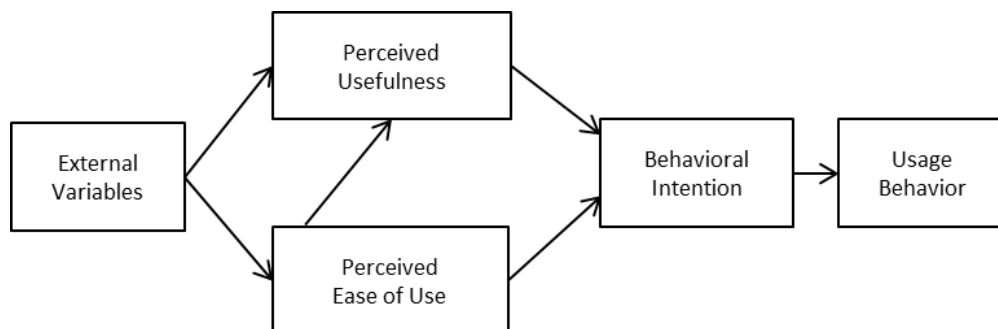
In the subsequent years, Venkatesh and Davis (1996) applied a few changes to the model, which gave birth to the final version of TAM. As shown in Figure 5, the attitude construct was eliminated, since both EOU and U proved to have a direct influence on Behavioural Intention (BI), without passing through the attitude mediator. Intention to use, which can be also referred to as acceptance (Davis, 1989; Mathieson, 1991; Szajna, 1996) was

considered reliable in predicting actual use and became the main object of interest and of possible measurability in the study of TAM (Chau and Hu, 2002). This model has achieved a great consensus; in fact, it represents a valid alternative to other models, including the Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB). However, the TAM has been criticized because it focuses only on the perceptions of the individual, leaving aside the social context. Furthermore, it is true that the perceptions of ease of use and usefulness leads to an increase in the use of a technology, but sometimes individuals are forced to take actions despite being of little use. For example, the inclusion of data in the system is an activity that is not very useful, but necessary and mandatory in a strong regulated sector such as healthcare.

ADDING EXTERNAL VARIABLES TO TAM

Many review works (Bagozzi, 2007; Lee and Larsen, 2003; Yousafzai et al., 2007; Bensabat and Barki, 2007) confirm how, taking the TAM as a reference, other new models have been derived. Considering TAM applied to health technologies, many studies start from TAM as a conceptual framework and they eliminate (Hu and Bentler, 1999; Rawstorne et al., 2000) or add predictor variables (Beldad and Hegner, 2017). In some cases, those variables are considered as independent predictors of intention to use, in other cases they are used to predict TAM variables such as EOU and U. Among the added variables are the personal characteristics of users and psychological variables such as ownership and trust (Beldad and Hegner, 2017).

2.1.4 TAM 2: AN EXTENDED MODEL

The most significant variant of TAM for the purpose of this research is TAM 2 (Figure 6). This model is presented since it gives an idea of how TAM can be extended, and it includes an external element that will be considered in the research model of the current study. Venkatesh and Davis (2000) introduced this specific proposal of revised TAM. In this model, the authors revisited the main variables and integrated new ones. TAM 2 follows the previous version of TAM and removes the 'attitude' component, considering instead the Intention to Use.

The external variables can be divided into two main categories, social influence processes and cognitive instrumental processes. The first, representing the social elements able to influence an individual's decision towards a new system, were recognized in subjective norms: voluntariness and image. The second category consisted of job relevance, output quality, and result demonstrability. Venkatesh and Davis (2000) also proposed the factor of 'experience'. The definitions of the mentioned factors that were introduced into the TAM as external determinants toward perceived usefulness and intention are reported in Table 2.

Figure 6. Technology Acceptance Model 2 (TAM2)
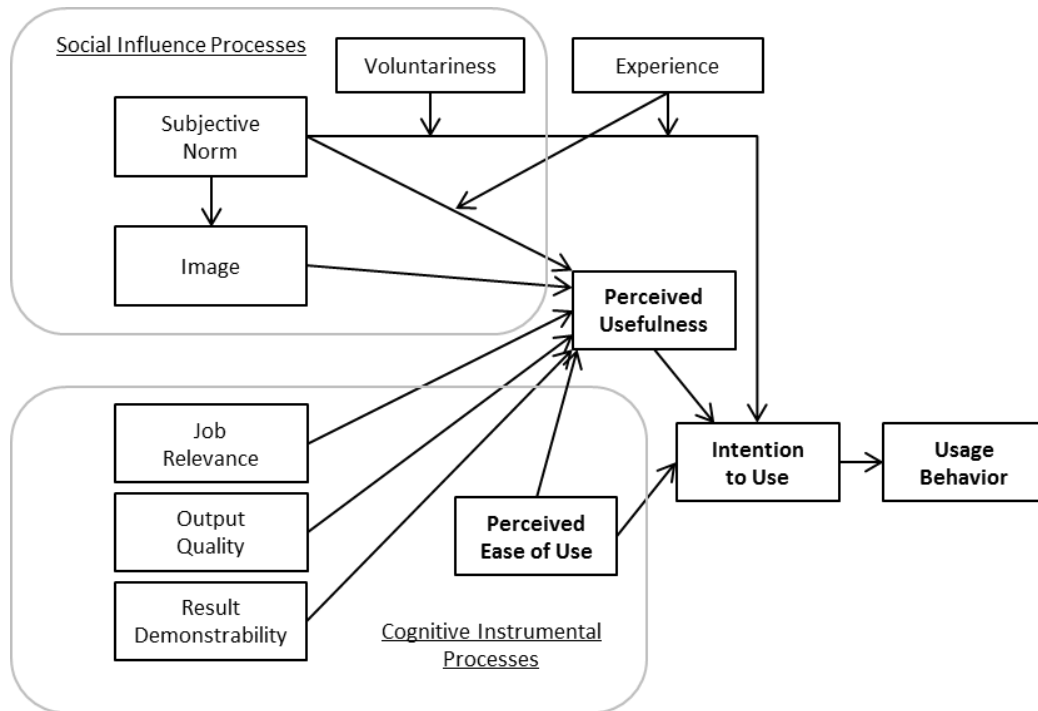
Table 2. External variables

Factors		Definition
Social Influence Processes	Subjective Norms	"The degree to which an individual perceives that most people who are important to him think he should or should not use the system" (Venkatesh and Davis, 2000).
	Voluntariness	"The extent to which potential adopters perceive the adoption decision to be non-mandatory" (Moore and Benbasat, 1991)
	Image	"The degree to which an individual perceives that use of an innovation will enhance his or her status in his or her social system" (Moore and Benbasat, 1991).
Cognitive Instrument al Processes	Job Relevance	"The degree to which an individual believes that the target system is applicable to his or her job" (Venkatesh and Davis, 2000).
	Output Quality	"The degree to which an individual believes that the system performs his or her job tasks well" (Venkatesh and Davis, 2000).
	Result Demonstrability	"The degree to which an individual believes that the results of using a system are tangible, observable, and communicable" (Moore and Benbasat, 1991).

In the same period, Venkatesh also examined the determinants that influence ease of use (Venkatesh et al., 2008). From the study, three main factors emerged: *control* (internal, through the ability to use technology; external, with favourable conditions), *intrinsic motivations* (pleasure in using technology) and *emotions* (anxiety about technology). In particular, *control* is defined as "a construct that reflects situational enablers or constraints to behavior" (Ajzen, 1985), so it is seen both as an enabling factor and as a constraint. In particular, internal control concerns knowledge, while external control refers to the

environment. There is a connection between the ability to use a technology and the perception of its ease of use. In fact, in the absence of direct experience with the system, the individual relies on his knowledge to judge the ease or difficulty of use (computer self-efficacy). Regarding external control, the presence of support staff is useful to help users use technology and overcome barriers, especially in the early stages. *Intrinsic motivation* "relates to perceptions of pleasure and satisfaction from performing behavior" (Vallerand, 1997). In the context of Information Technology, however, intrinsic motivation means pleasure in using technology (computer playfulness). This pleasure tends to underestimate the difficulty in using a system and implies a positive relationship between the use of a technology and the perceived ease of use. The *emotion* is "computer anxiety", that is the apprehension and fear of an individual at having to use technology. This state has a negative influence on the perception of ease of use of the system.

2.1.5 TAM 3

In 2008, Venkatesh again resumed and expanded the TAM model, producing TAM3 (Figure 7). This new version combines the studies carried out by the author in 2000. In fact, the determinants that influence ease of use and usefulness can be divided into four categories: *individual differences* (that includes demographic and personality differences), the *system characteristics* (that help the individual to develop perceptions, favorable or not, about the system), *social influence* and *facilitating conditions* (where organizational support facilitates the use of a technology).

Figure 7. Technology Acceptance Model 3 (TAM3)
(Venkatesh et al., 2008)
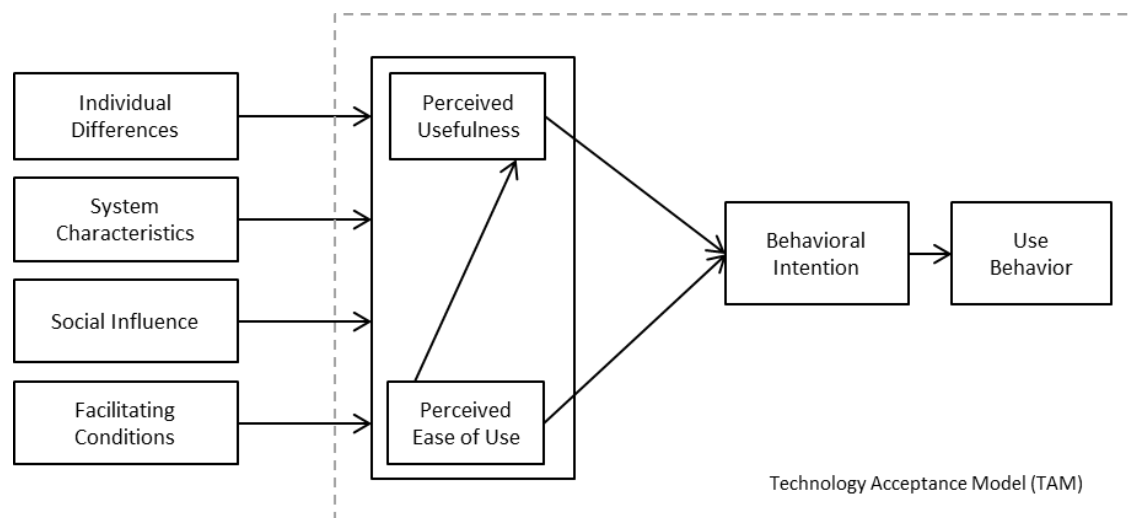
The determinants that influence usefulness are *subjective norms*, *image*, *job relevance*, *output quality,* and *result demonstrability*. The first two are part of the category *social influence*; the rest belong to the *system characteristics*. In addition to the determinants, two moderators have also been identified (Figure 8), namely *experience* and *voluntariness*. According to the author, individuals base their first impressions on the ease of use of a

system on different *"anchors"*, which are related to users' general beliefs about technology. The anchors identified are *computer self-efficacy*, *computer playfulness*, *computer anxiety* and *perception of external control*. The first three represent individual characteristics, while the last belongs to the category of facilitating conditions. Anchors are useful in the initial phase as they guide the first judgments on ease of use. Subsequently, after gaining experience with the system, users modify their opinions through a judgment.

Figure 8. Technology Acceptance Model (TAM3)
(Venkatesh et al., 2008)
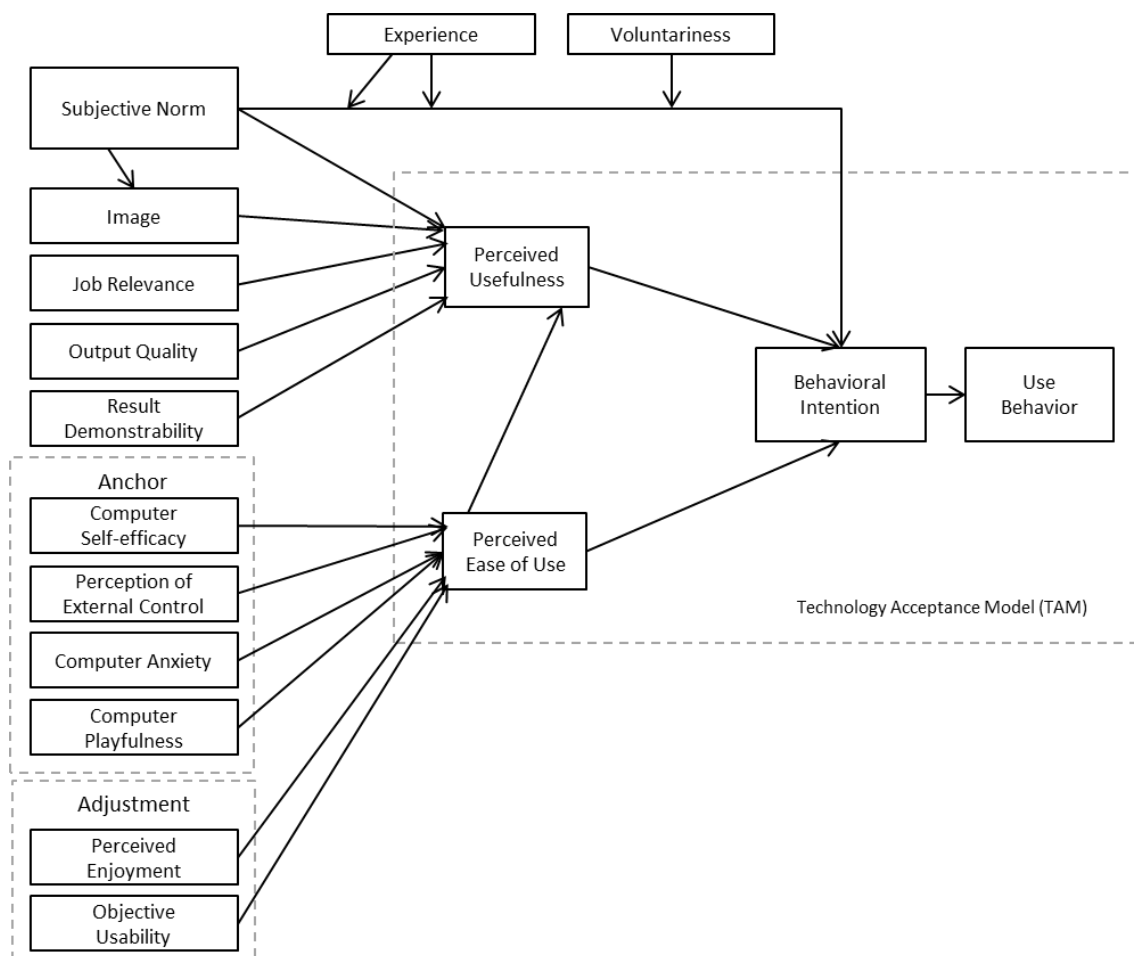
2.1.6 UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY (UTAUT)

The UTAUT is a very complex model that combines eight of the developed models in this area: the TRA, the TAM, the TPB, the Motivational Model, the Innovation Diffusion Theory, the Social Cognitive Theory, the Model of PC Utilization and a combination of Technology Acceptance Model and Theory of Planned Behavior. From the comparison of the eight existing models, four elements emerged that influence the adoption and use of a technology: *performance expectancy*, *effort expectancy*, *social influence* and *facilitating conditions*. Furthermore, *gender*, *age*, *experience* and *voluntariness of use* have been identified as

moderators.

Performance expectancy is defined by Venkatesh as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance". Five factors (Table 3) belonging to different models depend on this determinant. A relationship exists between performance expectancy and intention to use, which is mediated by gender and age.

Table 3. Performance expectancy
(Venkatesh, 2003)

FACTOR	DEFINITION
Perceived Usefulness	"The degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989)
Extrinsic Motivation	"The perception that users will want to perform an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions" (Davis et al., 1992)
Job-fit	"How the capabilities of a system enhance an individual's job performance" (Thompson et al., 1991)
Relative Advantage	"The degree to which using an innovation is perceived as being better than using its precursor" (Moore and Benbasat, 1991)
Outcome Expectation	"Outcome Expectation related to the consequences of the behaviour. Based on empirical evidence, they were separated into performance expectations (job-related) and personal expectations (individual goals)" (Compeau and Higgins, 1995)

Three elements (Table 4), coming from already existing models, explain the concept of expected e*ffort expectancy* that is "the degree of ease associated with the use of the system". In addition, in this case, the e*ffort expectancy* is influenced by gender, age and experience.

Table 4. Effort expectancy
(Venkatesh, 2003)

FACTOR	DEFINITION
Perceived Ease of Use	"The degree to which a person believes that using a system would be free of effort" (Davis, 1989)
Complexity	"The degree to which a system is perceived as relatively difficult to understand and use" (Thompson et al., 1991)
Ease of Use	"The degree to which using an innovation is perceived as being difficult to use" (Moore and Benbasat, 1991)

Social influence is defined as "the degree to which an individual perceives that important others believe he or she should use the new system". The elements concerning social influence are represented in Table 5. This determinant is conditioned by all the moderators present in the model: gender, age, experience and voluntariness of use. Moreover, social influence is strongly felt in contexts characterized by strict legislation and when individuals have little experience.

Table 5. Social influence
(Venkatesh, 2003)

FACTOR	DEFINITION
Perceived Behavioural Control	"Reflects perceptions of internal and external constraints on behavior and encompasses self-efficacy, resource facilitating conditions, and technology facilitating conditions" (Ajzen, 1991)
Facilitating Conditions	"Objective factors in the environment that observes agree make an act easy to do, including the provision of computer support" (Thompson et al., 1991)
Compatibility	*"The degree to which an innovation is perceived as being consistent with existing values, needs, and experiences of potential adopters"* (Moore and Benbasat, 1991)

Facilitating conditions are defined as "the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system". This definition includes three elements represented below (Table 6). An important difference compared to the other determinants is the absence of a direct relationship between favorable conditions and intention to use. However, facilitating conditions have a direct impact on the use of technology, and the effect increases with experience.

Table 6. Facilitating conditions
(Venkatesh, 2003)

FACTOR	DEFINITION
Subjective Norm	"The person's perception that most people who are important to him think he should or should not perform the behavior in question" (Ajzen, 1991; Davis, 1989)
Social Factors	"The individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that individual has made with others, in a specific social situation" (Thompson et al., 1991)
Image	"The degree to which use of an innovation is perceived to enhance one's image or status in one's social system" (Moore and Benbasat, 1991)

Figure 9. Unified Theory of Acceptance and Use of Technology (UTAUT)
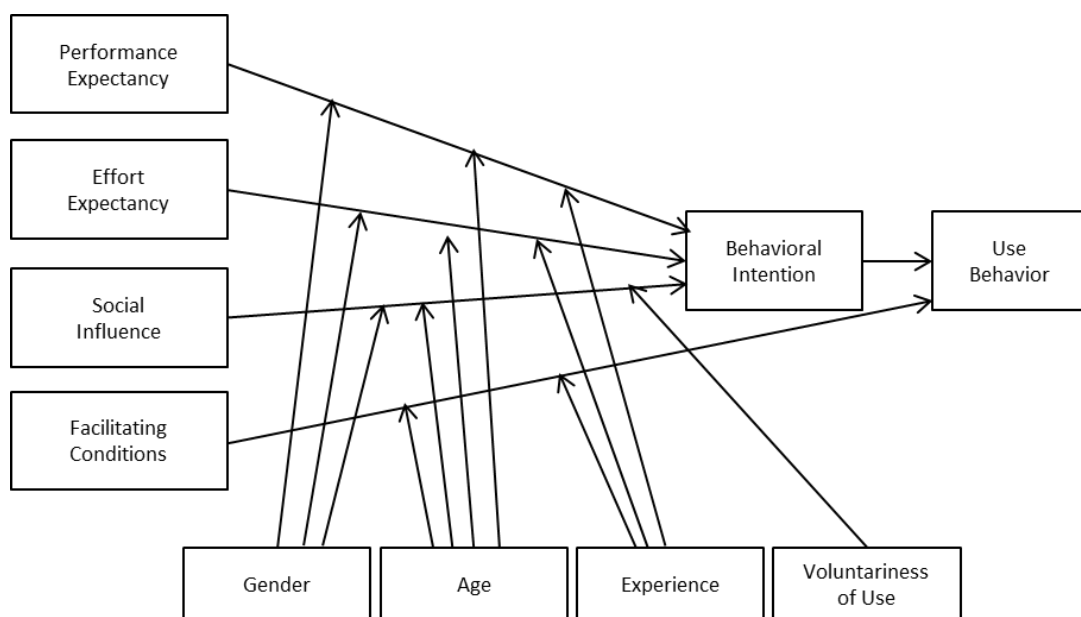
2.1.7 STRENGTHS AND WEAKNESSES OF USER ACCEPTANCE MODELS

The models described in the previous paragraphs present some general strenghts and weaknesses, synthesized in Table 7, which are worthy to be discussed.

Table 7. Strenghts and weakenesses of User Acceptance Models
(Olushola, 2017)

MODEL/THEORY	STRENGTHS	WEAKNESSES
Theory of Reasoned Action (TRA)	Strong predictive power of individuals' behavioural intention. A well-researched theory designed to explain virtually any human behaviour.	Individuals do not have complete control over their behaviour in some conditions. The direct effect of subjective norms on behavioural intention is difficult to isolate from the indirect effects of attitudes.
Theory of Planned Behaviour (TPB)	A broader model compared to TRA. The theory has received substantial empirical support for predicting behaviour in information systems and other domains	Constructs are difficult to define and measure in the study. The model suffers from multicollinearity among the independent variables.
Technology Acceptance Model (TAM)	Numerous empirical studies have found that TAM consistently explains a substantial proportion of the variance in usage intentions and behaviours with a variety of information technologies. The direct effect of subjective norms on behavioural intention has yielded mixed results in the past. This theory used perceived usefulness and perceived ease of use to replace the subjective norm. TAM is a robust, powerful, and parsimonious model for predicting user acceptance of information technologies. It has been used in many empirical studies and proven to be of quality and statistically reliable.	Ignores some important theoretical constructs. TAM does not reflect the variety of user task environments and constraints.
Unified Technology Acceptance Model (UTAUT)	The UTAUT model successfully integrated 32 variables with four moderators.	Inconsistencies when applied in different areas or situations; in other words, there is no universal UTAUT. The model does not include cultural factors, which may be important in most countries of the world.

Since the TAM does not consider the social context, that is the "subjective norm" present in the TRA and in TPB, but only the perceptions of the individual ("perceived usefulness", "perceived ease of use"), it has been integrated with other models up to the creation of a unified theory, or the UTAUT, which manages to make a synthesis of the principles underlying the rational theory.

However, despite the effort made to arrive at a unified User Acceptance Model, the unintended behavior imposed on the individual through organizational determinants (e.g., rules, normative factors or mimetic forces) is not taken into consideration. This can represent an important limit when User Acceptance Models are applied in hospitals, which are highly institutionalized and regulated contexts (Scott et al., 2000) where healthcare professionals have an high level of professionalism (Sherer et al., 2016). Indeed, professionals' intention to use new digital technology is not entirely based on rational thinking, but it is influenced by the the overarching structures, rules, social norms and culture in which they are embedded (Scott, 1995; Radaelli et al., 2017; Gastaldi et al.; 2019).

2.2 INSTITUTIONAL THEORY

In 2003 Lewis (Lewis, 2003) developed a model that includes three emergent factors as determinants of the ease of use and the usefulness of a new technology: individual characteristics, social context and institutional context. The three factors in the model are placed at different distances depending on the weight they have on individuals' beliefs (Figure 10). While the first two levels are present and well developed in the UTAUT, which is the model that summarizes the general characteristics of the User Acceptance Models, the third element is absent. In order to solve this lack, in this study institutional theory has also been included in the research framework to explain hospital professionals' acceptance of digital technology.

Figure 10. Influence of individual opinions on the use of technology
(Lewis et al., 2003)
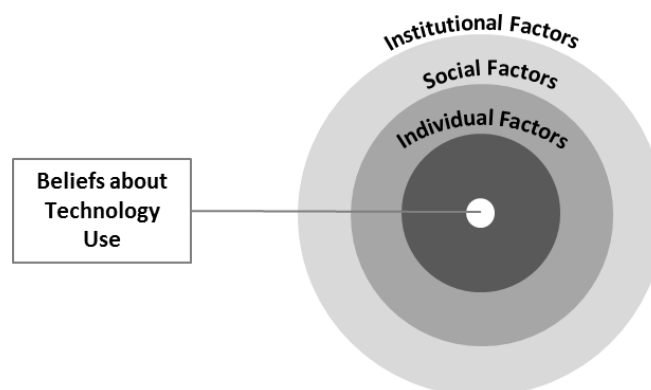
Institutional theory refers to a line of organizational research that recognizes the significant organizational effects associated with the increase of cultural and social forces: the institutional environment (Carvalho et al., 2017). Organizations have come to be seen

as being more than productive systems; they are cultural and social systems (Scott, 2001). In this sense, one of the main assumptions of Institutional Theory has to do with the social construction of reality (Berger and Luckmann, 1985), in which individuals' consciousness occurs in a subjective way through a complex interaction of institutional processes and forces. According to Scott (Scott and Davis, 2008) "Institutions are made up of cultural-cognitive, normative and regulative elements, which together with associated activities and resources offer stability and meaning to social life".

In particular, two kinds of processes are explored in institution theory: *institutional effects* (Jepperson, 1991) and *institutionalization* (Devereaux Jennings and Greenwood, 2003). Institutional effects pertain to processes in which institutions affect other institutions, organizations or organizational entities (Jepperson, 1991). The process of institutionalization refers to the stages in the formation of an institution (Devereaux and Greenwood, 2003). In such processes, the institution is the object of analysis (Mignerat and Rivard, 2009).

2.2.1 INSTITUTIONAL EFFECTS

Institutions exert three kinds of institutional pressures on organizations and organizational actors: coercive, normative and mimetic (Figure 11).

Figure 11. A conceptual framework of institutional effects
(Mignerat and Rivard, 2009)
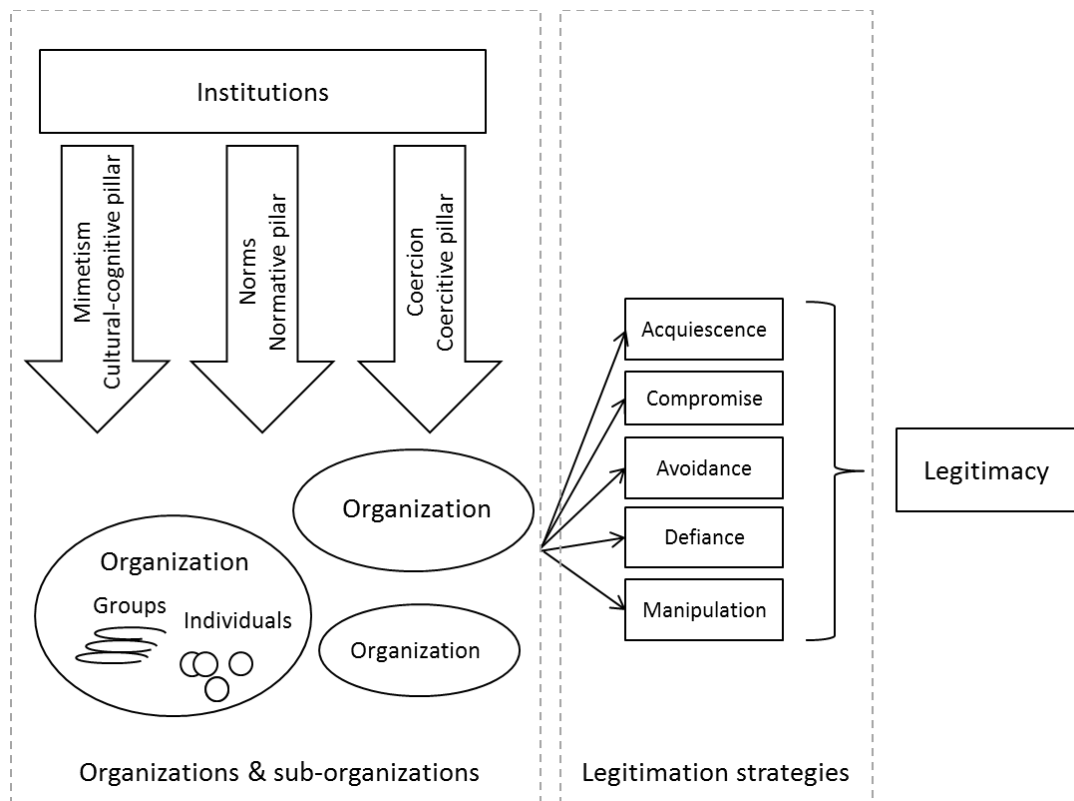
Coercive pressures come from the organization' legal environment and they are led, for example, through the presence of standards, which can be imposed by different structures (DiMaggio and Powell, 1983). Normative pressures are dependent on professionalization: for instance inter-organizational networks, similar educational backgrounds and mimetic behaviours (DiMaggio and Powell, 1983). Mimetic pressures appear usually when firms tend to model themselves on other organizations in their fields that are perceived to be more legitimate or successful, and in times of uncertainty (DiMaggio and Powell, 1983).In order to maintain stability, uniformity and the normative characteristics in their institutional field, organizations tend toward isomorphism (Scott, 2003) defined as "a constraining process that forces one unit in a population to resemble other units that face the same set of environmental conditions" (Di Maggio and Powell, 1983). Isomorphism is a homogeneity of structures observed in several fields (for example, hospitals and universities are organizations that have similar structures). According to Scott (2001), there are three institutional pillars – regulative (coercive), normative and cultural-cognitive – representing the analytical components of institutions (Table 8):
- *regulative pillar*: regarding the existence of regulations, rules and processes whose breach is monitored and sanctioned;
- *normative pillar*: introducing a social dimension of appropriate behaviour in the organization;
- *cultural pillar*: emphasizing the use of common schemas, frames, and other shared symbolic representations that create attachment to the 'appropriate' behaviour.

Table 8. The three institutional pillars
(Scott, 2001)

	Pillars		
	Regulative	**Normative**	**Cognitive-Cultural**
Bases for conformity	Obedience	Social obligation	Accepted as true
Mechanisms	Coercive	Normative	Mimetic
Logic	Instrumentalism	Conformity	Orthodoxy
Indicators	Rules. Laws and sanctions	Certification	Predominance
Bases for legitimacy	Legally sanctioned	Credibility Governed morally	Diffusion Culturally sustained Understandable Recognizable

In the regulative pillar, coercion explains how institutions, constrain and regularize the behaviour of actors. The normative pillar is based on social obligations, which are manifested through values and norms. The cultural-cognitive pillar is characterized by imitation. Thus, coercive, mimetic and normative pressures are control mechanisms exerted by regulative, cognitive and normative structures on organizations in order to constrain their behaviour (Haggerty and Golden, 2002; Mignerat and Rivard, 2009).

2.2.2 INSTITUTIONALIZATION

The institutionalization process begins following disruptions in the institutional field (Greenwood et al., 2002) which can be social, technological or legal. The existing consensus is questioned and new ideas and new possibilities of change emerge, leading to innovation. New structures are created responding to existing problems. However, up to this stage innovation remains rather localized, as problems are perceived as very specific. Subsequently, there occurs a process of theorization and development of abstract categories for the new structures, which are thus explained and legitimized. The new ideas are aligned with the existing norms and the structures are spread to other fields, acquiring a general consensus and a shared pragmatic value. The institutionalized structure can then survive for a long time (Greenwood et al., 2002). This institutionalization process may be followed by a deinstitutionalization process (Zucker, 1987), thus "the process of institutionalization is a cycle - institutions emerge, diffuse, change, die, and are replaced by new institutions" (Haunschild and Chandler, 2008). Figure 12 represents this process.

Figure 12. Institutionalization process
(Based on Tolbert and Zucker, 1996; Greenwood et al., 2002; Devereaux and Greenwood, 2003.
In: Mignerat and Rivard, 2009)
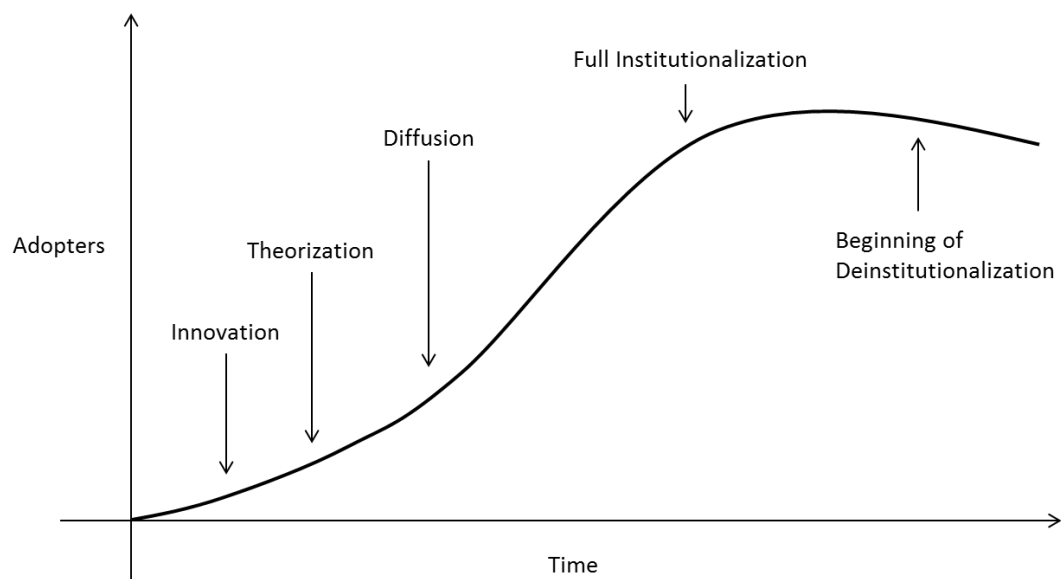
In recent years, several studies have used institutional theory for exploring Information Systems (IS)/Information Technology (IT) - related phenomena such as IT innovation, IS development and implementation, and IT adoption and use (Mignerat and Rivard, 2009; Sherer, 2016). In fact, institutional analysis has been said to have the potential to help researchers understand "how institutions influence the design, use, and consequences of technologies, either within or across organizations" (Orlikowski and Barley, 2001; Mignerat and Rivard, 2009).

However, only a few studies adopted Institutional Theory to explore Information Science in healthcare settings (Mignerat and Rivard, 2009; Sherer et al., 2016) and particularly to

explain hospital professionals' acceptance of digital technologies (see Paper I).

Institutional Theory has been mainly applied to explain the adoption of technologies - including for instance enterprise applications (Liang et al., 2007; Soares-Aguiar et al., 2008; Ugrin, 2009; Sherer et al., 2016), e-commerce and supply chains (Gibbs and Kraemer, 2004; Ming-Chih Tsai et al., 2013; Sherer et al., 2016), financial data interchange (Teo et al., 2003) or accounting standards (Collin et al., 2009; Judge and Pinsker, 2010) -, rather then to explain the acceptance of thechnology.

2.2.3 STRENGTHS AND WEAKNESSES OF INSTITUTIONAL THEORY

The Institutional Theory provides a structuralist explanation about the adoption of technologies in organisations. According to this perspective, organisations are conceived as strongly institutionalised settings in which individual behaviours are bounded by a complex combination of regulations, social norms and cultural systems (Butler, 2011). When applied in hospital, Institutional Theory might present some limits; indeed, it can exlclude important elements, such as the hospital professionals' rational and volitional assessment of the benefits they would attain from a new technology, and the professionals' autonomoy in the decision of 'engage' with a new technology because they rationally 'accept' it.

2.3 RESEARCH FRAMEWORK AND RESEARCH HYPOTHESES

The research framework combines the two different bodies of literature analyzed in the previous paragraphs (Figures 13-15). In particular, we considered the Technology Acceptance Model (TAM) (Davis, 1989) adding some variables coming from the 'institutional pillars', with the aim of understanding what moves hospital professionals' intention to use some digital technology. In particular, the main forces that influence hospital professionals' behaviours have been considered, including rational and volitional choices of individuals, organizational expectation, and peer influence.

Taking inspiration from the Institutional Theory, only two of the three Institutional Pillars have been considered, as they resulted the most important for physicians and nurses. Indeed, although the cultural pillar was initially included in the research framework, it was finally excluded after the questionnaires' face and content validity and the evaluation of physicians and nurses involved in the pilot study performed before the Surveys' administration. Moreover, the cultural pillar did not pass the Ethics Board' assessement of study feasibility. According to the research questions and the hypothesis, we also added the following control variables believed to be able to affect the results: age, seniority, clinical specialties, profession, and risk perception. Hence, the framework consists of two main levels: individual level, including TAM related factors, and institutional level, which includes normative pillar and regulative pillar. In this study we focused mainly on hospital professionals' perceptions about determinants of technology' acceptance.

Figure 14 and Figure 15 show the two specific research frameworks. In the case of EMR we considered the 'Intention to Use', since in the hospital under study EMR have not yet been implemented. In the case of WhatsApp the factor *use* substitute the *intention to use*

and the factor *ease of use* has been eliminated given the widespread use of this app in hospitals, including the hospital under study (Paper II and Paper IV). Instead, the control variable *perceived risks* has been added, since the use of WhatsApp is not regulated by guidelines and no recommendations based on proven levels of evidence are available (Paper II). The *perceived risks* was not considered for the study of EMR because the use of this technology is strongly regulated and controlled.

Figure 13. Research Framework
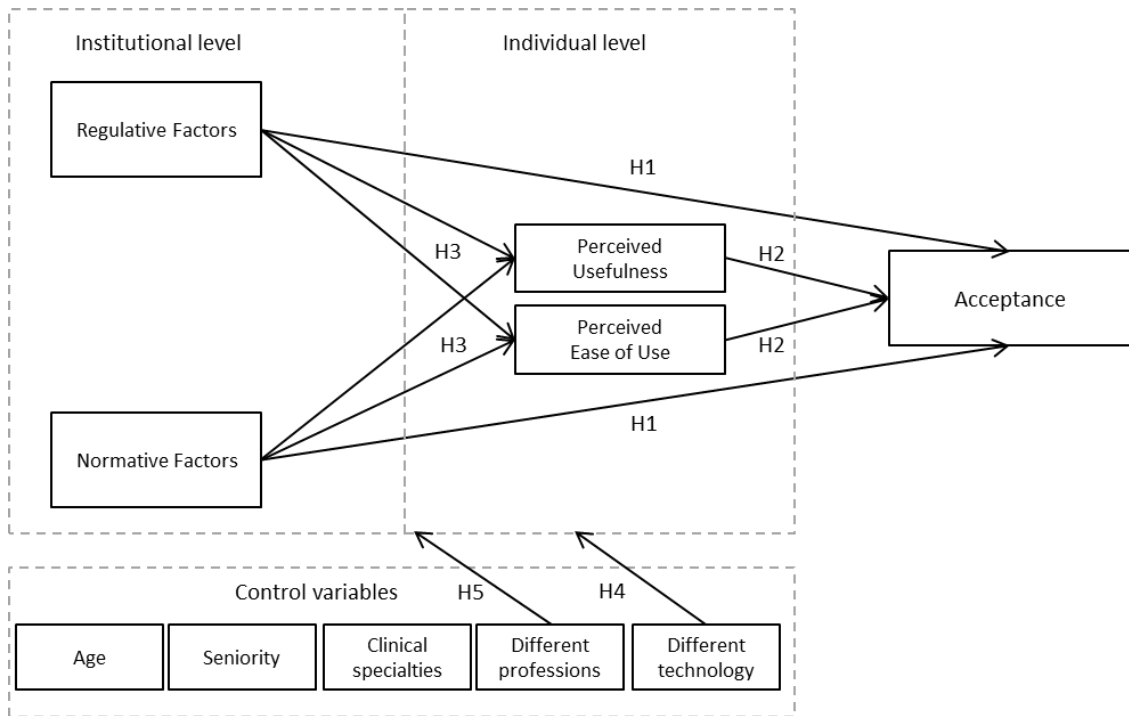
Figure 14. Research Framework (Electronic Medical Record)
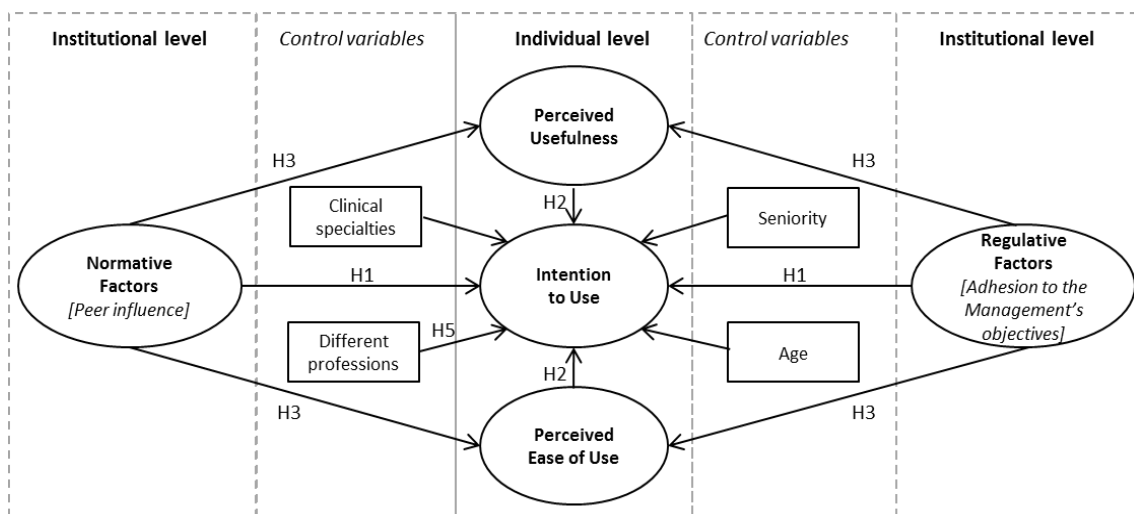
Figure 15. Research Framework (WhatsApp)
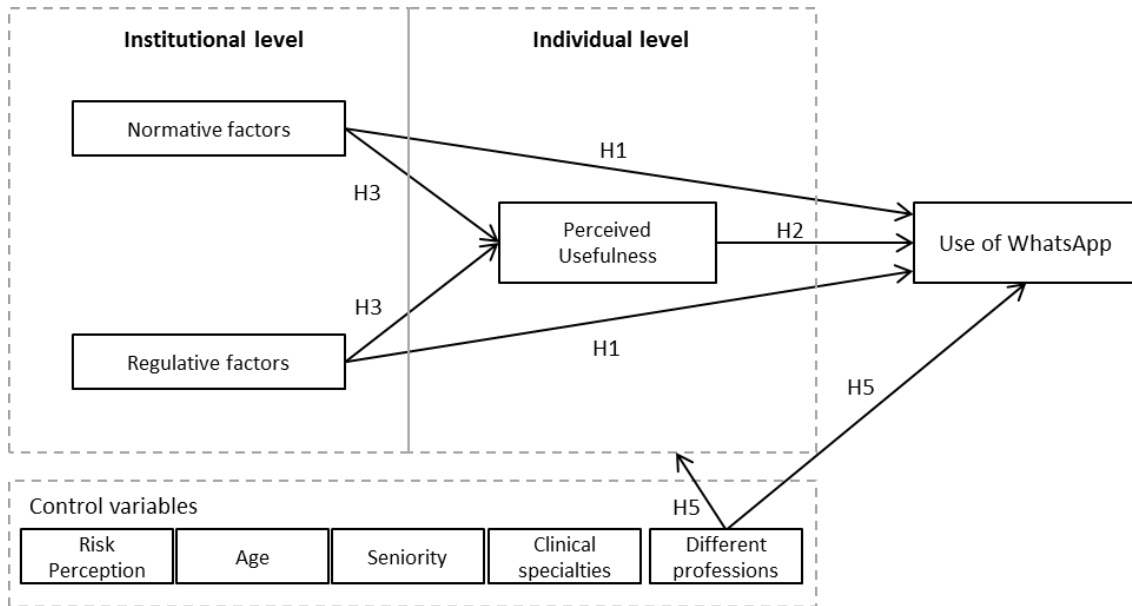
The research framework incorporated five hypotheses based on the three research questions. The **first hypothesis** (H1) was drawn from institutional theory, and it posited the direct effect of the perceived regulative and/or normative factors on the acceptance of digital technology. The **second hypothesis** (H2) was derived from user acceptance models, and it posited the direct effect of individuals' rational assessment of usefulness and ease of use on the acceptance of digital technology. The **third hypothesis** (H3) blended the two theories, positing an indirect effect of perceived institutional factors', mediated by individuals' perception of usefulness and ease of use, on the acceptance of digital technology. The **fourth** and **fifth hypotheses** (H4 and H5) posited, respectively, a direct effect of belonging to different professions and of the use of different types of technology on the acceptance of digital technology.

Drawing upon the main arguments from institutional theory, we thus hypothesized that perceived normative and regulative factors directly affect the intention to use EMR and the use of WhatsApp in hospitals:

H1: Perceived regulative and normative factors directly influence hospital professionals' acceptance of digital technology.

Several studies in the field of Information Science have extensively demonstrated that professionals' acceptance of digital technologies is directly explained by their perception of ease of use and of usefulness. Thus, we hypothesized the following:

H2: Perceived usefulness and perceived ease of use positively and directly affect the acceptance of digital technology.

Hypothesis 1 assumed that hospital professionals use EMR and WhatsApp for reasons beyond a rational assessment of their usefulness. If unmediated by a user acceptance model, that hypothesis suggested that individuals are induced/urged to use EMR by institutional factors. By contrast, Hypothesis 2 assumed that institutional influences are bypassed by the

individual; for instance, the perception of usefulness and ease of use is fully determined by a rational assessment of the technology, and determines the decision to adopt the technology.

An alternative view suggested that institutional factors influence how hospital professionals perceive the ease of use and/or the usefulness of a new technology. This interpretation is consistent with a body of institutional theory literature, according to which individuals embedded in organizations with stronger institutional influences are more likely to perceive the usefulness and ease of use of a new technology, but still retain enough practical consciousness to rationalize its adoption (Pozzebon, 2004; Lawrence, 2006).

Drawing upon these considerations, we argued that institutional factors affect individuals' perceptions of ease of use and usefulness and that, therefore, individual factors are mediators among institutional factors and acceptance of digital technology; we thus hypothesized the following:

H3: Perceived ease of use and perceived usefulness are mediators of the relationship between institutional factors and acceptance of digital technology.

Finally, we posited a direct effect of some control variables on the acceptance of digital technology, as follows:

H4: Different types of digital technologies directly affect hospital professionals' acceptance of digital technology.

Hypothesis 4 assumed that different technology, management-led types or those who are introduced by hospital professionals, influence professionals' behaviours and the acceptance of technology. Indeed, different types of digital technology required different processes of adoption and implementation, which can have an impact on individual and institutional variables. Especially, it was expected that different types of technology solicited in different way institutional forces and individual determinants of acceptance. It was been hypothesized a greater perception of usefulness and ease of use for digital technologies introduced by hospital professionals, rather than for the management-led ones, since the first ones are defined and chosen by professionals based on their needs and preferences. Indeed, in the case of digital technologies management-led, as the case of EMR, a single figure makes all the decisions and exercises its power for them to be implemented by all the dependent hierarchies. This model prioritizes decision-making so that it will be more effective and efficient in achieving the objectives. By contrast, the employee-driven model prioritizes the innovative capacity of an organization and its individual members (Buxton, 1987).

H5: Belonging to different hospital professions (nurse or physician) directly affects the determinants of hospital professionals' acceptance of digital technology.

Finally, it was been hypothesized that, the belonging to different group of professionals (e.g. nurses or physicians) explains professionals' behaviours and their acceptance of technology, since literature reports a different use of some digital technologies by doctors and nurses in the workplace (e.g. WhatsApp).

The hypotheses are detailed in the appended papers.

3. MATERIALS AND METHODS

This section summarizes the main methodology used in the research project. The materials and methods for each phase of the study are detailed in the five attached papers.

A quantitative study was designed, including surveys and interviews. Hospital professionals (nurses and physicians), IT staff and hospital executives were selected as participants in the project. Furthermore, two in-depth analysis of the literature have been carried out. Table 9 shows an overview of the materials and methods.

Table 9. Overview of the materials and methods

Electronic Medical Record *Management–led digital technology*	WhatsApp *Digital technology introduced by professionals*	Materials and Methods	Papers
Grand Theory: TAM + Institutional Theory	Grand Theory: TAM + Institutional Theory	Narrative review	
Framework design	Framework design	Expert elicitation	
Literature review	Literature review	Systematic literature review	Papers I, II
Empirical study	Empirical study	Quantitative study: - Questionnaires' design. - Analysis of questionnaires' face validity, content validity and internal consistency. - Survey administration. - Data analysis.	Papers III, IV
-	Empirical study	Psychometric analysis and validation of questionnaire.	Paper V

3.1 EMPIRICAL CONTEXT

Hospitals are exemplary settings for the study, since past research strongly supports both TAM-related and institutional explanations (Gastaldi, 2019), and a hospital offered an ideal setting for investigating whether and how the two theories are correlated. [6] Specifically, the Campus Bio-Medico (CBM) University Hospital in Rome (Italy) was selected as an adequate setting for the research project. The hospital, part of the Campus Bio-Medico University, is a medium-sized (around 300 beds), multi-disciplinary teaching hospital and it is home to a whole range of clinical, teaching and research activities.

For each phase of the study, one or more units of analysis were identified. As already described in the introduction, the choice of a single case study offers the opportunity to eliminate potentially confusing factors due to the heterogeneity that different hospitals might show.

3.2 ETHICAL CONSIDERATIONS

The study was approved by the Ethics Board of the University Campus Bio-Medico (Approval number: 61/16 OSS ComEt CBM), and it was conducted in accordance with the principles of the Declaration of Helsinki developed in Brazil by the World Medical Association (WMA, 2013). Professionals were invited to participate through an information letter about the purpose of the study, and consent was assumed by return of the questionnaire. Data were collected anonymously.

3.3 RESEARCH DESIGN

Two systematic literature reviews have been conducted[7] in order to analyze the topic, to establish the research framework and to develop the materials for the empirical study. Afterwards, the empirical phase was implemented and developed in two main phases, as described below, and was led by an interdisciplinary core-group of researchers and practitioners (a head-nurse quality manager as principal investigator, the head nurse of a medical inpatient unit, a physician, a senior nurse, two industrial engineers, and the head of a hospital information systems office).

3.3.1 FIRST PHASE

Aims

The main purposes of this first phase of the study were to design the questionnaires according to the literature review, the research questions and the theoretical frameworks, and to check the face and content validity of the two questionnaires. The first questionnaire[8]

---

[6] Insights are reported in Paper I.
[7] Literature reviews' contents are detailed in Papers I and II.
[8] The final questionnaire is reported in Paper III.

was specifically developed to explore Electronic Medical Record' intention to use, and the second[9] to analyze the acceptance and usage of WhatsApp.

Sampling, setting and unit of analysis

Nurses and physicians of the University Hospital Campus Bio-Medico of Rome represented the main unit of analysis. Moreover, in order to improve the questionnaires, middle managers and managers of the IT Department of the CBM Hospital have been involved.

Methods and data collection

Design of instruments (Questionnaires)

The questionnaires were designed and reviewed in detail by the group of researchers. The first version of the two questionnaires was designed by a panel of experts in the field and based on the literature review. The items were defined by translating into observable and measurable elements the concepts identified in the theoretical frameworks, in the research questions and in the research hypotheses. In particular, the scales for the measurement of perceived usefulness were adapted from the studies by Venkatesh (Venkatesh and Davis, 2000; Venkatesh et al., 2003; Venkatesh et al., 2011) and the scales for the measurement of normative and regulative factors were adapted from the study by Scott (Scott, 2003). All the questionnaire items used a 7-point Likert scale, with 1 indicating totally disagree, 2 strongly disagree, 3 quite disagree, 4 neither agree nor disagree, 5 quite agree, 6 strongly agree and 7 totally agree. Items related to WhatsApp usage used a 5-point Likert scale, with 1 indicating never and 5 always.

Face validity

The two questionnaires were reviewed for face validity by a panel of four experts. The panel members were one nurse and one physician with more than 9 years of work experience, and two engineers who were experts in Information Science. Panel members were asked to evaluate each statement item for clarity, ease of use and appropriateness (Polit and Beck, 2014). Based on their comments and suggestions, some items were removed and changes were made in the wording of several items to increase their clarity.

Content validity

Afterward, both questionnaires were tested for content validity by a pool of experts not involved in the preceding phase, to identify their ability to measure the determinants of hospital professionals' acceptance of EMR and WhatsApp in hospitals, and to identify, for each item, utility, consistency with the research objectives, easy of reply and other important aspects to take into account. Audio-recorded individual interviews using a semi-structured grid were carried out with ten experts including two nurses, three head nurses, two middle managers and three physicians. The interviews lasted sixty minutes on average, and they were conducted in a designated room by three researchers: one acted as interviewer, the other two helped with audio-recording and with filling out the grid for item

---

[9] The final questionnaire is reported in Paper IV.

evaluation. Based on the expert evaluation, seven items were eliminated and five items were modified.

Questionnaire

The final versions of the questionnaires were defined according to the data collected during the interviews. The two questionnaires are described in Papers III and IV.

3.3.2 SECOND PHASE: SURVEY IN CBM HOSPITAL AND VALIDATION OF TOOLS

Aims

The main purposes of this second phase of the study were to answer the research questions and to validate the questionnaires.

Sampling, setting and unit of analysis

The unit of analysis consisted of nurses and physicians of the CBM Hospital.

Methods and data collection

Two Surveys were performed in the CBM Hospital using questionnaires. Data analysis, validation of the tools and sharing of results were carried out as described below.

Survey administration

The items were entered in Google forms to be released in electronic format and the links for the on-line questionnaires were sent by e-mail to 380 nurses and 250 physicians representing different clinical areas of the CBM Hospital, between February and September 2017. Three reminders were sent periodically to participants. Data analysis was performed in October 2017. The data collected through the online questionnaires were exported into Excel format, and data cleaning was performed before the data analysis.

Statistical analysis

Descriptive statistics were executed of means, frequencies, and percentages for the sample's demographic characteristics and items. The questionnaires' reliability was evaluated through Cronbach's Alpha coefficients ($\alpha \geq 0.90$ were considered excellent; $0.8 \leq \alpha < 0.9$ good; $0.7 \leq \alpha < 0.8$ acceptable; $0.6 \leq \alpha < 0.7$ questionable; $0.5 \leq \alpha < 0.6$ poor; $\alpha < 0.5$ unacceptable), and both questionnaires were revised following this analysis. The data were processed and analyzed to verify the correlation between the variables considered. STATA® software was used for the statistical analysis. The Fisher's test was used to evaluate the correlation between the answers provided for each item by different professionals.

A Path Analysis was performed within the Structural Equation Modelling (SEM) builder environment in order to test the proposed models.[10]

---

[10] Structural Equation Modelling (SEM) is a combination of factor analysis and multiple regression that is used to analyze structural relationships (Tabachnick and Fidell 1996) and it represents an analytical method to assess relationship from exploratory to confirmatory analysis (Hair et al. 2010). Details are shown in Papers III and IV.

Validation of Questionnaire 'Digital Innovation Adoption in Hospitals' (DIAH)

Moreover, an Exploratory Factor Analysis (EFA) was conducted for the Questionnaire related to WhatsApp, named 'Digital Innovation Adoption in Hospitals' (DIAH), enabling the new DIAH questionnaire to be psychometrically tested and validated.[11] As preliminary analyses, skewness and kurtosis were evaluated to ascertain the data distribution. The Bartlett's test and the Kaiser-Meyer-Olkin (KMO) index were calculated to evaluate data factorability. The Bartlett's test had to be significant and values ≥ 0.90 of KMO were considered excellent; 0.80 - 0.90 good; 0.70 - 0.80 moderate; 0.60 - 0.70 acceptable; and ≤ 0.60 not acceptable. Exploratory factor analysis (EFA)[12] was conducted with SPSS using Principal Axis Factoring with Promax oblique rotation when normality of data distribution was ascertained (values of skewness and kurtosis <|1|). In these cases, the number of factors to retain in the final solution were identified by scrutinizing the scree plot of Eigenvalues. Items were excluded from the final solution if the loadings were low on the principal factor or if the primary loading was less than twice those on secondary factors (Brown, 2015). When data showed values of skewness and kurtosis <|1|, MLr (maximum likelihood) estimator with Geomin rotation was used (Muthén & Muthén, 2012). In these cases, the goodness of fit was evaluated considering the following indices: chi-square significance (if chi-square is not significant, the model reached a perfect fit with the observed data); comparative fit index (Bentler, 1990) and Tucker-Lewis index (Tucker and Lewis, 1973): values ≥ 0.95 indicate a good fit; root mean square error of approximation (Steiger, 1990): values ≤ 0.05 or 0.08 indicate a good fit (Hu and Bentler, 1999). With the purpose to validate the internal consistency of the items, the Cronbach's alpha[13] has been computed for each construct. In order to assess the alpha values, Nunnally and Bernstein's work (1994) was taken as a reference. According to them, "the construct can be considered reliable with a Cronbach Alpha of 0.70 or higher". Consequently, all constructs reporting a value higher than 0.70 have been accepted and considered valid. Internal consistency was evaluated thorough Cronbach's Alpha coefficients ($\alpha \geq 0.90$ were considered excellent; $0.8 \leq \alpha < 0.9$ good; $0.7 \leq \alpha < 0.8$ acceptable; $0.6 \leq \alpha < 0.7$ questionable; $0.5 \leq \alpha < 0.6$ poor; $\alpha < 0.5$ unacceptable) and Factor score determinacies coefficients (values > 0.90 were considered excellent) when appropriate. Statistical analyses were performed using SPSS 21.0 and MPLUS 6.12 (Muthén & Muthén, 2012).

---

[11] Details of questionnaire DIAH' validation are shown in the Paper V.
[12] EFA is a multivariate statistical method that is generally used to understand the underlying structure of a relatively large set of variables. In our specific case EFA was adopted with the aim of identifying which measured items could have better represented the construct.
[13] Cronbach's alpha assesses the Internal Consistency Reliability of a summative rating scale (Likert, 1932).

4 SUMMARY OF APPENDED PAPERS

The following summary of the five appended papers gives an understanding of the foundation for the doctoral dissertation and an overview of the common themes in the papers.

4.1 SUMMARY OF APPENDED PAPERS IN TABULAR FORM

As described in the previous chapters, this doctoral dissertation was designed and structured driven by the research questions, which have been analyzed in the five appended papers, as shown in Figure 16.

Figure 16. Summary of the contributions of the papers to the research questions
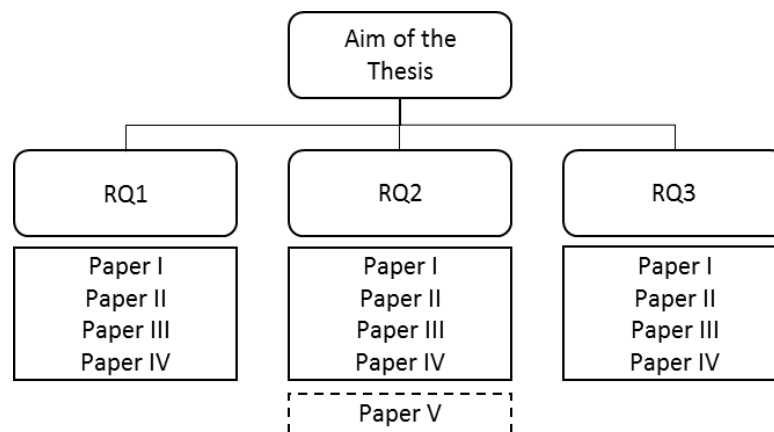
Furthermore, Table 10 provides a summary of the five papers, including a brief description, the purposes and the contributions.

Table 10. Summary of appended papers

Paper	Area	Purpose	Contribution
Paper I	Key determinants of the intention to use EMR in hospitals.	To identify the state-of-the-art of key determinants of the intention to use EMR in hospitals. To verify whether or not an interplay exists between institutional and individual determinants.	Categorization of the key determinants of EMR intention to use by hospital professionals. Analysis of the main theories used in this scientific field. Analysis of the interplay between institutional and individual determinants.
Paper II	State-of-the-Art of key determinants of WhatsApp usage in hospitals and strength of recommendations.	To identify the state-of-the-art of key determinants of WhatsApp acceptance and usage in hospitals. To verify whether or not an interplay exists between institutional and individual factors. To explore the current mode of use of WhatsApp and the strength of recommendations.	Key determinants of the current use of WhatsApp in hospitals. Analysis of the interplay between institutional and individual determinants. Analysis of the main theories. Strength of recommendations for WhatsApp usage in hospitals.
Paper III	Interplay between institutional and individual determinants in the intention to use EMR in hospitals.	To verify whether or not an interplay exists between institutional and individual factors. To test a new model.	Interplay existing between individual and institutional determinants. The key determinants of the intention to use EMR are the normative ones (peer influence). Normative factors directly affect perceived usefulness, perceived ease of use and intention to use EMR. Regulative factors directly affect intention to use EMR. Control variables have no impact on other variables in the model.
Paper IV	Interplay between institutional and individual determinants of WhatsApp usage in hospitals.	To verify whether or not an interplay exists between institutional and individual factors. To explore the current mode of use of WhatsApp. To test a new model.	Interplay existing between institutional and individual factors in determining the use of WhatsApp among hospital professionals and with patients. Individual factors play a key role: healthcare professionals use this technology mainly based on its perceived usefulness. Institutional factors play a secondary role; they do not have a direct influence on the use of WhatsApp but always act through perceived usefulness. *(continued)*

Paper	Area	Purpose	Contribution
Paper V	Measures for the determinants of the use of WhatsApp in hospitals.	Development and psychometric testing of a new measure of the determinants that influence the intention to use WhatsApp in hospitals.	Questionnaire' validation: adequate fit indices and reliability of the factors; positive and significant correlations between factors. Identification of nine dimensions, including institutional and individual variables.

4.2 PAPER I

This study aimed at identifying the State-of-the-Art of the key determinants that influence the intention to use EMR in hospitals, and at verifying whether an interplay exists between institutional and individual factors. From another perspective, this study explored whether and how theories arising from Organizational Studies and from Information Science can be combined to explain the phenomenon under study.

In the light of the results emerging from the literature review, three main issues are worthy of discussion. First, the results summarize the most important determinants of the intention to use EMR by hospital professionals. In particular, data were categorized in the following macro-determinants (Handayani, 2018): perceived usefulness or performance expectancy; perceived ease of use or effort expectancy; system quality/information quality; subjective norms or social influence; facilitating conditions; self-efficacy; compatibility with work processes or job relevance; individual attitudes toward using technology; management leadership; training; participation of end-users in the design and implementation process; information security expectancy; and participation of end-users in communication process. Second, the analysis showed that, although many organizational determinants (e.g. management support; institutional trust; organizational environment; support from organizational culture and leadership) were identified as affecting the intention to use EMR, all studies refer only to user acceptance models, to which some institutional or organizational factors are added from time to time. Third, the interplay between institutional and individual determinants has been studied in only three papers. Specifically, two past studies (Sharifi et al., 2014; Hsin-Ginn et al., 2019) explored the effects of organizational contextual factors (management support, physicians' involvement, physicians' autonomy and doctor-patient relationship, financial incentives) on physicians' intention to use EMR' and one study (Abdekhoda et al., 2019) proposed an integration between Technology, Organization and Environment (TOE) model, and the Technology Acceptance Model (TAM), identifying some significant factors (compatibility, complexity, organizational competency, management support, competitive pressure, and trading partner support) that affect the end user's behaviour when comprehensive implementation of EMR is considered.

The studies confirm that the integration between institutional theory and technology acceptance model is still unclear. Social influences and organizational conditions are often incorporated in Information Science studies without referring to well-established theories; while on the other hand, elements from Information Science are incorporated into Organizational Studies to explain the behaviour of organizations overlooking the choices made by individuals (Gastaldi et al., 2019). For this reason, it would be useful to promote research in which institutional and individual determinants are integrated, to shed new light on the acceptance of digital technology in hospitals.

4.3 PAPER II

The ways patients and professionals communicate and share data can now be faster but represents a social and economic challenge. WhatsApp is one of the most widely used communication applications more extended in use and, while not designed for this purpose, the number of health staff using it is increasing. Hospitals are increasingly looking to evaluate the impact of WhatsApp usage on care delivery; however, there is still limited evidence regarding whether and how individual and institutional determinants influence WhatsApp' acceptance and usage in hospitals. Moreover, few evidences are available about the strength of recommendations for safe use of WhatsApp in hospitals for specific clinical, research and teaching activity.

The main purpose of this study was to identify the individual and institutional determinants of WhatsApp' acceptance and usage in hospitals, and to evaluate the strength of recommendations about its use with patients and among hospital professionals.

A literature review was carried out using Scopus, Web of Science, Medline, EBSCOHost and Cochrane Library as the main sources of evidence. Inclusion and exclusion criteria were defined and applied. Only empirical journal articles and past reviews were included. Data extraction was performed based on a theoretical approach including institutional and individual determinants and the interplay between them, WhatsApp usage, and strength of recommendations.

Thirty-one past studies were selected, including two literature reviews whose main aims were to evaluate the various applications of WhatsApp in healthcare. The 29 empirical articles focused on exploring the effectiveness of WhatsApp usage for different particular processes, regarding both clinical and continuing education settings. Of these, 25 studies were conducted using different qualitative or quantitative methods; three studies were randomized controlled trials and one study was a cohort study. Only one study analyzed institutional and individual determinants of WhatsApp usage in hospitals and the interplay between the determinants. Three studies provided an "A" degree of recommendation (The Oxford levels of evidence, 2016) while the others provided a "B" degree of recommendation or none evidenced.

The findings confirm that WhatsApp is used for different purposes among physicians and with patients. However, high-quality and specific research is needed, particularly to address concerns about patient safety, quality of care, confidentiality and safety of communications. This study offers original insights in the field of Information Science. The main findings are useful for academia and for practitioners such as hospital executives, to manage the widespread use of WhatsApp in hospitals.

4.4 PAPER III

The implementation of hospital-wide Electronic Medical Record (EMR) is still an unsolved quest for many hospitals (Gastaldi, 2012; Shahmoradi, 2017). Despite a significant body of evidence about the numerous advantages of EMR (Ash et al., 2003; Poon, 2004; McGinn et al., 2011; Boonstra et al., 2014; Struik et al., 2014; Inokuchi et al., 2014; Shahmoradi et al., 2017), many initiatives of EMR implementation still fall far behind expectations, and hospitals appear unable to fully capture the opportunities offered by EMR in terms of improvement of the organization of hospital healthcare delivery, performance monitoring and support to clinical research and trials. Previous studies (e.g. Keshavjee et al., 2006; Boonstra et al., 2010; McGinn et al., 2011; Biruk et al., 2014; Cucciniello et al., 2015; Shahmoradi et al., 2017; Or et al., 2018) focused mainly on either the barriers or the facilitators that might impact on the implementation of EMR, but, there are only few in-depth studies of whether and how institutional and individual factors interact and jointly affect hospital professionals' motivation to use EMR.

This study combined institutional and individual factors to explain which determinants can trigger or inhibit the acceptance of EMR in hospitals, and thus which variables managers can exploit to guide professionals' behaviours. The main objective of the study was to explore if and how individual and institutional determinants influence the intention to use EMR in hospitals, whether an interplay exists among these variables, and whether a connection exists between to being nurse or physician and the intention to use EMR.

Data have been collected through a survey administered to physicians and nurses in an Italian University Hospital in Rome. A total of 114 high-quality responses had been received.

The findings showed that the main determinants of the intention to use EMR are normative ones (peer influence) (Scott, 2003), rather than regulative ones (adherence to the management's objectives) or individual ones (perceive usefulness and perceived ease of use). In other words, hospital executives can leverage lead peer influence (i.e., innovation champions) to motivate, generate and manage change and generate set up a virtuous circle inside the hospital to motivate the use of EMR.

Moreover, the results showed an interplay between individual and institutional factors in shaping hospital professionals' intention to use EMR. Professionals' perception of usefulness is affected by peer influence, thus confirming that hospitals are professional organizations where change is difficult – if not impossible – to mandate without the consensus of professionals. This study confirms the importance of involving front-line professionals, as soon as the hospital decides to start the implementation phase in order to increase their motivation to use EMR. In fact, as a result of their involvement, professionals will better understand the rationale of this technological shift and their perception of usefulness will consequently increase. Moreover, it is important to consider that in the absence of coercive mechanisms, institutional pressures toward EMR use are primarily normative and/or mimetic (Scott, 2003; Gastaldi et al., 2019).

4.5 PAPER IV

The increasing use of messaging applications such as WhatsApp for both social and personal purposes has determined an increase in the widespread use of these technologies, even in healthcare. A growing number of healthcare professionals have adopted WhatsApp in their daily work in order to share information with peers and patients. Past research has highlighted the advantages and disadvantages of WhatsApp usage in healthcare settings; in particular, two positions appear to coexist in the scientific debate: those that expose and underline all of the positive aspects of the phenomenon, and those which also highlight the negative aspects, linked in particular to the clinical risks for patients, data security and privacy protection. The main objective of this study was to assess whether and how individual and institutional determinants influence the use of WhatsApp in hospitals, whether an interplay exists between different variables, and whether there is a correlation between the belonging to different hospital profession (nurse or physician) and the use WhatsApp in the workplace.

Data were collected through a survey administered to physicians and nurses of the CBM University Hospital in Rome (Italy); a total of 191 high-quality responses were received.

This study is the first to analyze the influence of individual and institutional determinants on the use of WhatsApp in hospitals. The findings confirms that WhatsApp is increasingly used in personal life and in the hospital environment by doctors and nurses in order to communicate and share data between peers and patients (Boulos et al., 2016; Giordano et al., 2017). Also, its usage is mainly due to the perception of numerous advantages and benefits reported in clinical practice (Lee et al., 2008; Wani et al., 2013; Jagannathan, 2013; Astarcioglu et al., 2015; Johnston et al., 2015; Giordano et al., 2015; Gulacti et al., 2016; Kaliyadan et al., 2016; Boulos et al., 2016; Giordano et al., 2017; Raiman et al., 2017) and particularly related to the perception of greater ease in communication and to a leaner management of some processes. However, hospital professionals' behaviours do not appear to be uniform. In fact, compared to doctors, nurses rarely use WhatsApp for communicating with patients or sharing clinical information between colleagues. On the other hand, the use of WhatsApp is perceived to be not safe for both patients and professionals (Wani et al., 2013; Jagannathan, 2013; Choudhari, 2014; Pandian et al., 2014; Khanna et al., 2015; Migliore, 2015; Dhuvad et al., 2015), and its usage is inversely related to the perceived risk. At the same time, while nurses and physicians consider WhatsApp not safe, they use it anyway in their clinical practice with both colleagues and patients. For this reason, we assume that the use of WhatsApp in hospitals can be considered an extreme case of "back-door adoption", which is the case for technologies that are so easy to use that they are diffused without discussion or a prior policy definition, and which are introduced by hospital professionals without any formal approval or assessment from hospital executives about the opportunities and risks that these innovations might bring along with them (Pinzone et al., 2016). The findings show an interplay between institutional and individual factors in determining the use of WhatsApp in hospitals. In particular, individual factors play a key role: hospital professionals use this technology mainly based on its perceived usefulness. Meanwhile, institutional factors play a secondary role; they do not have a direct influence on the use of WhatsApp, but always act through individual factors. Among the

institutional factors, the regulative ones (e.g. rules imposed by management) have no influence on the use of WhatsApp, while the normative ones (e.g. the influence of colleagues or patients) have a positive impact. From these first results emerges the importance, for hospital executives, researchers and policy makers, of working to regulate a phenomenon that, while it is considered useful and effective, is widespread and has no shared rules.

Through the combination of institutional and individual factors in a coherent theoretical framework, the study showed connections between different factors as well as their independent effects on the adoption of innovations brought in by professionals, and shed new light on factors that can help hospital executives to oversee this phenomenon and implement adequate strategies to exploit its potential increase at the same time as the level of safety for the patients.

4.6 PAPER V

This study aimed to develop and psychometrically test the questionnaire "Digital Innovation Adoption in Hospitals" (DIAH), a measure of individual and institutional factors that influence the use of WhatsApp in Italian hospitals as perceived by nurses and physicians. The Exploratory Factor Analysis (EFA) showed good fit indices and high reliability of the solutions found for the four sections of the questionnaire, and it enables the identification of some important dimensions for each section analyzed. For the section "Perceived Usefulness", the following dimensions were identified: "communication and information sharing" and "clinical, research and teaching performances". These dimensions are specific to user acceptance models, which emphasize individuals' rational and volitional assessment of the costs and benefits they would attain from the new technology. The best solution for the section "Regulative factors" was a 1-factor model that explored the "adherence of nurses and physicians to the management's objectives". The normative factors were resolved into the following two dimensions: "peer influence" and "patient influence". In addition to the individual and institutional determinants analyzed in the three previous sections, the theoretical model also included some control variables. Among these variables, that of "perceived risks" was considered so important that a separate section was required, which was also validated through EFA. In this case, the following four dimensions were identified: "safety for patients and hospital professionals", "safety in data sharing", "data protection and clinical documentation", "safety in clinical evaluation".

The psychometric properties of the DIAH were examined, and we were able to strengthen the previous findings of content and face validity. To our knowledge, this is the first tool available in Italy to measure which determinants influence hospital professionals' motivation to use WhatsApp in hospitals. In particular, by combining institutional and individual factors in a coherent theoretical framework, the developed and tested questionnaire can help to explore the connections between different determinants as well as their independent effects on the adoption of innovations introduced in by professionals. Moreover, the use of this new measure can help hospital executives to oversee this phenomenon and implement adequate strategies to exploit its potential spread and to increase safety for both patients and hospital professionals. From this study, some possible future steps for practitioners and researchers in this area also emerged. First, further validation in additional hospitals would be useful to obtain generalizable results and to allow a Confirmatory Factors Analysis (CFA) to endorse the factor structure. Secondly, it would be very interesting to create different questionnaires specifically for doctors and for nurses, and for particular clinical settings, in order to deepen current knowledge about this rapidly spreading phenomenon.

4.7 COMMON THEMES OF THE PAPERS

An overview of the research questions considered in this doctoral dissertation, and how they relate to the findings from the appended papers, is presented in Table 11.

Table 11. Overview of research questions and findings

Research Question	Findings	Paper
RQ1 - Does an interplay exist between individual and institutional determinants in explaining hospital professionals' acceptance of digital technology?	**An interplay exists between individual and institutional determinants.** *Electronic Medical Record* Normative factors directly affect perceived usefulness, perceived ease of use and intention to use EMR. *WhatsApp* Normative factors directly affect perceived usefulness of WhatsApp, between professionals and with patients.	III, IV
	Perceived usefulness directly affects the acceptance of different digital technologies. *Electronic Medical Record* Perceived usefulness directly affects the intention to use EMR. *WhatsApp* Perceived usefulness directly related to the use of WhatsApp with patients and between professionals.	III, IV
RQ2 - Do differences in digital technologies influence hospital professionals' acceptance of digital technology?	**Regulative factors showed different impact on different technologies.** *Electronic Medical Record* Regulative factors inversely affect the intention to use EMR. *WhatsApp* Regulative factors do not have an impact on WhatsApp usage with patients or colleagues.	III, IV
RQ3 - Does belonging to different hospital profession influence the acceptance of digital technology?	A significant correlation exists between being nurse of physician and: the perceived ease of use and intention to use EMR; and the use of WhatsApp in hospitals.	III, IV

4.7.1 INTERPLAY BETWEEN INDIVIDUAL AND INSTITUTIONAL DETERMINANTS

RQ1 Does an interplay exist between individual and institutional determinants in explaining hospital professionals' acceptance of digital technology?

The literature reviews (Papers I and II) confirms that the integration between institutional and individual variables is still unclear, for both technologies introduced by professionals or by management. Indeed, social influences and institutional variables are often incorporated in Information Science without referring to well-established theories; on the other hand, elements from the Information Science field are incorporated in Organizational Studies to explain the behaviour of organizations, but overlook the choices made by individuals (Paper I).

Papers III and IV confirm that an interplay exists between individual and institutional determinants in explaining the hospital professionals' acceptance of digital technology. Normative factors directly affect perceived usefulness of EMR (C=0.30**) and WhatsApp (C=0.58***), perceived ease of use EMR (C=0.26**), intention to use EMR (C=0.33**), and the use of WhatsApp between colleagues (C=0.27**) and with patients (C=0.10**).

Regulative factors affect the intention to use EMR negatively (C= -0.21**) and they do not have any impact on the perceived usefulness of WhatsApp or on its usage with patients or colleagues. In other words, there is no connection between the adherence to management objectives and the perceived usefulness or acceptance of EMR. (Paper III)

The findings show that the main determinants of the intention to use EMR are the normative ones (peer influence), rather than the regulative ones (adherence to the management's objectives) or the individual ones (perceived usefulness and ease of use). (Paper III and Paper IV).

4.7.2 DIFFERENT DIGITAL TECHNOLOGIES AND HOSPITAL PROFESSIONALS' ACCEPTANCE

RQ2 Do different digital technologies influence hospital professionals' acceptance of digital technology?

A likeness exists between hospital professionals' behaviours towards digital technologies introduced by professionals, and those introduced by hospital executives, except for regulatory factors (Table 12).

The common determinants of acceptance for both EMR and WhatsApp are the normative ones (peer influence) and the perceived usefulness. In particular, for both kinds of technology, perceived usefulness works as a mediator between the normative factors and the acceptance.

At the same time, perceived usefulness directly affect the intention to use EMR (C=0.33**) and the use of WhatsApp between colleagues (C=0.27**) and with patients (C=0.10**).

Regulative factors act differently for the different technologies; they have no impact on WhatsApp usage with patients or colleagues, while they inversely affect the intention to use EMR.

Table 12. Overview of the key determinants of acceptance of digital technology

	Determinants of digital technology' acceptance	Electronic Medical Record	WhatsApp
Institutional level	Normative factors	Yes	Yes
	Regulative factors	Yes (negative)	No
Individual level	Perceived usefulness	Yes	Yes
	Perceived ease of use	Yes	No
Control variables	Different professions	Yes	*Not applicable*
	Risk perception	*Not applicable*	Yes (positive)

4.7.3 DIFFERENT HOSPITAL PROFESSION AND ACCEPTANCE OF DIGITAL TECHNOLOGY

RQ3 Does belonging to different hospital professions influence the acceptance of digital technology?

Control variables (i.e., age, seniority and clinical area) have no impact on other variables in the two models. However, the findings show a significant correlation between being nurse or physician and the perceived ease of use and intention to use EMR. In particular, more nurse than physicians perceive EMR as easy to use (p=0.019 for the item "the EMR will be easy to use") and state that they would like to use it (p=0.01 for the item "if I had the opportunity I would use the EMR for most of my work's processes"). By contrast, risk perception is negatively related to the use of WhatsApp with colleagues (C=-0.15*).

Moreover, a statistical correlation exists between the use of WhatsApp in hospitals and being a nurse or a physician. In particular, more physicians than nurses use WhatsApp to share scientific information (p=0.038), manage and share agendas (p=0.001), communicate about clinical situations (p<0.0001), ask for information or give directions (p=0.042), send patient data in the form of images or videos (p=0.042), and receive patient information from other hospitals (p=0.001). Nurses' behaviours are very different: almost none of the nurses interviewed used WhatsApp to communicate with patients (p<0.0001), only a few nurses reported that patients asked them to use this App to facilitate communication (p<0.0001), and the number of nurses who suggested using WhatsApp to patients was less than 5% (p<0.0001). Physicians more than nurses frequently use WhatsApp in order to organize the agenda with patients (p<0.0001), send patients the results of diagnostic tests (p=0.001), monitor chronic patients' clinical conditions (p<0.0001), and answer urgent questions from patients (p<0.0001).

5 DISCUSSION

The aim of this chapter is to reflect on the research conducted, by presenting a discussion in relation to the five papers and their common themes.

This chapter synthesize and discuss the main research findings, and it is organised in three macro-paragraphs. The first one (paragraph 5.1) describes the main contributions related to the acceptance of EMR in hospitals. The second one (paragraph 5.2) outlines the main findings related to the acceptance and use of WhatsApp in hospitals. The third macro-paragraphs (paragraph 5.3) discusses the research findings starting from the three research questions and comparing the two different types of digital tehnology considered.

5.1 DETERMINANTS OF EMR' ACCEPTANCE

In the light of the results emerged from the study of EMR, two main contributions are worthy of discussion. The first regards the **categorization of the most important determinants of the EMR' acceptance by hospital professionals**. In particular, data were categorized in the following macro-determinants (Handayani, 2018): perceived usefulness or performance expectancy; perceived ease of use or effort expectancy; system quality/information quality; subjective norms or social influence; facilitating condition; self-efficacy; compatibility with work processes or job relevance; individual attitude toward using technology; management leadership; training; participation of end-users in the design and implementation process; information security expectancy; and participation of end-users in communication process. Moreover, the empirical study showed that both physicians and nurses, expect many benefits from the use of the EMR; indeed, they believed that the use of EMR can represents a key factor for improving healthcare quality and safety; increasing efficiency and effectiveness of care; obtaining a better handover communication process between hospital professionals; improving teaching, tutoring and research

activities; and having a greater control of business (Cowie et al., 2017, Goldstein et al., 2017; Scott, 2018).

The second contribution relates to the **interplay between institutional and individual determinants** in the acceptance of EMR by hospital professionals. Data from systematic literature review demonstrate that the integration between institutional and individual determinants of digital technology' acceptance is still unclear. Social influences and organizational conditions are often incorporated in Information Science studies without referring to well-established theories (Sharifi et al., 2014; Hsin-Ginn et al., 2019; Abdekhoda et al., 2019); while on the other hand, elements from Information Science are incorporated into Organizational Studies to explain the behaviour of organizations overlooking the choices made by individuals (Gastaldi et al., 2019). The interplay between institutional and individual determinants in the studies of technology acceptance has been rarely studied. In the light of these findings, the empirical study (Paper III) added important knowledge in the field of Information Science, since the findings showed an interplay between individual and institutional determinants in shaping hospital professionals' intention to use EMR. Specifically, normative factors directly affect perceived usefulness, perceived ease of use and intention to use EMR. Thus, the study showed that the main determinants of the intention to use EMR are the normative ones (peer influence) (Scott, 2003), compared to the regulatory ones (adherence to the management's objectives) or the individual ones (perceive usefulness and perceived ease of use). This confirms that, in the absence of coercive mechanisms, institutional pressures toward EMR use are primarily normative (Scott, 2003; Gastaldi et al., 2019). Perceived usefulness is affected by peer influence, thus confirming hospitals are professional organizations where change is difficult – when it is not impossible – to mandate without the consensus of professionals. In other words, hospital executives can leverage on lead peer influence for motivating and managing change. Another important finding is the inverse correlation between regulative factors and the intention to use EMR. Data showed that regulative factors inversely affect the intention to use EMR. In the study, the construct "regulative factor" – e.g., alignment to management' goals – was aimed at exploring the pressure that a hospital professional might perceive from the goals set by hospital executives. This pressure is intended to be independent from the specific strategy and to be a general availability of hospital professionals to align their behaviours to the goals set by hospital executives. An example of question is "I very much agree with most of the objectives of the management". What is interesting is that the regulative factors affect negatively the intention to use, meaning that more the general agreement with executives' goals less the intention to use an EMR. This can be explained by the fact that the general goals crystallized by hospital executives about the digital transformation of care delivery, the search for both research and care excellence, the need of financial equilibrium or other, are not enough detailed to stimulate professionals' perception about the usefulness of an EMR – in fact, the linkage between the regulative factor and the perception of usefulness failed to materialize – and reduces the intention to use something that is not clearly connected to those goals that executives have set-up. It is predictable that more contextualized goals about the usage of EMR would positively affect the intention to use it among those professionals who are more willing to be adherent to executives' goals.

5.2 DETERMINANTS OF WHATSAPP' ACCEPTANCE

Based on the main results emerged from the study, at least four main issues can be considered for the discussion.

The first contribution relates to **the most important motivations that lead the widespread use of WhatsApp in hospitals**. The findings confirm that WhatsApp is increasingly used in personal life and in the hospital environment by doctors and nurses in order to communicate and share data between peers and patients (Boulos et al., 2016; Giordano et al., 2017). Also, its usage is mainly due to the perception of numerous advantages and benefits reported in clinical practice (Lee et al., 2008; Wani et al., 2013; Jagannathan, 2013; Astarcioglu et al., 2015; Johnston et al., 2015; Giordano et al., 2015; Gulacti et al., 2016; Kaliyadan et al., 2016; Boulos et al., 2016; Giordano et al., 2017; Raiman et al., 2017) and particularly related to the perception of greater ease in communication and to a leaner management of some processes. WhatsApp is perceived useful to reduce costs, to increase effectiveness, and to facilitate communication between hospital professionals and with patients. In particular it is used for communicating among physicians, discussing clinical cases and sharing knowledge in groups (Wani et al., 2013; Johnston et al., 2015; Khanna et al., 2015; Gulacti et al., 2016), or for facilitating decision making processes. Some studies reported evidences about the effectiveness of the use of WhatsApp to train residents and to share learning program with them on specific clinical themes (Khanna et al., 2015; Dungarwalla et al., 2019; Clavier et al., 2019). WhatsApp is also resulted effective for some kinds of teleconsultation (Boulos et al., 2016; Sarode et al., 2017; Kapıcıoğlu et al., 2019; Gross et al., 2019) and for patient-doctor communication on different types of requests (medical, administrative, etc.) (Boulos et al., 2016; Furtado Leão et al., 2018; Alanzi et al., 2018; Carmona et al., 2018). WhatsApp platforms can improve the adherence to care and the health outcomes in pregnancy and the postpartum period, and it is used to obtain second opinions or to confirm or make diagnosis (Sarode et al., 2017; Patel et al., 2018; Machado et al., 2019; Bennani and Sekal, 2019). Studies have been conducted that reveal the effectiveness of WhatsApp in the request for peer counseling (e.g. for particularly complex cases). In addition, the possibility of sending and sharing the results of certain tests (laboratory, X-ray, ultrasonography, electrocardiograms and photographs of patient's lesions) has proved effective and contributed to a more objective and efficient care, especially in cases of medical emergency. Another important area in which WhatsApp is resulted widely used is for inter and intra-departmental communication, for communication between clinical teams and for inter and intra-hospital communication. In this context, this application has proved particularly effective within the emergency department.

The second contribution regards **the interplay between institutional and individual determinants of the acceptance and use of WhatsApp**. This study is the first to analyze the influence of individual and institutional determinants on the use of WhatsApp in hospitals. The finding showed that only a few studies analyzed the adoption and use of WhatsApp by referring to well estabilished theories, and there are no evidences of the analysis of institutional and/or individual factors determining the use of this app in

hospitals. As already reported in the previous paragraph, studies demonstrated that WhatsApp is used mainly because it is perceived useful and easy to use. Based on these data, the empirical study (Paper IV) reports important findings, as it showed an interplay between institutional and individual factors in determining the use of WhatsApp in hospitals. Specifically, individual factors play a key role; hospital professionals use this technology mainly based on its perceived usefulness. Instead, institutional factors play a secondary role; they do not have a direct influence on the use of WhatsApp, but they always act through the individual factors. Among the institutional factors, the regulative ones (e.g. rules imposed by management) do not influence the use of WhatsApp, while the normative ones (e.g. the influence of colleagues or patients) show a positive impact. Regulatory factors do not have any impact on the use of WhatsApp, due to the lack of rules about its usage in the Hospital involved in the study. From these preliminary results emerges the importance, for hospital executives, researchers and policy makers, of working to regulate a phenomenon that, while it is considered useful and effective, it is widespread without shared rules. Through the combination of institutional and individual factors in a coherent theoretical framework, the study showed connections of different determinants as well as their independent effect on the adoption of a digital technology introduced by hospital professionals. Moreover, the study shed a new light on factors that can help hospital executives to manage and oversee this phenomenon and to implement adequate strategies to exploit its potential increase, with the aim of improving the level of safety for the patients.

The third contribution refers to the **level of evidences and the strength of recommendations about WhatsApp usage in hospitals**. The finding showed that only few studies are available about the effectiveness of the use of WhatsApp in clinical settings among hospital professionals and with patients. This aspect is particularly interesting especially in the medical setting, where it is so important to work based on scientific evidences and recommendations. The best available evidences provided an "A" degree of recommendation (The Oxford levels of evidence, 2016) concerning the efficacy of WhatsApp for consultations in Emergency Department (ED) (Gulacti and Lok, 2017), for improving knowledge, self-efficacy and awareness of patients about diabetes management (Alanzi, 2018), and for enhancing clinical reasoning in medical residents (Kapıcıoğlu et al., 2019). The others studies provided a "B" degree of recommendation or none evidenced (Paper II). New digital technologies are radically transforming some health care processes, and hospital executive, researchers and policy makers need urgently to explore how this change can affect technology acceptance, quality and safety of care for patients, trust between patients and professionals, and quality of life for hospital professionals (Machado et al., 2019).

The last contribution regards the issues related to **safety and risk perception about the use of WhatsApp in hospitals**. Although the end-to-end encryption had been implemented for WhatsApp messaging application, there is still concerns regarding some risks in terms of privacy, confidentiality, consent, and medical legal matters. The use of WhatsApp is perceived to be not safe for both patients and professionals (Wani et al., 2013; Jagannathan et al., 2013; Choudhari, 2014; Pandian et al., 2014; Khanna et al., 2015; Migliore, 2015; Dhuvad et al., 2015). Although several perceived benefits are reported, hospital professional, especially physicians, perceive that the use of WhatsApp does not be

safe for both patient and professionals, and they suggest that guidelines and recommendations are needed as well as patient's informed consent for data treatment when clinical data are transmitted through WhatsApp (Paper IV). At the same time, despite hospital professionals consider WhatsApp as unsafe, and although the use of WhatsApp is inversely related to the perceived risk (Paper IV), both nurses and physicians use this app in their clinical practice with both, colleagues and patients. For this reason, we assume that the use of WhatsApp in hospitals can be considered an extreme case of "back-door adoption", which is the case of technologies that are so easy to use that they are diffused without discussion or a prior policy definition, and which are brought by hospital professionals without any formal approval or assessment from hospital executives about the opportunities and risks that these innovations might bring along with them (Pinzone et al., 2016).

5.3 ANSWERING THE RESEARCH QUESTIONS

5.3.1 INTERPLAY BETWEEN INDIVIDUAL AND INSTITUTIONAL DETERMINANTS

The research offers a novel contribution for hospital executives, middle managers and hospital professionals since the results shed a new light on how individual and institutional determinants influence users' acceptance of digital technology.

An interplay between institutional and individual determinants exists, and it helps to understand what drives professionals' acceptance of digital techology. Data showed that **normative forces (peer influence) are able to increase the professionals' perceived usefulness of a digital technology**, both in the case of technology introduced by professional or management-led. Peer influence has an important function as it acts through the individual factors on the acceptance of a technology, so managers can leverage power users to improve the perceived usefulness of a new digital technology.

This result confirms some recent studies in this area (e.g. Gastaldi et al., 2019), and it might generate important consequences in the acceptance of new technologies, since, as already underlined by several authors (e.g. Katzenbach & Khan, 2010) "[...] Peer to peer interactions may be the single most neglected lever of change. When enlisted, they are change's most powerful ally; when resisted, they are its most stubborn foe. Peers in large organizations are invaluable in spreading behavior change across an enterprise. In that respect, they constitute a woefully underused set of resources, mostly accessible within the 'informal elements' of our organizations.".

5.3.2 ACCEPTANCE OF DIFFERENT DIGITAL TECHNOLOGY

The research findings show many similarities in professionals' perceptions towards digital technologies management-led and those who are introduced by hospital professionals. The common determinants of acceptance for both EMR and WhatsApp are the normative ones (peer influence) and the perceived usefulness. In particular, for both technologies, perceived usefulness works as a mediator between normative factors and acceptance. Regulative factors show a different influence on acceptance for the two different

technologies; they do not have any impact on WhatsApp usage with patients or colleagues, while they inversely affect the intention to use EMR. As already discussed in paragraphs 5.1 and 5.2, data showed that regulative factors inversely affect the intention to use EMR, while they did not influence he use of WhatsApp.

5.3.3 PERCEPTION OF DIFFERENT HOSPITAL PROFESSIONS

The study show a significant correlation between being nurse of physician and the perceived ease of use and intention to use EMR. In particular, nurses more than physicians perceive EMR easy to use (item 'the EMR will be easy to use') and they would like to use it (item 'if I had the opportunity I would use the EMR for most of my work's processes'). Second, a statistical correlation exists between the use of WhatsApp in hospitals and to being nurse or physician. In particular, physicians, more than nurses, use WhatsApp to share scientific information, manage and share agendas, communicate about clinical situations, ask for information or give directions, send patient data in the form of images or videos, receive patient information from other hospitals. Nurses' behaviors are very different. Almost none of the interviewed nurses use WhatsApp to communicate with patients, only a few nurses report that patients ask them to use this App to facilitate communication, and the number of nurses who suggest using WhatsApp to patients is less than 5% (Paper IV). Furthermore, very few studies are available on the use of WhatsApp in nursing care and it could be very interesting to understand the reasons of the evident different use between different professions. In particular, since some studies have demonstrated the effectiveness of WhatsApp for clinical education and for improving patients' compliance (e.g. Sarode et al., 2017; Patel et al., 2018; Machado et al., 2019; Bennani and Sekal, 2019), it would be very important for nurses to exploit these results to improve patient education, as education is one of the most important goals to be achieved in nursing.

6 CONCLUSIONS

This section summarizes the conclusions of the doctoral dissertation.

The main purpose of this doctoral dissertation was to discover the main determinants of hospital professionals' acceptance of digital technology, through the application of a new theoretical model including Institutional Theory and TAM. By combining these theories, the study offering novel insights on the determinants that influence the acceptance of digital technology, and pointing-out how and to what extent the interplay between individual and institutional determinants might trigger or inhibit the acceptance of digital technology by the hospital professionals. Moreover, the novelty of the research is in the consideration of and comparison of two different groups of hospital professionals (nurses and physicians) and between two different types of digital technology: EMR, seen as a management-led technology, and WhatsApp, seen as a technology introduced by hospital professionals.

6.1 THEORETICAL CONTRIBUTIONS

From an academic viewpoint, the study offers an original perspective and a new theoretical framework, which combines individual and institutional determinants to explain hospital professionals' acceptance of digital technology, and it provides academics with at least three main contributions. First, the results confirm the importance of individual variables, not only as directly related to the acceptance of a new technology, but also as important mediators between institutional variables and acceptance, thus highlight and confirming the importance of the connections between Organizational Studies and Information Science.

Second, even if the data are preliminary, the study is one of the first to compare the professionals' behaviours towards two different types of technologies, those who are management-led and that require at least a careful process of adoption, design and implementation, and those who are introduced by hospital professionals without any kind of planning or prevision of impact on processes, quality and safety of care. Third, the study shows a significant correlations, that are worthy to be better explored, between being nurse of physician and the perceived ease of use and intention to use EMR, as well as, the use of WhatsApp in hospitals.

6.2 PRACTICAL CONTRIBUTIONS

The research offers a novel insight for hospital executives, middle managers and hospital professionals since it provides several important insights into which levers can be used to improve the acceptance of digital technology, both in the case of technologies management-led or introduced by professionals.

For hospital executives, the results shed a new light on the role of normative factors (e.g. peer influence) in promoting the acceptance of new technology. More specifically, normative forces influence the perceived usefulness of both kinds of digital technology. Moreover, the study reveals important differences in the behaviour of doctors with respect to nurses, especially in the use of WhatsApp. For this reason it would be useful to analyse these two categories of professionals separately, and to understand the reasons for the evident different use between the different professions. Since some studies have demonstrated the effectiveness of WhatsApp for clinical education and for improving patients' compliance, it would be very important for nurses to exploit these results to improve patient education, as education is one of the most important goals to be achieved in nursing.

For policy makers, an important finding is that, for some technologies introduced by professionals, such as WhatsApp, an high perception of risk does not influence its usage. Therefore, it is very important to define guidelines for the safe use of such new digital technologies introduced by professionals without any formal evaluation.

For hospital professionals who use WhatsApp and similar "back door adopted" digital technology, it is very important to be aware that the use of this tool is not supported by sufficient scientific evidence and degree of recommendations. For this reason, it is necessary and urgent to promote high level of quality studies to support and document the use of these technologies, which are already widely used in hospitals.

Finally, a thought for hospital professionals and especially for patients, who should always benefit from technological and digital improvements, and who must always be the goal of every innovation in the hospital environment. As Pellegrino said, "medicine is the most humane of sciences, the most empiric of arts, and the most scientific of humanities", and the use of IT should be guided by such definition (Pellegrino, 1979; Delbanco and Sands, 2004). This will only be possible if the new digital technologies in healthcare will increasingly be used based on proven scientific evidences and by referring to the guidelines of internationally recognized scientific societies.

7 LIMITATIONS AND FURTHER RESEARCH

This section focuses on the main limitations of the doctoral dissertation, and points to potential areas for future research.

From this doctoral dissertation, some possible future steps for practitioners and researchers in this area emerge. However, despite the original contributions it makes, this study presents some limitations that should be addressed by future research. The results at this stage are still preliminary, and the new theoretical models described and tested in the previous chapter need to be further refined. However, the work represents a good starting point to frame the potential research that could be interesting to perform in the future.

One of the main limitations of the study is related to the generalizability of results, as the research design is based on a single case study. Further research should consider a multi-centre design, to increase the generalizability of results. Moreover, a multi-centre study will enable to explore the role that hospital characteristics – in terms of strategy, legacy, etc. – might have on shaping both the institutional and individual factors investigated in this study, and to improve the new theoretical framework proposed. Another limitation of the study is that it was carried out in a single state, thus excluding the variables linked to different cultures or different organizational models. A multicenter study that includes hospitals from different states, could better explore the phenomenon, enabling to understand, for instance, whether and how different cultures and different healthcare models (e.g. public vs private) can generate differences in the acceptance of new technologies.

Since the data reveal that normative forces play an important role in influencing acceptance and perceived usefulness of different kinds of technology, it would be very important to go more in depth, using both qualitative and quantitative research methods, for exploring how these forces act. Second, the study of EMR acceptance investigated the

intention to use EMR as the dependent variable. Further research should consider hospitals where EMR are already mature technologies, thus enabling an investigation of actual use, and which factors might facilitate/inhibit the translation of the intention to use into actual use. The implementation of new hospital information system, including EMR, is ongoing at the CBM Hospital, where the study was carried out. It would be interesting to perform a new survey at CBM Hospital after the EMR implementation, in order to evaluate whether and how differences in the model emerge before and after the actual use of the EMR.

Another limitation is that the comparison between the two different technologies was made using two different samples. It would be very important for both, researchers and practitioners, to deepen the analysis of the differences between management-led technologies and those who are introduced by professionals, through a multicenter study and by considering the same sample for the two kinds of technology.

The study found a significant correlation between being a doctor and a nurse and accepting and adopting a certain technology, but the sample of doctors and nurses included in the study was not very large Thus, it would be really useful to better understand which are the main motivations of the different behaviours, considering a larger sample, and using both qualitative and quantitative research methods to explore the phenomenon.

Some studies have demonstrated the effectiveness of WhatsApp for clinical education and for improving patients' compliance, it would be very important for managers and for nurses to exploit these results, and to perform other high quality studies, as education is one of the most important goals to be achieved in nursing.

Finally, the study showed that, although hospital professionals consider WhatsApp not safe, both nurses and physicians use this app in their clinical practice with both, colleagues and patients. For this reason, we assume that the use of WhatsApp in hospitals can be considered an extreme case of "back-door adoption", and we considered the importance to improve the knowledge based in this issue. At the same time, it would be important to define some guidelines for WhatsApp usage in the healthcare setting and in hospitals, and performing studies to evaluate the effectiveness of WhatsApp usage in hospitals and in different clinical areas and clinical services.

REFERENCES

Abdekhoda M., Ahmadi M., Dehnad A., Noruzi A., Gohari M. (2016) Applying electronic medical records in health care. *Applied Clinical Informatics* 7:341–354.

Abdekhoda M., Dehnad A. and Zarei J. (2019) Determinant factors in applying electronic medical records in healthcare. East Mediterranean Health Journal 25(1):24-33.

Ajzen I. (1985) From intention to actions: a theory of planned behavior. Springer.

Ajzen I. (1991) The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes* 50:179–211.

Alanzi T., Bah S., Alzahrani S., Alshammari S., Almunsef F. (2018) Evaluation of a mobile social networking application for improving diabetes Type 2 knowledge: an intervention study using WhatsApp. *Journal of Comparative Effectiveness Research* 7(9).

Ash J.S., Gorman P.N., Lavelle M., Payne T.H., Massaro T.A., Frantz G.L., Lyman J.A (2003) A cross-site qualitative study of physician order entry. *Journal of the American Medical Informatics Association* 10(2):188-200.

Astarcioglu M.A., Sen T., Kilit C., Durmus H.I., Gozubuyuk G, Kalcik M. et al. (2015) Time-to reperfusion in STEMI undergoing inter hospital transfer using smartphone and WhatsApp messenger. *The American Journal of Emergency Medicine* 33(10):1382–1384.

Bagozzi R. (2007) The Legacy of the Technology Acceptance Model and a Proposal for a Paradigm Shift. *Journal of the Association for Information Systems* 8(4):244-254.

Barley S.R., Tolbert P.S. (1997) Institutionalization and structuration: studying the links between action and Institution. *Organization Studies* 18(1): 93–117.

Barlow J. (2017) Managing Innovation in Healthcare. *World Scientific Publishing Europe*. London.

Battilana J. (2005) Agency and Institutions: The enabling role of individuals' social position. *Organization* 13(5):653-676.

Beldad A. and Hegner S. (2017) Expanding the Technology Acceptance Model with the Inclusion of Trust, Social Influence, and Health Valuation to Determine the Predictors of German Users'

Willingness to Continue using a Fitness App: A Structural Equation Modeling Approach. *International Journal of Human–Computer Interaction* 34(9):882-893.

Benbasat I. and Barki H. (2007) Quo vadis TAM? *Journal of the Association for Information Systems* 8(4):211-218.

Bennani A., Sekal M. (2019) Usefulness of WhatsApp for Discussing Difficult Cases in Pathology Practice: A Moroccan Experience. *Turk Patoloji Dergisi (Turkish Journal of Pathology)* 35:134-138.

Bentler P.M. (1990) Comparative fit indexes in structural models. *Psychological Bulletin* 107(2):238–246.

Berger P. & Luckmann T.A. (1985) Construcão social da realidade. *Petrópolis: Vozes.*

Biruk S., Yilma T., Andualem M., Tilahun B. (2014) Health Professionals' readiness to implement electronic medical record system at three hospitals in Ethiopia: a cross sectional study. *BMC Medical Informatics and Decision Making* 14.

Boonstra A., Broekhuis M. (2010) Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions. *BMC Health Services Research* 10:231.

Boonstra A., Versluis A., Vos J.F. (2014) Implementing electronic health records in hospitals: a systematic literature review. *BMC Health Service Research* 4(14):370.

Boulos M.N.K., Giustini D.M. and Wheeler S. (2016) Instagram and WhatsApp in Health and Healthcare: An Overview. *Future Internet* 8(37).

Brown T.A. (2015) Confirmatory factor analysis for applied research. *New York: Guilford Publications.*

Butler T. (2011) Compliance with Institutional Imperatives on Environmental Sustainability: Building Theory on the Role of Green IS. *Journal of Strategic Information Systems* 20(1):6–26.

Buxton M.J. Problems in the economic appraisal of new health technology the case of heart transplants. In: Drummond M.F (1987) *Economic appraisal of health technology in the European Community.* Oxford: Oxford University Press. 103–118.

Cao Q., Jones D., Sheng D. (2014) Contained nomadic information environments: technology, organization and environment influences on adoption of hospital RFID patient tracking. *Information & Management* 51(2):225–239.

Carmona S., Alayed N., Al-Ibrahim A. and D'Souza R. (2018) Realizing the potential of real-time clinical collaboration in maternal–fetal and obstetric medicine through WhatsApp. *Obstetric Medicine* 11(2):83–89.

Carvalho A.P., da Cunhab S.K., Ferreira L.L., Carstens D.D. (2017) The role and contributions of sociological institutional theory to thesocio-technical approach to innovation theory. *RAI Revista de Administração e Inovação* 14:250–259.

Chang I.C., Hwang H.G., Hung W.F., Li Y.C. (2007) Physicians' acceptance of pharmacokinetics-based clinical decision support systems. *Expert Systems with Applications* 33(2):296–303.

Chau P., Hu, P. (2002) Examining a Model of Information Technology Acceptance by Individual Professionals: An Exploratory Study. *Journal of Management Information Systems* 8(4):191-229.

Choudhari P. (2014) Study on effectiveness of communication amongst members at department of orthopedics surgery unit 3 using smartphone and mobile WhatsApp. *International Surgery Journal* 1(1):9-12.

Clavier T., Ramen Dureuil B., Veber B., Hanouz J.L., Dupont H., Lebuffe G., Besnier E., Compere V. (2019) Use of the Smartphone App WhatsApp as an E-Learning Method for Medical Residents: Multicenter Controlled Randomized Trial. *JMIR Mhealth Uhealth* 7(4).

Collin Sven-Olof Yrjö, Tagesson Torbjörn, Andersson Anette, Cato Joosefin, Hansson Karin (2009) Explaining the choice of accounting standards in municipal corporations: Positive accounting

theory and institutional theory as competitive or concurrent theories. *Critical Perspectives on Accounting* 20(2):141-174.

Compeau D.R., Higgins, C.A. (1995) Computer Self-Efficacy: Development of a Measure and Initial Test. *MIS Quarterly* 19:189-211.

Cowie M.C., Blomster J.I., Curtis L.H., Duclaux S., Ford I., et al. (2017) Electronic health records to facilitate clinical research. Clinical Research in Cardiology 106(1): 1–9.

Cresswell K. and Sheikh A. (2013) Organizational issues in the implementation and adoption of health information technology innovations: An interpretative review. *International Journal of Medical Informatics* 82:e73-e86.

Cucciniello M., Lapsley I., Nasi G., Pagliari C. (2015) Understanding key factors affecting electronic medical record implementation: a sociotechnical approach. *BMC Health Services Research* 15:268.

Daft R.L. (1978) A Dual-Core Model of Organizational Innovation. *Academy of management Journal* 21(2): 193-210.

Davis F. (1989) Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly* 13(3).

Davis F., Bagozzi R., Warshaw P. (1992) Extrinsic and Intrinsic Motivation to Use Computers in the Workplace*. Journal of Applied Social Psychology* 22(14).

Davis F. (1993) User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. *International Journal of Man-Machine Studies* 38(3):475-487.

Delbanco T., Sands D. (2004) Electrons in Flight - E-Mail between Doctors and Patients. *New England Journal of Medicine* 350(17):1705-7.

Devereaux J.P., Greenwood R. (2003) Constructing the Iron Cage: Institutional theory and enactment, in R. Westwood and S. Clegg (eds.) Debating Organization – Point and Counterpoint in Organization Studies. Malden, MA USA: *Blackwell Publishing*, pp. 195–207.

Dhuvad J.M., Dhuvad M.M., Kshirsagar R.A. (2015) Have Smartphones contributed in the clinical progress of oral and maxillofacial surgery? *Journal of Clinical and Diagnostic Research* 9(9):ZC22-ZC24.

DiMaggio P.J., Powell W.W. (1983) The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields, (1983) *American Sociological Review* 48(2):147-160.

Djellal F. and Gallouj F. (2005) Mapping innovation dynamics in hospitals. *Research Policy* 34:817-835.

Dungarwalla M., Chapireau D., Bentley R. (2019) Use of WhatsApp in an oral and maxillofacial surgery department at a major trauma centre and its role during major incidents: our experience. *British Journal of Oral and Maxillofacial Surgery* 57:449–453.

Elenkov D.S., Judge W., & Wright P. (2005) Strategic leadership and executive innovation influence: an international multi-cluster comparative study. *Strategic Management Journal* 26(7):665-682.

Fishbein M. and Ajzen I. (1975) Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research. *Contemporary Sociology* 6(2):244.

Furtado Leão C., da Silva Coelho M.E., Siqueira A.O., de Albuquerque Rosa B.A., Bastos Neder P.R. (2018) The use of WhatsApp in the physician-patient relationship. *Revista Bioética* 26(3):412-9.

Garman A.N., Evans R., Krause M.K., Anfossi J. (2006) Professionalism. *Journal of Healthcare Management* 51(4): 219-222.

Gastaldi L., Lettieri E., Corso M., Masella C. (2012) Performance improvement in hospitals: leveraging on knowledge asset dynamics through the introduction of an electronic medical record. *Measuring Business Excellence* 16(4):14-30.

Gastaldi L., Radaelli G., Lettieri E., Luzzini D., Corso M. (2019) Professionals' use of ICT in hospitals: the interplay between institutional and rational factors. *International Journal of Technology Management* (IJTM) 80(1/2).

Gibbs L.J., Kraemer K.L. (2004) A cross-country investigation of the determinants of scope of e-commerce use: an institutional approach. *Electronic Market* 14 (2):124–137.

Giordano V., Koch H., Godoy-Santos A., Dias Belangero W., Esteves Santos Pires R., Labronici P. (2017) WhatsApp Messenger as an Adjunctive Tool for Telemedicine: An Overview. *Interact Journal of Medical Research* 6(2):11.

Giordano V., Koch H.A., Mendes C.H., Bergamin A., and de Souza F.S., do Amaral N.P. (2015) WhatsApp Messenger is useful and reproducible in the assessment of tibial plateau fractures: Inter- and intra-observer agreement study. *International Journal of Medical Informatics* 84(2):141–148.

Goldstein B.A., Navar A.M., Pencina M.J., Ioannidis J.P.A. (2017) Opportunities and challenges in developing risk prediction models with electronic health records data: a systematic review. *Journal of the American Medical Informatics Association* 24(1):198–208.

Greenwood R., Suddaby R. and Hinings C.R. (2002) Theorizing Change: The role of professional associations in the transformation of institutionalized fields. *Academy of Management Journal* 45(1): 58–80.

Gross I., Langer Y., Pasternak Y., Abu Ahmad W., Eventov-Friedman S., Koplewitz B.Z. (2019) Questionnaire-based study showed that neonatal chest radiographs could be reliably interpreted using the WhatsApp messaging application. *Acta Pædiatrica* 108:94–100.

Gulacti U., Hatipoglu S., Polat H. (2016) An Analysis of WhatsApp Usage for Communication Between Consulting and Emergency Physicians. *Journal of Medical Systems* 40(6):130.

Gulacti U., Lok U. (2017) Comparison of secure messaging application (WhatsApp) and standard telephone usage for consultations on Length of Stay in the ED. *Applied Clinical Informatics* 8(3):742-753.

Haggerty N. and Golden B. (2002) Theorizing Technological Adaptation as a Trigger for Institutional Change. *Twenty-Third International Conference on Information Systems* (Barcelona 2002): 247–255.

Hair J., Black W., Babin B. and Anderson R. (2010) Multivariate Data Analysis. 7th ed. Upper Saddle River, New Jersey: Prentice Hall.

Handayani P.W., Hidayanto A.N. & Budi I. (2018) User acceptance factors of hospital information systems and related technologies: Systematic review. *Informatics for Health and Social Care* 43(4):401–426. https://doi.org/10.1080/17538157.2017.1353999.

Haunschild P. and Chandler D. Institutional-Level Learning: Learning as a source of institutional change. In: Greenwood R., Oliver C., Sahlin K. and Suddaby R. (2008) *The Sage Handbook of Organizational Institutionalism*, Thousand Oaks: Sage.

Hillestad R., Bigelow J., Bower A., Girosi F., Meili R., et al. (2005) Can Electronic Medical Record systems transform health care? Potential health benefits, savings, and costs. *Health Affairs* 24(5).

Holden R., Karsh B.-T. (2010) The technology acceptance model: its past and its future in health care, *Journal of Biomedical Informatics* 43:159–172.

Holm P. (1995) The dynamics of institutionalization: transformation processes in Norwegian fisheries. *Administrative Science Quarterly* 40(3):398–422.

Hsin-Ginn Hwang, Bireswar Dutta, Hui-chuan Chang. (2019) The differing effect of gender and clinical specialty on physicians' intention to use Electronic Medical Record. *Methods of Information in Medicine.* doi: 10.1055/s-0039-1695718.

Hu L. and Bentler P. (1999) Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal* 6(1):1-55.

Inokuchi R., Sato H., Nakamura K., Aoki Y., Shinohara K., Gunshin M., Matsubara T., Kitsuta Y., Yahagi N., Nakajima S. (2014) Motivations and barriers to implementing electronic health records and ED information systems in Japan. *American Journal of Emergency Medicine* 32(7):725-30.

Jagannathan M. (2013) Efficacy of communication amongst staff members at plastic and reconstructive surgery section using smartphone and mobile WhatsApp. *Indian Journal of Plastic Surgery* 46(3):506–507.

Jenkins H. (2006) Convergence culture. Where old and new media collide. NYU Press.

Jepperson R.L. Institutions, Institutional Effects, and Institutionalization. In: W.W. Powell and P.J. DiMaggio (1991) *The New Institutionalism in Organizational Analysis, Chicago*. University of Chicago Press.

Johnston M.J., King D., Arora S., Behar N., Athanasiou T., Sevdalis N., Darzi A., et al. (2015) Smartphones let surgeons know WhatsApp: An analysis of communication in emergency surgical teams. *The American Journal of Surgery* 209(1):45–51.

Judge W., Li S., Pinsker R. (2010) National Adoption of International Accounting Standards: An Institutional Perspective. *Corporate Governance An International Review* 18(3):161–174.

Kaliyadan F., Ashique K.T., Jagadeesan S., Krishna B. (2016) What's up dermatology? A pilot survey of the use of WhatsApp in dermatology practice and case discussion among members of WhatsApp dermatology groups. *Indian Journal of Dermatology, Venereology, and Leprology* 82(1):67-9.

Kapıcıoğlu M., Erden T., Ağır M., Küçükdurmaz F. (2019) The reliability of use of WhatsApp in type 1 and type 2 pediatric supracondylar fractures". *Eklem Hastalik Cerrahisi* 30(2):149-154.

Katzenbach J.R. and Khan Z. (2010) Positive Peer Pressure: A Powerful Ally to Change. *Harvard Business Review.*

Keshavjee K., Bosomworth J., Copen J., Lai J., Kucukyazici B., Liani R., Holbrook A.M. (2006) Best practices in EMR implementation: a systematic review. In: *Proceed of the 11th International Symposium on Health Information Mangement Research* – iSHIMR 1–15.

Khanna V., Sambandam S.N., Gul A., Mounasamy V. et al. (2015) "WhatsApp" ening in orthopedic care: a concise report from a 300-bedded tertiary care teaching center. *European Journal of Orthopaedic Surgery & Traumatology* 25(5):821-826.

Kimberly J.R. & Evanisko M.J. (1981) Organizational innovation: The influence of individual, organizational, and contextual factors on hospital adoption of technological and administrative innovations. *Academy of management journal* 24(4):689-713.

Laerum H., Faxvaag A. (2004) Task-oriented evaluation of electronic medical records systems: development and validation of a questionnaire for physicians. *BMC Medical Informatics and Decision Making* 4:1.

Lankton N., McKnight D.H. and Thatcher J.B. (2014) 'Incorporating trust-in-technology into expectation disconfirmation theory'. *Journal of Strategic Information Systems* 23(2):128–145.

Lawrence T.B., Suddaby R. (2006) Institutions and Institutional Work, in: Clegg S.R., Hardy C., Lawrence T.B., Nord W.R. (Eds.) *Handbook of Organization Studies*, London (UK), Sage, pp. 215–254.

Lawrence T.B., Suddaby R. and Leca B. (2009) Institutional Work: Actors and Agency in Institutional Studies of Organizations. Cambridge University Press, Cambridge, UK.

Leca B., Battilana J. and Boxenbaum E. (2008) Agency and Institutions: A Review of Institutional Entrepreneurship, Working Paper 08-096, Harvard Business School.

Lee R.S., Woods R., Bullard M., Holroyd B.R., Rowe B.H. (2008) Consultations in the emergency department: a systematic review of the literature. *Emergency Medicine Journal* 25(1): 4–9.

Lee Y. and Larsen K. (2003) The Technology Acceptance Model: Past, Present, and Future. *Communications of the Association for Information Systems* 12(50):752-780

Lewis W., Agarwal R. and Sambamurthy V. (2003) Sources of Influence on Beliefs about Information Technology Use: An Empirical Study of Knowledge Workers. *MIS Quarterly* 27(4):657-678.

Liang H., Saraf N., Hu Q., Xue Y. (2007) Assimilation of enterprise systems: the effect of institutional pressures and the mediating role of top management. *MIS Quarterly* 31(1):59–87.

Likert R. (1932) A technique for the measurements of attitudes. *Archives of psychology* 140(22):5-55.

Machado R.S., Richa R., Callegari F., Souza G.B., Tolentino L.L., Nakao F.S., Ferrari A., Libera E. (2019) Instant messenger smartphone application for endosonographer/cytopathologist real-time interaction at a distance in EUS-FNA for solid pancreatic lesions. *Endoscopy International Open* 07:E1027–E1030.

Mathieson K. (1991) Predicting User Intentions: Comparing the Technology Acceptance Model with the Theory of Planned Behavior. *Information Systems Research* 2(3):173-191.

McGinn C.A., Grenier S., Duplantie J., Shaw N., Sicotte C., Mathieu L., et al. (2011) Comparison of use groups perspectives of barriers and facilitator to implementing EHR – a systematic review. *BMC Medicine* 9:46.

Messerschmidt C.M., Hinz O. (2013) Explaining the Adoption of Grid Computing: An Integrated Institu-tional Theory and Organizational Capability Approach. *Journal of Strategic Information Systems* 22(2):137–156.

Migliore M. (2015) The use of smartphones or tablets in surgery. What are the limits? *Annali Italiani di Chirurgia* 86(2):185-186.

Mignerat Muriel, Rivard Suzanne (2009) Positioning the institutional perspective in information systems research. *Journal of Information Technology* 24(4).

Ming-Chih Tsai, Kee-Hung Lai, Wei-Che Hsu. (2013) A study of the institutional forces influencing the adoption intention of RFID by suppliers. *Information & Management* 50(1):59-65.

Mintzberg H. (1993) *Structure in Fives: Designing Effective Organizations*. Upper Saddle River. NJ: Prentice-Hall.

Mobasheri M.H., King D., Johnston M., Gautama S., Purkayastha S., et al. (2015) The ownership and clinical use of smartphones by doctors and nurses in the UK: a multicentre survey study. BMJ Innovation 00:1–8.

Mohr L.B. (1969) Determinants of innovation in organizations. *American political science review* 63(01):111-126.

Moore G.C. and Benbsat I. (1991) Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation. *Information Systems Research* 2(3):192-222.

Muthén L.K. & Muthén B.O. (2012) Mplus user's guide (7th ed.). Los Angeles, CA: Muthén & Muthén.

Nunnally J. and Bernstein I. (1994) Psychometric theory. 3rd ed. New York: Tata McGraw-Hill Ed., pp.264-265.

Oliveira T., Martins M. (2011) Literature review of information technology adoption models at firm level. *The Electronic Journal Information Systems Evaluation* 14(1):110–121.

Olushola T. & Abiola J.O. (2017) The Efficacy of Technology Acceptance Model: A Review of Applicable Theoretical Models in Information Technology Researches. *Journal of Research in Business and Management 4(11):*70-83.

Or C., Tong E., Tan J., Chan S. (2018) Exploring Factors Affecting Voluntary Adoption of Electronic Medical Records Among Physicians and Clinical Assistants of Small or Solo Private General Practice Clinics. *Journal of Medical Systems* 42(7):121.

Orlikowski W.J. and Barley S.R. (2001) Technology and Institutions: What can research on information technology and research on organizations learn from each other? *MIS Quarterly* 25(2):145–165.

Pandian S.S., Srinivasan P., Mohan S. (2014) The maxillofacial surgeon's march towards a smarter future-smartphones. *Journal of Maxillofacial and Oral Surgery* 13:355-358.

Patel S.J., Subbiah S., Jones R., Muigai F., Rothschild C.W., Omwodo L., et al. (2018) Providing support to pregnant women and new mothers through moderated WhatsApp groups: a feasibility study. *mHealth* 4:14.

Pellegrino E.D. (1979) Humanism and the Physician (Knoxville: University of Tennessee Press), p. 17.

Pinzone M., Guerci M., Lettieri E., Redman T. (2016) Progressing in the change journey towards sustainability in healthcare: the role of 'Green' HRM. *Journal of Cleaner Production* 122:201-211.

Polit D.F. & Beck C.T. (2014) *Essentials of Nursing Research: Appraising evidence for nursing practice* (8th ed.). Philadelphia: Wolters Kluwer-Lippincott Williams & Wilkins Health.

Poon E.G. (2004) Overcoming Barriers To Adopting And Implementing Computerized Physician Order Entry Systems in U.S. Hospitals. *Health Affairs* 4. DOI 10.1377/hlthaff.23.4.184.

Pozzebon M. (2004) The Influence of a Structurationist View on Strategic Management Research. *Journal of Management Studies* 41(2):247–272.

Radaelli G., Currie G., Frattini F. and Lettieri E. (2017) The role of managers in enacting twostep institutional work for radical innovation in professional organizations'. *The Journal of Product Innovation Managemen*t 34(4):450–470.

Raiman L., Antbring R., Mahmood A. (2017) WhatsApp messenger as a tool to supplement medical education for medical students on clinical attachment. *BMC Medical Education* 17(1):7.

Rasmi M., Alazzam M.B., Alsmadi Mutasem K., Almarashdeh I.A., Alkhasawneh R.A., Alsmadi S. (2018) Healthcare professionals' acceptance electronic health records system: critical literature review (Jordan case study). *International Journal of Healthcare Management*. DOI: 10.1080/20479700.2017.1420609.

Rawstorne P., Jayasuriya R. and Caputi P. (2000) Issues in predicting and explaining usage behaviors with the Technology Acceptance Model and the Theory of Planned Behavior when usage is mandatory. *Proceedings of the 21st International Conference on Information Systems* pp. pp.35–44.

Rogers E. (1995) *Diffusion of Innovations*. 4th ed., Free Press, New York.

Rogers E.M. (1995) Diffusion of Innovations: Modifications of a model for telecommunications. *Die Diffusion von Innovationen in der Telekommunikation* 17:25–38.

Rudin R.S., Bates D.W. and MacRae C. (2016) Accelerating Innovation in Health IT. *New England Journal of Medicine* 375,9.

Safi S., Thiessen T., Schmailzl K.J.G. (2018) Acceptance and Resistance of New Digital Technologies in Medicine: Qualitative Study. *JMIR Research Protocols* 7(12):e11072.

Sarode S.C., Sarode G.S., Anand R., Patil S., Unadkat H. (2017) WhatsApp is an effective tool for obtaining second opinion in oral pathology practice. *Journal of Oral Pathology & Medicine* 46: 513–519.

Schwarz A. and Chin W. (2007) Looking Forward: Toward an Understanding of the Nature and Definition of IT Acceptance. *Journal of the Association for Information Systems* 8(4):230-243.

Scott K.C., Stein A., Thomas H., Kaur H. (2018) The use of Electronic Health Records to support population health: a systematic review of the literature. *Journal of Medical Systems* 42(11).

Scott W.R. (1995) *Institutions and Organizations*. Thousands Oaks (CA): Sage.

Scott W.R., Ruef P., Mendel P., Caronna C. (2000) *Institutional change and healthcare organizations: from professional dominance to managed care*. University of Chicago Press. Chicago.

Scott W.R. (2001) *Institutions and Organizations*, Thousands Oaks (CA): Sage.

Scott W.R. (2003) Institutional Carriers: Reviewing Modes of Transporting Ideas over Time and Space and Considering Their Consequences. *Industrial and Corporate Change* 12:879–894.

Scott W.R., & Davis G. (2008) *Organizations and organizing: rational, natural and open systems perspectives.* New Jersey: Prentice Hall.

Shahmoradi L., Darrudi A., Arji G., Nejad A.F. (2017) Electronic Health Record Implementation: A SWOT Analysis. *Acta Medica Iranica* 55(10).

Sharifi R., Askarian F., Nematolahi M. and Farhadi P. (2014) Factors influencing nurses' acceptance of hospital information systems in Iran: application of the Unified Theory of Acceptance and Use of Technology. *The Health Information Management Journal*. DOI: 10.12826/18333575.2014.000.

Sherer S.A., Meyerhoefer C.D., Lizhong P. (2016) Applying institutional theory to the adoption of electronic health records in the U.S. *Information & Management* 53:570–580.

Soares-Aguiar A., Palma-dos-Reis A. (2008) Why do firms adopt e-procurement systems? Using logistic regression to empirically test a conceptual model. *IEEE. Transactions on Engineering Management* 1: 120–133.

Steiger J.H. (1990) Structural model evaluation and modification: An interval estimation approach. *Multivariate Behavioral Research* 25(2):173–180.

Struik M.H.L., Koster F., Schuit A.J., Nugteren R.J, Veldwijk Jorien, Lambooij M.S. (2014) The preferences of users of electronic medical records in hospitals: quantifying the relative importance of barriers and facilitators of an innovation. *Implementation Science* 9:69.

Szajna B. (1996) Empirical Evaluation of the Revised Technology Acceptance Model. *Management Science* 42(1):85-92.

Tabachnick B. and Fidell L. (1996) *Using multivariatle statistics*. 3rd ed. New York: HarperCollins.

Tate M., Evermann J. & Gable G. (2015) An integrated framework for theories of individual attitudes toward technology. *Information & Management* 52(6):710-727.

Teo H.H., Wei K.K., Benbasat I. (2003) Predicting intention to adopt interorganizational linkages: an institutional perspective. *MIS Quarterly* 27(1):19-49.

Thompson R.L., Higgins C.A., and Howell J.M. (1991) Personal computing : toward a conceptual model of utilization. *MIS Quarterly* 15(1):125-143.

Thornton P.H. (1999) The Sociology of Entrepreneurship. *Annual Review of Sociology* 25:19–46

Tolbert P.S. and Zucker L.G. The Institutionalization of Institutional Theory. In: S. Clegg, C. Hardy and W.R. Nord (1996) *Handbook of Organization Studies*. London, Thousand Oaks, New Delhi: Sage Publications.

Tornatzky L., Fleischer M. (1990) *The Process of Technology Innovation*, Lexington Books, Lexington, MA.

Tucker L.R. & Lewis C. (1973) A reliability coefficient for maximum likelihood factor analysis. *Psychometrika* 38(1):1–10.

Ugrin J.C. (2009) The Effect of System Characteristics, Stage of Adoption, and Experience on Institutional Explanations for ERP Systems Choice. *Accounting Horizons* 23(4):365-389.

Vallerand R.J. (1997) Toward a hierarchical model of intrinsic and extrinsic motivation. *Advances in experimental social psychology* 29:271-360.

van Dijk S., Berends H., Jelinek M., Romme A.G., Weggeman M. (2011) Micro-Institutional affordances and strategies of radical innovation. *Organization Studies* 23(11):1485-151.

Venkatesh V., Davis F. D. (1996) A model of the antecedents of perceived ease of use: development and test. *Decision Sciences* 27(3):451-481.

Venkatesh V. and Davis F. (2000) A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science* 46(2):186-204.

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

Venkatesh V., Brown S.A., Maruping L.M., Bala H. (2008) Predicting different conceptualizations of system USE: the competing roles of behavioral intention, facilitating conditions, and behavioral expectation. *MIS Quarterly: Management Information Systems* 32(3):483–502.

Venkatesh V., Zhang X., Sykes T.A. (2011) 'Doctors do too little technology'. A longitudinal field study of an Electronic Healthcare System implementation. *Information Systems Research* 22(3):523–546.

Walsh I. (2014) A strategic path to study IT use through users' IT culture and IT needs: A mixed-method grounded theory. *Journal of Strategic Information Systems* 23(2):146–173.

Wani S.A., Rabah S.M., AlFadil S., Dewanjee N., and Najmi Y. (2013) Efficacy of communication amongst staff members at plastic and reconstructive surgery section using smartphone and mobile WhatsApp. *Indian Journal of Plastic Surgery* 46(3):502-505.

Weerakkody V., Dwivedi Y.K., Irani Z. (2009) The diffusion and use of institutional theory a cross-disciplinary longitudinal literature survey. *Journal of Information Technology* 24:354–368.

Windrum P. Innovation and entrepreneurship in public service. In: Windrum P. & Koch P. (2008) *Innovation in public sector services. Enterpreneurship, creativity and management*. Cheltenham: Edward Elgar, UK.

World Medical Association (2013) World medical association declaration of Helsinki. Ethical principles or medical research involving human subjects. *Journal of the American Medical Association* 10(20): 2191–2194.

Yousafzai S., Foxall G. and Pallister J. (2007) Technology acceptance: a meta-analysis of the TAM: Part 1. *Journal of Modelling in Management* 2(3):251-280.

Zucker L.G. (1987) Institutional Theories of Organizations. *Annual Review of Sociology* 13:443–464.

APPENDED PAPERS

Paper I

De Benedictis A., Lettieri E., Masella C., Tartaglini D. **When Hospitals meet Information Technology Innovation: State-of-the-Art of key determinants of the intention to use Electronic Medical Records.**

Title

When Hospitals Meet Information Technology Innovation: State-of-the-Art of Key Determinants of the Intention to use Electronic Medical Records

Authors

Anna De Benedictis[1,2], Emanuele Lettieri[2], Cristina Masella[2] and Daniela Tartaglini[1]

Affiliation

[1]University Campus Bio-Medico of Rome. Via Alvaro del Portillo, 200, CAP.00128, Rome (Italy)
[2]Politecnico di Milano, Piazza Leonardo da Vinci, 32; 20133 Milan (Italy)

E-mail address and fax number of the corresponding author

Corresponding Author: Anna De Benedictis
E-mail a.debenedictis@unicampus.it
ORCID Id: https://orcid.org/0000-0001-8655-0895

Abstract

Background
The ability to innovate is now an integral part of the health system. However, in some contexts, such as hospitals, the complexity of system sometimes slows or limits the success of some innovation projects. The implementation an Electronic Medical Record system requires particular innovation strategies. In this field, it is still little studied which are the main organizational and individual determinants and which is the interplay between them.
Purpose
The purpose of this paper is to identify the state-of-the-art of the determinants that influence the intention to use Electronic Medical Records in hospitals, and to verify whether an interplay exists between organizational and individual determinants.
Methods
A literature review was carried out using Scopus, Web of Science, PubMed, EBSCOHost; IEEE Xplore Digital Library, Cochrane Library and Google Scholar as the main sources of evidence. Inclusion and exclusion criteria have been defined and applied. Data extraction has been informed based on a theoretical approach, whose building blocks are: theoretical framework, organizational factors, individual factors and the interplay between organizational and individual factors. Applying inclusion/exclusion criteria, 38 past studies were selected, including six past literature reviews.
Results
Past reviews focused mainly on the analysis of factors that influence adoption and implementation of Electronic Medical Records. The originality of this study is the theoretical point of view that allows to best understand some gaps in the theories about user

acceptance of technologies. In the light of the results emerged from the literature review, three main issues are worth of discussion. First, the categorization of the most important determinants of intention to use Electronic Medical Records by hospital professionals; second, the analysis of models and theories used and third, the interplay between organizational and individual determinants.

Originality/value

The originality of this study is the theoretical point of view, which offers original insights into the field of information technology. The main findings are useful for academia as they consolidate what we know about the users' acceptance of technologies. They are also useful for hospital managers and professionals, who might be involved in the adoption and implementation of Electronic Medical Records.

Keywords: digital innovation; electronic medical record; hospital, technology acceptance; intention to use; institutional theory

1. Background

Electronic Medical Records (EMRs) are one of the most common examples of Information and Communications Technology (ICT) innovations applied in health care, which are designed to improve the care delivery process, by creating legible and organized recordings of patient information and by managing both the distribution and processing of information [1]. However, the implementation of EMRs is still an unsolved quest for many hospital managers [2]. Although past studies have acknowledged the numerous advantages of EMRs, physicians and other hospital professionals have been found to be indifferent, when not resistant, to the implementation of EMRs [3]. In fact, the adoption and implementation of EMRs is a complex process that involves, before, during and after their adoption, a variety of organizational and individual factors. Moreover, the hospitals is very challenging because of the complexity of medical data, the security and confidentiality issues and the number of health-care providers involved [4], differing from many other industries because of the multiple objectives there are to achieve (such as caring for patients while educating new physicians and nurses), the complicated and highly varied structures and processes to consider and a varied workforce to integrate with different training and years of experience [5]. Recent studies [e.g.; 3,5,6,7] show the most significant barriers and facilitators to implementing EMRs in hospitals and offer first-hand recommendations about strategies and initiatives that might increase the chance of success. Moreover, past contributions have confirmed that the most salient predictor of the success of the implementation of EMRs in hospitals relies on hospital professionals' 'intention to use' them and change their current practices and behaviours because they perceive that the advantages will outbalance the costs of change. If claiming that the intention to use EMRs is the most significant predictor might appear as an expected factor – also trivial for many scholars of innovation management in health care – the comprehension of which factors might trigger or inhibit such intention to use is still an open question that needs further research and evidence. In fact, despite the undoubted value of past studies, some main limitations still puzzle our understanding of what actually drives the intention to use EMRs by hospital professionals

– namely, physicians and nurses. First, past reviews have offered a list of relevant factors that might affect the intention to use without clarifying the potential interconnections among them. Second, previous studies have gathered evidence to confirm the role played by institutional factors as well as by individual, professional factors, without exploring the potential interplay among them.

From a theoretical point of view, the mechanisms that drive the use of ICTs within organizations remain a controversial issue, especially in professional settings such as health care [2]. A still fragmented and puzzling theoretical frame fosters this controversy as the fields of Organizational Studies and information systems have explained employees' adoption of ICTs in two significantly different, sometimes conflicting, ways [8].

In fact, Organizational Studies conceive organizations as strongly institutionalized settings in which individual behaviours are bound by a complex combination of regulations, social norms and cultural systems [9,10]. On the other hand, information systems research has mostly adopted user acceptance models, which emphasize individuals' rational and volitional assessment of the costs and benefits they would attain from the new technology [11]. Past studies about information systems have developed several rational models, i.e. the Technology Acceptance Model (TAM) [12], the Theory of Planned Behaviour (TPB) [13] and the Unified Theory of Acceptance and Use of Technology (UTAUT) [14]. According to these models, the use of a new technology is mainly guided by a rational and voluntary choice of the individual, within a technology-centered view on technology acceptance, where acceptance is understood to be mostly dependent on the nature of the technology (i.e. functionality and ease of use). Socio-organizational, workflow, cultural or emotional aspects as well as differences in user groups (physicians, nurses and patients) are not well covered and may explain why in several studies in health care, basic assumptions of the model could not be confirmed [15].

Despite the effort to integrate organizational and user acceptance models, such unification is still puzzling. In fact, scholars from information studies incorporated social influences and organizational conditions without referring to well-established theories, and scholars of Organizational Studies incorporated elements from the information systems field to explain the behaviour of organizations but have overlooked the choices made by individuals [8]. Based on this context, this literature review aims at offering original insights to further the ongoing debate about the key determinants of the intention to use EMRs in hospitals. In particular, the main objective of this study is to assess which are the main organizational and individual determinants that influence the intention to use EMR in hospitals, to explore if and how an interplay exists between such determinants, and to analyse which are the main theories supporting the studies about intention to use EMRs in hospitals?

2. Methods

2.1 Identification of past contributions

We aimed at identifying previous literature reviews on this topic as well as studies that might be informative for our research questions. Editorials, positioning papers, debate papers were excluded. Since the focus of our search is about the intention to use EMRs in hospitals, which are a professional and institutionalized setting, we included studies with primary data and literature reviews. Additionally, we considered only studies or literature

reviews regarding empirical data about the different professionals (e.g. doctors, nurses, managers etc.) who might challenge the implementation of EMRs in hospitals; we thus excluded studies that involved only students, since they are not representative of the professional and organizational pressures.

EMRs is just one of the terms used to refer to electronic medical information systems, also called, for example electronic health records (EHRs) or computer physician order entry (CPOE). Although these terms are often used interchangeably as being synonymous, they actually refer to different systems. With this respect, the International Organization for Standardization (ISO) (ISO, 2005) considers EHR as 'a repository of information regarding the health status of a subject of care, in computer processable form'. An EMR is similar to an EHR but restricted to the medical domain: it represents the digital version of the traditional paper-based medical record. The CPOE is a computer-based system that automatizes the medication ordering process ensuring standardized, legible and complete orders.

In order to avoid the risk of overlooking relevant contributions, we did not limit our search to EMRs, but also included contributions about EHRs and CPOEs. We excluded articles about other information systems, such as health information networks, telemedicine/tele-health, decision support systems, business intelligence, data analytics etc.

Finally, we considered:

2.2 Types of studies
We considered studies published in English from January 1990 to August 2019, in particular literature reviews and other empirical studies responding to the research questions, excluding editorials, positioning papers, debate papers.

2.3 Types of participants
We included studies performed in hospitals and focused on physicians and nurses. We excluded studies involving only students.

2.4 Types of interventions
We included all interventions to promote the implementation of EMRs (electronic medical records, electronic health-care records, electronic drug administration). We excluded interventions related to other types of ICT (e.g. health information networks, telemedicine/telehealth, and decision support tools).

2.5 Search methods for identification of studies
The search strategy included the use of terms relevant to the aim of the research. In addition, we included synonyms and related terms using the Boolean Operators (AND/OR) and the truncations (*).

The search was performed combining the following keywords (Table 1):

Table 1 - Overview of the search strategy

Search strategy	Terms used
1	(("electronic medical record" OR "EMR" OR "electronic healthcare record" OR "electronic health care record" OR "EHR" OR "computerized physicians order entry" OR "CPOE" OR "electronic patient record") AND ("hospital*") AND ("intention to use" OR "motivation to use"))
2	(("electronic medical record" OR "electronic healthcare record" OR "electronic patient record") AND ("intention to use" OR "motivation to use"))
3	(("electronic medical record") AND ("intention to use" OR "motivation to use"))

The articles identified from the search strategy were assessed and they had to satisfy the following criteria to be included: published between January 1990 and August 2019; full text available; focused on hospitals; based on primary data being a literature review. The search covered well-established and well-known databases (Table 2).

Table 2 – List of databases

Database	No. of records found
Google Scholar	1,300
PubMed	367
Web of Science	138
Cochrane Library	81
IEEE Xplore Digital Library	47
Scopus	44
EBSCOHost	32

3. Data collection and analysis

3.1 Paper selection

The list of articles generated was reviewed by the authors in order to: remove duplicate records; remove obviously irrelevant reports; retrieve full text of the potentially relevant reports; examine full-text reports for compliance of studies with eligibility criteria; shortlist abstracts for detailed review and assess each study for eligibility; make final decisions on study inclusion and proceed to data collection.

Screening has been carried out by two co-authors for each contribution to limit the risk of excluding relevant past studies or including studies that were out of scope; in the case of an opposing judgment, the two co-authors discussed their opinions to gather an agreed evaluation; when the co-authors maintained their original opinions and an agreement could not be achieved, a third co-author reviewed the contribution to decide whether to include or exclude it. The first round of screening – coherently to the large number of contributions identified through the query strategies – dealt with titles and keywords.

The first screening based on title and keywords reduced the included contributions from 2,017 to 102, with the exclusion of 1,915 studies that were judged to be beyond the scope of the study. After eliminating 45 duplicate articles, the remaining records (102) were screened by the authors based on their abstract; another 63 related articles have been included as related articles. A total of 165 studies were finally assessed for eligibility. After this stage, 127 were excluded, either because they were out of the scope of the study or

because the full text was not retrievable. Finally, 38 contributions have been selected and included in this literature review. The results at the different stages have been synthetized in Figure 1.

4. **Main Results**

4.1 Data extraction

As a result of the screening, 38 contributions have been selected for grounding this literature review. Of these, 32 contributions are empirical studies and 6 are systematic reviews. Selected contributions are listed in Table 3. Data extraction has been informed by the design of a theoretical framework (Figure 2), based on a theoretical approach, the building blocks of which are: theoretical framework, organizational factors, individual factors and the interplay between organizational and individual factors.

4.2 Findings

As result of our screening, six past reviews have been identified, published between 2010 and 2018. Their focus was about factors affecting acceptance and/or implementation of EMRs or health information technologies by nurses and/or physicians in hospitals. The other empirical articles focused on the understanding of factors, determinants, barriers or facilitators related to the acceptance, intention to use and implementation of EMRs or other health information systems.

In this regard, Tables 3 and 4 offer a comprehensive overview of the information stored in the 38 papers.

Figure 1 – Selection procedure.
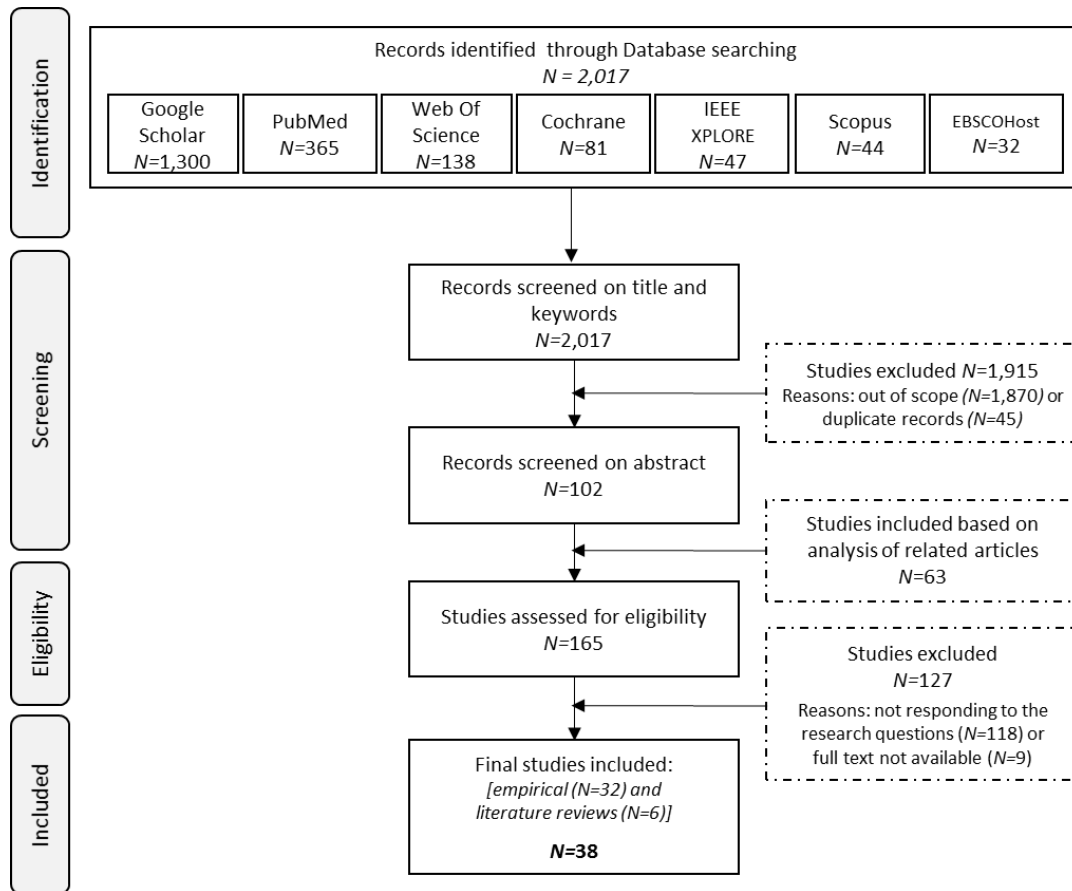
Figure 2 – Framework of intention to use EMRs in hospitals.
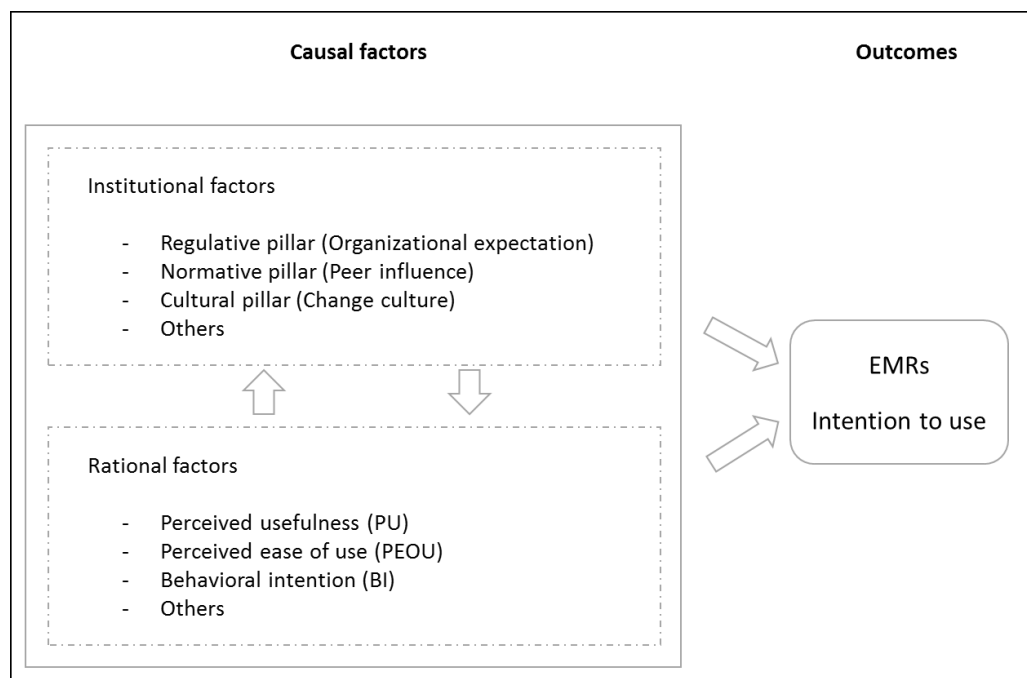
Table 3 – Overview of studies included in the literature review

No.	Type	Author(s)	Title	Journal	Year
1	Empirical study	Wilkins MA	Factors influencing acceptance of electronic health records in hospitals.	*Perspectives in Health Information Management*	2009
2	Literature review	Boonstra A and Broekhuis M	Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions.	*BMC Health Services Research*	2010
3	Literature review	McGinn CA, Grenier S, Duplantie J, et al.	Comparison of user groups' perspectives of barriers and facilitators to implementing electronic health records: a systematic review.	*BMC Medicine*	2011
4	Empirical study	McGinn CA, Gagnon M-P, Shaw N, et al.	Users' perspectives of key factors to implementing electronic health records in Canada: a Delphi study.	*BMC Medical Informatics and Decision Making*	2012
5	Empirical study	Lin C, Lin I-C, Roan J, et al.	Barriers to physicians' adoption of healthcare information technology: an empirical study on multiple hospitals.	*Journal of Medical Systems*	2012
6	Empirical study	Leblanc G, Gagnon M-P, Sanderson D, et al.	Determinants of primary care nurses' intention to adopt an electronic health record in their clinical practice.	*Journal of Medical Internet Research*	2012
7	Empirical study	Kuo K-M, Liu C-F and Ma C-C	An investigation of the effect of nurses' technology readiness on the acceptance of mobile electronic medical record systems.	*BMC Medical Informatics and Decision Making*	2013
8	Empirical study	Hsu S-C, Liu C-F, Weng R-H, et al.	Factors influencing nurses' intentions toward the use of mobile electronic medical records.	*Computer Informatics Nursing*	2013
9	Empirical study	Sharifi R, Askarian F, Nematolahi M and Farhadi P	Factors influencing nurses' acceptance of hospital information systems in Iran: application of the Unified Theory of Acceptance and Use of Technology.	*The Health Information Management Journal*	2014
10	Empirical study	Gagnon M-P, Ghandour EK, Kengne Talla P, et al.	Electronic health record acceptance by physicians: Testing an integrated theoretical model	*Journal of Biomedical Informatics*	2014

(continued)

No.	Type	Author(s)	Title	Journal	Year
11	Empirical study	Fleming ML, Hatfield MD, Wattana MK, et al.	Exploratory study of emergency physicians' use of a prescription monitoring program using a framework of technology acceptance.	*Journal of Pain & Palliative Care Pharmacotherapy*	2014
12	Empirical study	Khalifa M, Alswailem O	Hospital information systems (HIS) acceptance and satisfaction: a case study of a tertiary care hospital.	*Procedia Computer Science*	2015
13	Empirical study	Liu CF, Cheng TJ	Exploring critical factors influencing physicians' acceptance of mobile electronic medical records based on the dual-factor model: a validation in Taiwan.	*BMC Medical Informatics and Decision Making*	2015
14	Empirical study	Abdekhoda M, Ahmadi M, Gohari M, Noruzi A.	The effects of organizational contextual factors on physicians' attitude toward adoption of electronic medical records.	*Journal of Biomedical Informatics*	2015
15	Empirical study	Saleema JJ, Plewa WR, Speira RC, *et al.*	Understanding barriers and facilitators to the use of clinical information systems for intensive care units and anesthesia record keeping: a rapid ethnography.	*International Journal of Medical Informatics*	2015
16	Empirical study	Hsieh PJ	Physicians' acceptance of electronic medical records exchange: an extension of the decomposed TPB model with institutional trust and perceived risk.	*International Journal of Medical Informatics*	2015
17	Empirical study	Steininger K, Stiglbauer B	EHR acceptance among Austrian resident doctors.	*Health Policy and Technology*	2015
18	Empirical study	Phichitchaisopa N, Naenna T	Factors affecting the adoption of healthcare information technology.	*EXCLI Journal*	2015
19	Literature review	Garavand A, Mohseni M, Asadi H, et al.	Factors influencing the adoption of health information technologies: a systematic review.	*Electronic Physician*	2016

No.	Type	Author(s)	Title	Journal	Year
20	Empirical study	Kim S, Lee KH, Hwang H, Yoo S	Analysis of the factors influencing healthcare professionals' adoption of mobile electronic medical record (EMR) using the unified theory of acceptance and use of technology (UTAUT) in a tertiary hospital	*BMC Medical Informatics and Decision Making*	2016
21	Literature review	Kruse CS, Kristof C, Jones B, et al.	Barriers to electronic health record adoption: a systematic literature review.	*Journal of Medical Systems*	2016
22	Empirical study	Holden RJ, Asan O, Wozniak EM, et al.	Nurses' perceptions, acceptance, and use of a novel in-room pediatric ICU technology: testing an expanded technology acceptance model.	*BMC Medical Informatics and Decision Making*	2016
23	Empirical study	Gagnon MP, Simonyan D, Ghandour EK, et al.	Factors influencing electronic health record adoption by physicians: a multilevel analysis.	*International Journal of Information Management*	2016
24	Empirical study	Hadji B, Martin G, Dupuis I, et al.	14 years longitudinal evaluation of clinical information systems acceptance: The HEGP case.	*International Journal of Medical Informatics*	2016
25	Empirical study	Abdekhoda M, Ahmadi M, Dehnad A, et al.	Applying electronic medical records in health care.	*Applied Clinical Informatics*	2016
26	Empirical study	Beglaryan M, Petrosyan V, Bunker E	Development of a tripolar model of technology acceptance: hospital-based physicians' perspective on HER.	*International Journal of Medical Informatics*	2017
27	Empirical study	Hsieh H-L, Kuo Y-M, Wang S-R, et al.	A study of personal health record user's behavioral model based on the PMT and UTAUT integrative perspective.	*International Journal of Environmental Research and Public Health*	2017
28	Empirical study	Vitari C, Ologeanu-Taddei R	The intention to use an electronic health record and its antecedents among three different categories of clinical staff.	*BMC Health Services Research*	2018

No.	Type	Author(s)	Title	Journal	Year
29	Empirical study	Tubaishat A	Perceived usefulness and perceived ease of use of electronic health records among nurses: application of technology acceptance model.	*Informatics for Health and Social Care*	2018
30	Empirical study	Tavares J, Goulão A, Oliveira T	Electronic health record portals adoption: empirical model based on UTAUT2.	*Informatics for Health and Social Care*	2018
31	Empirical study	Tavares J, Oliveira T	New integrated model approach to understand the factors that drive electronic health record portal adoption: cross-sectional national survey.	*Journal of Medical Internet Research*	2018
32	Literature review	Rasmi M, Alazzam MB, Alsmadi MK, et al.	Healthcare professionals' acceptance of electronic health records system: critical literature review (Jordan case study).	*International Journal of Healthcare Management*	2018
33	Literature review	Handayani PW, Hidayanto AN, Budi I	User acceptance factors of hospital information systems and related technologies: systematic review.	*Informatics for Health and Social Care*	2018
34	Empirical study	Hwang H-G, Dutta B, Chang H-C	The differing effect of gender and clinical specialty on physicians' intention to use electronic medical record.	*Methods of Information in Medicine*	2019
35	Empirical study	Abdekhoda M, Dehnad A, Zarei J	Determinant factors in applying electronic medical records in healthcare.	*Eastern Mediterranean Health Journal*	2019
36	Empirical study	Al-Rawajfaha O, Tubaishatb A	Barriers and facilitators to using electronic healthcare records in Jordanian hospitals from the nurses' perspective: a national survey.	*Informatics for Health & Social Care*	2019
37	Empirical study	Ho KF, Ho CH, Chung MH	Theoretical integration of user satisfaction and technology acceptance of the nursing process information system.	*PLoS One*	2019
38	Empirical study	Biruk Shiferawa K, Abetu Meharib E	Modeling predictors of acceptance and use of electronic medical record system in a resource limited setting: Using modified UTAUT model.	*Informatics in Medicine Unlocked*	2019

Table 4 – Theoretical frameworks used in the empirical studies selected

Theory / Model	No. of papers	References
Technology Acceptance Model (TAM)	16	16, 20, 23–27, 32, 33, 35, 38, 41, 42, 44, 47, 48
Unified Theory of Acceptance and Use of Technology (UTAUT)	7	22, 31–33, 37, 40, 51
Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)	3	43–45
Theory of Planned Behaviour (TPB)	3	19, 23, 30
Theory of Diffusion of Innovations (DOI)	3	21, 38, 44
Theory of Interpersonal Behaviours (TIB)	2	23, 29
Technology Acceptance Model 2 (TAM 2)	1	37
Technology Readiness Index (TRI)	1	20
Information System Success Model (ISSM)	1	37
Expectation Confirmation Model (ECM)	1	37
Information Technology Post-adoption Model (ITPAM)	1	37
Tripolar Model of Technology Acceptance (TMTA)	1	39
Protection Motivation Theory (PMT)	1	40
Technology, Organization and Environment (TOE)	1	48
The 3Q Model	1	50

Table 4 shows the variety and frequency of use of different theoretical lenses to investigate the determinants of the intention to use EMRs in hospitals. With regard to previous literature reviews [e.g.: 32,34,46] we offer novel light on the determinants of the intention to use by grouping them as 'individual' and 'organizational' factors. This new classification helps to i) differentiate between rational choices taken by hospital professionals and pressures that come from peers, and ii) to understand the potential interplay between individual and organizational determinants. The most used theoretical lenses are grounded on TAM [16,20,23–27,32,33,35,38,41,42,44,47,48], UTAUT [22,31–33,37,40,51] UTAUT2 [43–45], TPB [19,23,30] and DOI [21,38,44] (Table 4). The interplay between organizational and rational determinants has been found only in three papers [27,47,48], and one study [48] proposed an integration between the two models TOE and TAM.

Table 5 – Overview of studies included in the literature review

No.	Author and Year	Objectives	Theoretical framework	Organizational / Institutional determinants of the intention to use EMRs	Individual/Rational determinants of the intention to use EMRs	Interplay between individual and organizational determinants
1	Wilkins MA *2009*	To examine factors that influence health information managers in the adoption of electronic health records.	TAM	-	Perceived usefulness; perceived ease of use; behavioural intention.	-
2	Boonstra A, et al., 2010	To identify, categorize, and analyse barriers perceived by physicians to the adoption of electronic medical records.	-	*Financial*: high start-up costs; high ongoing costs; uncertainty about return on investment; lack of financial resources. *Social*: uncertainty about the vendor; lack of support from external parties; interference with doctor–patient relationship; lack of support from other colleagues; lack of support from the management level. *Legal:* privacy or security concerns. *Organizational:* organizational type; change process; lack of support from organizational culture; lack of incentives; lack of participation; lack of leadership.	*Technical:* lack of computer skills of the physicians and/or the staff; lack of technical training and support; complexity of the system; limitation of the system; lack of customizability; lack of reliability; interconnectivity/standardization; lack of computers/hardware. *Time:* time to select, purchase and implement the system; time to learn the system; time to enter data; more time per patient; time to convert the records. *Psychological:* lack of belief in EMRs; need for control.	-
3	McGinn CA, et al., 2011	To synthesize current knowledge of the barriers and facilitators influencing electronic health record implementation.	-	Design or technical concerns; privacy and security concerns; cost issues; lack of time and workload; productivity; patient and health professional interaction; interoperability.	Motivation to use HER; perceived ease of use; familiarity, ability with HER.	-

No.	Author and Year	Objectives	Theoretical framework	Organizational / Institutional determinants of the intention to use EMRs	Individual/Rational determinants of the intention to use EMRs	Interplay between individual and organizational determinants
4	McGinn CA, et al., 2012	To understand electronic health record users' perspectives in relation to the electronic health record implementation projects.	-	Lack of time and workload (professional tasks & EHR use); productivity; resources available; participation of end-users in implementation; interoperability; patient and health professional interaction.	Motivation; outcome expectancy.	-
5	Lin C, et al., 2012	To understand users' resistance to new technologies and antecedents of technology rejection.	-	-	Perceived threat; perceived usefulness; perceived inequity.	-
6	Leblanc G, et al., 2012	To examine the factors that influence primary care nurses' intention to adopt the provincial electronic health record.	TPB	Perceived behavioural control, normative beliefs.	Attitudes.	-
7	Kuo K-M, et al., 2013	To investigate nurses' personality traits in regard to technology readiness toward mobile electronic medical record systems (MEMR) acceptance.	Technology readiness index (TRI) and TAM	-	Optimism; innovativeness; insecurity; discomfort; perceived ease of use; perceived usefulness; behavioral intention.	-
8	Hsu S-C, et al., 2013	To investigate the factors influencing nurses' intentions toward the use of mobile electronic medical records	DOI	Compatibility, complexity, and observability.	-	-
9	Sharifi R, et al., 2014	To investigate the factors affecting nurse–user acceptance of hospital information systems (HISs).	UTAUT	Social influence; facilitating conditions.	Performance expectancy; effort expectancy.	-

No.	Author and Year	Objectives	Theoretical framework	Organizational / Institutional determinants of the intention to use EMRs	Individual/Rational determinants of the intention to use EMRs	Interplay between individual and organizational determinants
10	Gagnon M-P, et al., 2014	To identify the main determinants of physician acceptance of EHR in a sample of general practitioners and specialists of the Province of Quebec (Canada).	TAM, TPB and Theory of Interpersonal Behaviours (TIB)	Demonstrability of the results; information about change; social norm; professional norm.	Perceived usefulness; perceived ease of use; computer self-efficacy; behavioural intention to use; resistance to change; personal identity; computer self-efficacy.	-
11	Fleming ML, et al., 2014	To determine emergency physicians' intention to use the Texas prescription monitoring programs (PMPs) within the framework of the Technology Acceptance Model.	TAM	-	Intention; attitude; perceived usefulness; perceived ease of use.	-
12	Khalifa M, et al., 2015	To evaluate hospital information systems (HISs) acceptance and satisfaction, through exploring the influential factors that might increase or decrease acceptance and satisfaction levels among different health-care professionals.	TAM	Support of users; training; channels of communication and feedback.	Perceived usefulness; perceived ease of use; performance and availability of the system.	-
13	Liu CF, et al., 2015	To explore physicians' acceptance of mobile electronic medical records based on the dual-factor model, which is comprised of inhibitors and enablers, to explain an individual's technology usage.	TAM extended	-	Perceived usefulness; perceived ease of use; perceived threat; perceived mobility.	-

(continued)

No.	Author and Year	Objectives	Theoretical framework	Organizational / Institutional determinants of the intention to use EMRs	Individual/Rational determinants of the intention to use EMRs	Interplay between individual and organizational determinants
14	Abdekhoda M, et al., 2015	To determine the organizational contextual factors affecting physicians' adoption of EMRs.	TAM extended	Management support; adequate training; physicians' involvement.	Perceived usefulness; perceived ease of use physicians' autonomy; doctor–patient relationship.	Organizational contextual factors (management support, physicians' involvement, physicians' adequate training; autonomy and doctor–patient relationship) affect physicians' intention to use EMRs
15	Saleema JJ, et al., 2015	To understand barriers and facilitators to the use of clinical information systems for Intensive Care Units and anaesthesia record keeping: a rapid ethnography.	-	*Barriers:* integration issues with other software; systems technical; software challenges; hardware challenges; training concerns; unclear roles and lack of coordination among stakeholders; insufficient technical support. *Facilitators:* automation; dedicated facility coordinator; social and external environment (funding).	*Barriers:* poor usability.	-
16	Hsieh PJ 2015	To propose a theoretical model to explain the intention of physicians to use an EMR exchange system.	TPB extended	Institutional trust.	Attitude; subjective norm; perceived behaviour control; perceived risk.	-
17	Steininger K, et al., 2015	To understand factors affecting physicians' acceptance of EHR systems, and the effects of the determinants' social influence, health IT (HIT) experience, and privacy concerns.	TAM extended	Social influence.	Social influence; HIT experience; privacy concerns; perceived usefulness; perceived ease of use.	-

No.	Author and Year	Objectives	Theoretical framework	Organizational / Institutional determinants of the intention to use EMRs	Individual/Rational determinants of the intention to use EMRs	Interplay between individual and organizational determinants
18	Phichitchaisopa N, et al., 2015	To apply and test the Unified Theory of Acceptance and Use of Technology (UTAUT), to examine the factors influencing health-care information technology (IT) services.	UTAUT	Social influence; facilitating conditions.	Performance expectancy; effort expectancy; provincial area; behavioural intention.	-
19	Garavand A, et al., 2016	To determine the most important factors affecting the adoption of health information technologies.	UTAUT	Social impact.	Perceived usefulness; perceived ease of use.	-
20	Kim S, et al., 2016	To confirm the factors that influence users' intentions to utilize a mobile electronic health records (EMR) system.	UTAUT	Social influence; facilitating conditions.	Performance expectancy; effort expectancy; attitude; behaviour intention to use.	-
21	Kruse CS, et al., 2016	To understand the barriers that have deterred certain health-care organizations from adopting even a basic electronic health record system in the United States.	-	Initial cost; technical support; technical concerns; maintenance/ongoing costs; training; privacy concerns; financial incentives; eligibility criteria; technical infrastructure; effort needed to select system; degree of integration; facility location; clarity of federal and state policies; complexity of system; consensus within the practice; penalties; limitations of system; medical errors; staff shortages; upgrades; external factors; missing data; competitiveness; provider or patient age race and income disparities; need organizational cultural change; interoperability.	Resistance to changing work; habits; insufficient time; productivity loss; perceived usefulness; physician attitude; physician autonomy; user acceptance; agility to make changes.	-

(continued)

No.	Author and Year	Objectives	Theoretical framework	Organizational / Institutional determinants of the intention to use EMRs	Individual/Rational determinants of the intention to use EMRs	Interplay between individual and organizational determinants
22	Holden RJ, et al., 2016	To examine paediatric intensive care unit nurses' perceptions, acceptance, and use of a novel health IT, the Large Customizable Interactive Monitor.	TAM extended	Social influence; institutional social influence; patient/family training on system.	Perceived ease of use; perceived usefulness; perceived usefulness for patient/family; involvement; satisfaction with system.	-
23	Gagnon MP, et al., 2016	To assess the specific contribution of organizational and individual factors on physician intention to use EHR.	Multilevel modelling based on an integrated theoretical framework.	Professional norms; social norms.	Computer self-efficacy; perceived ease of use; perceived usefulness; personal identity.	-
24	Hadji B, et al., 2016	To measure and analyse the Clinical Information System (CIS) use and satisfaction determinants in a multi-professional group at the Georges Pompidou University Hospital (HEGP) in Paris.	TAM2, UTAUT, Information System Success Model (ISSM), Expectation Confirmation Model (ECM) and Information Technology Post-adoption Model (ITPAM)	-	Use; system quality (information quality, compatibility with work; availability; ease of use); facilitating conditions (technical support, training); perceived usefulness; confirmation of expectations; global satisfaction.	-
25	Abdekhoda M, et al., 2016	To present an integrated model of applying EMRs by physicians.	TAM and DOI	-	Perceived usefulness; perceived ease of use; relative advantage; compatibility; complicatedness; observability; trialability.	-
26	Beglaryan M, et al., 2017	To understand the barriers of EHR implementation from the perspective of physicians; to identify major determinants of physicians' acceptance of technology; and develop a model that explains better how EHRs are accepted by physicians.	Tripolar Model of Technology Acceptance (TMTA) and TAM	Organizational support; administrative monitoring; professional relationship; organizational change; patient influence; projected collective usefulness.	Computer anxiety; personal innovativeness; resistance to change; perceived ease of use; perceived usefulness.	-

(continued)

No.	Author and Year	Objectives	Theoretical framework	Organizational / Institutional determinants of the intention to use EMRs	Individual/Rational determinants of the intention to use EMRs	Interplay between individual and organizational determinants
27	Hsieh H-L, et al., 2017	To explore factors affecting the adoption of personal health records (PHRs) from technical, medical, and social perspectives.	Protection Motivation Theory (PMT) and UTAUT	Subjective norm; response costs.	Perceived usefulness; perceived ease-of-use; subjective norm; behavioural intention; usage behaviour; perceived severity; perceived susceptibility; self-efficacy.	-
28	Vitari C, et al., 2018	To evaluate to what extent different categories of clinical staff (physicians, paraprofessionals and administrative personnel) influence the intention to use an EHR and its antecedents.	TAM extended	-	Perceived usefulness; ease of use; misfit; data security; anxiety; self-efficacy; trust.	-
29	Tubaishat A et al., 2018	To explore nurses' perceptions of usefulness and ease-of-use of EHRs.	TAM	-	Perceived usefulness; perceived ease of use.	-
30	Tavares J, Goulão A and Oliveira T 2018	To understand the factors that drive individuals to adopt EHR portals.	UTAUT2	-	Performance expectancy; effort expectancy; social influence; habit.	-
31	Tavares J and Oliveira T 2018	To understand the factors that drive individuals to adopt EHR portals.	TAM, UTAUT, UTAUT2 and DOI	-	Use behaviour; intention to recommend; effort expectancy; performance expectancy.	-
32	Rasmi M, et al., 2018	To know clearly and determine the factors that affect the acceptance of EHRs in Jordan hospitals.	UTAUT2	Social influence.	Performance expectancy; effort expectancy; facilitating conditions; hedonic motivation; price value; habit.	-

(continued)

No.	Author and Year	Objectives	Theoretical framework	Organizational / Institutional determinants of the intention to use EMRs	Individual/Rational determinants of the intention to use EMRs	Interplay between individual and organizational determinants
33	Handayani PW, et al., 2018	To identify the user groups' perspectives of acceptance factors regarding Hospital Information System (HIS).	-	Factors related to ICT; organizational environment; lack of organizational training; the presence of a champion; management motivation; participation of end-users in the design; communication of HIS implementation.	Individual factors; health-care professional characteristics; human environment (patients' and peers' attitudes toward ICT for health care).	-
34	Hwang H-G, et al., 2019	To identify the factors that influence physicians' intention to use EMR in Taiwan.	TAM extended	Financial incentives.	Attitude toward using EMR; average variance; perceived ease of use; perceived usefulness.	Financial incentives influence perceived usefulness and intention to use EMR.
35	Abdekhoda M, et al., 2019	To identify the determinants of electronic medical record (EMR) adoption by presenting a comprehensive model.	Integration between two models: TOE and TAM	Relative advantage; compatibility; complexity; organizational competency; management support; training and education; competitive pressure; trading partner support.	Perceived usefulness; perceived ease of use.	Compatibility, complexity, organizational competency, management support, competitive pressure, and trading partner support affect the end user's behaviour when an implementation of EMRs is considered.

(continued)

No.	Author and Year	Objectives	Theoretical framework	Organizational / Institutional determinants of the intention to use EMRs	Individual/Rational determinants of the intention to use EMRs	Interplay between individual and organizational determinants
36	Al-Rawajfaha O, et al., 2019	To explore Jordanian nurses' views on the factors that act as barriers or facilitators to implementing EHRs in the country's hospitals.	-	*Perceived barriers:* costs; lack of adequate IT staff; disruption in clinical care during implementation; privacy and security; finding an EHR system that meets your organization's needs; training and support; technical problems. *Perceived facilitators:* incentives; technical assistance; additional reimbursement for the use of an HER; security certification and warranty; presence of a demo presentation for the system by vendors.	*Perceived barriers:* resistance to implementation from physicians or other providers.	-
37	Ho KF, et al., 2019	To analyse the factors influencing the use of the nursing process information system, based on user satisfaction and technology acceptance within the 3Q (service quality, information quality, and system quality) model.	The 3Q Model (service quality, information quality, and system quality)	-	Currency; completeness; format; accuracy; information quality; reliability; accessibility; flexibility; timeliness; system quality; empathy; service reliability; tangible; assurance; responsiveness; service quality; user satisfaction; perceived enjoyment; perceived ease of use; perceived usefulness.	-
38	Biruk Shiferawa K, et al., 2019	To introduce a modified UTAUT model and show its applicability to assess acceptance and use of electronic medical record (EMR) systems in resource-limited settings.	UTAUT extended	-	Performance expectancy; self-efficacy; effort expectancy; social influence; facilitating condition; attitude.	-

Table 6 – Summary of user acceptance determinants

	Organizational factors	Rational factors	References
Perceived usefulness or performance expectancy: the degree to which a person believes that using a particular system would enhance his or her job performance.			
Perceived usefulness.		x	16, 18, 20, 23-27, 30, 32, 34-42, 46, 47, 50
Performance and outcomes expectancy.		x	17, 22, 25, 31, 33, 43, 44-46, 51
Projected collective usefulness.	x		39
Demonstrability of the results.	x		23
Perceived ease of use or effort expectancy: the degree to which a person believes that using a particular system would be free of effort / the degree of ease associated with the use of the system.			
Perceived ease of use.		x	16, 20, 23-27, 30, 32, 35-42, 46, 47, 50
Effort expectancy.		x	22, 31, 33, 43-46, 51
System quality / information quality: the degree of excellence of the software / the degree of excellence of the information produced by the software.			
Design, technical concerns, complexity and limitation of the system.	x		3, 6, 21, 28, 34, 38, 46
Empathy, service reliability, tangible, assurance, responsiveness.	x		37, 46, 50
Interoperability.	x		3, 6, 17, 46
Interconnectivity/standardization.	x		3, 34, 46
Customizability.	x		3, 46
Compatibility.	x		38, 46
Observability.	x		38, 46
Trialability.	x		38, 46
Reliability.	x		3
Complicatedness.	x		38
Currency, completeness, format, accuracy.	x		50
Subjective norms or social influence: the person' perception that most people who are important to him/her think he/she should or should not perform the behaviour in question.			
Social influence.	x		22, 30–33, 35, 43, 46, 51
Behavioural intention.		x	16, 20, 23, 24, 31, 40, 46
Subjective norms / Normative beliefs.	x		19, 29, 37, 40, 46
Professional norms and social norms.	x		23, 36, 46
Support from other colleagues.	x		16, 46
Presence of champions.	x		46
Facilitating condition: objective factors in the environment that observers agree make an act easy to perform, including the provision of computer support.			
Facilitating conditions.	x		22, 31, 33, 45, 46, 38
Perceived mobility.		x	26, 46
Optimism.		x	20
Insecurity.		x	20
Time to select, purchase and implement the system.	x		3
Time to learn the system.	x		3

	Organizational factors	Rational factors	References
Self-efficacy: the degree to which a person believes that the better their understanding and knowledge regarding computers, the more likely a person would feel (as a result of their confidence level) comfortable using computer.			
Computer self-efficacy.		x	23, 36, 40, 41, 46, 38
Habit or familiarity with EMRs.		x	6, 30, 34, 43, 45, 46
Computer anxiety.		x	39, 41, 46
Ability with EMRs and professional tasks.		x	6, 17, 30, 46
Computer skills of the physicians and/or the staff.		x	16, 30, 46
User acceptance.		x	34, 46
Compatibility with work process or job relevance: the degree to which an innovation is perceived as being consistent with the existing values, needs and experiences of potential adopters.			
Lack of time and workload.	x		3, 6, 17, 34, 46
Perceived inequity.		x	18, 46
Staff shortages.	x		34, 46
Resistance to change.		x	23, 34, 39, 46
Change process.	x		3, 39, 40, 46
Medical error.	x		34
Missing data.	x		34
More time per patient.	x		3
Patient and health professional interaction.	x		3, 6, 16, 17, 27, 46
Productivity.	x		3, 6, 17, 34, 46
Individual attitude toward using technology: an individual's positive or negative feelings about performing the target behaviour (individual's evaluation of the behaviour of interest).			
Attitudes toward using EMR.		x	19, 24, 29, 33, 34, 46, 47, 51
User satisfaction.		x	35, 46, 50
Personal innovativeness.		x	20, 39, 46
Hedonic motivation.		x	45, 46
Perceived enjoyment.		x	50
Management leadership: management provides/needs to provide a supportive working environment and encouragement to innovate and improve working practice.			
Management support.	x		16, 27, 39, 46
Institutional trust.	x		29, 41, 46
Organizational environment.	x		3, 46
Support from organizational culture.	x		3, 46
Leadership.	x		3, 46
Training: providing adequate training – for example, involving end-users through onsite training by colleagues or individual follow-up, reinforces the perception of future benefits and allows for fewer degrees of resistance.			
Technical training and support.	x		3, 25, 27, 28, 34, 35, 46
Financial incentives.	x		3, 34, 47, 49
Costs and financial resources.	x		3, 6, 16, 17, 34, 40, 45, 46
Participation of end-users in the design and implementation process: favouring active involvement of users during all implementation phase can help them develop feelings of ownership toward the clinical system.			
Physicians' involvement.	x		27, 46
Participation of end-users in implementation.	x		17, 46

	Organizational factors	Rational factors	References
Information security expectancy: the degree to which a person believes that their sensitive information will not be viewed, stored, or manipulated by unauthorized persons. Data confidentiality is preserved and the right levels of authorization to access data are given.			
Privacy or security concerns.	x		16, 3, 6, 30, 34, 41, 46
Perceived threat/risk		x	18, 26, 29, 46
Perceived behavioural control.	x	x	19, 29, 46
Participation of end-users in communication process: active involvement of users during all implementation phases can help them develop feelings of ownership toward the clinical system.			
Channels of communication and feedback.	x		25, 46
Service quality (information quality, reliability, accessibility, flexibility, timeliness).	x		50
Information about change.	x		23

5. Discussion

This study aimed at identifying the state-of-the-art of the determinants that influence the intention to use EMRs in hospitals, and at verifying whether or not an interplay exists between organizational and individual factors. In the light of the results that emerged from the literature review, three main issues are worthy of discussion. First, the results summarize the most important determinants of the intention to use EMRs and other health information systems by hospital professionals. In particular, data were categorized into the following macro-determinants [46] (Table 6): perceived usefulness or performance expectancy; perceived ease of use or effort expectancy; system quality/information quality; subjective norms or social influence; facilitating conditions; self-efficacy; compatibility with work process or job relevance; individual attitude toward using technology; management leadership; training; participation of end-users in the design and implementation process; information security expectancy; participation of end-users in communication process. The most frequent determinants identified are the individual ones, including perceived usefulness, performance and outcomes expectancy, perceived ease of use, effort expectancy, behavioural intention, computer self-efficacy (e.g.: habit or familiarity with EMRs; computer anxiety; ability with EMRs and professional tasks; computer skills of the physicians and/or the staff; user acceptance), perceived threat/risk, perceived behavioural control, or individual attitude toward using technology. These factors are followed by determinants related to system quality and information quality, including design, technical concerns, complexity and limitation of the system, subjective norms or social influence, facilitating conditions, privacy or security concerns. Another relevant factor identified was about costs and financial resources, but this refers in particular to management. Finally, an important class of organizational and/or individual determinants refers to the compatibility of systems' implementation with work process, in other words, the degree to which an innovation is perceived as being consistent with the existing values, needs and experiences of potential adopters. Some of the most cited factors in this category are, for example: lack of time and workload; perceived inequity; staff shortages; resistance to change; change process; medical error; patient and health-care professionals' interaction; and productivity. Second, the analysis shows that, although many organizational determinants (e.g.: management support; institutional trust; organizational environment; support from

organizational culture and leadership) were identified as affecting the intention to use the EMRs, all studies refer only to functional models, to which some organizational factors are added from time to time, but never refer to theories derived from Organizational Studies, such as institutional theories.

Third, the interplay between organizational and rational determinants has been studied only in three papers. In particular, past studies explored the effects of organizational contextual factors (management support, physicians' involvement, physicians' autonomy and doctor–patient relationship, financial incentives) on physicians' intention to use EMRs [27,47] and one study [48] proposed an integration between the models TOE and TAM, identifying some significant factors (compatibility, complexity, organizational competency, management support, competitive pressure, and trading partner support) that affect the end-user's behaviour when comprehensive implementation of EMRs is considered.

6. Conclusions

This study confirms that the integration between organizational and user acceptance models is still puzzling; in other words, social influences and organizational conditions are often incorporated in information technology studies without referring to well-established theories; on the other hand, elements from the information systems field are incorporated in Organizational Studies to explain the behaviour of organizations but overlook the choices made by individuals [8]. For this reason it would be useful to promote research in which institutional theories and rational models are integrated, to bring new light on the phenomena that influence digital technology' acceptance in hospitals.

This study offers original insights into the field of Information Science. The main findings are useful for academia as they consolidate what we know about the users' acceptance of technologies. They are also useful for practitioners, such as hospital managers, who might be involved in adoption and implementation of EMRs in hospitals.

References

1. Laerum H, Faxvaag A. Task-oriented evaluation of electronic medical records systems: development and validation of a questionnaire for physicians. BMC Medical Informatics and Decision Making. 2004;4:1.
2. Gastaldi L, Lettieri E, Corso M, Masella C. Performance improvement in hospitals: leveraging on knowledge asset dynamics through the introduction of an electronic medical record. Measuring Business Excellence. 2012;16(4):14–30.
3. Boonstra A, Broekhuis M. Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions. BMC Health Services Research. 2010; 10:231.
4. Cucciniello et al. Understanding key factors affecting electronic medical record implementation: a sociotechnical approach. BMC Health Services Research. 2015;15:268; doi: 10.1186/s12913-015-0928-7.
5. Boonstra A, Versluis A, Vos JF. Implementing electronic health records in hospitals: a systematic literature review. BMC Health Service Research. 2014;4(14):370.
6. McGinn CA, Grenier S, Duplantie J, Shaw N, Sicotte C, Mathieu L, Leduc Y, Legare F, Gagnon MP. Comparison of use groups perspectives of barriers and facilitator to implementing EHR: a systematic review. BMC Medicine 2011;9:46.
7. Keshavjee K, Bosomworth J, Copen J, Lai J, Kucukyazici B, Liani R, Holbrook AM. Best practices in EMR implementation: a systematic review. In Proceeds of the 11th International Symposium on Health Information Management Research – iSHIMR. 2006;1–15.
8. Gastaldi L., Radaelli G., Lettieri E., Luzzini D., Corso M. Professionals' use of ICT in hospitals: the interplay between institutional and rational factors. International Journal of Technology Management (IJTM). 2019;80(1/2). https://doi.org/10.1504/IJTM.2019.099768.
9. Scott WR. Institutions and organizations. Thousands Oaks (CA): Sage; 1995.
10. Radaelli G, Currie G, Frattini F., Lettieri E. The role of managers in enacting twostep institutional work for radical innovation in professional organizations. The Journal of Product Innovation Management. 2017;34(4):450–470.
11. Gastaldi L, Corso M. Smart healthcare digitalization: using ICT to effectively balance exploration and exploitation within hospitals. International Journal of Engineering Business Management, Special Issue on Digital and Mobile Economy. 2012;4(1):1–13.
12. Davis F. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly. 1989;13(3):319–340.
13. Ajzen I. The Theory of Planned Behavior. Organizational Behavior and Human Decision Process. 1991;50:179–211.
14. Venkatesh V., Morris MG, Davis GB, and Davis FD. User acceptance of information technology: toward a unified view. MIS Quarterly: Management Information Systems. 2003;27:425–478.
15. Ammenwerth Elske. Technology acceptance models in health informatics: TAM and UTAUT. Applied Interdisciplinary Theory in Health Informatics; 2019; doi:10.3233/SHTI190111.
16. Wilkins M A. Factors influencing acceptance of electronic health records in hospitals. Perspectives in Health Information Management 2009; 6.

17. McGinn CA, Gagnon M-P, Shaw N, Sicotte C, Mathieu L, Leduc Y, et al. Users' perspectives of key factors to implementing electronic health records in Canada: a Delphi study. BMC Medical Informatics and Decision Making. 2012;12:105.

18. Lin Chihung, Lin I-Chun, Roan Jinsheng et al. Barriers to physicians' adoption of healthcare information technology: an empirical study on multiple hospitals. Journal of Medical Systems. 2012;36(3):1965–1977.

19. Leblanc G., Gagnon M.-P., Sanderson D. et al. Determinants of primary care nurses' intention to adopt an electronic health record in their clinical practice. Journal of Medical Internet Research. 2012;14(5):e5.

20. Kuo1 Kuang-Ming, Liu Chung-Feng, Ma Chen-Chung. An investigation of the effect of nurses' technology readiness on the acceptance of mobile electronic medical record systems. BMC Medical Informatics and Decision Making. 2013;13:88.

21. Hsu Su-Chen, Liu Chung-Feng, Weng Rhay-Hung and Chen Chia-Jung. Factors influencing nurses' intentions toward the use of mobile electronic medical records. Computer Informatics Nursing. 2013; 31(3):124–132.

22. Sharifi R, Askarian F, Nematolahi M Farhadi P. Factors influencing nurses' acceptance of hospital information systems in Iran: application of the Unified Theory of Acceptance and Use of Technology. The Health Information Management Journal. 2014; doi: 10.12826/18333575.2014.000.

23. Gagnon M-P, Ghandour El K, Kengne T P, Simonyan D, Godin G, Labrecque M, Mathieu O, Rousseau M. Electronic health record acceptance by physicians: testing an integrated theoretical model. Journal of Biomedical Informatics. 2014;48:17–27 .

24. Fleming M L., Hatfield M D., Wattana MK., and Todd KH. Exploratory study of emergency physicians' use of a prescription monitoring program using a framework of technology acceptance. Journal of Pain & Palliative Care Pharmacotherapy. 2014;Early Online:1–9.

25. Khalifa M, Alswailem O. Hospital information systems (his) acceptance and satisfaction: a case study of a tertiary care hospital. Procedia Computer Science. 2015;63:198–204.

26. Liu Chung-Feng, Cheng Tain-Junn. Exploring critical factors influencing physicians' acceptance of mobile electronic medical records based on the dual-factor model: a validation in Taiwan. BMC Medical Informatics and Decision Making. 2015;15:4; doi 10.1186/s12911-014-0125-3.

27. Abdekhoda M, Ahmadi M, Gohari M, Noruzi A. The effects of organizational contextual factors on physicians' attitude toward adoption of electronic medical records. Journal of Biomedical Informatics. 2015;53:174–179.

28. Saleema J J, Plewa WR, Speira RC, Herouta J, Wilcka NR, Ryanc DM, Cullend TA., Scotte JM., Beenec MS., Phillips T. Understanding barriers and facilitators to the use of clinical information systems for intensive care units and anesthesia record keeping: a rapid ethnography. International Journal of Medical Informatics. 2015;84(7):500–511. doi:10.1016/j.ijmedinf.2015.03.006.

29. Hsieh Pi-Jung. Physicians' acceptance of electronic medical records exchange: an extension of the decomposed TPB model with institutional trust and perceived risk. International Journal of Medical Informatics. 2015; 84(1):1–14.

30. Steininger Katharina, Stiglbauer Barbara. EHR acceptance among Austrian resident doctors. Health Policy and Technology. 2015;4(2):121–130.

31. Phichitchaisopa N., Naenna T. Factors affecting the adoption of healthcare information technology. EXCLI Journal. 2015;12:413–436.

32. Garavand A, Mohseni M, Asadi H, Etemadi M, Moradi-Joo Mohammad, Moosavi A. Factors influencing the adoption of health information technologies: a systematic review. Electronic Physician. 2016;8(8):2713–2718; doi: http://dx.doi.org/10.19082/2713.

33. Kim S, Lee KH, Hwang H, Yoo S. Analysis of the factors influencing healthcare professionals' adoption of mobile electronic medical record (EMR) using the unified theory of acceptance and use of technology (UTAUT) in a tertiary hospital. BMC Medical Informatics and Decision Making. 2016;16:12; doi 10.1186/s12911-016-0249-8.

34. Kruse CS, KC, Jones B, Mitchell E, Martinez A. Barriers to electronic health record adoption: a systematic literature review. Journal of Medical Systems. 2016;40: 252; doi 10.1007/s10916-016-0628-9.

35. Holden RJ, Asan, Wozniak EM, Flynn KE., Scanlon MC. Nurses' perceptions, acceptance, and use of a novel in-room pediatric ICU technology: testing an expanded technology acceptance model. BMC Medical Informatics and Decision Making. 2016;16:145; doi 10.1186/s12911-016-0388-y.

36. Gagnon M-P, Simonyan D, Ghandour El K, Godin G*aston*, Labrecque M, Ouimet M, Rousseau M. Factors influencing electronic health record adoption by physicians: a multilevel analysis. International Journal of Information Management. 2016; 36(3):258–270.

37. Hadji B, Martin G, Dupuis I, Campoy Eric, Degoulet P. 14 years longitudinal evaluation of clinical information systems acceptance: the HEGP case. International Journal of Medical Informatics. 2016;86:20–29.

38. Abdekhoda M, Ahmadi M, Dehnad A, Noruzi A, Gohari M. Applying electronic medical records in health care. Applied Clinical Informatics. 2016;7: 341–354. http://dx.doi.org/10.4338/ACI-2015-11-RA-0165.

39. Beglaryan M, Petrosyan V, Bunker E. Development of a tripolar model of technology acceptance: hospital-based physicians' perspective on HER. International Journal of Medical Informatics. 2017;102:50–61.

40. Hsieh Hui-Lung, Kuo Yu-Ming, Wang Shiang-Ru, Chuang Bi-Kun, Tsai Chung-Hung. A study of personal health record user's behavioral model based on the PMT and UTAUT integrative perspective. International Journal of Environmental Research and Public Health. 2017;14(8); doi:10.3390/ijerph14010008.

41. Vitari C, Ologeanu-Taddei R. The intention to use an electronic health record and its antecedents among three different categories of clinical staff. BMC Health Services Research. 2018;18:194. https://doi.org/10.1186/s12913-018-3022-0.

42. Tubaishat A. Perceived usefulness and perceived ease of use of electronic health records among nurses: application of Technology Acceptance Model. Informatics for Health and Social Care. 2018;43(4).

43. Tavares J, Goulão A, Oliveira T. Electronic health record portals adoption: empirical model based on UTAUT2. Informatics for Health and Social Care. 2018;43(2).

44. Tavares J, Oliveira T. New integrated model approach to understand the factors that drive electronic health record portal adoption: cross-sectional national survey. Journal of Medical Internet Research. 2018;20(11):e11032); doi:10.2196/11032.

45. Rasmi M, Alazzam MB, Alsmadi Mutasem K, Almarashdeh IA, Alkhasawneh RA, Alsmadi S. Healthcare professionals' acceptance electronic health records system: critical literature review (Jordan case study). International Journal of Healthcare Management. 2018; https://doi.org/10.1080/20479700.2017.1420609.

46. Handayani PW, Hidayanto AN, Budi I. User acceptance factors of hospital information systems and related technologies: systematic review. Informatics for Health and Social Care. 2018;43(4):401–426. https://doi.org/10.1080/17538157.2017.1353999.

47. Hwang Hsin-Ginn, Dutta Bireswar, Chang Hui-chuan. The differing effect of gender and clinical specialty on physicians' intention to use electronic medical record. Methods of Information in Medicine. 2019. doi: 10.1055/s-0039-1695718.

48. Abdekhoda M, Dehnad A, Zarei J. Determinant factors in applying electronic medical records in healthcare. East Mediterr Health J. 2019;25(1):24–33. doi: 10.26719/emhj.18.007.

49. Al-Rawajfaha O, Tubaishatb A. Barriers and facilitators to using electronic healthcare records in Jordanian hospitals from the nurses' perspective: a national survey. Informatics for Health and Social Care. 2019;44(1):1-11. https://doi.org/10.1080/17538157.2017.1353998.

50. Ho KF, Ho CH, Chung MH. Theoretical integration of user satisfaction and technology acceptance of the nursing process information system. PLoS One. 2019;14(6):e0217622; doi: 10.1371/journal.pone.0217622.

51. Biruk SK, Abetu ME. Modeling predictors of acceptance and use of electronic medical record system in a resource limited setting: using modified UTAUT model. Informatics in Medicine Unlocked. 2019. https://doi.org/10.1016/j.imu.2019.100182.

De Benedictis A., Lettieri E., C. Pensieri; R. Alloni; Tartaglini D. **WhatsApp in Hospitals: Poison or Medicine? Insights from a Systematic Review**

Title

WhatsApp in Hospitals: Poison or Medicine? Insights from a Systematic Review

Authors

Anna De Benedictis[1,2], Emanuele Lettieri[2], Rossana Alloni[1], Claudio Pensieri[1] and Daniela Tartaglini[1]

Affiliation

[1]University Campus Bio-Medico of Rome. Via Alvaro del Portillo, 200, CAP.00128, Rome (Italy).

[2]Politecnico di Milano, P.zza Leonardo da Vinci, 32; 20133 Milan (Italy)

E-mail address and fax number of the corresponding author

Corresponding Author: Anna De Benedictis

E-mail a.debenedictis@unicampus.it

Abstract

Background
WhatsApp is one of the instant messaging application more extended in use and, while not being designed for this purpose, the number of healthcare professionals using it is increasing. Recent research evaluated the impact of the use of WhatsApp on quality and safety of patient care; however, there are still little evidences about the strength of recommendations about WhatsApp usage in hospitals for specific clinical, research and education activities, and it is not clear whether and how individual and organizational determinants influence the hospital professionals' intention to use WhatsApp.
Purpose
The main purpose of this study is to identify which are the organizational and individual determinants of WhatsApp usage in hospitals and to evaluate the strength of recommendations about its use with patients and between hospital professionals.
Methods
A literature review was carried out using Scopus, Web of Science, Medline, EBSCOHost and Cochrane Library as the main sources of evidence. Inclusion and exclusion criteria have been defined and applied. Only empirical journal articles and past reviews have been included. Data extraction has been informed based on a theoretical approach including organizational and individual determinants and the interplay between them, usage and strength of recommendations.
Results
A total of 31 past studies were selected, including 2 literature reviews whose main aims were to evaluate the various applications of WhatsApp in healthcare. The 29 empirical articles focused on to explore the effectiveness of WhatsApp usage for different and particular process regarding both, clinical or continuous education setting. Of these, 25

studies have been conducted using different qualitative or quantitative methods; three studies were randomized controlled trials and one study was a cohort study. Only one study analyze organizational and individual determinants of WhatsApp usage in hospitals and the interplay between the determinants. Three studies provide a degree of recommendation of A, while the others a level of recommendation of B or none evidence.

Conclusion

The findings confirm that WhatsApp is used for different purposes among physicians and with patients. However, high-quality and specific research is needed, particularly to address concerns about patient safety, quality of care, confidentiality and safety of communications. This study offers original insights in in the field of Information Science. The main findings are useful for academia and for practitioners, as hospital managers, to manage the widespread use of WhatsApp in hospitals.

Keywords: WhatsApp, Hospital, Healthcare, Organization, Technology Acceptance, Intention to Use.

1. Background

In the last twenty years, social media and communication tools have developed in a very fast way, and with the availability of Internet on mobile phones, a new era of communication has begun [1]. These developments have had a great impact on the private and professional lives of people who now have the chance to always be "in touch" with the world. Even in healthcare context and particularly in hospital setting, the growing use of apps to support clinical and care processes and to communicate between peers and with patients has been documented [2]. There is currently a large number of mHealth apps available and useful to empower patients to manage disease conditions, and there is also an increasing number of apps designed specifically for healthcare professional use in the clinical environment to enhance efficiency around work-related tasks [2].

In this systematic review we focused on WhatsApp because is the most diffused text messaging application used by an increasing number of healthcare professionals in their daily work and for different reasons [3-7], and because its usage in hospitals is actually very controversial. In fact, its ease of use – and penetration in our daily life – matches with the risks related to errors, communication misunderstandings and privacy violations.

The first paper reporting the use of WhatsApp in a clinical setting appeared in the year 2013 [4] where plastic surgeons in Saudi Arabia studied "the efficacy of smartphone and its WhatsApp application as a communication method amongst the staff of plastic and reconstructive surgery section at tertiary care health facility". With respect to the use of WhatsApp in healthcare past research highlighted both some related advantages [8-15] and some possible risks [4, 15, 19-24]. Recent research is increasingly seeking to evaluate the impact of the use of WhatsApp on quality and safety of patient care [7]; however, there are still little evidence about the strength of the recommendations for a safe use of WhatsApp in hospitals for specific clinical, research and education activities, and it is not clear whether and how individual and organizational determinants influence the hospital professionals' intention to use WhatsApp.

2. Objectives

Based on this context, this literature review aims at offering original insights to further the ongoing debate about WhatsApp usage in hospitals. In particular, the main objectives of this literature review are to map the current use of WhatsApp in hospitals, to identify which are the organizational and individual determinants of the intention to use it, and to evaluate the strength of recommendations about WhatsApp usage with patients and between hospital professionals.

3. Methods

3.1 Identification of past contributions
We aimed at identifying previous literature reviews on this topic as well as studies that might be informative for our research questions. The first search has been carried out in June 2016 and it has been reviewed and concluded in August 2019.

3.2 Types of studies
We included studies with primary data and systematic literature reviews; positioning papers and debate papers were excluded. In particular, we considered studies published in English from January 2000 to August 2019.

3.3 Types of participants
We included studies performed in hospitals and focused on physicians, residents, nurses or patients. We excluded studies that assessed only students.

3.4 Types of interventions
We included all interventions related to WhatsApp application. We excluded interventions related to other type of messaging applications.

3.5 Search methods for identification of studies
A systematic electronic search of the EBSCOHost, PubMed, Web Of Science, Scopus and the Cochrane Library databases was performed (Table 1) to find all literature using the term "WhatsApp [All fields]" combined with "Hospital", "Health", "nurse", "physician" and "patient" (Table 2). In addition, we included synonymous and related terms using the Boolean Operators (AND/OR) and the truncations (*). (Table 2)

Table 1 – List of databases.

Database	N. of records found
EBSCOHost	149
PubMed	300
Web of Science	263
Scopus	244
Cochrane Library	116

Table 2 - Overview of the terms used

Search strategy	Terms used
1	"WhatsApp"
2	"WhatsApp" AND "hospital"
3	(WhatsApp AND ("healthcare" OR "health" OR health* OR "hospital" OR "hospital*" OR "clinic" OR "medic" OR "medic*" OR "physician" OR "physician*" OR "nurse" OR "nurse*" OR "care" OR "patient" OR "patients" or patient*))

The articles identified from the search strategy were assessed and they had to satisfy the following criteria to be included: published between January 2000 and August 2019; focused on hospital; based on primary data being a literature review. No study was excluded due to the original language in which it was written.

4. Data collection and analysis

4.1 Paper selection
The list of articles generated was been reviewed by the authors in order to remove duplicate records; retrieve full text of the potentially relevant reports; examine full-text reports for compliance of studies with eligibility criteria; shortlisted abstracts for detailed review and assessed each study for eligibility; make final decisions on study inclusion and proceed to data collection.

Screening has been carried out by two co-authors for each contribution to limit the risk of excluding relevant past studies or including studies that were out of scope. The first round of screening dealt with titles and key words and it reduced the included contributions from 1,072 to 335 with the exclusion of 737 studies that have judged as out of scope. After eliminating 198 duplicate articles the remained records (140) were screened by the authors based on their abstract. A total of 140 studies are finally assessed for eligibility. After this stage, other 109 studies have been excluded because out of the scope (in particular not about hospitals or assessing only students) or because they did not meet the inclusion/exclusion criteria. Moreover, two studies conducted through randomized controlled trials have been excluded because the full texts were no available. Finally, 31 contributions have been selected and included. The results at the different stages have been synthetized in Figure 1.

5. Main Results

5.1 Data extraction
As result of the screening, 31 contributions have been selected for grounding this literature review. Of them, 29 are empirical studies and 2 systematic reviews. Selected contributions are listed in Table 4. The authors have read the selected papers and evidences from them have been extracted after having agreed a data extract form. Data extraction has been informed by the design of a theoretical framework (Figure 2), based on a theoretical approach including organizational and individual determinants and the interplay between them, usage and strength of recommendations. The level of evidence was determined according to the Oxford Levels of Evidence ranking system produced [25] (Table 3).

Table 3 – Oxford Levels of Evidence [25]

Grade of recommendation	Level of evidence	Intervention
A	1a	Systematic review of randomized controlled trials
	1b	Individual randomized controlled trial
B	2a	Systematic review of cohort studies
	2b	Individual cohort study
	3a	Systematic review of case-control studies
	3b	Individual case-control study
C	4	Case series
D	5	Expert opinion without explicit critical appraisal or based on physiology or bench research

5.2 Main findings

In order to answer the research questions each study has been analyzed based on the theoretical framework (Figure 2). In particular, for each paper were identified also the organizational and institutional determinants considered and the interplay between them, the mode of use WhatsApp and the strength of recommendations (Tables 4-6). Two past reviews have been identified, whose main aims were to explore the various applications of WhatsApp in healthcare. By the results of the two papers emerge that WhatsApp is a promising system, that can be used as a communication tool between health care professionals, as a means of communication between health care professionals and the general public, or as a learning tool for providing health care information to professionals or patients. Using WhatsApp for clinical communication and teaching facilitates timely responses among healthcare professionals, faster handovers for physicians at hospitals, and a wider dissemination of public health messages. WhatsApp is used for different purposes: sharing of information and images between physicians; interdepartmental communication; participation in group discussion for preventing smoking; participation in WhatsApp groups in order to facilitate laboratory management system. However, the authors assume that high-quality and specific research is needed, particularly to address concerns about patient safety, quality of care, confidentiality and safety of communications. The 29 empirical articles focused on explore the effectiveness of WhatsApp usage for different and particular process in clinical or continuous education setting. Of these, 25 studies have been conducted using various qualitative or quantitative methods (e.g.: survey, retrospective or prospective analysis; ground theory; focus group, etc.); 3 studies were randomized controlled trials and 1 study was a cohort study. Only one study analyzes organizational and individual determinants of WhatsApp usage in hospitals and the interplay between the determinants. Three studies provide an evidence level of 1b and therefore a degree of recommendation of A, and the others a level of recommendation of B, C or none evidences. Tables 4 and 5 offer a comprehensive overview of the selected papers' methods and content, and Table 6 summarizes the degree of recommendation for the use of WhatsApp emerging from each selected paper.

Figure 1 – Selection procedure.
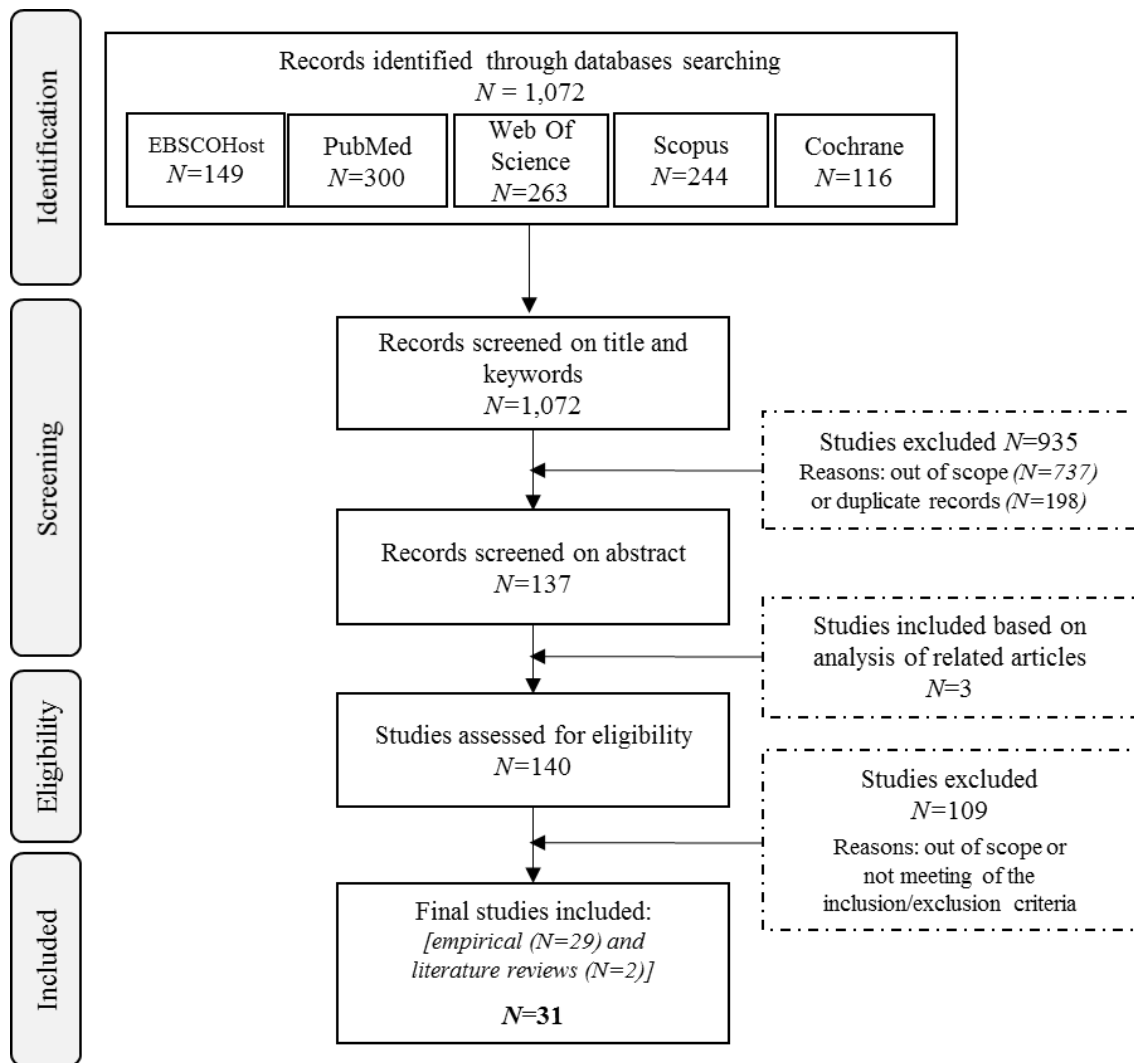
Figure 2 – Theoretical Framework
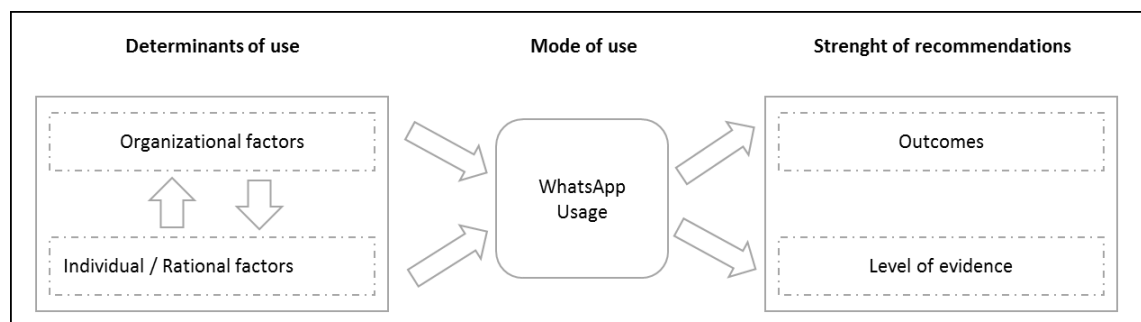
Table 4 – Overview of studies included in the literature review.

No.	Type	Author(s)	Title	Journal	Year
1	Empirical study	Wani SA, *et al.*	Efficacy of communication amongst staff members at plastic and reconstructive surgery section using smartphone and mobile WhatsApp.	*Indian Journal of Plastic Surgery*	2013
2	Empirical study	Khanna V, *et al.*	"WhatsApp"ening in orthopedic care: a concise report from a 300-bedded tertiary care teaching centre.	*European Journal of Orthopaedic Surgery & Traumatology*	2015
3	Empirical study	Giordano V, *et al.*	WhatsApp messenger is useful and reproducible inthe assessment of tibial plateau fractures: Inter-and intra-observer agreement study.	*International Journal of Medical Informatics*	2015
4	Empirical study	Johnston MJ, *et al.*	Smartphones let surgeons know WhatsApp: an analysis of communication in emergency surgical teams.	*The American Journal of Surgery*	2015
5	Empirical study	Astarcioglu MA, *et al.*	Time-to-reperfusion in STEMI undergoing inter-hospital transfer using smartphone and WhatsApp messenger.	*American Journal of Emergency Medicine*	2015
6	Empirical study	Nardo B, *et al.*	Optimizing Patient Surgical Management Using WhatsApp Application in the Italian Healthcare System.	*Telemedicine and e-health*	2016
7	Literature review	Boulos K, *et al.*	Instagram and WhatsApp in Health and Healthcare: An Overview.	*Future Internet*	2016
8	Empirical study	Pérez Z, *et al.*	LifeQuestionnaire. A new tool for the evaluation of quality of life in patients with hearing loss-using WhatsApp.	*European Annals of Otorhinolaryngology, Head and Neck diseases*	2016
9	Empirical study	Gulacti U, *et al.*	An Analysis of WhatsApp Usage for Communication Between Consulting and Emergency Physicians.	*Journal of Medical System*	2016
10	Empirical study	Sarode SC, *et al.*	WhatsApp is an effective tool for obtaining second opinion in oral pathology practice.	*Journal of Oral Pathology & Medicine*	2017
11	Empirical study	Ganasegeran K, *et al.*	The m-Health revolution: Exploring perceived benefits of WhatsApp use in clinical practice.	*International Journal of Medical Informatic*	2017
12	Empirical study	Gulacti U, *et al.*	Comparison of secure messaging application (WhatsApp) and standard telephone usage for consultations on Length of Stay in the ED.	*Applied Clinical Informatics*	2017

(continued)

No.	Type	Author (s)	Title	Journal	Year
13	Empirical study	Bakshi SG, *et al.*	Role of WhatsApp-based discussions in improving residents' knowledge of post-operative pain management: a pilot study.	*Korean Journal of Anesthesiology*	2017
14	Literature review	Giordano V, *et al.*	WhatsApp Messenger as an Adjunctive Tool for Telemedicine: An Overview.	*Interactive Journal of Medical Research*	2017
15	Empirical study	Ellanti P, *et al.*	The Use of WhatsApp Smartphone Messaging Improves Communication Efficiency within an Orthopaedic Surgery Team.	*Cureus*	2017
16	Empirical study	Eksert S, *et al.*	Efficiency of instant messaging applications in coordination of emergency calls for combat injuries: A pilot study.	*Turkish Journal Of Trauma & Emergency Surgery*	2017
17	Empirical study	Furtado Leão C, *et al.*	The use of WhatsApp in the physician-patient relationship.	*Revista Bioética*	2018
18	Empirical study	Martinez R, *et al.*	The value of WhatsApp communication in paediatric burn care.	*Burns*	2018
19	Empirical study	Patel SJ, *et al.*	Providing support to pregnant women and new mothers through moderated WhatsApp groups: a feasibility study.	*mHealth*	2018
20	Empirical study	Alanzi T, *et al.*	Evaluation of a mobile social networking application for improving diabetes Type 2 knowledge: an intervention study using WhatsApp.	*Journal of Comparative Effectiveness Research*	2018
21	Empirical study	Senera TE, *et al.*	WhatsApp Use In The Evaluation of Hematuria.	*International Journal of Medical Informatics*	2018
22	Empirical study	Carmona S, *et al.*	Realizing the potential of real-time clinical collaboration in maternal–fetal and obstetric medicine through WhatsApp.	*Obstetric Medicine*	2018
23	Empirical study	Garg N, *et al.*	Utility of WhatsApp as a Tool for Tele-oncopathology for Oral Lesions.	*Indian Journal of Surgical Oncology*	2019
24	Empirical study	Othman M, *et al.*	Developing a nationwide spine care referral programme on the WhatsApp messenger platform: The Oman experiment.	*International Journal of Medical Informatics*	2019
25	Empirical study	Dungarwalla M, *et al.*	Use of WhatsApp in an oral and maxillofacial surgery department at a major trauma centre and its role during major incidents: our experience.	*British Journal of Oral and Maxillofacial Surgery*	2019

(continued)

No.	Type	Author (s)	Title	Journal	Year
26	Empirical study	Kapıcıoğlu M, *et al.*	The reliability of use of WhatsApp in type 1 and type 2 pediatric supracondylar fractures.	*Eklem Hastalik Cerrahisi*	2019
27	Empirical study	Clavier T, *et al.*	Use of the Smartphone App WhatsApp as an E-Learning Method for Medical Residents: Multicenter Controlled Randomized Trial.	*JMIR Mhealth Uhealth*	2019
28	Empirical study	Gross I, *et al.*	Questionnaire-based study showed that neonatal chest radiographs could be reliably interpreted using the WhatsApp messaging application.	*Acta Pædiatrica*	2019
29	Empirical study	Bennani A, *et al.*	Usefulness of WhatsApp for Discussing Difficult Cases in Pathology Practice: A Moroccan Experience.	*Turk Patoloji Dergisi (Turkish Journal of Pathology)*	2019
30	Empirical study	De Benedictis A, *et al.*	WhatsApp in hospital? An empirical investigation of individual and organizational determinants to use.	*PLoS One*	2019
31	Empirical study	Machado RS, *et al.*	Instant messenger smartphone application for endosonographer/cytopathologist real-time interaction at a distance in EUS-FNA for solid pancreatic lesions.	*Endoscopy International Open*	2019

6. Discussion

The aims of this study were to evaluate the state of art of WhatsApp usage in hospitals and the related individual and organizational determinants, and to verify if and how strength of recommendations for each founded intervention are available. The results confirm that WhatsApp is widely used in hospitals for different reasons and with a deep impact on how hospitals professionals and healthcare organizations interact among themselves, with patients and the community [48]. WhatsApp proved useful to reduce costs, increase effectiveness, and facilitate communication between hospital professionals and with patients.

In particular it is used for communication among physicians to discuss clinical cases or share interest or knowledge in groups [3,4,9,19], either in relation to a single or multiple disciplines to facilitate communication and discussion or decision making. Some studies report evidence about the effectiveness of WhatsApp usage to train residents and share learning program with them on specific clinical themes [19,42,44]. WhatsApp is also effective for some kind of teleconsultation [14,28,43,45] and for patient-doctor communication for different types of requests (medical, administrative, etc.) [14,34,37,39]. WhatsApp platforms can improve the adherence to care and the health outcomes in pregnancy and the postpartum period, and it is also used to obtain second opinions or to confirm or make diagnosis [28,36,46,47].

Studies have been conducted that reveal the effectiveness of WhatsApp in the request for peer counseling (eg: for particularly complex cases). In addition, the possibility of sending and sharing the results of certain tests (laboratory, X-ray, ultrasonography, electrocardiogram and photographs of patient's lesions) has proved effective and contributed to a more objective and efficient care, especially in cases of medical emergency. WhatsApp is widely used for inter and intra-departmental communication and for communication between clinical teams and for inter and intra-hospital communication. In this context, this application has proved particularly effective within the emergency department. Few studies are available about the effectiveness of WhatsApp usage in hospitals. The best available evidences, with a level of recommendation of grade A (Table 3) [25] concern the efficacy of WhatsApp for consultations in Emergency Department (ED) [30], for improving knowledge, self-efficacy and awareness of patients about diabetes management [37], for enhancing clinical reasoning in medical residents [44]. The study of Gulacti et al. [30] demonstrates that the use of this app for consultations in the ED reduces the total emergency department length of stay consultation time, and that consultation with secure messaging application eliminated more than half of in-person ED consultation visits. Others studies demonstrated, with a minor strength of recommendation (grade B), that WhatsApp is effective for facilitating communication among the staff of plastic and reconstructive clinical area [4], during elective surgery program between two distant teaching hospitals [26], among orthopedic residents [19] and in orthopaedic surgery team [32], in emergency surgical teams [3, 9, 33] and for hospital without percutaneous coronary intervention (PCI) [6]. With the same level of evidence WhatsApp results effectual in the diagnosis and classification by means of plain radiographs and CT scans of tibial plateau fractures (photographed and sent via WhatApp) [5], for obtaining second opinion on histopathological diagnosis in oral pathology practice and for discussing difficult cases [28, 46], for the evaluation of hematuria through inter-rater agreement [38], to assess radiological X-ray images of traumatic injuries in the elbows of children [43], for the improving of physician-patient relationship in a pediatrics and obstetrics outpatient clinic [34], and in the paediatric burn injury consultations to a regional burn centre [35].

Results show that WhatsApp platforms are effective to train residents on pain management [31], for maxillofacial surgery junior trainees [42] and to enhance physician-education in obstetric and maternal–fetal medicine [39]. Moreover, level B of evidence [25] demonstrate that WhatsApp is effective for online evaluation of quality of life in patients with hearing loss using WA [27] and for paediatric residents and neonatologists for an online neonatal chest radiographs consultation [45]. Is interesting that no studies about nursing care are available. Some studies confirm that physicians more than nurses use WhatsApp to share information among working team and with patients, and that patients ask to physicians but not so much to nurses to use WhatsApp for communicating [8]. It would be very interesting to understand which are the reasons of the evident different use among different professions, also because, if some studies demonstrate the effectiveness of WhatsApp for clinical education and for patients' compliance improvement, it would be very important to deep this area for nurses, since the education is an important area of nursing care.

Although the end-to-end encryption had been implemented, there is still concern regarding some risks in terms of privacy, confidentiality, consent, and medical legal matters. In fact, despite the numerous perceived benefits, hospital professional, particularly physicians, perceive the use of WhatsApp not safe for both patient and professionals, and they suggest that guidelines and recommendations are needed as well as patient's informed consent for

data treatment when transmission of patient's sensitive data through WhatsApp is provided [8]. Finally, only one study [8] analyzes organizational and / or individual factors that might influence the use of WhatsApp in hospitals; and it show that WhatsApp is used because it is perceived as useful and easy to use (individual factors), and because it facilitates and optimizes some clinical processes and communication between professionals and patients.

6.1 Limitations

This paper presents several limitations. First, in this study only WhatsApp Messenger app has been considered, although many other similar messaging applications exist and are used. Second, the studies identified presented a relatively medium level of evidence, which reduces the trust that can be placed in their findings. Finally, despite WhatsApp is widely used in other healthcare settings only studies performed in hospitals have been considered. For these reasons it would be very important to explore the use of WhatsApp in different contexts and to improve the available level of evidences by conducting randomized controlled trials in different settings.

7. Conclusions

New digital technologies are radically transforming some health care processes and we need urgently to explore how this change may affect quality and safety of care for patients, and quality of life for doctors [48]. As Pellegrino [49] said *"medicine is the most humane of sciences, the most empiric of arts, and the most scientific of humanities"*, and the use of ICTs should be guided by such definition [50]. This will be possible even if the new digital technologies in healthcare will increasingly be used on the basis of proven scientific evidence and by making reference to the guidelines of internationally recognized scientific societies.

Table 5 – Overview of studies included in the literature review

No.	Author/Year	Objectives	Methods	Outcomes/Results	Conclusion	Grade of recommendation
1	Wani SA, *et al.*, 2013	To assess the efficacy of smartphone and its WhatsApp application as a communication method amongst the staff of plastic and reconstructive surgery section at tertiary care health facility.	From January 2012 onwards, the authors used smartphones and its WhatsApp application as a communication method amongst their team for various aspects of patient management and as a tool for academic endorsements.	116 episodes regarding patient management. Opinion of residents was sought regarding the efficacy of this method of communication. Overall majority of residents were satisfied with this mode of communication.	This new method of communication is an effective method for clinical and academic endorsements. The method is cheap and quick and easy to operate.	B
2	Khanna V, *et al.*, 2015	To report the impact of introduction of WhatsApp as an intradepartmental communication tool among orthopedic residents in a 300-bedded tertiary care teaching centre.	Twenty-five consecutive admissions before and after WhatsApp were included in the study. Eight orthopedic residents attempted fifty randomly arranged questions based on the twenty-five patients in each study period.	A significant improvement was observed in scores obtained by residents in the after WhatsApp group. The residents also reported swifter and efficient handovers after the introduction of WhatsApp.	The introduction of WhatsApp as an intradepartmental communication tool can bring about an improvement in patient-related awareness, communication and handovers among orthopedic residents.	B
3	Giordano V, *et al.*, 2015	To evaluate the inter- and intra-observer agreement in the initial diagnosis and classification by means of plain radiographs and CT scans of tibial plateau fractures photographed and sent via WhatsApp Messenger.	Plain radiographs and Cta scans were obtained from 13 cases of tibial plateau fractures. Images were photographed with a smartphone and sent to 6 observers via WhatsApp. Observers were asked to determine standard deviation and type of injury, classification, and whether the CT scan changed the classification.	The inter- and intra-observer agreement for both periods of the study ranged from excellent to perfect across all survey questions. When asked if the inclusion of the CT images would change their final X-ray classification, the inter- and intra-observer agreement was perfect on both assessment occasions.	The study demonstrates an excellent inter- and intra-observer agreement in the imaging assessment of tibial plateau fractures sent via WhatsApp Messenger.	B

(continued)

No.	Author/Year	Objectives	Methods	Outcomes/Results	Conclusion	Grade of recommendation
4	Johnston MJ, *et al.*, 2015	To evaluate implementation of the WhatsApp messaging service within emergency surgical teams.	A prospective mixed-methods study was conducted in a London hospital. All emergency surgery team members (n 5 40) used WhatsApp for communication for 19 weeks. The initiator and receiver of communication were compared for response times and communication types. Safety events were reported using direct quotations.	More than 1,100 hours of communication pertaining to 636 patients were recorded, generating 1,495 communication events. The attending initiated the most instruction-giving communication, whereas interns asked the most clinical questions (p =0.001). The resident was the speediest responder to communication compared to the intern and attending (p=0.001). The participants felt that WhatsApp helped flatten the hierarchy within the team.	The WhatsApp platform was deemed to be user friendly and was extensively used to facilitate communication within a team where junior physicians rotate on a weekly basis. In addition, significant benefits were realized through a system in which senior physicians had a constant overview of activities undertaken within their team without active interference, allowing their juniors to develop a degree of clinical independence at minimal risk to patient safety.	B
5	Astarcioglu MA, *et al.*, 2015	To assess the efficacy of WhatsApp application as a communication method among the emergency physician (EP) in a rural hospital without percutaneous coronary intervention (PCI) capability and the interventional cardiologist at a tertiary PCI centre.	Evaluation of 108 patients with STEMI in a rural hospital with emergency department but without PCI capability to determine the impact of WhatsApp triage and activation of the cardiac catheterization laboratory on D2B time.	The images were obtained from cases of suspected STEMI using the smartphones by the EP and were sent to the interventional cardiologist via the WhatsApp application (group 1, n=53). The control group included concurrently treated patients with STEMI during the same period but not receiving triage (group 2, n = 55). The D2B time was significantly shorter in the intervention group (p<0 .001) with significant reduction in false STEMI rate as well.	This study demonstrates that use of WhatsApp triage with activation of the cardiac catheterization laboratory was associated with shorter D2B time and results in a greater proportion of patients achieving guideline recommendations. The method is cheap, quick, and easy to operate.	B
6	Nardo B, *et al.*, 2016	To verify if WhatsApp usage facilitates communication, enhances learning, and improves patient care preserving their privacy, during elective surgery program between two distant teaching hospitals.	A group of selected specialists communicated healthcare matters through the newly founded "WhatsApp Surgery Group." Each patient enrolled in the study signed a consent form to let the team communicate his/her clinical data using WhatsApp. Communication between team members, response times, and types of messages were evaluated. Two focus groups were performed.	Forty six (n = 46) patients were enrolled in the study. A total of 1,053 images were used with an average of 78 images for each patient (range 41–143). 125 h of communication were recorded, generating 354 communication events.	WhatsApp is a low cost, secure, and fast technology and it offers the opportunity to facilitate clinical and non clinical communications, enhance learning, and improve patient care preserving their privacy.	B

No.	Author/Year	Objectives	Methods	Outcomes/Results	Conclusion	Grade of recommendation
7	Boulos MNK, *et al.*, 2016	To explore the various applications of Instagram and WhatsApp in healthcare.	Literature review using the keywords "WhatsApp OR Instagram" in the following searching databases: PubMed, CINAHL and Embase.	WhatsApp in used for: tobacco treatment and control; eLearning; enhancing of communication and social interaction; exercise and fitness; medicolegal aspects; nurses; teleconsultation and surgical; visual-social information-sharing.	Adding Instagram and WhatsApp to the clinical communication and teaching toolbox facilitates timely responses among health teams, faster handovers for residents at hospitals, and a wider dissemination of public health messages to more people. However, more research into the safety and security of Instagram, WhatsApp and similar apps should be conducted, particularly to address concerns about patient confidentiality and safe, secure communications.	-
8	Pérez Zaballos NT, *et al.*, 2016	To develop an online application for the evaluation of quality of life in patients with hearing loss using WhatsApp.	The Laboratory of Psychoacoustics developed a platform that allows patients to answer surveys from remote locations.	The developed tool allows to: (1) answer a test repeatedly under different personal situations and (2) evaluate the patient remotely. Hence, obtaining a more reliable assessment of the patient's QoL.	Preliminary results using 5 teenagers aged 12–18 that answered the KINDL questionnaire is used to evidence the value of this new tool.	-
9	Gulacti U, *et al.*, 2016	To evaluate WhatsApp messenger usage for communication between consulting and emergency physicians.	A retrospective, observational study was conducted in the emergency department (ED) of a tertiary care university hospital between January 2014 and June 2014.	614 consultations requested via WhatsApp were evaluated, and 519 consultations were included in the study. A total of 510 (98.3 %) photographic images, 517 (99.6 %) text messages, 59 (11.3 %) videos, and 10 (1.9 %) voice messages were collected. The majority of requested consultations were terminated only by evaluation via WhatsApp (n = 311, 59.9 %). The majority of outside consultation request were concluded by only WhatsApp ($p < .001$).	WhatsApp is useful a communication tool between physicians, especially for ED consultants who are outside the hospital, because of the ability to transfer large amounts of clinical and radiological data during a short period of time.	B

(continued)

No.	Author/Year	Objectives	Methods	Outcomes/Results	Conclusion	Grade of recommendation
10	Sarode SC, et al., 2017	To find out the efficacy of WhatsApp application for obtaining second opinion on histopathological diagnosis in oral pathology practice.	A total of 247 cases comprising of 34 different oral pathologies were photomicrographed using smartphone cameras through compound microscopes and sent for second opinion diagnosis (SOD) to 20 different oral pathologists using WhatsApp.	Of 4795 (97.06%) total second opinion received, correct SOD were received for 4710 (98.22%) cases. A positive correlation was observed between correct SOD and age (P = 0.0143) and experience (P = 0.0189) of the pathologist. The time taken for giving second opinion by the pathologists ranged from 81.98 ± 32.89 to 90.72 ± 38.88 min.	Smartphone camera is a handy and efficient tool in capturing photomicrographs from the compound microscope. Transfer of such photomicrograph via WhatsApp is an effective and convenient approach in procuring second opinion on histopathological diagnosis of oral pathologies.	B
11	Ganasegeran K, et al., 2017	To investigate perceived benefits of WhatsApp use across general medical and emergency teams during clinical practice.	A cross-sectional study was conducted in a universal sample of 307 health professionals comprising of nurses, medical assistants, medical residents, medical officers and physicians in a Malaysian public hospital. The self-administered questionnaire consisted of items on socio-demographics, WhatsApp usage characteristics and the type of communication events during clinical practice.	The majority of respondents (68.4%) perceived WhatsApp as beneficial during clinical practice. In multivariate analysis, perceived benefits was significantly higher amongst the clinical management group (p = 0.001), those using WhatsApp for >12 months (p = 0.047), those receiving response ≤15 min to a new communication (p = 0.017), and frequent information giving events (p = 0.016).	Perceived benefits of WhatsApp use in clinical practice was significantly associated with usage characteristics and type of communication events. This study lays the foundation for quality improvement innovations in patient management delivered through m-Health technology.	B
12	Gulacti U, et al., 2017	To evaluate the effect of secure messaging application usage for consultations on Emergency Department Length of Stay and consult time.	A prospective, randomized controlled trial was conducted in the ED using allocation concealment over three months. Consultations requested in the ED were allocated into two groups: consultations requested via the secure messaging application and consultations requested by telephone as verbal.	439 consultations requested in the ED were assessed for eligibility and 345 were included in the final analysis: 173 consultations were conducted using secure messaging application and 172 consultations using standard telephone communications. The median total ED LOS was lower among consults conducted using Secure messaging application relative to consults conducted by telephone (p<0.0001). Consultations completed without ED arrival was 61.8% in the secure messaging group and 33.1% in the Telephone group (p<0.001).	Use of secure messaging application for consultations in the ED reduces the total ED LOS and consultation time. Consultation with secure messaging application eliminated more than half of in-person ED consultation visits.	A

No.	Author/Year	Objectives	Methods	Outcomes/Results	Conclusion	Grade of recommendation
13	Bakshi SG, *et al.*, 2017	To explore the benefits of the 3-month informal WhatsApp training by evaluating pre- and post-discussion responses to standard pain questionnaires. We also evaluated improvements in residents' self-rated confidence scores and documentation in the APS clinical sheets.	Second- and third-year anesthesia residents were included in a WhatsApp group, along with consultants (board certified anesthesiologists with a special interest in pain). Pain knowledge assessment was performed pre and post discussion using a 22-point questionnaire. A feedback form, which included self-rated confidence scores (1–10, 10-most confident) and opinions about the 3-month WhatsApp discussion, was collected. Improvements in the documentation in clinical sheets post-discussion were also analyzed.	A total of 38 residents were included in the WhatsApp group. An improvement in the percentage of correct answers from 69.1% (pre-discussion) to 73.6% (post-discussion) was observed (P = 0.031). Improvements in the self-rated residents' confidence levels were also noted (P < 0.05). A total of 37 residents felt that the WhatsApp-based discussion was useful. Documentation of the details of epidural blockade in clinical sheets improved from 30% to 100%.	The WhatsApp discussion improved residents' knowledge and confidence levels, and also resulted in improved documentation of essential details in the clinical notes.	B
14	Giordano V, *et al.*, 2017	To perform a comprehensive systematic review of present literature on the use of the WhatsApp Messenger app as an adjunctive health care tool for medical doctors.	Searches were performed in PubMed, EMBASE, and the Cochrane Library using the term "WhatsApp*" in articles published before January 2016. The level of evidence of each study was determined according to the Oxford Levels of Evidence ranking system produced by the Oxford Centre for Evidence-Based Medicine.	Ten empirical studies have been included.	The pooled data presents compelling evidence that the WhatsApp is a promising system, whether used as a communication tool between health care professionals, as a means of communication between health care professionals and the general public, or as a learning tool for providing health care information to professionals or to the general population. However, high-quality research is needed.	-

(continued)

No.	Author/Year	Objectives	Methods	Outcomes/Results	Conclusion	Grade of recommendation
15	Ellanti P, *et al.*, 2017	To monitor and analyze the use of WhatsApp over a six-month period in an orthopaedic surgery team, and compared it to the more traditional hospital pager and phone systems.	Analysis of WhatsApp communication between non consultant members of an orthopaedic team over a six-month period.	Using WhatsApp messaging system is time saving. All participants found WhatsApp easy to use and found it to be more efficient than the traditional pager system. Compared to the traditional pager systems, the use of WhatsApp is easy, inexpensive, and reliable and can help improve the efficiency of communication within a surgical team.	WhatsApp communication between non-consultant members of an orthopaedic team over a six-month period was analyzed. Both the phones and the WhatsApp application were password-protected, and patient details were anonymized. A series of 20 communications using the hospital pager system and the telephone system were also analyzed.	B
16	Eksert S, *et al.*, 2017	To investigate the efficiency of a commercial instant messaging application (WhatsApp, Mountain View, CA) as a communication tool for the emergency team in a level-I trauma centre.	Retrospective evaluation of the messages in the instant messaging application group that was formed to coordinate responses to patients who were transported to hospital via helicopter during an 8-week period. Response times, response time periods during or outside of work hours, and the differences in the response of doctors, nurses, and technicians among the members of the emergency team to the team leader's initial message about the patients were evaluated.	A total of 510 emergency call messages pertaining to 17 combat injury emergency cases were logged. The median time of emergency response was 4.1 minutes, 6 minutes, and 5.3 minutes for doctors, nurses, and the other team members, respectively. From the team leader's perspective, using this application reduced the workload and the time loss, and also encouraged the team.	Instant messaging applications for smartphones can be efficient, easy-to-operate, and time-saving communication tools in the transfer of medical information and the coordination of emergency response team members in hospitals.	B
17	Furtado Leão C, *et al.*, 2018	To explore how WhatsApp is used in the physician-patient relationship at the pediatrics and obstetrics outpatient clinic.	Data was collected in qualitative field research using a semi-structured questionnaire applied to eight physicians.	*Perceived benefits:* maintain good doctor-patient relationship; monitor long distance treatment; avoid unnecessary trips to the doctor; guiding and clarification of doubts of the patient; send test results; inform the doctor about new symptoms; emergency; quick communication. *Perceived disadvantages:* lack of patient's boundaries; patient no longer wants to go the consultation; loss of privacy; lack of legal support; banalisation of the medical service.	We conclude that there is a lack of research on the subject addressed and of regulation of the use of the application in the health area.	B

No.	Author/Year	Objectives	Methods	Outcomes/Results	Conclusion	Grade of recommendation
18	Martinez R, *et al.*, 2018	To evaluate and review the use of WhatsApp to facilitate paediatric burn injury consultations to a regional burn centre.	A retrospective review was undertaken of all consultations using WhatsApp over an 18-month period, received by the burn centre's two senior medical practitioners. The specific origin and nature of the telemedicine requests for advice, transfer or follow-up were collected, as were data relating to the demographics of the patients, the aetiology, mechanism and extent of the burn injury. The impact of the system of communication in terms of reductions in admissions and clinic visits was assessed, and a cost analysis was undertaken. Feedback was also obtained from those health practitioners regularly using the service.	838 communications (including 1562 clinical queries) occurred. 486 interactions (58%) originated from within the hospital, and 352 (42%) from outside. Queries related to the full spectrum of burn care, including emergency management and stabilization, triage and transfer, the need for escharotomy, fluid resuscitation, wound care, the timing and nature of surgical intervention, as well as follow-up and rehabilitation. While no significant changes in the number of surgical interventions or admissions were observed when compared to the five years prior to the intervention, outpatient visits reduced significantly. Over 150 unnecessary admissions were also avoided as a result of the triage made possible by WhatsApp, which translated into considerable cost saving for the institution.	Incorporating WhatsApp technology into the daily processes of burn care significantly improve the quality of paediatric burn care referrals to specialist burn services. WhatsApp contribute to reductions in unnecessary referrals and outpatient visits, facilitate opportunities for continuing medical education, improve the care of major burn injuries through more effective prehospital communication, and enable greater allocation of scarce specialist resources at the burn centre.	B
19	Patel SJ, *et al.*, 2018	To assess the feasibility of a group-based support intervention using the WhatsApp text-messaging platform, to improve the adherence to care and the health outcomes in pregnancy and the postpartum period.	A mixed-methods approach was used. Pregnant women were enrolled at Jacaranda Health (JH), a maternity centre in peri-urban Kiambu County, Kenya. Their phone numbers were added to WhatsApp groups consisting of participants with similar estimated due dates. The WhatsApp group administrator was a JH employee. Acceptability, demand, implementation, and practicality of this service were evaluated through in-depth interviews, surveys, chart review, and analysis of group chats.	Fifty women (88%) of 57 eligible enrolled in the study. Five WhatsApp groups were created. A total of 983 messages were exchanged over 38 weeks. Participants reported several benefits.	A moderated mobile-based support group service for pregnant women and new mothers is safe and feasible. Additional research using experimental designs to strengthen evidence of the effectiveness of the support intervention is warranted.	B

(continued)

No.	Author/Year	Objectives	Methods	Outcomes/Results	Conclusion	Grade of recommendation
20	Alanzi T, *et al.*, 2018	To evaluate the WhatsApp social networking application for improving knowledge, self-efficacy and awareness about diabetes management.	The study was conducted with intervention and control groups at Teaching Hospital in Al-Khobar, Saudi Arabia. The intervention group received weekly educational messages using WhatsApp, while the control group received regular care.	Statistically, compared with the control group, the diabetes knowledge and self-efficacy of the intervention group increased significantly after the intervention with WhatsApp.	WhatsApp can be effectively used for enhancing diabetes knowledge, self-efficacy and awareness among the Saudi population.	A
21	Senera TE, *et al.*, 2018	To evaluate the reliability of WhatsApp in the evaluation of hematuria through inter-rater agreement.	212 patients were evaluated prospectively for hematuria by 2 groups of urologists; Group A: in direct contact with patients for evaluation; Group B: "blind" urologist who had no access to the patients' data but received pictures via WhatsApp. Two photos of voided urine in a sterile container were taken and sent using WhatsApp. The opinions of Group A and B about the grade of hematuria were evaluated.	The Group A urologists were in accordance in 96.22% of cases. Group B urologists had common opinions in 99.5% (n=203) and there was almost perfect agreement between 2 groups (λ=0.992). The number of common opinions among "blind" urologists is more than the number of common opinions among the consultants. When further classification is performed as serious and non-serious hematuria, the rate of misdiagnosing serious cases is approximately 6.5–7%.	This study demonstrates that patients presenting with hematuria can be consulted through WhatsApp with high inter- and intra-observer agreement and that telemedicine can help in decision-making in hematuria patients.	B
22	Carmona S, *et al.*, 2018	To explore the potential of using instant messaging to enhance patient-care and physician-education in obstetric medicine and maternal–fetal medicine.	Retrospective examination of the real-time correspondence between a closed group of maternal–fetal medicine physicians and fellows-in-training. Correspondence was grouped into four domains. Time to obtain a response and their utility was analyzed.	Over the two-year period, 41 international members contributed 534 clinically relevant messages: 33% advice seeking, 23.4% case-sharing, 35% educational content and 8.2% miscellaneous content. The median response time was 52 min, and 53% responded in less than 60 min. At least one response in each case influenced clinical management.	Instant messaging is effective for real-time clinical collaboration and could serve as an important platform for enhancing management and continuing education for obstetric medicine and maternal–fetal medicine physicians. International societies should consider exploring this avenue further.	B

(continued)

No.	Author/Year	Objectives	Methods	Outcomes/Results	Conclusion	Grade of recommendation
23	Garg N, *et al.*, 2019	To study the utility of WhatsApp image transfer in the isto-pathological diagnosis of common oral malignant and benign lesions.	100 cases of oral biopsy were included in the study: 58 cases of squamous cell carcinoma, 33 cases of oral leukoplakia, 3 cases of oral lichen planus and 6 cases of dysplasia. The conventional microscopy diagnosis made by glass slide viewing was taken as the gold standard and the concordance of the WhatsApp diagnosis with the gold standard was calculated for each category of diagnosis and for all the 100 cases.	For all the categories taken together, the overall concordance rate was 95%.	A concordance rate of 95% is very encouraging; with the availability of better smartphone cameras and faster internet, it will be possible to send better quality images in the future. The pathologists will also learn where to draw the line and ask for glass slides for final diagnosis.	B
24	Othman M, *et al.*, 2019	To explore the use of the WhatsApp messenger as a platform for integrating the Spine care services in the Sultanate of Oman by streamlining the referral patterns to tertiary care centres.	A WhatsApp group was created including representatives of spine units from all 8 regional hospitals in Oman including Spine Consultants from tertiary care spine centre in the country Khoula Hospital. The referral data was retrospectively retrieved and analyzed to determine the response time and treatment plans proposed for each case. They were compared with the available data of the previous year.	452 cases were referred using this platform during the study period. Forty percent of these were accepted and about 25% were advised to be treated conservatively at the referring hospital itself. The time to response reduced dramatically from over 12 h to a mean of one hour and 45 min as a result of this change.	The WhatsApp messenger platform appears to be an effective tool for inter-hospital referral based on clinical data and imaging studies and to obtain rapid responses from the referee centre. This leads to optimal utilization of specialized resources and indirectly helps reducing waiting times in specialty clinics. It also minimises inappropriate transfers and helps standardize care across the system.	-
25	Dungarwalla M, *et al.*, 2019	To investigate WhatsApp usage among the oral and maxillofacial surgery junior trainees'.	Messages sent across the group were recorded over a continuous seven-day period and were classified as patient-related, administrative, or other.	On five of the seven days analyzed, there were 191 communications. Most (n = 127, 67%) were related to administrative issues and patient care (n = 62, 33%). Only two (1%) related to neither and were classified as "other".	There is a consensus among our team of junior surgical trainees that WhatsApp has several advantages over conventional pager or bleep systems. However, concerns about the compromise of confidentiality and issues of professionalism remain.	-

No.	Author/Year	Objectives	Methods	Outcomes/Results	Conclusion	Grade of recommendation
26	Kapıcıoğlu M, *et al.*, 2019	To evaluate the reliability of the assessment of radiological X-ray images of traumatic injuries in the elbows of children using WhatsApp application, compared to true-size images on a Picture Archiving and Communication System (PACS) screen.	X-ray images of a total of 90 pediatric patients with an elbow injury were retrospectively evaluated. The images were captured and sent to three orthopedic surgeons via WhatsApp on an iPhone 7S smartphone. Observers were asked to diagnose and classify for each case over their personal smartphones. The three observers independently assessed the images with a seven day interval. Following one-week interval, revaluation was conducted using the PACS.	There was a good agreement between the first and second evaluations by the physicians via WhatsApp (k=0.74). The intra-observer reliability was very good (k=0.8), moderate (k=0.55), and good (k=0.67). There was no significant difference in the intra- and inter-observer reliability between the groups.	Using WhatsApp for consulting is a reliable method which can be used in the emergency setting for decision-making. Using WhatsApp can improve the efficacy of medical assessment and reduce waiting time in emergency admissions, although this method is not a substitution for evaluation of the images using computer-based PACS.	B
27	Clavier T, *et al.*, 2019	To measure the impact of a learning program via WhatsApp on clinical reasoning in medical residents.	A prospective, randomized, multicentre study was conducted among first and second year anesthesiology residents from four university hospitals in France. Residents were randomized in two groups of online teaching (WhatsApp and control). The WhatsApp group benefited from daily delivery of teaching documents on the WhatsApp app and a weekly clinical case supervised by a senior physician. In the control group, residents had access to the same documents via a traditional computer electronic learning (e-learning) platform. Medical reasoning was self-assessed online by a script concordance test (SCT; primary parameter), and medical knowledge was assessed using multiple-choice questions (MCQs).	62 residents were randomized (32 to the WhatsApp group and 30 to the control group) and 22 residents in each group answered the online final evaluation. We found a difference between the WhatsApp and control groups for SCTs (p=0.006) but no difference for MCQs (p=0.22). Concerning satisfaction, there was a better global satisfaction rate in the WhatsApp group than in the control group (p=0.049).	The use of WhatsApp for teaching residents was associated with worse clinical reasoning despite better global appreciation. The use of WhatsApp probably contributes to the dispersion of attention linked to the use of the smartphone. The impact of smartphones on clinical reasoning should be studied further.	A

No.	Author/Year	Objectives	Methods	Outcomes/Results	Conclusion	Grade of recommendation
28	Gross I, *et al.*, 2019	To assess the extent and reliability of smartphone use for professional purposes by paediatric residents and neonatologists and to determine if neonatal chest radiographs sent for online consultation via a messaging application could be reliably interpreted.	The study was conducted at three university-affiliated medical centres in Israel. Questionnaires on using smartphones for professional purposes were completed by 68/71 paediatric residents and 20/28 neonatologists. In addition, 11 neonatologists viewed 20 chest radiographs on a computer screen followed by a smartphone and 10 viewed the same radiographs in the opposite order, separated by a washout period of 2 months. After another 2 months, five from each group viewed the same radiographs on a computer screen.	Most respondents used WhatsApp to send chest radiographs for consultation: 82% of the paediatric residents and 80% of the neonatologists. The mean number of inconsistencies in diagnosis was 3.7/20 between two computer views and 2.9/20 between computer and smartphone views (p = 0.88) and the disease severity means were 3.7/20 and 2.85/20, respectively (p = 0.94). Neonatologists using WhatsApp only determined umbilical line placement in 80% of cases.	WhatsApp proved to be a valid and reliable means for transferring neonatal chest radiographs for initial interpretation, including determining the diagnosis, assessing the severity of the pathology and identifying the endotracheal tube position. The assessment of the umbilical line position was suboptimal and further assessment of this parameter is required. Ethical and patient rights' guidelines are needed for smartphone use in clinical settings.	B
29	Bennani A, *et al.*, 2019	To determine the effectiveness of WhatsApp in the field of pathology for obtaining a second opinion and discussing difficult cases.	A WhatsApp group named "FESPATH" was created with total of 17 pathologists from 7 different cities in Marocco, working in 12 different institutions. At the end of 20 months, members were asked to complete a feedback questionnaire.	Over a 20-month period, 86 cases were discussed with 515 posted pictures. A total of 14 participants out of 17 were active participants, and the majority of them found the discussions very useful for overcoming challenging cases.	WhatsApp is a good tool for discussing cases in histopathology and cytology as it allows quick answers and instantaneous discussion compared to other social media tools.	B
30	De Benedictis A, *et al.*, 2019	To assess if and how individual and organizational determinants can trigger or inhibit the use of WhatsApp in a hospitals.	Survey administered to physicians and nurses in an Italian University Hospital.	A total of 191 high-quality responses were received. The results show that WhatsApp is widely used in the Hospital, and that its use is mainly due to the perception of numerous advantages and benefits reported in clinical practice.	Individual factors play a key role as determinants of the use of WhatsApp; hospital professionals use WhatsApp mainly based on perceived usefulness. Organizational factors play a secondary role; they act through individual factors.	-
31	Machado RS, *et al.*, 2019	To evaluate the feasibility of TC through a multiplatform instant messenger smartphone application to evaluate specimens of EUS-FNA of pancreatic solid lesions.	Twenty-three patients with a solid pancreatic lesion were included. During each EUS-FNA, the aspirated material was spread over a glass slide and was stained by the endoscopist. The glass slide was reviewed on a microscope with a smartphone fitted in, and sent to the pathologist using WhatsApp.	In initial evaluation using TCP rapid on-site evaluation (ROSE), adequate cellularity of the glass slide was detected in 16 of 23 patients (69.6%). An initial diagnosis of malignancy (positive or suspicious) was possible in 14 of 23 patients (60.8%).	The current study demonstrated the feasibility of a low-cost, Internet-based, tele-cytopathology system using WhatsApp Messenger to provide ROSE of EUS-FNA slides in patients with solid pancreatic lesions.	B

Table 6 – Use of WhatsApp in hospitals and grade of recommendation

Use of WhatsApp (WA)	Grade of recommendation	References
Training of residents	**A or B**	
Learning program via WhatsApp on clinical reasoning in medical residents.	A	[44]
Training of residents on pain management using WA.	B	[31]
Diagnosis and classification by means of plain radiographs and CT scans of tibial plateau fractures photographed and sent via WA.	B	[5]
Patients' education, adherence to care	**A or B**	
WA for improving knowledge, self-efficacy and awareness about diabetes management.	A	[37]
WA platform to improve the adherence to care and the health outcomes in pregnancy and the postpartum period.	B	[36]
WA to enhance patient-care and physician-education in obstetric medicine and maternal–fetal medicine.	B	[39]
WA for the evaluation of hematuria through inter-rater agreement.	B	[38]
Inter and intra-emergency department communication	**A, B or none**	
WA for consultations on Emergency Department Length of Stay and consult time.	A	[30]
WA messaging for communication in emergency surgical teams.	B	[3]
WA for communication among the emergency physician in a rural hospital without percutaneous coronary intervention (PCI) capability.	B	[6]
WA usage for communication between consulting and emergency physicians.	B	[9]
Perceived benefits of WA use across general medical and emergency teams during clinical practice.	B	[29]
WA as a communication tool for the emergency team in a level-I trauma centre.	B	[33]
WA as a platform for integrating the Spine care services in the Sultanate of Oman by streamlining the referral patterns to tertiary care centres.	-	[41]
Diagnosis, consultation and second opinion	**B**	
WA to facilitate paediatric burn injury consultations to a regional burn centre.	B	[35]
To find out the efficacy of WA application for obtaining second opinion on histopathological diagnosis in oral pathology practice.	B	[28]
WA image transfer in the isto-pathological diagnosis of common oral malignant and benign lesions.	B	[40]
WA usage by paediatric residents and neonatologists for an online neonatal chest radiographs consultation.	B	[45]
WA in the field of pathology for obtaining a second opinion and discussing difficult cases.	B	[46]
WA for the assessment of radiological X-ray images of traumatic injuries in the elbows of children.	B	[43]
WA platform to evaluate specimens of EUS-FNA of pancreatic solid lesions.	B	[47]
Inter and intra-departmental communication	**B**	
WA as a communication method amongst the staff of plastic and reconstructive surgery section at tertiary care health facility.	B	[4]
WA for intradepartmental communication among orthopedic residents in a 300-bedded tertiary care teaching centre.	B	[19]
Surgery programs	**B or none**	
WA usage during elective surgery program between two distant teaching hospitals.	B	[26]
WA usage in orthopaedic surgery team.	B	[32]
WA usage among the oral and maxillofacial surgery junior trainees'.	-	[42]
Physician-patient relationship	**B or none**	
WA usage in the physician-patient relationship at the pediatrics and obstetrics outpatient clinic.	B	[34]
Evaluation of quality of life in patients with hearing loss using WA.	-	[27]
Other	**None**	
Individual and organizational determinants of WA usage in hospitals.	-	[8]
WA in used for: tobacco treatment and control; eLearning; communication; medicolegal aspects; nursing; teleconsultation; information-sharing.	-	[14]
WA as an adjunctive health care tool for medical doctors.	-	[7]

References

1. Jenkins H. Convergence culture. Where old and new media collide. NYU Press. August 2006;1.
2. Mobasheri MH, King D, Johnston M, Gautama S, Purkayastha S, et al. The ownership and clinical use of smartphones by doctors and nurses in the UK: a multicentre survey study. BMJ Innovation. 2015;00:1–8.
3. Johnston MJ, King D, Arora S, Behar N, Athanasiou T, Sevdalis N, Darzi A, et al. Smartphones let surgeons know WhatsApp: An analysis of communication in emergency surgical teams. American Journal of Surgery. 2015;209(1):45–51.
4. Wani SA, Rabah SM, AlFadil S, Dewanjee N, and Najmi Y. Efficacy of communication amongst staff members at plastic and reconstructive surgery section using smartphone and mobile WhatsApp. Indian Journal of Plastic Surery. 2013;46(3):502-505.
5. Giordano V, Koch HA, Mendes CH, Bergamin A, and de Souza FS, do Amaral NP. WhatsApp Messenger is useful and reproducible in the assessment of tibial plateau fractures: Inter- and intra-observer agreement study. International Journal of Medical Informatics. 2015;84(2):141–148.
6. Astarcioglu MA, Sen T, Kilit C, Durmus HI, Gozubuyuk G, Kalcik M. et al. Time-to reperfusion in STEMI undergoing inter hospital transfer using smartphone and WhatsApp messenger. American Journal of Emergency Medicine. 2015;33(10):1382–1384.
7. Giordano V, Koch H, Godoy-Santos A, Dias Belangero W, Esteves Santos Pires R, Labronici P. WhatsApp Messenger as an Adjunctive Tool for Telemedicine: An Overview. Interact Journal of Medical Research. 2017; 6(2):11.
8. De Benedictis A, Lettieri E, Masella C, Gastaldi L, Macchini G, Santu C, Tartaglini D. "WhatsApp in hospital? An empirical investigation of individual and organizational determinants to use". PLoS One. 2019;14(1).
9. Gulacti U, Hatipoglu S, Polat H. An Analysis of WhatsApp Usage for Communication Between Consulting and Emergency Physicians. Journal of Medical Systems. 2016;40(6):130.
10. Johnston MJ, King D, Arora S, Behar N, Athanasiou T, Sevdalis N, Darzi A, et al. Smartphones let surgeons know WhatsApp: An analysis of communication in emergency surgical teams. American Journal of Surgery. 2015;209(1):45–51.
11. Lee RS, Woods R, Bullard M, Holroyd BR, Rowe BH. Consultations in the emergency department: a systematic review of the literature. Emergency Medicine Journal. 2008; 25(1): 4–9.
12. Raiman L, Antbring R, Mahmood A. WhatsApp messenger as a tool to supplement medical education for medical students on clinical attachment. BMC Medical Education. 2017;17(1):7.
13. Kaliyadan F, Ashique KT, Jagadeesan S, Krishna B. What's up dermatology? A pilot survey of the use of WhatsApp in dermatology practice and case discussion among members of WhatsApp dermatology groups. Indian Journal of Dermatology, Venereology, and Leprology. 2016;82(1):67-9.
14. Boulos MNK, Giustini DM and Wheeler S. Instagram and WhatsApp in Health and Healthcare: An Overview. Future Internet. 2016;8(37).

15. Jagannathan M. Efficacy of communication amongst staff members at plastic and reconstructive surgery section using smartphone and mobile WhatsApp. Indian Journal of Plastic Surgery. 2013;46(3):506–507.

16. Petruzzi M, De Benedittis M. WhatsApp: A telemedicine platform for facilitating remote oral medicine consultation and improving clinical examinations. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2016;121(3):248-254.

17. Graziano F, Maugeri R, Iacopino DG. Telemedicine versus WhatsApp: from tradition to evolution. Neuroreport. 2015;26:602-603.

18. Martyn-Hemphill C., Sarkar S., Withington J., Roy A., Cohen D., Green J.S.A. et al. Whatsapp doc?' evaluating a novel modality of communication amongst urology team members to promote patient safety. The Journal of Urology. 2015;193:e169-e170.

19. Khanna V, Sambandam SN, Gul A, Mounasamy V. et al. "WhatsApp" ening in orthopedic care: a concise report from a 300-bedded tertiary care teaching centre, European Journal of Orthopaedic Surgery & Traumatology. 2015;25(5):821-826.

20. Choudhari P. Study on effectiveness of communication amongst members at department of orthopedics surgery unit 3 using smartphone and mobile WhatsApp, International Surgery Journal. 2014;1(1):9-12.

21. Migliore, M. The use of smartphones or tablets in surgery. What are the limits? Annali Italiani di Chirurgia. 2015;86(2):185-186.

22. Dhuvad JM, Dhuvad MM, Kshirsagar RA. Have Smartphones contributed in the clinical progress of oral and maxillofacial surgery? Journal of Clinical and Diagnostic Research. 2015;9(9):ZC22-ZC24.

23. Pandian SS, Srinivasan P, Mohan S. The maxillofacial surgeon's march towards a smarter future-smartphones. Journal of Maxillofacial and Oral Surgery. 2014;13:355-358.

24. Watson L, Pathiraja F, Depala A, O'Brien B, Beyzade S. Ensuring safe communication in health care: a response to Johnston et al on their paper "Smartphones let surgeons know WhatsApp: an analysis of communication in emergency surgical teams". American Journal of Surgery. 2016;211(1):302–3.

25. The Oxford levels of evidence. OCEBM Levels of Evidence May 1, 2016. http://www.cebm.net/ocebm-levels-of-evidence.

26. Nardo B, Cannistra` M, Diaco V, Naso A, Novello M, Zullo A, et al. Optimizing Patient Surgical Management Using WhatsApp Application in the Italian Healthcare System. Telemedicine and e-health. 2016;22(9).

27. Pérez Zaballos NT, Ramos Macías Á, Pérez Placencia D, Borkoski Barreiro SA, Ramos de Miguela Á. LifeQuestionnaire. A new tool for the evaluation of quality of life in patients with hearing loss-using WhatsApp". European Annals of Otorhinolaryngology, Head and Neck diseases. 2016;133S:S44–S49.

28. Sarode SC, Sarode GS, Anand R, Patil S, Unadkat H. WhatsApp is an effective tool for obtaining second opinion in oral pathology practice. Journal of Oral Pathology & Medicine. 2017;46: 513–519.

29. Ganasegeran K, Renganathan P, Rashid A, Radman Al-Dubai SA. The m-Health revolution: Exploring perceived benefits of WhatsApp use in clinical practice. International Journal of Medical Informatics. 2017;97:145–151.

30. Gulacti U, Lok U. Comparison of secure messaging application (WhatsApp) and standard telephone usage for consultations on Length of Stay in the ED. Applied Clinical Informatics. 2017;8(3):742-753.

31. Bakshi SG and Bhawalkar P. Role of WhatsApp-based discussions in improving residents' knowledge of post-operative pain management: a pilot study. Korean Journal of Anesthesiology. 2017;70(5):542-549.

32. Ellanti P, Moriarty A, Coughlan F, McCarthy T. The Use of WhatsApp Smartphone Messaging Improves Communication Efficiency within an Orthopaedic Surgery Team. Cureus. 2017;9(2):e1040.

33. Eksert S, Aşık MB, Akay S, Keklikçi K, Aydın FN, Çoban M, Kantemir A, Güngör O, Garip B, Turgut MS, Olcay K. Efficiency of instant messaging applications in coordination of emergency calls for combat injuries: A pilot study. Turkish Journal Of Trauma & Emergency Surgery. 2017;23(3):207-211.

34. Furtado Leão C, da Silva Coelho ME, Siqueira AO, de Albuquerque Rosa BA, Bastos Neder PR. The use of WhatsApp in the physician-patient relationship. Revista Bioética. 2018; 26(3):412-9.

35. Martinez R, Rogers AD, Numanoglu A, Rode H. The value of WhatsApp communication in paediatric burn care. Burns. 2018;44:947-955.

36. Patel SJ, Subbiah S, Jones R, Muigai F, Rothschild CW, Omwodo L, Ogolla T, Kimenju G, Pearson N, Meadows A, Nour NM. Providing support to pregnant women and new mothers through moderated WhatsApp groups: a feasibility study. mHealth. 2018;4:14.

37. Alanzi T, Bah S, Alzahrani S, Alshammari S, Almunsef F. Evaluation of a mobile social networking application for improving diabetes Type 2 knowledge: an intervention study using WhatsApp. Journal of Comparative Effectiveness Research. 2018;7(9).

38. Senera TE, Butticè S, Sahin B, Netsch C, Dragos L, Pappalardo R, Magno C. WhatsApp Use In The Evaluation of Hematuria. International Journal of Medical Informatics. 2018;111:17–23.

39. Carmona S, Alayed N, Al-Ibrahim A and D'Souza R. Realizing the potential of real-time clinical collaboration in maternal–fetal and obstetric medicine through WhatsApp. Obstetric Medicine. 2018;11(2):83–89.

40. Garg N, Tanveer N, Gaur JH. Utility of WhatsApp as a Tool for Tele-oncopathology for Oral Lesions. Indian Journal of Surgical Oncology. 2019;10(3):446–450.

41. Othman M, Menon V. Developing a nationwide spine care referral programme on the WhatsApp messenger platform: The Oman experiment. International Journal of Medical Informatics. 2019;126:82-85.

42. Dungarwalla M, Chapireau D, Bentley R. Use of WhatsApp in an oral and maxillofacial surgery department at a major trauma centre and its role during major incidents: our experience. British Journal of Oral and Maxillofacial Surgery. 2019;57:449–453.

43. Kapıcıoğlu M, Erden T, Ağır M, Küçükdurmaz F. The reliability of use of WhatsApp in type 1 and type 2 pediatric supracondylar fractures". Eklem Hastalik Cerrahisi. 2019;30(2):149-154.

44. Clavier T, Ramen Dureuil B, Veber B, Hanouz JL, Dupont H, Lebuffe G, Besnier E, Compere V. Use of the Smartphone App WhatsApp as an E-Learning Method for Medical Residents: Multicenter Controlled Randomized Trial. JMIR Mhealth Uhealth. 2019;7(4).

45. Gross I, Langer Y, Pasternak Y, Abu Ahmad W, Eventov-Friedman S, Koplewitz BZ. Questionnaire-based study showed that neonatal chest radiographs could be reliably interpreted using the WhatsApp messaging application. Acta Pædiatrica. 2019;108:94–100.

46. Bennani A, Sekal M. Usefulness of WhatsApp for Discussing Difficult Cases in Pathology Practice: A Moroccan Experience. Turk Patoloji Dergisi (Turkish Journal of Pathology). 2019;35:134-138.
47. Machado RS, Richa R, Callegari F, Souza GB, Tolentino LL, Nakao FS, Ferrari A, Libera E. Instant messenger smartphone application for endosonographer/cytopathologist real-time interaction at a distance in EUS-FNA for solid pancreatic lesions. Endoscopy International Open. 2019;07:E1027–E1030.
48. Delbanco T, Sands D. Electrons in Flight - E-Mail between Doctors and Patients. New England Journal of Medicine. 2004;350(17):1705-7.
49. Pellegrino ED., Humanism and the Physician (Knoxville: University of Tennessee Press, 1979), p. 17.
50. Krynski L, Goldfar G. Technology-mediated communication with patients: WhatsApp Messenger, e-mail, patient portals. A challenge for pediatricians in the digital era. Archivos Argentinos de Pediatria. 2018;116(4):e554-e559/e554.

De Benedictis A., Lettieri E., Gastaldi L., Masella C., Urgu A., Tartaglini D. **Electronic Medical Record implementation in Hospital: An empirical investigation of individual and organizational determinants.**

Title

Electronic Medical Record implementation in Hospital: An empirical investigation of individual and organizational determinants

Authors

Anna De Benedictis[1,2,#a*¶] , Emanuele Lettieri[3#b¶] , Luca Gastaldi[3#b¶] , Cristina Masella[3#b¶] , Alessia Urgu[1,#a¶] , Daniela Tartaglini[1,2#a¶]

Affiliation

[1] Department of Healthcare Professions, University Hospital Campus Bio-Medico, Rome, Italy.
[2] Faculty of Medicine & Surgery, University Campus Bio-Medico, Rome, Italy.
[3] Department of Economics, Management and Industrial Engineering, Politecnico of Milan, Italy.

[#a]Current Address: Department of Healthcare Professions, University Hospital Campus Bio-Medico, via Alvaro del Portillo, 200, 00128, Rome, Italy.
[#b]Current Address: Department of Economics, Management and Industrial Engineering, Politecnico of Milan, via Lambruschini 4/b, 20156, Milan, Italy.

E-mail address and fax number of the corresponding author

* Corresponding author
E-mail: a.debenedictis@unicampus.it (ADB)
ORCID Id: https://orcid.org/0000-0001-8655-0895

Abstract

The implementation of hospital-wide Electronic Medical Records (EMRs) is still an unsolved quest for many hospital managers. EMRs have long been considered a key factor for improving healthcare quality and safety, reducing adverse events for patients, decreasing costs, optimizing processes, improving clinical research and obtaining best clinical performances. However, hospitals continue to experience resistance from professionals to accepting EMRs. This study combines institutional and individual factors to explain which determinants can trigger or inhibit the EMRs implementation in hospitals, and which variables managers can exploit to guide professionals' behaviours. Data have been collected through a survey administered to physicians and nurses in an Italian University Hospital in Rome. A total of 114 high-quality responses had been received. Results show that both, physicians and nurses, expect many benefits from the use of EMRs. In particular, it is believed that the EMRs will have a positive impact on: quality, efficiency and effectiveness of care; handover communication between healthcare workers; teaching, tutoring and research activities; greater control of your own business. Data show an interplay between individual and institutional determinants: normative factors directly affect perceived usefulness (C = 0.30 **), perceived ease of use (C = 0.26 **) and intention to use EMRs (C =

0.33 **), and regulative factors affect the intention to use EMRs (C = -0.21 **). The analysis carried out shows that the key determinants of the intention to use EMRs are the normative ones (peer influence). Therefore, Management can leverage on power users to motivate, generate and manage change.

1. Introduction

Healthcare is the most complex and fast-moving industry that exists. New digital technologies are constantly being developed, all with the potential to support clinical practice by bringing many advantages into the healthcare sector [1]. Nevertheless, the healthcare industry has lagged behind other sectors in the adoption of Information Technology (IT) in the workplace [2]. Electronic Medical Records (EMRs) have long been considered a key factor for improving healthcare quality and safety, reducing adverse events for patients, decreasing costs, optimizing processes, improving clinical research and obtaining best clinical performances [e.g. 3-5]. However, the pace of the adoption of EMRs or of other digital technology in healthcare continues to lag [2,6], and hospitals continue to experience resistance from professionals to accepting digital technology [7]. Though many research and development programs exist and venture capital investment has been growing, successful IT projects in healthcare continue to be rare, and a plan to accelerate innovation is needed beginning with a diagnosis of the problem [2]. Some studies analyzed both individual and organizational factors that affect technology acceptance and implementation [8], but they have generated mixed results [9]. Indeed, the mechanisms that drive the adoption and implementation of IT in hospitals remain unclear: Organizational Studies conceive organizations as strongly institutionalized settings in which individual behaviours are influenced by regulations, social norms and cultural systems [10,11]. In contrast, Information Science has mostly adopted user acceptance models, which emphasise individuals' rational and volitional assessment of the costs and benefits they would attain from the new digital technology [11].

Hospitals are highly institutionalized and regulated contexts, in terms of regulatory oversight and professional roles, and are operationally and technically complex [12]. Physicians and nurses have a high level of professionalism and they often affiliate within their own specialties via professional training and participation in specialty-focused organizations [13]. Successful adoption or perceived usefulness of EMRs by others within their own specialties may influence hospital professionals' decisions, particularly if they are uncertain about individual benefits. Nevertheless, the majority of academic research in IT adoption in healthcare has focused on the individual level [14]. The most widely used model to explore issues related to the acceptance of technology is the Technology Acceptance Model (TAM) [15], which identifies two main antecedents, the perceived usefulness and the perceived ease of use of technology. The TAM has been validated in multiple settings [e.g. 16-18]. In its basic framework the end user's attitudes and perceptions regarding the use of new technology determine the user's behavioural intention to use it. Institutional theory, instead, is based on the assumption that individual behaviours are modelled by regulations, social norms and meaning systems and that institutions embodied in routines rely on automatic cognition and uncritical processing of existing schemata and privilege

consistency with stereotypes and speed over accuracy [19]. Thus, in this theory normative and cultural conditions are co-determinants of the adoption of new technologies [20]. The use of institutional theory in Information Science is rare compared to other fields such as organization science [21]. However, several studies have used an institutional approach for exploring the adoption of technology considering institutional forces as crucial to shaping organizational actions and the opinions of the decision makers [22,23,24].

Both institutional theory and user acceptance models have independently tried to incorporate elements of the other theory to enrich their explanatory power [2]. User acceptance models have incorporated the direct effects of social influences and organizational conditions on individuals' behavioural intention [25,26], and institutional studies have demonstrated that even when professionals are subject to institutional influences, their self-determination plays an important role even in highly-institutionalized and regulated settings such as hospitals [27]. Previous studies about technology acceptance and adoption compared individual and social levels including environmental factors [22,28-30], typically based on the diffusion of innovation theory (DOI) [31] or the TOE (technology, organization, and environment) framework [32]. Moreover, only a few studies have tested both explanations (institutional and individual) in an integrative framework [23] to explain the behaviour of organizations.

The main purpose of this study was to explore which are the main determinants of hospital professionals' intention to use EMRs, through the experimentation with a new theoretical model including organizational theories and technology acceptance models. By combining these theories, the study investigated the interplay between organizational and individual factors, thus offering novel insights on the determinants of hospital professionals' acceptance of digital technology and pointing out how and to what extent the interplay between individual and organizational determinants might trigger or inhibit the acceptance of digital technology. The study focused mainly on the perception by hospital professionals of individual factors and inter-hospital normative and regulative forces that might influence the intention to use EMRs, since in the CBM Hospital the implementation of the new information system, including EMRs, is ongoing, and professionals didn't yet experience the use of a fully paper-less medical record.

2. Material and methods

2.1 Ethics statement

The study has been approved by the Ethics Board of the University Hospital Campus Bio-Medico of Rome. (Approval number: 61/16 OSS ComEt CBM), and a written consent has been obtained by professionals involved in the study.

2.2 Theoretical background

In order to evaluate the potential interplay between individual and institutional variables, a research framework has been created (Fig. 1). The framework integrates into a coherent view of two theories that belong to two different bodies of literature:

- *The Technology Acceptance Model* (TAM), from Information Science, that has been widely used in the last decades in healthcare to understand what leads professionals or patients to accept or reject Information Technology [15];

- *The Institutional Theory*, from Public Management, that has been largely adopted in the last decades to assess how institutional factors shape professionals' behaviours [33-34].

2.2.1 Technology Acceptance Model

Davis introduced the TAM for the first time in 1989 [15]. The main problem raised by the author was to understand what leads people to accept or reject Information Technology. In this regards, two main variables have been identified: the perceived usefulness and the ease of use. Perceived usefulness measures "the degree to which a person believes that using a particular system would enhance his or her job performance" [15], and therefore induces individuals to use technology as it allows to obtain better results. On the other hand, the ease of use measures "the degree to which a person believes that using a system would be free of effort" [15] and induces the potential users to use a certain technology since it requires low energy expenditure while it may bring advantages. The first one induces an individual to use technology as it allows to obtain better results in his work; the ease of use, on the other hand, stimulates potential users to use a certain technology since many advantages are supported with low energy expenditure.

2.2.2 Institutional Theory

The Institutional Theory refers to a line of organizational research that recognize the significant organizational effects that are associated with the increase of cultural and social forces. According to Scott [33-34], "Institutions are made up of cultural-cognitive, normative and regulative elements, which together with associated activities and resources offer stability and meaning to social life." These three forces are present in totally developed institutional systems, with economists and political scientists placing emphasis on regulative, sociological and normative factors, and anthropologists and organizational theorists placing emphasis on cognitive-cultural factors. According to this perspective, individuals are embedded in institutional pillars that limit the scope of their rational assessment and direct the engagement of specific behaviours [33-34]. Scott [33-34] defines the three institutional pillars as follows: *regulative pillars*: which regard the existence of regulations, rules and processes whose breach is monitored and sanctioned;
- *normative pillars*: which introduce a social dimension of appropriate behaviours in the organization*;*
- *cultural pillars*: which emphasize the use of common schemas, frames, and other shared symbolic representations that create an attachment to the 'appropriate' behaviour.

2.2.3 Research Framework

Consistently to our research questions, we combined the two theories described above to develop an original, comprehensive research framework where individual and institutional determinants have been interlinked to explore their potential interplay in explaining hospital professionals' intention to use an EMR. Coherently to past researches about user acceptance of new technologies [35,36], we considered age and job seniority as key control variables. Additionally, to narrow the knowledge gap about how hospital professionals belonging to either different profession (e.g., physicians vs. nurses) or different speciality (e.g., cardiology vs. orthopaedics) might be interested to use an EMR, we included clinical speciality and profession as control variables. Figure 1 offers a synoptic view of our research

framework, where the independent variable (i.e., the intention to use an EMR) is explained by individual factors from TAM (i.e., perceived usefulness and perceived ease of use) as well as by institutional factors from Institutional Theory (i.e., regulative factors that refer to the degree of adhesion to hospital managers' goals, and normative factors that explain the peer influence among hospital colleagues. Control variables have been also displayed.
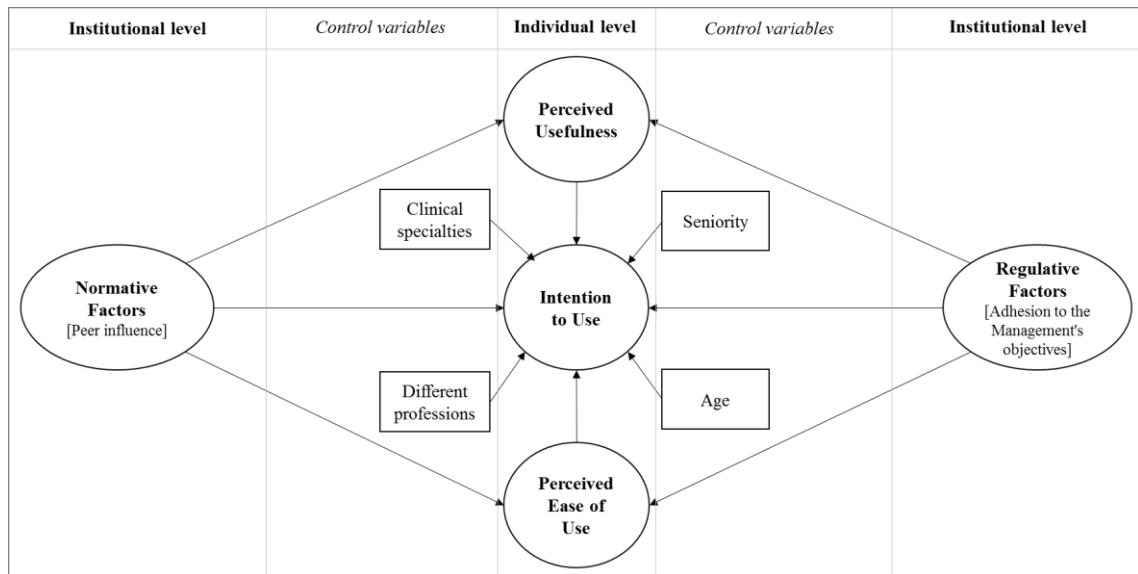
Fig 1. Research Framework.

According to the research questions and the research framework the following research hypotheses (H) were stated: H1: Individual factors (perceived usefulness, perceived ease of use) directly affect the intention to use EMRs; H2: Organizational factors (normative and regulative factors) directly affect individual factors and the intention to use EMRs; H3: Some control variables (age, seniority, clinical specialties and different professions) directly affect individual factors and the intention to use EMRs.

2.3 Setting and research methodology

Given the explorative nature of this study, a single case study research design has been adopted. The choice of a single case study offers the opportunity to eliminate potential confounding factors due to the heterogeneity – in terms of strategy, legacy, professionals' behaviours and technology infrastructure – that different hospitals might show. We selected the Teaching Hospital Campus Bio-Medico (CBM) in Rome (Italy) as an adequate setting for investigating our research questions. This hospital is mid-size (around 300 beds), many-disciplines, teaching and private. Being teaching hospital, there is more room for divergent goals between professionals and managers, thus creating the correct setting where to investigate the interplay between individual and organizational factors. Being many-discipline, there is room to study the potential conflict among professionals from different disciplines with respect to the intention to use EMRs. Finally, being mid-size, CBM is a valid setting to observe the potential divergence between nurses and doctors in the intention to use EMRs. A quantitative study has been performed using a survey administered to hospital professionals (physicians and nurses). The questionnaire has been designed based on the scales identified in the literature and reviewed in detail by the authors. Moreover, a pilot test of the questionnaire has been carried out before the survey. The initial questionnaire

comprised 20 items that were reviewed for face validity by a panel of four experts, consisting of one nurse and one physician - with more than 9 years of work experience -, and two engineers with expertise in Information Science. Panel members were asked to evaluate each statement for clarity, ease of use and appropriateness. Based on their comments and suggestions, five items were removed and changes were made in the wording of several items to increase clarity.

This 15-item questionnaire was tested for content validity by 10 experts not involved in the preceding phase to identify its ability to measure the determinants of the intention to use EMRs in hospitals and to identify, for each item, utility, consistency with the research objectives, easy of reply and other important aspects to take into account. Audio-recorded individual interviews using a semi-structured grid were carried out with 10 experts including two nurses, three head nurses, two managers and three physicians. The interviews lasted 60 minutes on average and were conducted in a designated room by three researchers: one acted as interviewer, the other two helped with audio-recording and with filling out the grid for item evaluation. Based on the expert evaluation, three items were modified.

The questionnaire consists of two main sections: scales and constructs of the proposed model; control variables and characteristics of respondents. Eleven items evaluated individual variables, in particular, the scale for the measurement of perceived usefulness has been adapted from the studies of Venkatesh [37,38]. Organizational variables were explored through 4 items related to normative and regulative factors. The scale for the measurement of normative and regulative factors has been adapted from the study of Scott [20]. The survey items are available in Annex (S1 Table). Additional questions have been designed to gather demographic and sample information. All questionnaire items related to the constructs of the proposed model were explored using a 7 point Likert scale with 1 indicating "strongly disagree" and 7 "strongly agree". The first re-call has been made one week after the expiration date for compilation. Three days after the first follow-up, the second recall has been sent. Finally, three days after, the third recall has been sent.

Statistical analysis was performed using the software Stata 14.1® Internal consistency was evaluated thorough Cronbach's Alpha coefficients, and a path analysis was performed in order to test the proposed model; a p-value of <0.05 was considered significant. The correlation between profession (doctors vs. nurses) and the answers provided for each item were analyzed through the Fisher's test; a p-value of <0.05 was considered significant.

The study has been approved by the General Management and the Ethics Board of CBM. The link for the online questionnaire was sent by e-mail to 380 nurses and 250 physician representatives of different clinical areas. All questionnaires were filled out in a period between February and September 2018. The final sample included 114 healthcare professionals, of which 78 (68%) were nurses and 36 (32%) physicians, with a response rate of 19%. They were 84 (74%) female, aged 37.4 years on average (range 23-66, SD 9.6), with a mean work experience of 13.24 (range 0.5-41, SD 8.73).

3. Results

3.1 Questionnaire's constructs internal consistency

The internal consistency of constructs was evaluated through Cronbach's Alpha coefficients, values greater than or equal to 0.7 were considered acceptable. ($\alpha \geq 0.90$ were considered

excellent; 0.8 ≤ α < 0.9 good; 0.7 ≤ α < 0.8 acceptable; 0.6 ≤ α < 0.7 questionable; 0.5 ≤ α < 0.6 poor; α < 0.5 unacceptable) (Table 1).

Construct	Items (corresponding to the survey questions)*	Cronbach's alpha
Perceived Usefulness	**A**. I'm convinced that the EMR will help me carry out my tasks faster. **B**. Using the EMR will greatly improve the effectiveness of my work. **C**. Using the EMR in my work will greatly increase my productivity.	0.79
Perceived Ease of Use	**A**. The use of EMR will increase my workload. **B**. Using the EMR I will have more control of my own work. **C**. I will have problems to use the EMR. **D**. I will be able to get the system to do what I want. **E**. The EMR will be easy to use.	0.73
Intention to Use	**A**. If I had the opportunity I would use the EMR, **B**. If I had the opportunity I would use the EMR for most of my work's processes. **C**. If I had the opportunity I would work in a Hospital where the EMR is already used.	0.76
Normative pillar	**A**. The colleagues I value most believe that I should systematically use the EMR. **B**. The colleagues I value most consider the use of EMR as essential for the Hospital.	0.82
Regulative pillar	**A**. I very much agree with most of the objectives of the management. **B**. I often come into conflict with the management on the priorities to give to my work (reversed).	0.77

All items were measured on a 7-point Likert scale, where 1 = strongly disagree, 2 = moderately disagree, 3 = somewhat disagree, 4 = neutral (neither disagree nor agree), 5 = somewhat agree, 6 = moderately agree, and 7 = strongly agree.

Table 1. Measurement properties of constructs.

3.2 Determinants of current behaviours

Data show that both physicians and nurses expect many benefits from the use of EMRs. In particular, they think EMRs will have a positive impact on relevant factors such as quality, efficiency and effectiveness of care; handover communication among healthcare workers; teaching, tutoring and research activities; greater control of their tasks. Data confirm that perceived usefulness (C=0.33**) directly affects the intention to use EMRs. With respect to the organizational factors, data prove that does exist an interplay between them and individual determinants. In fact, normative factors directly affect perceived usefulness (C=0.30**), perceived ease of use (C=0.26**) and intention to use EMRs (C=0.33**). Regulative factors affect the intention to use EMRs, with a negative sign (C= -0.21**). Control variables (i.e., age, seniority, clinical area and profession) have no impact on other variables in our model. Fig 2 offers a graphical representation of our results.

Moreover, the findings show a significant correlation between being nurse or physician and the perceived ease of use and intention to use EMRs. In particular, more nurse than physicians perceive EMRs as easy to use (p=0.019 for the item "the EMR will be easy to use") and state that they would like to use it (p=0.01 for the item "if I had the opportunity I would use the EMR for most of my work's processes").
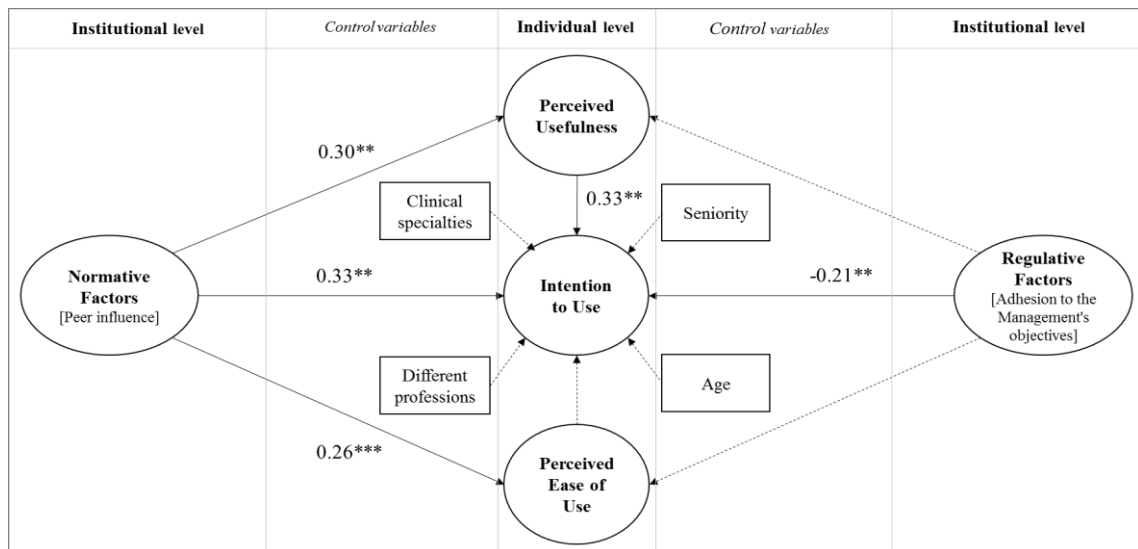
Fig 2. Determinants of current behaviours.

4. Discussion

Our study sought to better clarify the relationship between organizational and individual determinants of the intention to use EMRs in a hospital setting by nurses and physicians. Previous studies [39-45] have focused mainly on either the barriers or the facilitators that might impact on the implementation of EMRs, but, to the best of our knowledge, it has never been deepened if and how organizational and individual factors interact and affect jointly hospital professionals' motivation to use EMR. Our findings show that the main determinants of the intention to use EMRs are the normative ones (peer influence) [2], compared to the regulatory ones (i.e. alignment to management' goals) or the individual ones (perceived usefulness and perceived ease of use). In other words, hospital managers can leverage on lead peer influence (i.e., innovation champions) to motivate, generate and manage change and generate a virtuous circle inside the hospital to motivate the use of EMRs. The EMRs implementation process should take into account that professionals need proper time to re-establish control over their tasks and processes. In fact, the introduction of EMRs in daily clinical practice changes the status quo and, if on one hand, it allows many new opportunities, on the other hand, it involves changes that can have different effects on hospital professionals also based on their own characteristics, knowledge, skills and work type. In general, this is what happens in the case of effective implementation, while the consequences of poorly managed implementation can be very complex and involve a greater expenditure of time, energy and money to restart the processes at the previous speed and functionality. In this sense, to increase the motivation of users in all phases of the project represent an essential point for an effective management of change. This study confirms the importance of involving front-line professionals, as soon as the hospital decides to start the implementation phase in order to increase their motivation to use EMRs. In fact, as a result of their involvement, professionals will better understand the rationale of this technological shift and their perception of usefulness will increase consequently. Moreover it is important to consider that, as reported by Gastaldi et al. [2] in the absence of coercive mechanisms, institutional pressures toward EMR use are primarily normative

and/or mimetic [2]; in other words, hospital executives can leverage on lead peer influence for motivating and managing change.

In the study, the construct "Regulative factor" has been derived from the Institutional theory and is aimed at exploring the pressure that a hospital professional might perceive from the goals set by hospital managers. This pressure is intended to be independent from the specific strategy/initiative and to be a general availability of a hospital professional to align his/her behavior to the goals set by hospital managers. An example of question is: "I very much agree with most of the objectives of the management". The regulative factor should be analyzed together with the construct "Normative factor" that crystallize the perceived pressure from peers. Hospitals are intended as professional bureaucracies where professionals feel more the pressures from peers rather than from apex managers. What is interesting is that the regulative factor affects negatively the intention to use, meaning that more the general agreement with managers' goals less the intention to use an EMR. This can be explained by the fact that the general goals crystallized by hospital managers about the digital transformation of care delivery, the search for both research and care excellence, the need of financial equilibrium etc. are not enough detailed to stimulate professionals' perception about the usefulness of an EMR – in fact, the linkage between the regulative factor and the perception of usefulness failed to materialize – and reduces the intention to use something that is not clearly connected to those goals that managers have set-up. We expect that more contextualized goals about the usage of EMR would positively affect the intention to use it among those professionals who are more willing to be adherent to managers' goals.

5. Conclusion

This study offers original insights to further the ongoing debate about the digital transformation of hospitals, with a focus to EMRs. Our results show that there is an interplay between individual and organizational factors in shaping hospital professionals' intention to use EMRs. The study showed that the main determinants of the intention to use EMRs are the normative ones (peer influence), compared to the regulatory ones (adherence to the management's objectives) or the individual ones (perceive usefulness and perceived ease of use). From an academic viewpoint, the study offers an original perspective and a new theoretical framework, which combines organizational theories and technology acceptance models to explain hospital professionals' acceptance of EMRs. In particular, the results confirm the importance of individual variables, not only as directly related to the acceptance of a new technology, but also as important mediators between institutional variables and acceptance, thus highlight and confirming the importance of the connections between Organizational Studies and Information Science.

Despite the original contributions, this study suffers at least two limitations that should be addressed by future research. First, the research design is based on a single case study. Further research should consider a multi-centre design, thus allowing the generalization of our results. Moreover, a multi-centre study will allow exploring the role that hospital characteristics – in terms of strategy, legacy, etc. – might have on shaping both the organizational and individual factors investigated in this study. Second, this study investigated the intention to use EMRs as the dependent variable. Further research should consider hospitals where EMRs are already mature technologies, thus allowing the investigation of the actual use and which factors might facilitate/inhibit the translation of the intention to use into actual use.

Supporting information

S1 Table. Questionnaire.
S2 Table. Perceived Usefulness.
S3 Table. Perceived Ease of Use.
S4 Table. Intention to Use.
S5 Table. Normative Factors (Peer Influence).
S6 Table. Regulative Factors (Adhesion to the Management Objectives).

Acknowledgments

References

1. Barlow J. Managing Innovation in Healthcare. World Scientific Publishing Europe. London; 2017.
2. Rudin R.S., Bates D.W. and MacRae C. Accelerating Innovation in Health IT. New England Journal of Medicine. 2016;375(9).
3. Cowie M.C., Blomster J.I., Curtis L.H., Duclaux S., Ford I., et al. Electronic health records to facilitate clinical research. Clinical Research in Cardiology. 2017;106(1):1–9.
4. Goldstein B.A., Navar A.M., Pencina M.J., Ioannidis J.P.A. Opportunities and challenges in developing risk prediction models with electronic health records data: a systematic review. Journal of the American Medical Informatics Association. 2017;24(1):198–208.
5. Scott K.C., Stein A., Thomas H., Kaur H. The use of Electronic Health Records to support population health: a systematic review of the literature. Journal of Medical Systems. 2018;42(11).
6. Hillestad R., Bigelow J., Bower A., Girosi F., Meili R., et al. Can Electronic Medical Record systems transform health care? Potential health benefits, savings, and costs. Health Affairs. 2005;24(5).
7. Safi S., Thiessen T., Schmailzl K.J.G. Acceptance and Resistance of New Digital Technologies in Medicine: Qualitative Study. JMIR Research Protocols. 2018;7(12):e11072.
8. Oliveira T., Martins M. Literature review of information technology adoption models at firm level. The Electronic Journal Information Systems Evaluation. 2011;14(1):110–121.
9. Holden R., Karsh B.-T. The technology acceptance model: its past and its future in health care, Journal of Biomedical Informatics. 2010;43:159–172.
10. Scott W.R., & Davis G. Organizations and organizing: rational, natural and open systems perspectives. New Jersey: Prentice Hall; 2008.
11. Gastaldi L., Radaelli G., Lettieri E., Luzzini D., Corso M. Professionals' use of ICT in hospitals: the interplay between institutional and rational factors. International Journal of Technology Management (IJTM). 2019;80(1/2).
12. Scott W.R., Ruef P., Mendel P., Caronna C. Institutional change and healthcare organizations: from professional dominance to managed care. University of Chicago Press. Chicago; 2000.
13. Sherer S.A., Meyerhoefer C.D., Lizhong P. Applying institutional theory to the adoption of electronic health records in the U.S. Information & Management. 2016;53:570–580.
14. Cao Q., Jones D., Sheng D. Contained nomadic information environments: technology, organization and environment influences on adoption of hospital RFID patient tracking. Information & Management. 2014; 51(2):225–239.
15. Davis F. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. MIS Quarterly. 1989;13(3).
16. Venkatesh V., Morris M.G., Davis G.B., Davis F.D. User Acceptance of Information Technology: Toward a Unified View. MIS Quarterly. 2003;27(3):425-478.
17. Lankton N., McKnight D.H. and Thatcher J.B. 'Incorporating trust-in-technology into expectation disconfirmation theory'. Journal of Strategic Information Systems. 2014;23(2):128–145.

18. Walsh I. A strategic path to study IT use through users' IT culture and IT needs: A mixed-method grounded theory. Journal of Strategic Information Systems. 2014;23(2):146–173.

19. Lawrence, T.B., Suddaby, R. and Leca, B. Institutional Work: Actors and Agency in Institutional Studies of Organizations. Cambridge University Press, Cambridge, UK; 2009.

20. Scott W.R. Institutional Carriers: Reviewing Modes of Transporting Ideas over Time and Space and Considering Their Consequences. Industrial and Corporate Change. 2003;12:879–894.

21. Weerakkody V., Dwivedi Y.K., Irani Z. The diffusion and use of institutional theory a cross-disciplinary longitudinal literature survey. Journal of Information Technology. 2009;24:354–368.

22. Oliveira T., Martins M. Literature review of information technology adoption models at firm level. The Electronic Journal Information Systems Evaluation. 2011;14(1):110–121.

23. Mignerat Muriel, Rivard Suzanne. Positioning the institutional perspective in information systems research. Journal of Information Technology. 2009;24(4).

24. Sherer S.A., Meyerhoefer C.D., Lizhong P. Applying institutional theory to the adoption of electronic health records in the U.S. Information & Management. 2016;53:570–580.

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

26. Chang I.C., Hwang H.G., Hung W.F., Li Y.C. Physicians' acceptance of pharmacokinetics-based clinical decision support systems. Expert Systems with Applications. 2007;33(2):296–303.

27. Leca, B., Battilana, J. and Boxenbaum, E. Agency and Institutions: A Review of Institutional Entrepreneurship, Working Paper 08-096, Harvard Business School; 2008.

28. Abdekhoda M., Ahmadi M., Dehnad A., Noruzi A., Gohari M. Applying electronic medical records in health care. Applied Clinical Informatics. 2016;7:341–354.

29. Rasmi M., Alazzam M.B., Alsmadi Mutasem K., Almarashdeh I.A., Alkhasawneh R.A., Alsmadi S. Healthcare professionals' acceptance electronic health records system: critical literature review (Jordan case study). International Journal of Healthcare Management. 2018. DOI: 10.1080/20479700.2017.1420609.

30. Abdekhoda M., Dehnad A. and Zarei J. Determinant factors in applying electronic medical records in healthcare. East Mediterranean Health Journal. 2019;25(1):24-33.

31. Rogers E. Diffusion of Innovations. 4th ed., Free Press, New York; 1995.

32. Tornatzky L., Fleischer M. The Process of Technology Innovation, Lexington Books, Lexington, MA; 1990.

33. Scott WR. The Adolescence of Institutional Theory. Administrative Science Quarterly. 1987;32(4):493–511.

34. Scott WR. Lords of the Dance: professionals as institutional agents. Organization Studies. 2008; 29:2(219–238).

35. Agarwal R, Prasad J. Are Individual Differences Germane To The Acceptance Of New Information Technologies? Decision Science. 1999;30(2):361-391.

36. Morris MG, Venkatesh V. Age Differences in Technology Adoption decision: Implications for a Changing Work Force. Personnel Psychology. 2000;53(2):375-403.

37. Venkatesh V, Morris MG, Davis GB, Davis FD. User Acceptance of Information Technology: Toward a Unifie d View. MIS Quarterly. 2003;27(3):425-478.

38. Venkatesh V, Zhang X, Sykes TA. Doctors 'Do Too Little Technology' A Longitudinal Field Study of an Electronic Healthcare System Implementation. Information Systems Research. 2011;22(3):523–546.
39. Shahmoradi L., Darrudi A., Arji1 G., Nejad AF. Electronic Health Record Implementation: A SWOT Analysis. Acta Medica Iranica. 2017; 55(10).
40. McGinn CA, Grenier S, Duplantie J, Shaw N, Sicotte C, Mathieu L, Leduc Y, Legare F, Gagnon MP: Comparison of use groups perspectives of barriers and facilitator to implementing EHR – a systematic review. BMC Med. 2011;9:46.
41. Inokuchi R, Sato H, Nakamura K, Aoki Y, Shinohara K, Gunshin M, Matsubara T, Kitsuta Y, Yahagi N, Nakajima S. Motivations and barriers to implementing electronic health records and ED information systems in Japan. Am J Emerg Med. 2014 Jul;32(7):725-30.
42. Cucciniello et al. Understanding key factors affecting electronic medical record implementation: a sociotechnical approach. BMC Health Services Research. 2015;15:268.
43. Boonstra A, Broekhuis M. Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions. BMC Health Serv Res. 2010;10:231.
44. Biruk S., Yilma T., Andualem M., Tilahun B. Health Professionals' readiness to implement electronic medical record system at three hospitals in Ethiopia: a cross sectional study. BMC Medical Informatics and Decision Making. 2014;14.
45. Or C., Tong E., Tan J., Chan S. Exploring Factors Affecting Voluntary Adoption of Electronic Medical Records Among Physicians and Clinical Assistants of Small or Solo Private General Practice Clinics. Journal of Medical Systems. 2018;42(7):121. doi: 10.1007/s10916-018-0971-0.

Supporting information

S1 Table. Questionnaire.

Variables	Items/assumptions
Section 1: Scales and constructs of the proposed model	
Individual variable: Perceived Usefulness	I'm convinced that the EMR will help me carry out my tasks faster
	Using the EMR will greatly improve the effectiveness of my work
	Using the EMR in my work will greatly increase my productivity
Individual variable: Perceived Ease of Use	The use of EMR will increase my workload
	Using the EMR I will have more control of my own work
	I will have problems to use the EMR
	I will be able to get the system to do what I want
	The EMR will be easy to use
Individual variable: Intention to Use	If I had the opportunity I would use the EMR
	If I had the opportunity I would use the EMR for most of the my work's processes
	If I had the opportunity I would work in an Hospital where the EMR is already used
Normative Factors (Peer Influence)	The colleagues I value most believe that I should systematically use EMR
	The colleagues I value most consider the use of EMR as essential for the Hospital
Regulative Factors (Adhesion to the Management Objectives)	I very much agree with most of the objectives of the management
	I often come into conflict with the management on the priorities to give to my work
Section 2: Control variables and characteristics of the respondent	
General information Perceived Risks	Age
	Gender
	Profession
	Clinical Area
	Seniority

S2 Table. Perceived Usefulness

		Totally disagree	Strongly disagree	Quite disagree	Neither agree nor disagree	Quite agree	Strongly agree	Totally agree	p-value
I'm convinced that the EMR will help me carry out my tasks faster	Nurses	0	0	1	2	32	22	20	0.8
	Physicians	0	0	1	2	15	10	7	
Using the EMR will greatly improve the effectiveness of my work	Nurses	1	0	1	5	32	24	13	0.55
	Physicians	0	0	0	6	16	10	3	
Using the EMR in my work will greatly increase my productivity	Nurses	1	1	2	15	29	20	9	0.43
	Physicians	1	0	1	9	18	4	2	

S3 Table. Perceived Ease of Use.

		Totally disagree	Strongly disagree	Quite disagree	Neither agree nor disagree	Quite agree	Strongly agree	Totally agree	p-value
The use of EMR will increase my workload	Nurses	18	12	18	11	9	3	2	0.81
	Physicians	2	6	6	8	6	6	0	
Using the EMR I will have more control of my own work	Nurses	1	1	2	8	31	17	11	0.88
	Physicians	1	0	0	5	13	7	8	
I will have problems to use the EMR	Nurses	12	12	19	14	14	0	0	0.26
	Physicians	2	8	13	7	3	1	0	
I will be able to get the system to do what I want	Nurses	2	8	19	11	16	9	2	0.20
	Physicians	1	4	9	11	9	1	0	
The EMR will be easy to use	Nurses	0	1	3	10	30	12	8	**0.019**
	Physicians	0	1	5	10	15	2	0	

S4 Table. Intention to Use.

		Totally disagree	Strongly disagree	Quite disagree	Neither agree nor disagree	Quite agree	Strongly agree	Totally agree	p-value
If I had the opportunity I would use the EMR	Nurses	0	0	0	3	24	18	32	0.69
	Physicians	0	0	0	3	9	16	8	
If I had the opportunity I would use the EMR for most of the my work's processes	Nurses	0	0	1	3	30	15	28	**0.01**
	Physicians	0	0	1	3	9	17	6	
If I had the opportunity I would work in an Hospital where the EMR is already used	Nurses	2	1	3	14	22	14	18	**0.31**
	Physicians	0	2	1	5	9	13	6	

S5 Table. Normative Factors (Peer Influence).

		Totally disagree	Strongly disagree	Quite disagree	Neither agree nor disagree	Quite agree	Strongly agree	Totally agree	p-value
The colleagues I value most believe that I should systematically use the EMR	Nurses	3	3	2	35	10	9	3	0.48
	Physicians	0	0	2	17	8	2	3	
The colleagues I value most consider the use of EMR as essential for the Hospital	Nurses	2	1	0	23	24	7	8	0.54
	Physicians	0	0	2	12	13	3	2	

S6 Table. Regulative Factors (Adhesion to the Management Objectives).

		Totally disagree	Strongly disagree	Quite disagree	Neither agree nor disagree	Quite agree	Strongly agree	Totally agree	p-value
I very much agree with most of the objectives of the Management	Nurses	0	1	3	6	27	29	10	0.89
	Physicians	1	0	2	3	14	11	4	
I often come into conflict with the management on the priorities to give to my work	Nurses	17	18	17	18	4	3	0	0.07
	Physicians	5	4	10	8	8	0	0	

Paper IV

An earlier draft of this paper was presented as oral communication and published in the Proceedings of the *European Health Management Association (EHMA) 2017 Annual Conference "Health Futures*", Milan, Italy, 13 - 15 June 2017.

An earlier draft of this paper was presented as oral communication and published in the Proceedings of the *R&D Management Conference "R&Designing Innovation", Milan, Italy, 2 - 4 July 2018.*

The paper was presented as oral presentation in the Conference of Public Health *"Simposio di Salute Pubblica 2019" OMCeO Varese, Italy, 5 October 2019.*

Title

WhatsApp in Hospital? An empirical investigation of individual and organizational determinants to use

Authors

Anna De Benedictis[1,2,#a*], Emanuele Lettieri[3#c], Cristina Masella[3#c], Luca Gastaldi[3#c], Giordana Macchini[2,#b], Camilla Santu[3#c], Daniela Tartaglini[1,2#a]

Affiliation

[1] Department of Healthcare Professions, Hospital General Management, University Hospital Campus Bio-Medico, Rome, Italy.
[2] Faculty of Medicine & Surgery, University Campus Bio-Medico, Rome, Italy.
[3] Department of Economics, Management and Industrial Engineering, Politecnico of Milan, Italy.

[#a]Current Address: Department of Healthcare Professions, University Hospital Campus Bio-Medico, via Alvaro del Portillo, 200, 00128, Rome, Italy.

[#b]Current Address: Department of Nursing, University Campus Bio-Medico, via Alvaro del Portillo, 21, 00128, Rome, Italy.

[#c]Current Address: Department of Economics, Management and Industrial Engineering, Politecnico of Milan, via Lambruschini 4/b, 20156, Milan, Italy.

E-mail address and fax number of the corresponding author

* Corresponding author
E-mail: a.debenedictis@unicampus.it (ADB)
ORCID Id: https://orcid.org/0000-0001-8655-0895

Abstract

The increasing use of messaging applications such as WhatsApp for both social and personal purposes has determined an increase in the widespread use of these technologies, even in healthcare. A growing number of healthcare professionals have adopted WhatsApp in their daily work in order to share information with peers and patients. Past research has highlighted the advantages and disadvantages of WhatsApp usage in healthcare settings; in particular two positions appear to coexist in the scientific debate: those that expose and underline all of the positive aspects of the phenomenon, and those which also highlight the negative aspects, linked in particular to the clinical risks for patients, data security and privacy protection. The main objective of this study was to assess if and how individual and organizational determinants can trigger or inhibit the use of WhatsApp in hospitals, and which variables managers can exploit to guide professionals' behaviors. Data were collected through a survey administered to physicians and nurses in an Italian University Hospital in Rome; a total of 191 high-quality responses were received. The results show that WhatsApp is widely used in the Hospital, and that its use is mainly due to the perception of numerous advantages and benefits reported in clinical practice. Moreover, an interplay exists between organizational and individual factors in determining the use of WhatsApp between healthcare professionals and with patients. In particular, individual factors play a key role as determinants of the use of WhatsApp; healthcare professionals use this technology mainly based on its perceived usefulness. Instead, organizational factors play a secondary role; they do not have a direct influence on the use of WhatsApp, but always act through individual factors. This study is the first to analyses the influence of individual and organizational determinants of WhatsApp usage in hospitals, and provides hospital managers with important information in order to manage this phenomenon and implement adequate strategies to exploit its potential increase.

Key Words
Digital Innovation, Healthcare, Hospital, WhatsApp, Technology Acceptance.

1. Introduction

The increasing use of messaging applications such as WhatsApp for both social and personal purposes has determined an increase in the widespread use of these technologies in healthcare [1-6]. A growing number of healthcare professionals have adopted WhatsApp in their daily work in order to share information with peers and patients [7-11]. Past research has highlighted the advantages and disadvantages of WhatsApp usage in healthcare. In this regard, two positions appear to coexist in the scientific debate: those that expose and underline all of the positive aspects of the phenomenon [6-16], and those which highlight the negative aspects, linked in particular to the clinical risks for patients, data security and privacy protection [8,16-21].
Some of the main advantages of using WhatsApp in healthcare are as follows: improvement of communication [22]; no requirement for a computer [23,24]; time saving [6,15]; possibility of an immediate response [20,25]; improvement of surgery performance and reduction of consultation time [25,26]; smoothing of hierarchy [8]; and the encouragement of junior doctors to seek help and improve the team perception of effectiveness [19]. On

the other hand, existing risks or disadvantages have also been reported: increase in workload, disparity in the sense of urgency, worsening of professional relationships and risk of unprofessional behavior [18]; need to stay online 24 hours a day; impossibility to print a record of the chat; clinical information not being included in medical records; difficulty identifying patients in chats [16,19]; possible issues of privacy and data protection [20]; and the risk of reducing the autonomy of junior doctors [8]. Despite the many benefits, WhatsApp is used by professionals without political strategies, so it is necessary to develop guidelines for its usage by interdisciplinary groups and for communication between patients and professionals [27]. Hospitals are increasingly looking to evaluate the impact of WhatsApp usage on care delivery [11]; however, there is still very limited evidence regarding if and how individual and organizational determinants can trigger or inhibit such phenomenon.

The main objective of the study is to assess if and how individual and organizational determinants can trigger or inhibit the use of WhatsApp in hospitals, and which variables managers can exploit to guide professionals' behaviors. In particular, the following research questions have been investigated:

- In what way is WhatsApp-used in hospitals by physicians and nurses with patients and between colleagues?
- Which are the main perceived benefits and threats concerning the use of WhatsApp in hospitals by physicians and nurses?
- Which are the determinants (individual and/or organizational) of the use of WhatsApp in hospitals?
- Is there an interplay between individual and organizational determinants?

2. Theoretical background

In order to evaluate the interplay between individual and organizational variables, it was necessary to create a theoretical model that could explain this phenomenon (Fig. 1). In particular, we drew inspiration from two well-established and respected theories:

- *Technology Acceptance Model* (TAM): that has been widely used in the last decades in healthcare in order to understand what leads people to accept or reject information technology [28];
- *Institutional Theory*, which explains how "institutional" – in our case, "organizational" – forces shape organizations and professionals' behaviors [30-32].

These theories are introduced briefly in the followings.

2.1 Technology Acceptance Model

The **TAM** theory was introduced for the first time by Davis in 1989 [28]. The main problem raised by the author was understanding what leads people to accept or reject information technology. In this regard, two explanatory factors have been identified: the perceived usefulness and the perceived ease of use. Perceived usefulness measures "the degree to which a person believes that using a particular system would enhance his or her job performance" [28], and therefore induces individuals to use technology as it allows them to obtain better results. On the other hand, the perceived ease of use measures "the degree to which a person believes that using a system would be free of effort" [28, 29] and induces the potential users to adopt a certain technology since it requires low energy expenditure.

TAM adopted these explanatory factors from other previous theories, in particular, the Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB). In the last years, TAM has undergone a number of modifications that resulted in different models, such as TAM2, which adds a variable about the social influence towards adoption, and UTAUT, which reasons about the influence of performance expectancy. For the sake of our study, we relied upon the original model, which is still the most commonly used and consistently proved as effective. Additionally, the potential role of social influence has been captured by the inclusion in our model of organizational factors.

In this study we decided to include in our explanatory framework only the variable "perceived usefulness" because from preliminary interviews and past experiences we know that all physicians and nurses included in this Hospital use smartphones and WhatsApp daily, so we excluded any problems related to the digital divide. Moreover, such digital literacy in the use of WhatsApp has been confirmed by the study.

2.2 Institutional Theory

Institutional Theory refers to a stream of organizational research that recognizes the significant organizational effects that are associated with an increase in cultural and social forces. According to Scott [30-32], "Institutions are made up of cultural-cognitive, normative and regulative elements, which together with associated activities and resources offer stability and meaning to social life." These three forces are present in totally developed institutional systems, with economists and political scientists placing emphasis on regulative, sociological and normative factors, and anthropologists and organizational theorists placing emphasis on cognitive-cultural factors. According to this perspective, individuals are embedded in institutional pillars that limit the scope of their rational assessment, and direct the engagement of specific behaviors [30-32]. Scott [30-32] defines the three "institutional pillars" as follows:

- *Regulative pillar*: which regards the existence of regulations, rules and processes whose breach is monitored and sanctioned;
- *Normative pillar*: which introduces a social dimension of appropriate behaviors in the organization*;*
- *Cultural pillar*: which emphasizes the use of common schemas, frames, and other shared symbolic representations that create an attachment to the 'appropriate' behavior.

In this study we decided to include in our explanatory framework only the regulative and normative pillars, since, being a single center study, we were not able to appreciate significant differences in the cultural pillar. Further multicenter studies should add this additional organizational explanatory variable.

3. Research Framework

Consistent with the research questions and taking inspiration from the theories described above, a theoretical framework has been defined, in which it is assumed that individual and organizational determinants are combined together to explain the use of WhatsApp between healthcare professionals and with patients in hospitals. Coherently with past research on user acceptance models [33,34], we added some control variables that are considered able to affect the results; they are: risk perception, age, seniority, clinical specialties and profession. (Fig 1)
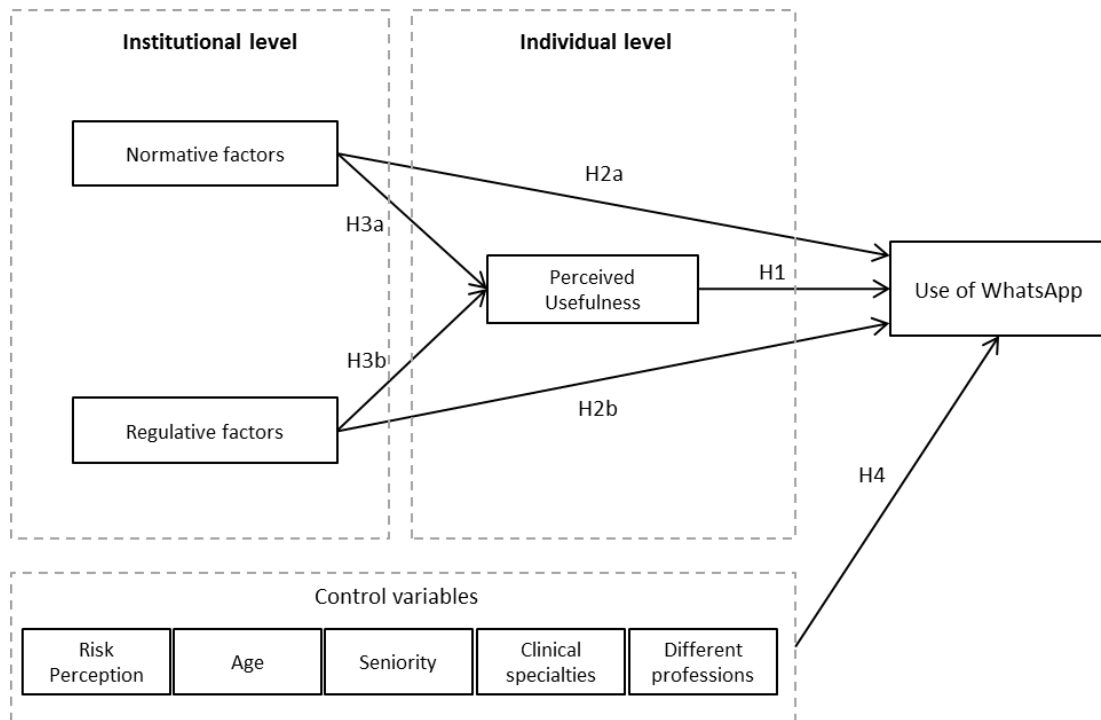
Fig 1. Theoretical Framework.

According to the research questions and the theoretical model the following research hypotheses (H) were stated: H1: Perceived usefulness directly affect the use of WhatsApp; H2a: Normative factors directly affect the use of WhatsApp; H2b: Regulative factors directly affect the use of WhatsApp; H3a: Normative factors directly affect the perceived usefulness of WhatsApp; H3b: Regulative factors directly affect the perceived usefulness of WhatsApp; H4: Control variables (risk perception, age, seniority, clinical specialties and different professions) affect the use of WhatsApp. Hypotheses 3a and 3b are the most relevant to the study, since they explore if and how the individual and organizational variables interact and which of these variables are dominant. All hypotheses regarding the use of WhatsApp with patients and colleagues were tested to assess whether or not the interplay between variables is the same.

4. Materials and methods

4.1 Setting and research methodology

A survey was designed and administered in an Italian University Hospital, in Rome. The unit of analysis is the group of healthcare professionals (both nurses and physicians) of the Hospital. The questionnaire (S1 Table) was designed based on the scales identified in the literature and reviewed in detail by the group of researchers. Moreover, a pilot test of the questionnaire was carried out before the survey. The questionnaire consists of three main sections: the use of WhatsApp; scales and constructs of the proposed model; control variables and characteristics of the respondents. The use of WhatsApp was evaluated through the following macro-constructs, including 30 items: personal use of WhatsApp in daily life, use of WhatsApp with patients, and use of WhatsApp with other healthcare professionals [1,35]. Individual variables were evaluated by 15 items, in particular, the scale for the measurement of perceived usefulness was adapted from the studies by Venkatesh

146

[36-39]. Organizational variables were explored through 11 items related to regulative and normative factors. The scale for the measurement of regulative and normative factors has been adapted from the study by Scott [40]. The survey items are listed in the questionnaire (S1 Table). Moreover, the risk perception related to the use of WhatsApp in hospitals was explored by 12 items. Additional questions have been designed to gather demographic and sample information. All of the questionnaire items were explored using a 7-point Likert scale, with 1 indicating "totally disagree" and 7 "totally agree", or a 5-point Likert-like scale with 1 indicating "never" and 5 "always". The completion rate was assessed weekly. The first re-call was made one week after the expiration date for compilation. Two or three days after the first follow-up, the second recall was sent, and two or three days after the second follow-up, the third recall was sent.

4.2 Statistical analysis

Statistical analysis was performed using the software Stata 14.1®. The internal consistency of the constructs was verified through the Cronbach's Alpha. The correlation between professional role (doctors vs. nurses) as well as the answers provided for each item were analyzed through the Fisher's test. A p-value of <0.05 was considered significant. Moreover, a path analysis was performed in order to test the proposed model.

5. Results

All questionnaires were completed in the period between February and September 2017, and a total of 191 responses (125 nurses and 66 physicians) were received (30.3%). Three follow-ups were sent to nurses and three to physicians (Table 1). The characteristics of respondents are described in Table 1.

		Frequency	Percentage
Gender	Male	63	33
	Female	128	67
Age	21-30	45	23.6
	31-40	81	42.4
	41-50	43	22.5
	> 50	22	11.5
Profession	Physician	66	34.6
	Nurse	125	65.4
Seniority (years of working experience)	0-10	101	52.9
	11-20	59	30.9
	21-30	19	9.9
	31-40	10	5.2
	> 40	2	1.0

Table 1. Characteristics of respondents

5.1 WhatsApp usage

Data confirm the widespread use of WhatsApp by the doctors and nurses included in the study, both in their personal life and in the workplace. WhatsApp usage in personal life is very common; nurses and physicians use it in order to participate in group discussion, send private messages to other people, send written messages or send images. Instead, the use of WhatsApp to organize agendas with others, to send audio notes or to share moments of life with others is less frequent (S2 Table). In hospitals, WhatsApp is used for different reasons, between colleagues and with patients. Data show that a statistical correlation exists between the use of WhatsApp in the clinical setting and the profession. In particular, physicians, more than nurses, use WhatsApp to share scientific information ($p=0.038$), manage and share agendas ($p=0.001$), communicate about clinical situations ($p<0.0001$), ask for information or give directions ($p=0.042$), send patient data in the form of images or videos ($p=0.042$), receive patient information from other hospitals ($p=0.001$) (S3 Table). Some physicians report that patients often ask them to use WhatsApp to facilitate communication, and send images or videos to get an evaluation before a visit, or without having a scheduled visit. Nurses' behaviors are very different: almost none of the interviewed nurses use WhatsApp to communicate with patients ($p<0.0001$), only a few nurses report that patients ask them to use this App to facilitate communication ($p<0.0001$), and the number of nurses who suggest using WhatsApp to patients is less than 5% ($p<0.0001$) (S4 Table). Respect to nurses, physicians use WhatsApp more frequently in order to: organize the agenda with patients ($p<0.0001$); send to patients results of diagnostic tests ($p=0.001$); monitor chronic patients' clinical conditions ($p<0.0001$); to answer urgent questions of patients ($p<0.0001$). Many perceived benefits are reported; in fact, data suggest that the use of WhatsApp: improve communication between professionals and doctor-patient relationship; increase efficiency; can reduce the costs in the Hospital; is time saving; improve the sharing of clinical and scientific knowledge; might improve performances of research and teaching activities. At the same time, some respondents suggest that the use of WhatsApp at work can reduce productivity (e.g. *I am distracted by other factors that do not concern my job*), or can increase the workload (S5 and S6 Tables), and that it could generate several risks for both healthcare professionals and patients. Respect to nurses, physicians report more frequently that WhatsApp usage in the clinical setting is risky because no guidelines or recommendations are available ($p=0.005$), and because it can compromise the patient-physician relationship ($p<0.0001$). Moreover, professionals agree with the assumption that the transmission of sensitive patients' data through WhatsApp should provide the patient's informed consent for data treatment (S7 and S8 Tables).

5.2 Testing the Theoretical Framework

5.2.1 Questionnaire's constructs internal consistency

The internal consistency of the questionnaire's constructs was verified through the Cronbach's Alpha (Table 2). Values greater than or equal to 0.7 were considered acceptable.

Variable/Macro-item	Cronbach's Alpha
Use	0,92
Perceived Usefulness	0,81
Normative Factors	0,79
Regulative Factors	0,77
Perceived Risk	0,93

Table 2. Questionnaire's constructs validity analysis.

5.2.2 Determinants of current behaviors

Thanks to a Path Analysis performed within the SEM builder environment, it was possible to verify the proposed model and evaluate the main determinants (individual and organizational) of the use of WhatsApp by the doctors and nurses included in the study. Results suggest that regulative factors do not have an impact on the use of WhatsApp with patients or colleagues, while normative factors have a direct impact on the perceived usefulness of WhatsApp. Moreover, perceived usefulness is directly related to the use of WhatsApp with both patients and colleagues, and risk perception is negatively related to the use of WhatsApp with colleagues. (Table 3, Figs 2 and 3)

Research Hypotheses	Use of WhatsApp between professionals	Use of WhatsApp with patients
RH1: *Perceived Usefulness* directly affect the *use of WhatsApp*.	Coeff= 0.27 p**=0.022	Coeff= 0.10 p**=0.022
RH2a: *Normative factors* directly affect the *use of WhatsApp*.	p=0.723 NS	p=0.25 NS
RH2b: *Regulative factors* directly affect the *use of WhatsApp*.	p=0.436 NS	p=0.582 NS
RH3a: *Normative factors* directly affect the *perceived usefulness* of WhatsApp.	Coeff=0.58 p***=0.00	Coeff=0.58 p***=0.00
RH3b: *Regulative factors* directly affect the *perceived usefulness* of WhatsApp.	p=0.70 NS	p=0.68 NS
RH4: *Risk perception* affect the *use of WhatsApp*.	p*=0.095 Coeff. =-0.15	p=0.884 NS
RH4: Other control variables (*Age, seniority, clinical specialties and different professions)* affect the *use of WhatsApp*.	NS	NS
NS=Not Significant, *p value<0.1, **p value<0.05, ***p value<0.005		

Table 3. Determinants of current behaviors

The main results of the impact of individual and organizational determinants on WhatsApp usage between colleagues and with patients are reported in Figures 2 and 3. In both cases, normative factors (e.g. colleagues' behaviors and patients' preference) directly influence the perceived usefulness of WhatsApp, while individual factors (perceived usefulness) directly influence WhatsApp usage.
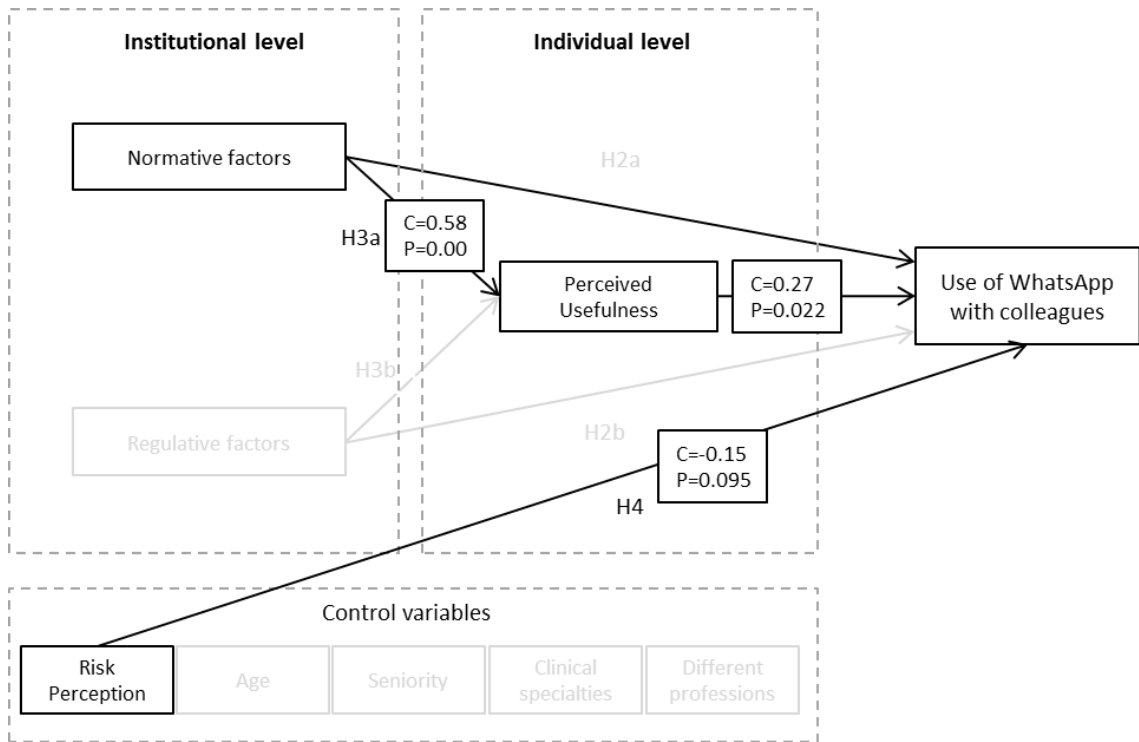
Fig. 2. Determinants of current behaviors between professionals
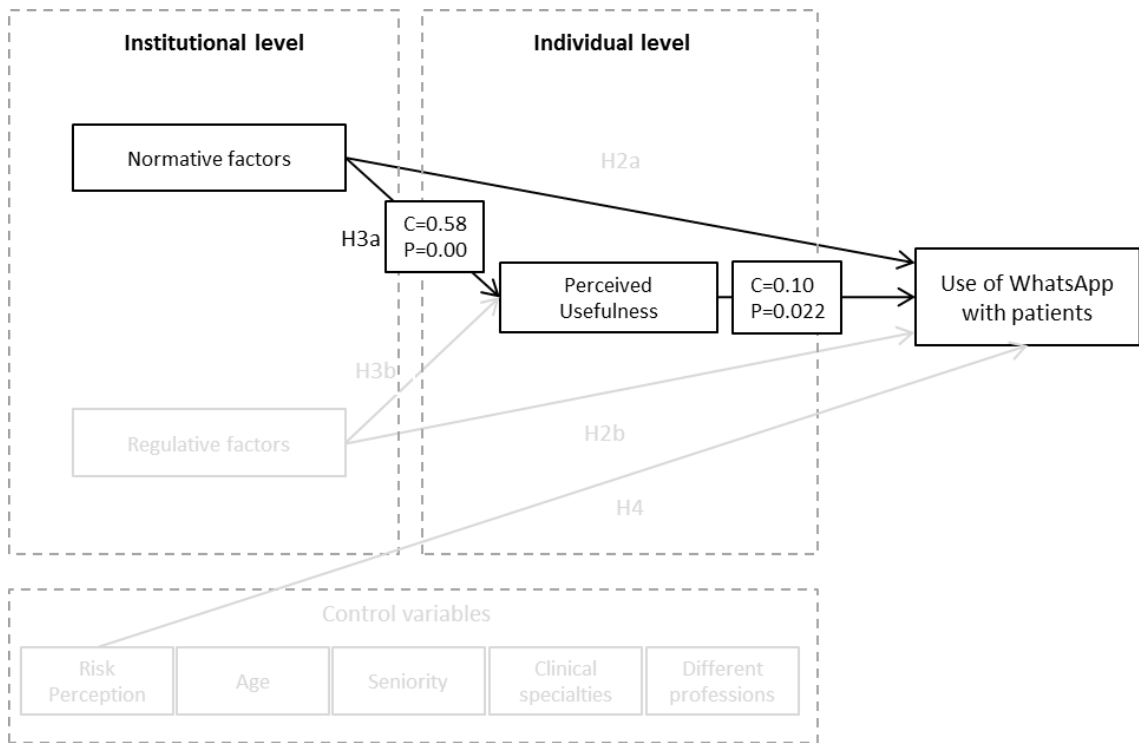
Fig. 3. Determinants of current behaviors with patients

6. Discussion

This study is the first to analyse the influence of individual and organizational determinants on the use of WhatsApp in hospitals. The findings confirms that WhatsApp is increasingly used in personal life and in the hospital environment by doctors and nurses in order to communicate and share data between peers and patients [11,15]. Also, its usage is mainly due to the perception of numerous advantages and benefits reported in clinical practice [6-16] and particularly related to the perception of greater ease in communication and to a leaner management of some processes. However, healthcare professionals' behaviors do not appear to be uniform. In fact, compared to doctors, nurses rarely use WhatsApp in order to communicate with patients or share clinical information between colleagues. On the other hand, the use of WhatsApp is perceived to not be safe for both patients and professionals [8 16-21], and its usage is inversely related to the perceived risk. At the same time, while nurses and physicians consider WhatsApp not safe, they use it anyway in their clinical practice with both colleagues and patients. For this reason, we assume that the use of WhatsApp in a healthcare setting can be considered an extreme case of "back-door adoption", which is the case for technologies that are so easy to use that they are diffused without discussion or a prior policy definition, and which are brought by healthcare professionals without any formal approval or assessment from top managers about the opportunities and risks that these innovations might bring along with them [41]. Furthermore, this phenomenon could be particularly dangerous because of its speed and uncontrolled spread in a very peculiar and complex context, where even small process variables can negatively and harmfully affect clinical risk for patients.

The findings show an interplay between organizational and individual factors in determining the use of WhatsApp in the healthcare context between healthcare professionals and with patients. In particular, individual factors play a key role as determinants of the use of WhatsApp; healthcare professionals use this technology mainly based on its perceived usefulness. Instead, organizational factors play a secondary role; they do not have a direct influence on the use of WhatsApp, but always act through individual factors. Between organizational factors, the regulative ones (e.g. rules imposed by management) have no influence on the use of WhatsApp, while normative ones (e.g. the influence of colleagues or patients) have a positive impact. From these first results emerges the importance of managers, researchers and policy makers working to regulate a phenomenon that, while it is considered useful and effective, is widespread without shared rules. The fact that the regulatory factors have no impact on the use of WhatsApp is probably related to the lack of clear rules for professionals. Management interventions must therefore be aimed at the regulation of its use, and focused on training and information for doctors, nurses and patients with respect to the risks and benefits of this tool, rather than the complete prohibition of the same, a strategy that would be useless and counterproductive.

The results of the study are valid, with several limitations. First, it was a single center survey conducted with a relatively small number of healthcare professionals, although they were representative of all Hospital departments. The number of nurses who answered the questionnaire was higher than the number of physicians, even though, despite the relatively small response rate, the number of respondents was high. This was probably due to the size of the Hospital and the accessibility to personal email of healthcare professionals.

7. Conclusion

This study furthers current knowledge about digital innovation implementation in a professional setting with a focus on "back door" adoption. In particular, by combining organizational and individual factors in a coherent theoretical framework, the study showed connections of different factors as well as their independent effect on the adoption of "employee driven" innovation, and shed new light on factors that can help managers to oversee this phenomenon and implement adequate strategies to exploit its potential increase at the same time as the level of safety for the patients. It would be desirable to continue the study by involving a larger number of hospitals to test the model and make the data more generalisable. From this study, some possible future steps for practitioners and researchers in this area also emerge. First, it is important to define some guidelines for WhatsApp usage in the healthcare setting. Another important point would be verifying the level of evidence of recommendation for the use of WhatsApp with patients in specific clinical settings and the outcomes on patient care and Key Performance Indicators that are directly related to the use of WhatsApp. In fact, despite the numerous perceived benefits, only a few studies are available about the level of evidence of recommendations regarding the use of WhatsApp in clinical and care settings. This aspect is particularly interesting especially in the medical setting, showing why it is so important to work based on scientific evidence and recommendations.

Supporting information

S1 Table. Questionnaire.
S2 Table. Personal use of WhatsApp.
S3 Table. Mode of WhatsApp usage between healthcare professionals.
S4 Table. Mode of WhatsApp usage with patients.
S5 Table. Perceived benefits about WhatsApp usage between healthcare professionals.
S6 Table. Perceived benefits related to WhatsApp usage with patients.
S7 Table. Perceived threats about WhatsApp usage between healthcare professionals.
S8 Table. Perceived threats related to WhatsApp usage with patients.

Acknowledgments

References

1. Mobasheri MH, King D, Johnston M, Gautama S, Purkayastha S, et al. The ownership and clinical use of smartphones by doctors and nurses in the UK: a multicentre survey study. BMJ Innovation. 2015;00:1–8.
2. Wolf JA, Moreau JF, Akilov O, Patton T, English JC, Ferris LK Diagnostic inaccuracy of smartphone applications for melanoma detection. JAMA Dermatology. 2013; 149:422–6.
3. Haffey F, Brady RR, Maxwell S. A comparison of the reliability of smartphone apps for opioid conversion. Drug Safety. 2013;36:111–17.
4. Martinez-Perez B, De La Torre-Diez I, Lopez-Coronado M. Privacy and security in mobile health apps: a review and recommendations. Journal of Medical Systems. 2015;39:181.
5. Dorwal P, Sachdev R, Gautam D, Jain D, Sharma P, Tiwari AK, et al. Role of WhatsApp Messenger in the Laboratory Management System: A Boon to Communication. Journal of Medical Systems. 2016;40(1):14.
6. Gulacti U, Hatipoglu S, Polat H. An Analysis of WhatsApp Usage for Communication Between Consulting and Emergency Physicians. Journal of Medical Systems. 2016;40(6):130.
7. Johnston MJ, King D, Arora S, Behar N, Athanasiou T, Sevdalis N, Darzi A, et al. Smartphones let surgeons know WhatsApp: An analysis of communication in emergency surgical teams. American Journal of Surgery. 2015;209(1):45–51.
8. Wani SA, Rabah SM, AlFadil S, Dewanjee N, and Najmi Y. Efficacy of communication amongst staff members at plastic and reconstructive surgery section using smartphone and mobile WhatsApp. Indian Journal of Plastic Surery. 2013;46(3):502-505.
9. Giordano V, Koch HA, Mendes CH, Bergamin A, and de Souza FS, do Amaral NP. WhatsApp Messenger is useful and reproducible in the assessment of tibial plateau fractures: Inter- and intra-observer agreement study. International Journal of Medical Informatics. 2015;84(2):141–148.
10. Astarcioglu MA, Sen T, Kilit C, Durmus HI, Gozubuyuk G, Kalcik M. et al. Time-to reperfusion in STEMI undergoing inter hospital transfer using smartphone and WhatsApp messenger. American Journal of Emergency Medicine. 2015;33(10):1382–1384.
11. Giordano V, Koch H, Godoy-Santos A, Dias Belangero W, Esteves Santos Pires R, Labronici P. WhatsApp Messenger as an Adjunctive Tool for Telemedicine: An Overview. Interact Journal of Medical Research. 2017; 6(2):11.
12. Lee RS, Woods R, Bullard M, Holroyd BR, Rowe BH. Consultations in the emergency department: a systematic review of the literature. Emergency Medicine Journal. 2008; 25(1): 4–9.
13. Raiman L, Antbring R, Mahmood A. WhatsApp messenger as a tool to supplement medical education for medical students on clinical attachment. BMC Medical Education. 2017;17(1):7.
14. Kaliyadan F, Ashique KT, Jagadeesan S, Krishna B. What's up dermatology? A pilot survey of the use of WhatsApp in dermatology practice and case discussion among members of WhatsApp dermatology groups. Indian Journal of Dermatology, Venereology, and Leprology. 2016;82(1):67-9.
15. Boulos MNK, Giustini DM and Wheeler S. Instagram and WhatsApp in Health and Healthcare: An Overview. Future Internet. 2016;8(37).

16. Jagannathan M. Efficacy of communication amongst staff members at plastic and reconstructive surgery section using smartphone and mobile WhatsApp. Indian Journal of Plastic Surgery. 2013;46(3):506–507.

17. Khanna V, Sambandam SN, Gul A, Mounasamy V. et al. "WhatsApp" ening in orthopedic care: a concise report from a 300-bedded tertiary care teaching center, European Journal of Orthopaedic Surgery & Traumatology. 2015;25(5):821-826.

18. Choudhari P. Study on effectiveness of communication amongst members at department of orthopedics surgery unit 3 using smartphone and mobile WhatsApp, International Surgery Journal. 2014;1(1):9-12.

19. Migliore, M. The use of smartphones or tablets in surgery. What are the limits?, Annali Italiani di Chirurgia. 2015;86(2):185-186.

20. Dhuvad JM, Dhuvad MM, Kshirsagar RA. Have Smartphones contributed in the clinical progress of oral and maxillofacial surgery? Journal of Clinical and Diagnostic Research. 2015;9(9):ZC22-ZC24.

21. Pandian SS, Srinivasan P, Mohan S. The maxillofacial surgeon's march towards a smarter future-smartphones. Journal of Maxillofacial and Oral Surgery. 2014;13:355-358.

22. Petruzzi M, De Benedittis M. WhatsApp: A telemedicine platform for facilitating remote oral medicine consultation and improving clinical examinations. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2016;121(3):248-254.

23. Kelahmetoglu O, Firinciogullari R, Yagmur C. Efficient utility of Whatsapp: from computer screen to the surgeon's hand to determine maxillofacial traumas. Journal of Craniofacial Surgery. 2015;26:1437.

24. Suliman MT. Sending photos through WhatsApp: A faster method for teleconsultation, Journal of Local and Global Health Science. 2014; 2.

25. Graziano F, Maugeri R, Iacopino DG. Telemedicine versus WhatsApp: from tradition to evolution. Neuroreport. 2015;26:602-603.

26. Martyn-Hemphill C., Sarkar S., Withington J., Roy A., Cohen D., Green J.S.A. et al. Whatsapp doc?' evaluating a novel modality of communication amongst urology team members to promote patient safety. The Journal of Urology. 2015;193:e169-e170.

27. Watson L, Pathiraja F, Depala A, O'Brien B, Beyzade S. Ensuring safe communication in health care: a response to Johnston et al on their paper "Smartphones let surgeons know WhatsApp: an analysis of communication in emergency surgical teams". American Journal of Surgery. 2016;211(1):302–3.

28. Davis F. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly. 1989;13(3):319–340.

29. Moore, G., & Benbasat, I. Development of an instrument to measure the perceptions of adopting an information technology innovation. Information Systems Research. 1991;2(3):192–222.

30. Scott WR. The Adolescence of Institutional Theory. Administrative Science Quarterly. 1987;32(4):493–511.

31. Scott WR. Institutions and Organizations. 2nd ed. Thousands Oaks (CA): Sage; 2001.

32. Scott WR. Lords of the Dance: professionals as institutional agents. Organization Studies. 2008; 29:2(219–238).

33. Agarwal R, Prasad J. Are Individual Differences Germane To The Acceptance Of New Information Technologies? Decision Science. 1999;30(2):361-391.

34. Morris MG, Venkatesh V. Age Differences in Technology Adoption decision: Implications for a Changing Work Force. Personnel Psychology. 2000;53(2):375-403.

35. O'Reilly MK, Nason GJ, Liddy S, Fitzgerald CW, Kelly ME, Shields C. DOCSS: doctors on-call smartphone study. Irish Journal of Medical Science. 2014;183(4):573-577.

36. Venkatesh V & Davis FD. A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. Management Science. 2000;46(2):186-204.

37. Venkatesh V. Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model. Information Systems Research. 2000a;11(4):342–365.

38. Venkatesh V, Morris MG, Davis GB, Davis FD. User Acceptance of Information Technology: Toward a Unifie d View. MIS Quarterly. 2003;27(3):425-478.

39. Venkatesh V, Zhang X, Sykes TA. Doctors 'Do Too Little Technology' A Longitudinal Field Study of an Electronic Healthcare System Implementation. Information Systems Research. 2011;22(3):523–546.

40. Scott WR. Institutionale Cerriers: Reviewing Models of Transporting Ideas over Time and Space and Considering Their Consequences. Industrial and Corporate Change. 2003;12(4):879-894.

41. Pinzone M, Guerci M, Lettieri E, Redman T. Progressing in the change journey towards sustainability in healthcare: the role of 'Green' HRM. Journal of Cleaner Production. 2016;122:201-211.

Supporting Information

S1 Table. Questionnaire.

Variables	Items/assumptions
Section 1: Use of WhatsApp	
Use (personal)	I use WhatsApp to participate in group discussions
	I use WhatsApp to send private messages to other people
	I use WhatsApp to organize my agenda with others
	I use WhatsApp to share moments of my life with others
	I use WhatsApp to send written messages
	I use WhatsApp to send images
	I use WhatsApp to send audio notes
	I use WhatsApp to send videos
	I use WhatsApp even in front of other people
	I connect to WhatsApp many times a day
Use (Colleagues)	I use WhatsApp to share scientific information with my colleagues
	I use WhatsApp for manage and share the agenda with my colleagues
	I use WhatsApp for the management of clinical trials
	I use WhatsApp to communicate with my colleagues about clinical situations, without mentioning specific information of patients
	I use WhatsApp to ask for information or give directions to my colleagues, without mentioning specific information of patients
	I use WhatsApp to compare clinical data of specific patients with my colleagues, using patient data
	I use WhatsApp to send patient data to my colleagues, in form of images or videos
	I use WhatsApp to receive patient information from other hospitals
Use (with patients)	Some of my patients ask me to use WhatsApp to communicate with them
	I suggest to some of my patients to use WhatsApp to communicate with me
	I use WhatsApp to organize the agenda of appointments with my patients
	I use WhatsApp to send to my patients the results of diagnostic tests
	My patients send me pictures or videos via WhatsApp to get an evaluation before a visit
	My patients send me via WhatsApp photos or videos to get an evaluation without having a scheduled visit
	I use WhatsApp to prescribe drugs or treatments to my patients
	I use WhatApp with chronic patients to monitor their clinical conditions
	I use WhatsApp with patients to monitor the effects of certain drugs
	I use WhatsApp to answer urgent questions that my patients ask me
	I make clinical decisions based on information received via WhatsApp without further patient assessment
Section 2: Scales and constructs of the proposed model	
Individual variable: Perceived Usefulness	I am convinced that the use of WhatsApp improves communication
	Using WhatsApp lets you know if the messages have been read by colleagues
	To use WhatsApp for work is time saving because it is faster than phone or mail
	I am convinced that if everyone used WhatsApp there would be a greater and more effective sharing of clinical knowledge

156

	The use of WhatsApp can greatly contribute to reducing the costs in the Hospital
	The use of WhatsApp has the limit of the need for internet connection
	The use of WhatsApp at work reduces my productivity (eg: I am distracted by other factors that do not concern my job)
	The use of WhatsApp positively affects my research activity (ie: it is easier to share data and results)
	The use of WhatsApp positively affects my teaching activity
	The use of WhatsApp for communication between health workers can increase the workload
	The evaluation of images or videos sent via WhatsApp is not sufficient to make a diagnosis
	Using WhatsApp to monitor patients' clinical conditions increases the likelihood of recovery of their clinical situation
	Use of WhatsApp facilitates the doctor-patient relationship
	Using WhatsApp in my work allows me to effectively exchange information with the patient, thus avoiding a medical examination
Regulative Factors	The hospital management asks me not to use WhatsApp among colleagues
	The Hospital Management asks me not to use WhatsApp with patients
	The Hospital Management asks me not to communicate sensitive patient data via WhatsApp
Normative Factors	My colleagues are using WhatsApp for personal reasons
	My colleagues are using WhatsApp for professional reasons
	My colleagues are using WhatsApp to share scientific information
	My colleagues are using WhatsApp to communicate patient information
	My colleagues do not want to use WhatsApp for professional reason
	My patients ask me the use of WhatsApp
	My patients prefer doctors who use WhatsApp
	My patients are more likely to recover if they are using WhatsApp for care continuity
Section 3: Control variables and characteristics of the respondent	
General information	Age
	Gender
	Profession
	Clinical Area or Unit
	Academic role in this healthcare company
	Work experience (indicate the number of years)
	Work experience in this healthcare company (indicate the number of years)
	What is the average age of your patients?
	Do you have access to your smartphone at work?
	What brand of smartphone do you use?
	Use the Smartphone to communicate with patients?
	How many years have you been using WhatsApp?
	When do you use WhatsApp for work purposes?
	How often do you use WhatsApp for work purposes?
	When do you use WhatsApp for work purposes?
	How often do you use WhatsApp for work purposes?
	What is the percentage of the patients you follow who contact you via WhatsApp?

	What is the average age of your patients using WhatsApp to communicate with her?					
Perceived Risks	The use of WhatsApp to communicate patient data with other health professionals is safe and does not entail risks					
	Sending clinical data via WhatsApp involves risks for health professionals					
	The use of WhatsApp involves risks related to privacy and data protection					
	The use of WhatsApp carries the risk of uncontrolled spread of sensitive data					
	To communicate through WhatsApp involves clinical risks as it is not documented within the medical record					
	The use of WhatsApp for communication between patients and health professionals is safe and does not involve risks					
	The use of WhatsApp for communication can generate misunderstandings with the patient					
	Sending clinical-care data via WhatsApp involves risks for the patient					
	The use of WhatsApp involves the risk of incorrect clinical evaluations					
	The use of WhatsApp involves the risk of incorrect diagnosis and clinical decisions					
	The use of WhatsApp involves the risk of compromising the patient-physicians relationship					
	The use of WhatsApp for the transmission of sensitive data with the patient should provide consent for personal data treatment by the patient					
	The use of WhatsApp in the clinical setting is risky because no guidelines and recommendations are available about the safe mode of use and transmission of data					

S2 Table. Personal use of WhatsApp.

		Never	*Rarely*	*Occasionally*	*Often*	*Always*	*p-value*
I use WhatsApp to participate in group discussions	Nurses	13	16	35	50	11	0.68
	Physicians	11	6	20	25	4	
I use WhatsApp to send private messages to other people	Nurses	2	6	10	48	59	0.23
	Physicians	3	3	7	32	21	
I use WhatsApp to organize my agenda with others	Nurses	17	18	37	40	12	0.47
	Physicians	13	14	17	17	4	
I use WhatsApp to share moments of my life with others	Nurses	10	16	24	52	22	0.057
	Physicians	11	16	10	23	6	
I use WhatsApp to send written messages	Nurses	3	4	10	53	55	0.061
	Physicians	6	1	6	35	18	
I use WhatsApp to send images	Nurses	4	6	23	52	39	0.30
	Physicians	5	5	14	29	13	
I use WhatsApp to send audio notes	Nurses	13	18	34	32	27	**< 0.0001**
	Physicians	18	18	19	8	3	
I use WhatsApp to send videos	Nurses	11	21	32	31	29	**0.003**
	Physicians	11	20	20	11	4	
I use WhatsApp even in front of other people	Nurses	30	30	32	23	10	0.73
	Physicians	15	17	17	15	2	
I connect to WhatsApp many times a day	Nurses	7	19	35	42	20	**0.05**
	Physicians	7	4	14	21	20	

S3 Table. Mode of WhatsApp usage between healthcare professionals.

		Never	Rarely	Occasionally	Often	Always	p-value
I use WhatsApp to share scientific information with my colleagues	Nurses	22	36	41	22	4	**0.038**
	Physicians	10	13	15	24	4	
I use WhatsApp for manage and share the agenda with my colleagues	Nurses	10	18	46	39	10	**0.001**
	Physicians	17	5	10	27	7	
I use WhatsApp for the management of clinical trials	Nurses	55	34	22	10	2	0.097
	Physicians	27	18	14	5	1	
I use WhatsApp to communicate with my colleagues about clinical situations, without mentioning specific information of patients	Nurses	69	25	20	7	3	**<0.0001**
	Physicians	17	16	15	14	4	
I use WhatsApp to ask for information or give directions to my colleagues, without mentioning specific information of patients	Nurses	44	32	30	12	6	**0.042**
	Physicians	17	15	13	18	3	
I use WhatsApp to compare clinical data of specific patients with my colleagues, using patient data	Nurses	56	25	28	11	4	0.64
	Physicians	33	14	9	8	2	
I use WhatsApp to send patient data to my colleagues, in form of images or videos	Nurses	85	19	12	5	3	**0.029**
	Physicians	30	17	13	4	2	
I use WhatsApp to receive patient information from other hospitals	Nurses	105	7	7	3	2	**0.001**
	Physicians	39	13	6	6	2	

S4 Table. Mode of WhatsApp usage with patients.

		Never	Rarely	Occasionally	Often	Always	p-value
Some of my patients ask me to use WhatsApp to communicate with them	Nurses	102	14	4	1	0	**<0.0001**
	Physicians	18	10	18	17	3	
I suggest to some of my patients to use WhatsApp to communicate with me	Nurses	112	6	2	1	0	**<0.0001**
	Physicians	41	10	6	6	3	
I use WhatsApp to organize the agenda of appointments with my patients	Nurses	111	7	2	1	0	**<0.0001**
	Physicians	39	11	9	6	1	
I use WhatsApp to send to my patients the results of diagnostic tests	Nurses	117	2	2	0	0	**0.001**
	Physicians	53	8	3	1	1	
My patients send me pictures or videos via WhatsApp to get an evaluation before a visit	Nurses	114	3	2	2	0	**<0.0001**
	Physicians	20	19	14	11	2	
My patients send me via WhatsApp photos or videos to get an evaluation without having a scheduled visit	Nurses	114	3	2	2	0	**<0.0001**
	Physicians	26	14	12	13	1	
I use WhatsApp to prescribe drugs or treatments to my patients	Nurses	118	1	2	0	1	**<0.0001**
	Physicians	52	11	1	2	0	
I use WhatsApp with chronic patients to monitor their clinical conditions	Nurses	114	5	2	0	0	**<0.0001**
	Physicians	42	11	9	4	0	
I use WhatsApp with patients to monitor the effects of certain drugs	Nurses	117	2	2	0	0	**<0.0001**
	Physicians	49	9	4	3	1	
I use WhatsApp to answer urgent questions that my patients ask me	Nurses	111	3	6	1	0	**<0.0001**
	Physicians	32	17	13	3	1	
I make clinical decisions based on information received via WhatsApp without further patient assessment	Nurses	115	2	2	2	0	**0.002**
	Physicians	54	8	3	0	1	

S5 Table. Perceived benefits about WhatsApp usage between healthcare professionals.

		Totally disagree	Strongly disagree	Quite disagree	Neither agree nor disagree	Quite agree	Strongly agree	Totally agree	p-value
I am convinced that the use of WhatsApp improves communication	Nurses	6	8	20	16	49	17	7	0.73
	Physicians	2	5	6	8	26	11	7	
Using WhatsApp lets you know if the messages have been read by colleagues	Nurses	7	8	8	21	45	25	11	0.28
	Physicians	1	3	1	15	20	21	5	
I am convinced that if everyone used WhatsApp there would be a greater and more effective sharing of clinical knowledge	Nurses	17	18	15	30	22	12	6	0.97
	Physicians	5	3	3	14	21	14	6	
The use of WhatsApp can greatly contribute to reducing the costs in the Hospital	Nurses	17	13	20	41	16	9	3	0.17
	Physicians	11	8	9	17	14	4	3	
The use of WhatsApp has the limit of the need for internet connection	Nurses	15	9	11	32	26	17	9	0.29
	Physicians	4	2	2	21	17	12	8	
The use of WhatsApp at work reduces my productivity (e.g.: I am distracted by other factors that do not concern my job)	Nurses	9	12	17	24	29	24	8	**0.046**
	Physicians	14	7	10	11	17	4	3	
The use of WhatsApp positively affects my research activity (e.g.: it is easier to share data and results)	Nurses	17	12	16	30	23	16	5	0.26
	Physicians	7	10	12	20	11	2	3	
The use of WhatsApp positively affects my teaching activity	Nurses	11	13	13	41	18	17	5	0.053
	Physicians	10	10	10	21	13	1	1	
The use of WhatsApp for communication between health workers can increase the workload	Nurses	18	14	9	16	12	5	1	>0.05
	Physicians	12	9	7	20	11	4	3	

S6 Table. Perceived benefits related to WhatsApp usage with patients.

		Totally disagree	*Strongly disagree*	*Quite disagree*	*Neither agree nor disagree*	*Quite agree*	*Strongly agree*	*Totally agree*	*p-value*
The evaluation of images or videos sent via WhatsApp is not sufficient to make a diagnosis	Nurses	10	11	8	34	20	22	9	**0.008**
	Physicians	4	4	5	6	13	16	15	
Using WhatsApp to monitor patients' clinical conditions increases the likelihood of recovery of their clinical situation	Nurses	10	16	5	19	32	17	20	**0.045**
	Physicians	12	7	8	14	13	8	4	
Use of WhatsApp facilitates the doctor-patient relationship	Nurses	19	7	13	29	21	18	8	0.53
	Physicians	8	6	5	16	17	10	1	
Using WhatsApp in my work allows me to effectively exchange information with the patient, thus avoiding a medical examination	Nurses	42	16	15	18	16	8	4	0.69
	Physicians	21	11	11	11	10	2	0	

S7 Table. Perceived threats about WhatsApp usage between healthcare professionals.

		Totally disagree	Strongly disagree	Quite disagree	Neither agree nor disagree	Quite agree	Strongly agree	Totally agree	p-value
The use of WhatsApp to communicate patient data with other health professionals is safe and does not entail risks	Nurses	33	25	28	9	22	4	2	0.41
	Physicians	12	10	19	10	12	1	2	
Sending clinical data via WhatsApp involves risks for health professionals	Nurses	7	2	8	14	45	27	15	0.17
	Physicians	0	1	10	10	23	11	11	
The use of WhatsApp involves risks related to privacy and data protection	Nurses	5	1	5	10	39	38	23	0.37
	Physicians	0	3	4	6	22	16	14	
The use of WhatsApp carries the risk of uncontrolled spread of sensitive data	Nurses	5	2	5	12	34	34	29	0.12
	Physicians	1	5	2	9	25	11	11	
To communicate through WhatsApp involves clinical risks as it is not documented within the medical record	Nurses	8	1	5	11	27	37	30	**0.03**
	Physicians	1	5	1	8	20	11	18	

S8 Table. Perceived threats related to WhatsApp usage with patients.

		Totally disagree	Strongly disagree	Quite disagree	Neither agree nor disagree	Quite agree	Strongly agree	Totally agree	p-value
The use of WhatsApp for communication between patients and health professionals is safe and does not involve risks	Nurses	39	25	31	11	10	4	2	0.86
	Physicians	17	13	21	7	7	1	0	
The use of WhatsApp for communication can generate misunderstandings with the patient	Nurses	6	0	10	11	47	33	13	0.21
	Physicians	2	1	9	9	24	10	11	
Sending clinical data via WhatsApp involves risks for the patient	Nurses	8	1	12	13	45	28	12	**0.03**
	Physicians	0	2	12	9	26	7	10	
The use of WhatsApp involves the risk of incorrect clinical evaluations	Nurses	5	0	8	14	41	33	20	0.20
	Physicians	1	3	7	5	24	13	13	
The use of WhatsApp involves the risk of incorrect diagnosis and clinical decisions	Nurses	6	1	11	15	39	32	17	0.29
	Physicians	1	4	5	7	24	12	12	
The use of WhatsApp involves the risk of compromising the patient-physicians relationship	Nurses	6	2	12	14	34	32	19	**<0.0001**
	Physicians	3	12	9	14	13	7	8	
The use of WhatsApp for the transmission of sensitive data with the patient should provide consent for personal data treatment by the patient	Nurses	6	2	3	16	25	34	36	0.27
	Physicians	3	3	2	8	22	11	15	
The use of WhatsApp in the clinical setting is risky because no guidelines and recommendations are available about the safe mode of use and transmission of data	Nurses	19	15	9	31	13	21	4	**0.005**
	Physicians	5	3	3	17	11	13	13	

De Benedictis A., Lettieri E., Piredda M., Tartaglini D. **Development and psychometric testing of a new measure of determinants that influence the adoption of WhatsApp in Hospitals.**

Title

Development and psychometric testing of a new measure of determinants that influence the adoption of WhatsApp in Hospitals

Authors

Anna De Benedictis[1,4], Michela Piredda[3], Emanuele Lettieri[4] and Daniela Tartaglini[2]

Affiliation

[1]University Hospital Campus Bio-Medico of Rome, Via Alvaro del Portillo 200 - 00128, Rome (Italy).
[2]University Campus Bio-Medico of Rome, Via Alvaro del Portillo 21 - 00128, Rome (Italy).
[3]Research Unit Nursing Science, University Campus Bio-Medico of Rome, Via Alvaro del Portillo 21 - 00128, Rome (Italy).
[4]Politecnico di Milano, P.zza Leonardo da Vinci, 32 - 20133 Milan (Italy).

E-mail address and fax number of the corresponding author

Corresponding Author: Anna De Benedictis

E-mail a.debenedictis@unicampus.it

ORCID Id: https://orcid.org/0000-0001-8655-0895

Abstract

Aim: To develop and psychometrically test the questionnaire 'Digital Innovation Adoption in Hospitals', a measure of individual and institutional factors that influence the use of WhatsApp in hospitals as perceived by nurses and physicians.
Background: The rising use of messaging applications, such as WhatsApp, for both social and personal purposes has determined a widespread use of these technologies also in healthcare contexts. Hospitals are increasingly looking for evaluating the impact of WhatsApp usage on care delivery; however, there is still limited evidence about instruments that can help to explore this phenomenon.
Method: Item generation included identifying and adapting items from existing measures. A pool of 50 items was generated and evaluated by a panel of researchers and clinical experts. A 41-item instrument including four sections ('Perceived Risks', 'Perceived usefulness', 'Regulative factors' and 'Normative factors') was created. Content validity indices and face validity was pilot-tested with fourteen professionals. To assess construct validity, a sample of 191 hospital professionals (nurses and physicians) completed the instrument. Reliability was evaluated using Cronbach's alpha coefficients and factor score determinacy coefficients.
Results: Nine dimensions were identified. Adequate fit indices and reliability of the factors were found. Correlations between factors were positive and significant.

Conclusion: This study is the first that offers a validated tool to evaluate the phenomenon of WhatsApp usage in hospitals. The new instrument shows reasonable psychometric properties and is a promising widely applicable measure of individual and institutional factors that influence the use of WhatsApp in hospitals.

KEYWORDS
Digital innovation, acceptance, employee-driven innovation, WhatsApp, hospital.

1. BACKGROUND

In healthcare context and particularly in hospitals, a growing use of mobile health applications to support clinical and care processes is documented [1-6]. An increasing number of hospital professionals use instant messaging applications, such as WhatsApp, in their daily work and to communicate between peers and with patients [6-11]. Previous research mainly focused on the effectiveness of WhatsApp usage in different clinical and care settings [6-26], but there is still limited evidence about whether and how individual and organisational determinants can influence the use of WhatsApp in Hospitals [27] and about instruments that can help to explore such phenomenon. This study aims to shed new light on the widespread phenomenon of the use of WhatsApp in hospitals, developing a new tool to measure the individual and institutional determinants that influence the use of WhatsApp in hospitals as perceived by nurses and doctors.

A theoretical model was created taking inspiration from two well-established theories: the Technology Acceptance Model (TAM) [28,29] and the Institutional Theory [30-32]. The TAM [28] is the most widely used rational model to explore what leads people to accept or reject Information Technology, and it identifies two main antecedents, the perceived usefulness and the perceived ease of use of technology. Perceived usefulness measures "the degree to which a person believes that using a particular system would enhance his or her job performance" [28], the ease of use measures "the degree to which a person believes that using a system would be free of effort" [28,29].

Institutional theory, instead, is based on the assumption that individual behaviours are modelled by regulations, social norms and meaning systems and that institutions embodied in routines rely on automatic cognition and uncritical processing of existing schemata and privilege consistency with stereotypes and speed over accuracy. According to this perspective, individuals are embedded in institutional pillars that limit the scope of their rational assessments and direct the engagement of specific behaviours [30-32]. Scott [30-32] defines the three institutional pillars as follows: regulative pillar (which regard the existence of regulations, rules and processes whose breach is monitored and sanctioned), normative pillar (which introduces a social dimension of appropriate behaviours in the organisation) and cultural pillar (which emphasises the use of common schemas, frames and other shared symbolic representations that create attachment to the 'appropriate' behaviour).

2. THE STUDY

2.1. Aim
The study aims at developing and psychometrically testing the questionnaire 'Digital Innovation Adoption in Hospitals' (DIAH), a measure of individual and institutional factors that influence the use of WhatsApp in hospitals as perceived by nurses and physicians.

2.2. Methodology

2.2.1. Item generation

A theoretical model (Fig. 1), taking inspiration from the 'Technology Acceptance Model' (TAM) and the Institutional Theory, guided the instrument development [27]. We decided to include in our theoretical model only the individual variable 'perceived usefulness', excluding 'ease of use', because from preliminary interviews and past experiences, we know that physicians and nurses daily use smartphones and WhatsApp, so we excluded any problems related to the digital divide. Moreover, such digital literacy in the use of WhatsApp has been confirmed by the study. Finally, some variables have been included as they are considered significant to better understand the phenomenon. To identify key concepts related to individual and institutional factors that influence the use of WhatsApp in hospitals, a comprehensive literature search was conducted in the PubMed and CINAHL databases, searching for articles published from inception to April 2019. This search was performed using keywords such as "WhatsApp", "questionnaire" and "synonyms". Additional studies were identified through a hand search of reference lists and the PubMed instrument 'similar articles'. Key concepts from the records retrieved were considered according to the theoretical model to generate a pool of items. The criteria for item creation were "ability to investigate intention to use digital innovation in hospitals by healthcare professionals" and "appropriateness for the Italian context".

Fig 1. Theoretical model
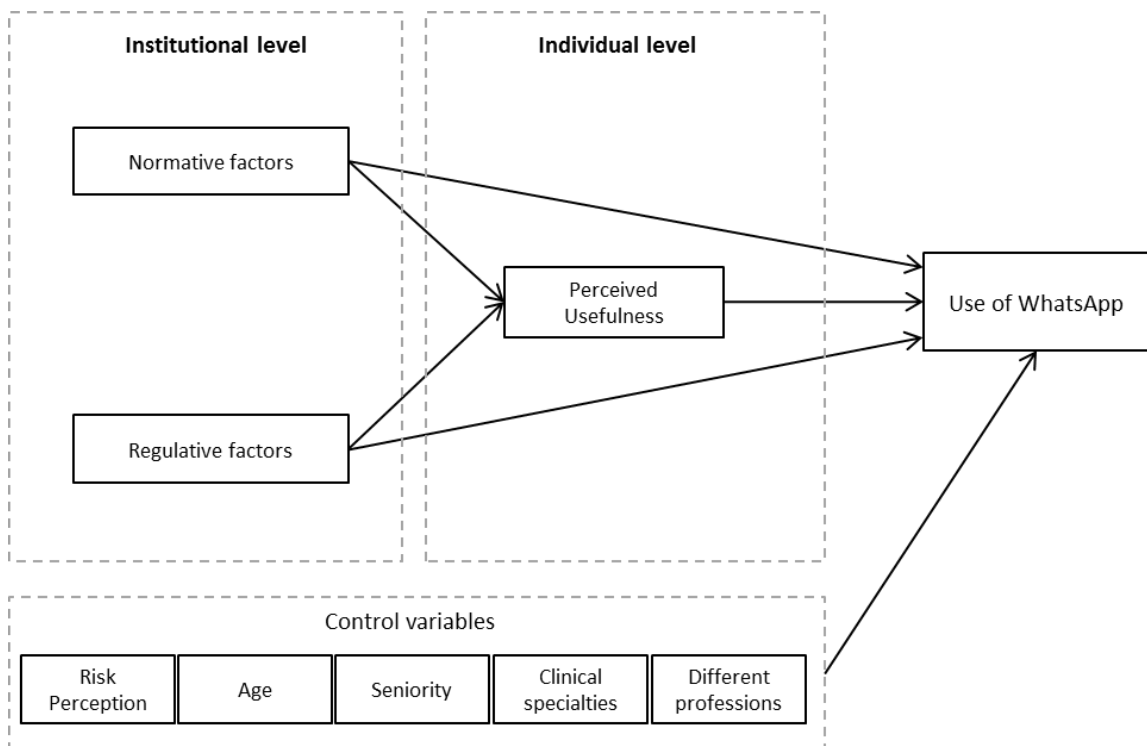
2.2.2. Face validity

The initial item pool comprised 50 indicators that were reviewed for face validity by a panel of four experts. The panel members were one nurse and one physician, with more than 9 years of work experience, and two engineers with expertise in Information Science. Panel members were asked to evaluate each statement for clarity, ease of use and appropriateness [33]. Based on their comments and suggestions, two items were removed and changes were made in the wording of several items to increase clarity.

2.2.3. Content validity

This 48-item questionnaire was tested for content validity by 10 experts not involved in the preceding phase to identify its ability to measure the determinants of the intention to use WhatsApp in hospitals and to identify, for each item, utility, consistency with the research objectives, easy of reply and other important aspects to take into account. Audio-recorded individual interviews using a semi-structured grid were carried out with 10 experts including two nurses, three head nurses, two managers and three physicians. The interviews lasted 60 minutes on average and were conducted in a designated room by three researchers: one acted as interviewer, the other two helped with audio-recording and with filling out the grid for item evaluation. Based on the expert evaluation, seven items were eliminated and five items were modified.

2.2.4. Instrument
The questionnaire consisted of four main sections beyond the initial part designed to gather demographic and sample information. The section 'Perceived Risks' had 12 items, the section 'Perceived usefulness' consisted of 11 items, and the last sections 'Regulative factors' and 'Normative factors' have three and seven items, respectively. Based on the theoretical model proposed, the scale for the measurement of perceived usefulness has been adapted from the studies of Venkatesh [34-37], and the scale for the measurement of normative and regulative factors has been adapted from the study of Scott [32]. The survey items are shown in Table 1. All questionnaire items related to the constructs of the proposed model were explored using a 7-point Likert scale with 1 indicating totally disagree, 2 strongly disagree, 3 quite disagree, 4 neither agree nor disagree, 5 quite agree, 6 strongly in agree and 7 totally in agree.

2.3. Participants and data collection
The link for the online questionnaire was sent by e-mail to all nurses (n = 380) and to 250 physician representatives of different clinical areas of a medium-size teaching hospital in Rome between February and September 2017. Three reminders were sent periodically to participants. Data analysis was performed in October 2017.

2.4 Ethical considerations
The study has been approved by the Ethics Board of the University Hospital Campus Bio-Medico of Rome. (Approval number: 61/16 OSS ComEt CBM), and it was conducted in accordance with the principles of the Declaration of Helsinki developed in Brazil [38]. A written consent has been obtained by professionals involved in the study. Professionals were invited to participate through an information letter about the purpose of the study, and consent was assumed by return of the questionnaire. Data were collected anonymously.

2.5 Statistical analyses
Descriptive statistics of means, frequencies and percentages for the sample's demographic characteristics and items were performed. As preliminary analyses, skewness and kurtosis were evaluated to ascertain the data distribution. The Bartlett's test and the Kaiser-Meyer-Olkin (KMO) index were calculated to evaluate data factorability. The Bartlett's test must be significant, and values ≥ 0.90 of KMO are considered excellent; 0.80 - 0.90 good; 0.70 - 0.80; moderate; 0.60 - 0.70 acceptable and ≤ 0.60 not-acceptable.
Exploratory factor analysis (EFA) was conducted with SPSS using Principal Axis Factoring with Promax oblique rotation when normality of data distribution was ascertained (values of skewness and kurtosis <|1|). In these cases, the number of factors to retain in the final solution was identified by scrutinising the scree plot of Eigenvalues. Items were excluded

from the final solution if the loadings were low on the principal factor or if the primary loading was less than twice those on secondary factors [39]. When data showed values of skewness and kurtosis <|1|, the MLr (maximum likelihood) estimator with Geomin rotation was used [40]. In these cases, the goodness of fit was evaluated considering the following indices: chi-square significance (if chi-square is not significant, the model reached a perfect fit with the observed data); comparative fit index [41] and Tucker-Lewis index [42]: values ≥ 0.95 indicate a good fit; root mean square error of approximation [43]: values ≤ 0.05 or 0.08 indicate a good fit [44]. Internal consistency was evaluated thorough Cronbach's Alpha coefficients ($\alpha \geq 0.90$ were considered excellent; $0.8 \leq \alpha < 0.9$ good; $0.7 \leq \alpha < 0.8$ acceptable; $0.6 \leq \alpha < 0.7$ questionable; $0.5 \leq \alpha < 0.6$ poor; $\alpha < 0.5$ unacceptable) and Factor score determinacies coefficients (values > 0.90 were considered excellent) when appropriate. Statistical analyses were performed using SPSS 21.0 and MPLUS 6.12 [39]

3. RESULTS

3.1. Sample and item descriptive characteristics

The final sample included 191 healthcare professionals, of which 125 (65.4%) were nurses and 66 (34.6%) physicians, with a response rate of 30.3%. They were 63 (33%) male, aged 38 years on average (range 22-69, SD 10.66), with a mean work experience of 12.94 (range 0.3-45, SD 9.75). Skewness and kurtosis values were <|1| for all the items of the section 'Regulative Factors'; therefore, the EFA for this section was performed with SPSS using Principal Axis Factoring with Promax oblique rotation. In contrast, some of the items of the sections 'Perceived Usefulness', 'Perceived Risks' and 'Normative factors' were >|1|, and therefore, the EFA was conducted using the MLr estimator from Mplus.

Mean scores for the items of the section 'Regulative Factors' ranged from 3.35 (SD 1.76) to 5.02 (SD 1.84), for 'Perceived Usefulness' from 2.87 (SD 1.74) to 4.80 (SD 1.45), for 'Perceived Risks' from 2.62 (SD 1.45) to 5.31 (SD 1.57 and 1.59) and for 'Normative factors' from 2.85 (SD 1.69) to 5.40 (SD 1.37).

3.2. Construct validity

The 3-item section 'Regulative Factors' yielded a KMO = 0.625 and a significant (p < 0.001) Bartlett's test of sphericity. Therefore, the dataset could be subjected to factor analysis that identified a 1-factor solution (Table 1). The factor was named 'adherence to management's objectives'.

The data set of the 11-item section 'Perceived Usefulness' was considered suitable for factor analysis because the KMO was 0.835 and Bartlett's test of sphericity was significant (p < 0.001). Comparisons of the 1–5-factor solutions led to the choice of the 2-factor model (Table 2), with all of the items showing a loading > 0.3 and only one item (PU 7) showing cross-loading. This solution yielded the following fit indices: Chi-Square (df 34) = 58.259, p = 0.0059; RMSEA = 0.066, 90% CI [0.035; 0.094], probability RMSEA <= .05; p = 0.171; CFI = 0.937; TLI = 0.898; SRMR = 0.042. The first factor, termed 'communication and information sharing', was loaded by six items and the second, 'clinical, research and teaching performances' by five items.

The data set of the 12-item section 'Perceived Risks' was considered suitable for factor analysis because the KMO was 0.893 and Bartlett's test of sphericity resulted significant (p < 0.001). Comparison of the 1–5-factor solutions from the EFA led to the choice of the 4-factor model, as it yielded the following satisfactory fit indices: Chi-Square (df 27) = 27.537, p = 0.2800; RMSEA = 0.029, 90% CI [0.000; 0.071], probability RMSEA <= .05; p = 0.747; CFI

= 0.995; TLI = 0.986; SRMR = 0.022. All of the items showed a loading > 0.3, and three items (PR3, PR4 and PR9) showed cross-loadings. The first factor was termed 'safety for patients and healthcare professionals' and was loaded by four items; the second factor, termed 'safety in data sharing', was loaded by two items; the third factor, 'Data protection and clinical documentation', was loaded by four items and the fourth, termed 'Safety in clinical evaluation', was loaded by two items (Table 3).

Finally, the 7-item section 'Normative Factors' yielded a KMO = 0.799 and a significant (p < 0.001) Bartlett's test of sphericity and was deemed suitable for factor analysis. Comparison of the 1–4-factor solutions from the EFA led to the choice of the 2-factor model, which showed the following fit indices: Chi-Square (df 8) = 14.683, p = 0.0656; CFI = 0.995; TLI = 0.986; RMSEA= 0.075, 90% CI [0.000; 0.134], probability RMSEA <= .05; p = 0.216; CFI = 0.971; TLI = 0.924; SRMR = 0.026. All of the items had a loading > 0.3, and only one item (NF4) showed a cross-loading (Table 4).

3.3. Reliability

Cronbach's alpha coefficient (α) values ranged from acceptable (0.7 ≤ α < 0.8) and excellent (α ≥ 0.90) for all the considered scales. In particular, for the scale 'Regulative Factors', α was = 0.773, and for the two factors found in the sections 'Perceived Usefulness', it was, respectively, PU1 = 0.81 and PU2 = 0.725. For the scale 'Perceived Risks', the α was PR1 = 0.923; PR 2 = 0.828; PR 3 = 0.774; PR 4 = 0.841, and for the scale 'Normative Factors', it was NF1 = 0.713; NF2 0.890.

3.4. Factor scores and correlations

The factor 'Adherence to management's objectives' of the section 'Regulative Factors' presented an acceptable Cronbach's Alpha Coefficient (0.773) (Table 1).

In the section 'Perceived Usefulness', the correlation between the two factors was found positive and high (r = 0.565) (Table 5). Cronbach's alpha coefficient resulted good for the factor 'Communication and information sharing' (α = 0.817) and acceptable for the factor 'Clinical, research and teaching performances' (α = 0.725) (Table 2).

The correlations between the factors in the section 'Perceived Risks' ranged from -0.154 to 0.716 (Table 5). The highest correlations were found between 'Safety for patients and healthcare professionals' and 'Data protection and clinical documentation' (r = 0.716) and between 'Safety for patients and healthcare professionals' and 'Safety in clinical evaluation' (r = 0.604). The correlation between 'Safety in clinical evaluation' and 'Data protection and clinical documentation' was also high (r = 0.582). The lowest correlation was found between 'Safety in data sharing' and 'Safety in clinical evaluation' (r = -0.154).

Cronbach's alpha coefficient resulted excellent for the factor 'Safety for patients and healthcare professionals' (α = 0.923), good for the factors 'Safety in data sharing' (α = 0.828) and 'Safety in clinical evaluation' (α = 0.841) and good for the factor 'Data protection and clinical documentation' (α = 0.774) (Table 3).

In the last section, 'Normative Factors', the correlation between the two factors was positive (r = 0.451) (Table 5). Cronbach's Alpha Coefficient resulted acceptable for the factor 'Peer influence' (α = 0.713) and good for the factor 'Patient influence' (α = 0.890) (Table 4).

Table 1. Statistics of the items related to 'Regulative Factors' and their factor loadings at EFA§ (n = 167)

Item	Mean	*SD*	Skew	Kurt	RF1
RF1. The hospital management asks me not to use WhatsApp among colleagues	3.35	1.767	0.234	-0.681	**0.552**
RF2. The Hospital Management asks me not to use WhatsApp with patients	4.36	1.939	-0.390	-0.854	**0.971**
RF3. The Hospital Management asks me not to communicate sensitive patient data via WhatsApp	5.02	1.840	-0.779	-0.222	**0.689**
Factor score determinacy coefficients – Cronbach's alpha coefficient					0.773

Abbreviations: § using Principal Axis Factoring with Promax oblique rotation through SPSS; RF1 = Adherence to management's objectives; Kurt = kurtosis; SD = standard deviation; Skew = skewness; primary factor loadings in bold.

Table 2. Statistics of the items related to 'Perceived Usefulness' and their factor loadings at EFA§ using Mplus (n = 147)

Item	Mean	*SD*	Skew	Kurt	PU1	PU2
PU1. I am convinced that the use of WhatsApp improves communication	4.54	1.48	-0.571	-0.097	**0.714**	0.004
PU2. Using WhatsApp lets you know if the messages have been read by colleagues	4.80	1.45	-0.866	0.540	**0.659**	-0.076
PU3. To use WhatsApp for work is time saving because it is faster than phone or mail	4.49	1.64	-0.672	-0.187	**0.798**	0.073
PU4. I am convinced that if everyone used WhatsApp there would be a greater and more effective sharing of clinical knowledge	3.65	1.71	-0.016	-0.868	**0.713**	0.173
PU5. The use of WhatsApp has the limit of the need for internet connection	4.31	1.67	-0.458	-0.383	**0.675**	-0.280
PU6. The use of WhatsApp positively affects my research activity	3.72	1.64	-0.051	-0.733	0.015	**0.474**
PU7. The use of WhatsApp positively affects my teaching activity	3.74	1.56	-0.129	-0.584	0.333	**0.402**
PU8. The evaluation of images or videos sent via WhatsApp is not sufficient to make a diagnosis	4.54	1.76	-0.466	-0.652	**0.385**	-0.092
PU9. Using WhatsApp to monitor patients' clinical conditions increases the likelihood of recovery of their clinical situation	4.23	1.88	-0.283	-0.980	0.024	**0.609**
PU10. Use of WhatsApp facilitates the doctor-patient relationship	3.98	1.75	-0.337	-0.825	-0.112	**0.691**
PU11. Using WhatsApp in my work allows me to effectively exchange information with the patient, thus avoiding a medical examination	2.87	1.74	0.475	-0.943	0.073	**0.505**
Factor score determinacy coefficients – Cronbach's alpha coefficient					0.817	0.725

Abbreviations: § using MLr (maximum likelihood) estimator with Geomin rotation from M-plus; PU1 = Communication and information sharing; PU2 = Clinical, research and teaching performances; Kurt = kurtosis; SD = standard deviation; Skew = skewness; primary factor loadings in bold.

Table 3. Statistics of the items related to 'Perceived Risks' and their factor loadings at EFA§ (n = 167)

Item	Mean	*SD*	Skew	Kurt	PR1	PR2	PR3	PR4
PR1. The use of WhatsApp to communicate patient data with other health professionals is safe and does not entail risks	2.99	1.597	0.422	-0.699	-0.104	**0.368**	-0.110	0.072
PR2. Sending clinical data via WhatsApp involves risks for health professionals	4.94	1.427	-0.770	0.624	**0.916**	-0.034	0.012	-0.037
PR3. The use of WhatsApp involves risks related to privacy and data protection	5.32	1.372	-1.100	1.453	**0.580**	0.034	0.347	0.033
PR4. The use of WhatsApp carries the risk of uncontrolled spread of sensitive data	5.23	1.477	-0.987	0.884	0.116	-0.033	**0.563**	0.324
PR5. To communicate through WhatsApp involves clinical risks as it is not documented within the medical record	5.31	1.593	-1.131	0.906	0.035	-0.068	**0.795**	0.039
PR6. The use of WhatsApp for communication between patients and health professionals is safe and does not involve risks	2.62	1.459	0.717	-0.083	0.013	**1.576**	0.006	-0.008

Item	Mean	SD	Skew	Kurt	PR1	PR2	PR3	PR4
PR7. The use of WhatsApp for communication can generate misunderstandings with the patient	4.98	1.414	-0.894	0.915	**0.673**	0.051	0.138	0.001
PR8. Sending clinical-care data via WhatsApp involves risks for the patient	4.85	1.437	-0.672	0.355	**0.743**	-0.022	0.005	0.218
PR9. The use of WhatsApp involves the risk of incorrect clinical evaluations	5.14	1.415	-0.904	0.871	0.408	0.002	-0.035	**0.574**
PR10. The use of WhatsApp involves the risk of incorrect diagnosis and clinical decisions	5.03	1.469	-0.853	0.592	-0.018	0.015	0.084	**1.020**
PR11. The use of WhatsApp involves the risk of compromising the patient-physician relationship	4.69	1.665	-0.510	-0.526	0.066	-0.032	**0.555**	0.204
PR12. The use of WhatsApp for the transmission of sensitive data with the patient should provide consent for personal data treatment by the patient	5.31	1.577	-1.086	0.902	-0.071	0.064	**1.010**	-0.041
Factor score determinacy coefficients					0.923	0.828	0.774	0.841

Abbreviations: § using MLr (maximum likelihood) estimator with Geomin rotation from M-plus; PR1 = Safety for patients and healthcare professionals; PR2 = Safety in data sharing; PR3 = Data protection and clinical documentation; PR4 = Safety in clinical evaluation; Kurt = kurtosis; SD = standard deviation; Skew = skewness; primary factor loadings in bold.

Table 4. Statistics of the items related to 'Normative Factors' and their factor loadings at EFA§ (n = 147)

Item	Mean	SD	Skew	Kurt	NF1	NF2
NF1. My colleagues are using WhatsApp for personal reasons	5.40	1.377	-1.007	1.356	**0.415**	-0.030
NF2. My colleagues are using WhatsApp for professional reasons	4.44	1.590	-0.559	-0.098	**0.609**	0.144
NF3. My colleagues are using WhatsApp to share scientific information	4.43	1.591	-0.508	-0.041	**0.714**	-0.004
NF4. My colleagues are using WhatsApp to communicate patient information	3.56	1.769	-0.097	-1.008	**0.449**	0.528
NF5. My patients ask me to use WhatsApp	3.15	1.848	0.277	-1.094	-0.004	**0.900**
NF6. My patients prefer doctors who use WhatsApp	3.15	1.715	0.214	-0.778	0.033	**0.815**
NF7. My patients are more likely to recover if they are using WhatsApp for care continuity	2.85	1.692	0.471	-0.634	-0.111	**0.645**
Factor score determinacy coefficients					0.713	0.890

Abbreviations: § using MLr (maximum likelihood) estimator with Geomin rotation from M-plus; F1 = Peer influence; F2 = Patient influence; Kurt = kurtosis; SD = standard deviation; Skew = skewness; primary factor loadings in bold.

Table 5. Factor correlations

Section 'Perceived Usefulness'		
	PU1	**PU2**
PU1: Communication and information sharing	1.000	-
PU2: Clinical, research and teaching performances	0.565	1.000

Section 'Perceived Risks'				
	PR1	**PR2**	**PR3**	**PR4**
PR1: Safety for patients and healthcare professionals	1.000	-		
PR2: Safety in data sharing	-0.087	1.000	-	
PR3: Data protection and clinical documentation	0.716	-0.124	1.000	-
PR4: PR4 = Safety in clinical evaluation	0.604	-0.154	0.582	1.000

Section 'Normative Factors'		
	NF1	**NF2**
NF1: Peer influence	1.000	-
NF2: Patient influence	0.451	1.000

4.   DISCUSSION

This study aimed to develop and psychometrically test the questionnaire 'Digital Innovation Adoption in Hospitals' (DIAH), a measure of individual and institutional factors that influence the use of WhatsApp in Italian hospitals as perceived by nurses and physicians. The EFA showed good fit indices and a high reliability of the solutions for the four questionnaire sections, and it allowed to identify some important dimensions for each section analysed.

For the section *'Perceived Usefulness'*, a 2-factor model was selected, and the following dimensions were identified: 'communication and information sharing' and 'clinical, research and teaching performances'. These dimensions are specific of user acceptance models which emphasise individuals' rational and volitional assessment of the costs and benefits they would attain from the new technology [45]. According to these models, the use of a new technology is mainly guided from a rational and voluntary choice of the individual, in a technology-centered view on technology acceptance, where acceptance is understood to be mostly dependent on the nature of the technology (i.e. functionality and ease of use) [46].

The best solution for the section 'Regulative factors' was a 1-factor model that explored the *'adherence of nurses and physicians to the management's objectives'*. The normative factors were solved in a 2-factor model and in the following two dimensions: peer influence and patient influence. The regulative and normative factors' dimensions are specific of organisational studies and theories which conceive organisations as strongly institutionalised settings in which individual behaviours are bounded by a complex combination of regulations, social norms and cultural systems [47,48].

In addition to the individual and organisational determinants analysed in the three previous sections, the theoretical model also included some control variables. Among these variables, the *'perceived risks'* was considered that important that a separate section was required, which was also validated through the EFA. In this case, the 4-factor model was selected, and the following dimensions were named: safety for patients and healthcare professionals, safety in data sharing, data protection and clinical documentation, safety in clinical evaluation.

Beyond the validation of the questionnaire, the study also allowed to highlight the mode of WhatsApp usage in personal life and in the hospital environment by doctors and nurses in order to communicate and share data between peers and patients [27]. In particular, its usage is mainly due to the perception of numerous advantages and benefits reported in clinical practice. However, healthcare professionals' behaviours do not appear to be uniform. In fact, compared to doctors, nurses rarely use WhatsApp to communicate with patients or share clinical information among colleagues [27]. On the other hand, the use of WhatsApp is perceived to be unsafe for both patients and professionals, and its usage is inversely related to the perceived risk. At the same time, while nurses and physicians consider WhatsApp not safe, they use it anyway in their clinical practice with both colleagues and patients. For these reasons, it would be useful to create additional specific tools for the different professional categories (doctors and nurses) and to deepen the knowledge related to the *'perceived risks'*, exploring the reasons that lead healthcare professionals to use certain digital technologies even if perceived as risky.

4.1. Limitations

Some limitations of our study should be acknowledged. A single-centre survey was conducted with a relatively small number of healthcare professionals, although they were representatives of all hospital departments. The number of nurses who answered the questionnaire was higher than the number of physicians.

5. CONCLUSIONS

The study validated the 41-item Italian 'Digital Innovation Adoption in Hospitals' (DIAH), a measure of individual and institutional determinants of WhatsApp usage in hospitals. The psychometric properties of the DIAHS were examined, and we were able to strengthen the previous findings of content and face validity. To our knowledge, this is the first tool available to measure which determinants influence the healthcare professionals' motivation to use WhatsApp in Italian hospitals. In particular, by combining organisational and individual factors in a coherent theoretical framework, the developed and tested questionnaire can help to explore connections of different determinants as well as their independent effects on the adoption of 'employee-driven' innovation. Moreover, the use of this new measure can help managers to oversee this phenomenon and to implement adequate strategies to exploit its potential increase and to increase safety for both patients and healthcare professionals. From this study, some possible future steps for researchers in this area also emerge. First, further studies in additional hospitals would be useful to obtain more generalisable results and to allow a Confirmatory Factors Analysis (CFA) to indorse the factor structure. Second, it would be interesting to create different and specific questionnaires for doctors and nurses, and for particular clinical settings, to deepen our current knowledge about this spreading phenomenon.

LIST OF ABBREVIATIONS

Abbreviation	Explanation
CFA	Confirmatory Factors Analysis
CFI	Comparative fit index
CINAHL	Cumulated Index to Nursing and Allied Health Literature
DIAH	Digital Innovation Adoption in Hospitals'
EFA	Exploratory factor analysis (EFA)
KMO	Kaiser-Meyer-Olkin index
MLr	Maximum Likelihood estimator
RMSEA	Root-Mean-Square Error of approximation
SD	Standard Deviation
SPSS	Statistical Package for Social Science
SRMR	Standardized Root Mean squared Residual
TAM	Technology Acceptance Model
TLI	Tucker-Lewis Index

REFERENCES

1. Mobasheri MH, King D, Johnston M, Gautama S, Purkayastha S, et al. (2015) The ownership and clinical use of smartphones by doctors and nurses in the UK: a multicentre survey study. BMJ Innovation 00:1–8.
2. Wolf JA, Moreau JF, Akilov O, Patton T, English JC, Ferris LK (2013) Diagnostic inaccuracy of smartphone applications for melanoma detection. JAMA Dermatology 149:422–6.
3. Haffey F, Brady RR, Maxwell S (2013) A comparison of the reliability of smartphone apps for opioid conversion. Drug Safety 36:111–17.
4. Martinez-Perez B, De La Torre-Diez I, Lopez-Coronado M (2015) Privacy and security in mobile health apps: a review and recommendations. Journal of Medical Systems 39:181.
5. Dorwal P, Sachdev R, Gautam D, Jain D, Sharma P, Tiwari AK, et al. (2016) Role of WhatsApp messenger in the laboratory management system: a boon to communication. Journal of Medical Systems 40(1):14.
6. Gulacti U, Hatipoglu S, Polat H (2016) An analysis of WhatsApp usage for communication between consulting and emergency physicians. Journal of Medical Systems 40(6):130.
7. Johnston MJ, King D, Arora S, Behar N, Athanasiou T, Sevdalis N, Darzi A, et al. (2015) Smartphones let surgeons know WhatsApp: An analysis of communication in emergency surgical teams. American Journal of Surgery 209(1):45–51.
8. Wani SA, Rabah SM, AlFadil S, Dewanjee N, and Najmi Y (2013) Efficacy of communication amongst staff members at plastic and reconstructive surgery section using smartphone and mobile WhatsApp. Indian Journal of Plastic Surgery 46(3):502-505.
9. Giordano V, Koch HA, Mendes CH, Bergamin A, and de Souza FS, do Amaral NP (2015) WhatsApp Messenger is useful and reproducible in the assessment of tibial plateau fractures: Inter- and intra-observer agreement study. International Journal of Medical Informatics 84(2):141–148.
10. Astarcioglu MA, Sen T, Kilit C, Durmus HI, Gozubuyuk G, Kalcik M. et al (2015) Time-to reperfusion in STEMI undergoing inter hospital transfer using smartphone and WhatsApp messenger. American Journal of Emergency Medicine 33(10):1382–1384.
11. Giordano V, Koch H, Godoy-Santos A, Dias Belangero W, Esteves Santos Pires R, Labronici P (2017) WhatsApp messenger as an adjunctive tool for telemedicine: an overview. Interact Journal of Medical Research 6(2):11.
12. Lee RS, Woods R, Bullard M, Holroyd BR, Rowe BH (2008) Consultations in the emergency department: a systematic review of the literature. Emergency Medicine Journal 25(1): 4–9.
13. Raiman L, Antbring R, Mahmood A (2017) WhatsApp messenger as a tool to supplement medical education for medical students on clinical attachment. BMC Medical Education 17(1):7.
14. Kaliyadan F, Ashique KT, Jagadeesan S, Krishna B (2016) What's up dermatology? A pilot survey of the use of WhatsApp in dermatology practice and case discussion among members of WhatsApp dermatology groups. Indian Journal of Dermatology, Venereology, and Leprology 82(1):67-9.
15. Boulos MNK, Giustini DM and Wheeler S (2016) Instagram and WhatsApp in health and healthcare: an overview. Future Internet 8(37).

16. Jagannathan M (2013) Efficacy of communication amongst staff members at plastic and reconstructive surgery section using smartphone and mobile WhatsApp. Indian Journal of Plastic Surgery 46(3):506–507.

17. Khanna V, Sambandam SN, Gul A, Mounasamy V. et al. (2015) "WhatsApp" ening in orthopedic care: a concise report from a 300-bedded tertiary care teaching center, European Journal of Orthopaedic Surgery & Traumatology 25(5):821-826.

18. Choudhari P (2014) Study on effectiveness of communication amongst members at department of orthopedics surgery unit 3 using smartphone and mobile WhatsApp, International Surgery Journal 1(1):9-12.

19. Migliore, M (2015) The use of smartphones or tablets in surgery. What are the limits? Annali Italiani di Chirurgia 86(2):185-186.

20. Dhuvad JM, Dhuvad MM, Kshirsagar RA (2015) Have smartphones contributed in the clinical progress of oral and maxillofacial surgery? Journal of Clinical and Diagnostic Research 9(9):ZC22-ZC24.

21. Pandian SS, Srinivasan P, Mohan S (2014) The maxillofacial surgeon's march towards a smarter future-smartphones. Journal of Maxillofacial and Oral Surgery 13:355-358.

22. Petruzzi M, De Benedittis M (2016) WhatsApp: A telemedicine platform for facilitating remote oral medicine consultation and improving clinical examinations. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology 121(3):248-254.

23. Kelahmetoglu O, Firinciogullari R, Yagmur C (2015) Efficient utility of Whatsapp: from computer screen to the surgeon's hand to determine maxillofacial traumas. Journal of Craniofacial Surgery 26:1437.

24. Suliman MT (2014) Sending photos through WhatsApp: A faster method for teleconsultation, Journal of Local and Global Health Science 2.

25. Graziano F, Maugeri R, Iacopino DG (2015) Telemedicine versus WhatsApp: from tradition to evolution, Neuroreport 26:602-603.

26. Martyn-Hemphill C, Sarkar S, Withington J, Roy A, Cohen D, Green JS. et al. (2015) 'Whatsapp doc?' evaluating a novel modality of communication amongst urology team members to promote patient safety. The Journal of Urology 193:e169-e170.

27. De Benedictis A, Lettieri E, Masella C, Gastaldi L, Macchini G, Santu C, Tartaglini D (2019) WhatsApp in hospital? An empirical investigation of individual and organizational determinants to use. PLoS One 14(1).

28. Davis F (1989) Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly 13(3):319–340.

29. Moore G, & Benbasat I (1991) Development of an instrument to measure the perceptions of adopting an information technology innovation. Information Systems Research 2(3):192–222.

30. Scott WR (1987) The Adolescence of Institutional Theory. Administrative Science Quarterly 32(4):493–511.

31. Scott WR (2001) Institutions and Organizations. 2nd ed. Thousand Oaks (CA): Sage.

32. Scott WR (2003) Institutionale Cerriers: Reviewing models of transporting ideas over time and space and considering their consequences. Industrial and Corporate Change 12(4):879-894.

33. Polit DF & Beck CT (2014) Essentials of Nursing Research: Appraising evidence for nursing practice (8th ed.). Philadelphia: Wolters Kluwer-Lippincott Williams & Wilkins Health.

34. Venkatesh V & Davis FD (2000) A Theoretical extension of the Technology Acceptance Model: Four Longitudinal Field Studies. Management Science 46(2):186-204.

35. Venkatesh V (2000a) Determinants of Perceived Ease of Use: Integrating control, intrinsic motivation, and emotion into the Technology Acceptance Model. Information Systems Research 11(4):342–365.

36. Venkatesh V, Morris MG, Davis GB, Davis FD (2003) User acceptance of Information Technology: Toward a Unifie d View. MIS Quarterly 27(3):425-478.

37. Venkatesh V, Zhang X, Sykes TA (2011) "Doctors do too little technology": A longitudinal field study of an electronic healthcare system implementation. Information Systems Research 22(3):523–546.

38. World Medical Association (2013) World Medical Association Declaration of Helsinki. Ethical principles or medical research involving human subjects. Journal of the American Medical Association 310(20): 2191–2194.

39. Muthén LK & Muthén BO (2012) Mplus user's guide (7th ed.). Los Angeles, CA: Muthén & Muthén.

40. Brown TA (2015) Confirmatory factor analysis for applied research (2nd ed.). New York: Guilford Publications.

41. Bentler PM (1990) Comparative fit indexes in structural models. Psychological Bulletin 107(2):238–246.

42. Tucker LR & Lewis C (1973) A reliability coefficient for maximum likelihood factor analysis. Psychometrika 38(1):1–10.

43. Steiger JH (1990) Structural model evaluation and modification: An interval estimation approach. Multivariate Behavioral Research 25(2):173–180.

44. Hu L & Bentler PM (1999) Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling: A Multidisciplinary Journal 6(1):1–55.

45. Gastaldi L and Corso M (2012) Smart healthcare digitalization: using ICT to effectively balance exploration and exploitation within hospitals. International Journal of Engineering Business Management, Special Issue on Digital and Mobile Economy 4(1):1–13.

46. Ammenwerth Elske (2019) Technology acceptance models in health informatics: TAM and UTAUT. Applied Interdisciplinary Theory in Health Informatics, doi:10.3233/SHTI190111.

47. Scott WR (1995) Institutions and Organizations. Thousand Oaks (CA): Sage.

48. Radaelli G, Currie G, Frattini F and Lettieri E (2017) The role of managers in enacting twostep institutional work for radical innovation in professional organizations. The Journal of Product Innovation Management 34(4):450–470.

ANNEXES

Annex 1. Questionnaire

Variables	Items/indicators
Control variables and characteristics of the respondent	
General information	Age
	Gender
	Profession
	Clinical Area or Unit
	Academic role in this healthcare company
	Work experience (indicate the number of years)
	Work experience in this healthcare company (indicate the number of years)
	What is the average age of your patients?
Section 1: Perceived risks	
Perceived Risks	The use of WhatsApp to communicate patient data with other health professionals is safe and does not entail risks
	Sending clinical data via WhatsApp involves risks for health professionals
	The use of WhatsApp involves risks related to privacy and data protection
	The use of WhatsApp carries the risk of uncontrolled spread of sensitive data
	To communicate through WhatsApp involves clinical risks as it is not documented within the medical record
	The use of WhatsApp for communication between patients and health professionals is safe and does not involve risks
	The use of WhatsApp for communication can generate misunderstandings with the patient
	Sending clinical-care data via WhatsApp involves risks for the patient
	The use of WhatsApp involves the risk of incorrect clinical evaluations
	The use of WhatsApp involves the risk of incorrect diagnosis and clinical decisions
	The use of WhatsApp involves the risk of compromising the patient-physicians relationship
	The use of WhatsApp for the transmission of sensitive data with the patient should provide consent for personal data treatment by the patient
Section 2: Perceived Usefulness	
Individual determinants: Perceived Usefulness	I am convinced that the use of WhatsApp improves communication
	Using WhatsApp lets you know if the messages have been read by colleagues
	To use WhatsApp for work is time saving because it is faster than phone or mail
	I am convinced that if everyone used WhatsApp, there would be a greater and more effective sharing of clinical knowledge
	The use of WhatsApp has the limit of the need for internet connection
	The use of WhatsApp positively affects my research activity (e.g. it is easier to share data and results)
	The use of WhatsApp positively affects my teaching activity
	The evaluation of images or videos sent via WhatsApp is not sufficient to make a diagnosis
	Using WhatsApp to monitor patients' clinical conditions increases the likelihood of recovery of their clinical situation
	Use of WhatsApp facilitates the doctor-patient relationship
	Using WhatsApp in my work allows me to effectively exchange information with the patient, thus avoiding a medical examination
hSection 3: Regulative Factors	
Organisational determinants: Regulative Factors	The hospital management asks me not to use WhatsApp among colleagues
	The Hospital Management asks me not to use WhatsApp with patients
	The Hospital Management asks me not to communicate sensitive patient data via WhatsApp
Section 4: Normative Factors	
Organisational determinants: Normative Factors	My colleagues are using WhatsApp for personal reasons
	My colleagues are using WhatsApp for professional reasons
	My colleagues are using WhatsApp to share scientific information
	My colleagues are using WhatsApp to communicate patient information
	My patients ask me to use WhatsApp
	My patients prefer doctors who use WhatsApp
	My patients are more likely to recover if they are using WhatsApp for care continuity