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# Acceptance and use of telemedicine technology by health professionals: Development of a conceptual model

**Mohammed Rouidi[1*], Abdelmajid Elouadi[1] and Amine Hamdoune[2]**

## Abstract

Recent developments in information technology (IT) in health are extended to highly specialized services, an example is telemedicine technology, understood as the use of IT to enable the transfer of medical information for diagnostic purposes, therapeutic and educational. Despite the benefits of implementing such technology, healthcare professionals, as end users, do not fully utilize it. The Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), are among the models applied to assess and predict the acceptance and use of telemedicine. This article aims to identify the relevant literature related to these two models, to review and summarize the methodologies and results, and propose a conceptual model for the acceptance and use of telemedicine technology by healthcare professionals.

## Keywords

Telemedicine, acceptance, health professionals, UTAUT, conceptual model

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## 1 Introduction

For several years, the adoption of new information technologies (IT) in the health sector has become a priority, the introduction of this IT has been validated as a tool participating in improving the quality of care, in facilitating tasks of health professionals and the relationship with patients.[1] IT can be implemented in the form of an electronic patient record, a computerized medical prescription entry system, a clinical decision support system, etc. Or, in some cases, a combination of two or more of these elements.

Recent developments in IT in health are extended to highly specialized services, an example is telemedicine technology, understood as the use of IT to enable the transfer of medical information for diagnostic, therapeutic and educational purposes,[2] telemedicine has become the focus of increasing attention in clinical practice research.

Telemedicine is a knowledge-intensive interactive technology platform that acts as a mediator in medical transactions between two healthcare professionals (or between a healthcare professional and a patient) located in two geographically distant areas. It can sometimes be very complex like the use of robotics in telesurgery, and it can be simple like the use of text messaging on a cell phone to transmit medical information.[3]

The World Health Organization (WHO) has assessed the potential of telemedicine applications, it recognizes that proper use of this technology can strengthen the health care sector in many countries, and considerably improve the quality of health care services, especially for poor populations and medically underserved communities. According to Whitten et al.[4] telemedicine has the potential to make health care facilities more cost effective and comprehensive in providing care. According to Gagnon et al.[5] studies have reported that home telemonitoring of high-risk pregnant women and patients with heart failure or chronic obstructive pulmonary disease induces a significant reduction in

[1]Ensak, Ibn Tofail University, B.P 242 Kenitra, Kénitra, Morocco
[2]Hassan 1er University, Settat, Morocco

**Corresponding author:**
Mohammed Rouidi, Ensak, PhD student at Ibn Tofail University, B.P 242 Kenitra, in Kénitra, Morocco.
Email: mohammed.rouidi@uit.ac.ma

health costs. For Croteau et al.[6] telemedicine offers the possibility of bringing health services to the patient, reducing the time needed to establish a diagnosis and make decisions about treatment and improve the continuity of care.

In the context of the health situation faced with the Covid-19 pandemic, the use of telemedicine technology has been the ideal solution in the majority of developed countries, in order to ensure continuity of care for patients with a chronic disease and in pregnant women.Countries have even used this technology to provide home care for patients with symptoms of the infection or recognized as having Covid-19 (HAS).

Despite the benefits of implementing such technology, healthcare professionals, as end users, do not fully utilize these systems.[7] In a review of the literature on telemedicine and its clinical applications, Perednia et al.[8] suggest that the ultimate success of telemedicine requires that an adopting organization address not only technological challenges but also management issues, including user acceptance of this technology, it is therefore important to study the factors essential to its acceptance and use by health professionals.

The Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), are among the models applied to assess and predict the acceptance and use of telemedicine. This article aims to identify the relevant literature related to these two models, to review and summarize the methodologies and results, and propose a conceptual model for the acceptance and use of telemedicine technology by healthcare professionals.

## 2 The introduction of telemedicine in the health sector:

The introduction of IT is a two-way process, in which IT transforms the way organizations work and in which users determine the future evolution of technology. Therefore, such a process can only be successful if it is adequately supported by future end users.[9]

In the healthcare industry the introduction of IT has a reputation for being very difficult. Huge investments have been made to computerize hospital information systems around the world. The estimated costs for each large hospital are around 50 million $, but the overall benefits and costs of hospital information systems have rarely been evaluated. When systems are evaluated, about three-quarters are considered to have failed and there is no evidence that they improve the productivity of health professionals.[10] This is why organizations should plan very carefully when proposing to introduce IT systems.

For telemedicine, an increasing number of healthcare facilities have deployed (or are in the process of) deploying this technology around the world, and although its potential benefits for improving healthcare are validated, its value still depends on its acceptance and of its successful implementation by the entity that adopts it.

Kayode et al.,[11] confirm that despite the inherent advantages that this technology can offer in terms of clinical diagnosis, management and remote administration, the obvious challenges are whether healthcare professionals are ready to use this technological innovation, for Cilliers et al.,[12] the availability of an appropriate technology and the acceptance of this technology by health professionals are considered to be two of the main reasons for the failure of telemedicine projects.

In South Africa, in one of the poorest provinces of the country with large rural areas, a telemedicine system has been set up in to improve health care services. Despite significant investments, only a third of the province's telemedicine sites have been operational. Technological issues, such as unreliable electricity supply and low bandwidth, have been identified as obstacles to the successful implementation of telemedicine, but these issues have since been resolved. Nevertheless, the uptake of telemedicine remains low. One of the documented barriers to the successful implementation of telemedicine is the acceptance of this technology by healthcare professionals.[12]

In Germany, a technology project which aimed to provide a secure infrastructure for the dissemination of telemedicine was built nationwide to enable innovations in the field of health care, and although most German doctors recognize the potential benefits of telemedicine, the implementation of this project was delayed by more than five years due to the non-acceptance of this technology by German doctors.[13]

In South Korea, and despite the introduction of telemedicine technology since 1988 as a pilot project at Seoul National University Hospital, its progression and generalization remains very slow due to resistance from doctors about Korean Telemedicine Law. Physicians are the primary users and stakeholders of telemedicine services, and their acceptance in healthcare settings has a profound influence on its success. However, resistance from physicians is common when new information systems are implemented within a healthcare facility. Some physicians may perceive telemedicine technology as a threat to their expertise and may be reluctant to adopt it.[14]

Three examples in three different continents: Africa, Asia and Europe share the same concern, the difficulty of introducing this technology into health establishments, this indicates that the success of a telemedicine system will be determined by the end users who are the health professionals. This finding is validated by several researchers in this field. For Bashshur et al.,[15] one of the reasons why the establishment of telemedicine systems has failed in the past is the lack of adoption of the new technology by physicians. Croteau et al.,[6] suggest that in order to avoid wasted investment by governments in this technology, it

is necessary that the organizations which adopt it meet not only the technological challenges, but also those of management and in particular the acceptance and the use by the health professionals.

In a systematic review of the obstacles and factors that favor the implementation of e-health, Mair et al. state that the integration of new technologies of all kinds in the health sector, involve complex change processes at the micro level for professionals.[16] In an update of this systematic review, Ross stress the importance of understanding the factors that influence e-health implementation to design strategies and policies that aim to improve effective and widespread integration and to remedy blockages in implementation.[17]

## 2 Theoretical frame

Over the past decades, various models have been developed and applied to examine the acceptance and use of information technology. The Technology Acceptance Model (TAM) is among the most popular theories to study the perception and factors that contribute to the acceptance of a new technology. The central idea of TAM (Figure 1), as developed by Davis in 1986,[18] is to increase the use of IT by promoting its acceptance, and acceptance can only be fostered if the factors influencing it are known. According to Christine el al.,[19] the development of the TAM meets two objectives: allow a better understanding of the acceptance process of an information system by end users, provide an operational tool allowing designers and decision-makers to test a system before its implementation. Davis hypothesized that 'perceived usefulness' and 'perceived ease of use' are the main factors that determine user acceptance, he also hypothesized that the intention to accept a technology is influenced by the attitude of the individual as shown in Figure 1:

For Davis, 'perceived usefulness' defined as the degree to which a person believes that the use of a given technology or innovation will increase labor productivity and therefore performance within their organization, the more the user believes in a positive usage-performance relationship, the more the system achieves a high rate of perceived utility. 'Perceived ease of use' refers to the degree to which a person believes that using a new technology does not require significant physical and mental effort, when the user thinks that he is not going to put in the effort to use a technology, he will be more willing to use it.

Most researchers have found this model to be very simple and easy to use. Its simplicity, generality and being a very powerful model for identifying variables influencing user acceptance of computer technology have led to huge popularity, many studies have tried to apply this model to different environments and different software, with acceptable results. TAM has been shown to be effective in predicting and explaining usage across a variety of new technologies. In addition to being validated several times by various researchers, the TAM model has also been subject to various improvements and adaptations, starting with its author.In 2000, Venkatesh and Davis,[20] proposed a new version of TAM called TAM2 which based the identification of the determinants of 'perceived usefulnessis' and moderating variables. After Venkatesh and Baia,[21] proposed TAM 3 which includes all the determinants of TAM 2 with the addition of a set of determinants for 'Perceived ease of use'.

In 2003, and following a comparative review of the literature and more specifically, the eight theories and models that have been proven to explain the variance in the acceptance and use of information technologies, Venkatesh et al.,[22] formulated and validated the Unified Theory of Acceptance and Use of Technologies (UTAUT).Theories and models are: the theory of planned behaviors,[23] the theory of reasoned action,[24] the technology acceptance model,[18] the combined model of the theory of planned behavior with the technology acceptance model, Applied Motivational Model,[25] Diffusion of Innovation Theory,[26] Social Cognitive Theory,[27] Computer Acceptance Theory.[28]By consolidating and improving previous models of information technology acceptance, the model created is based on the conceptual and empirical similarities of these eight models.

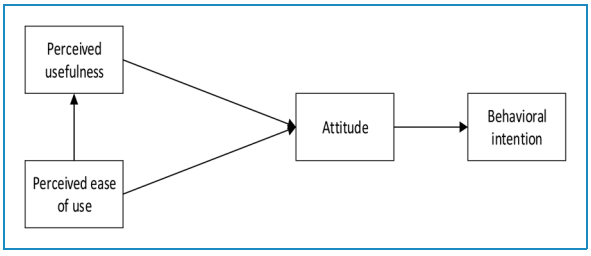


**Figure 1.** The technology acceptance model (TAM).

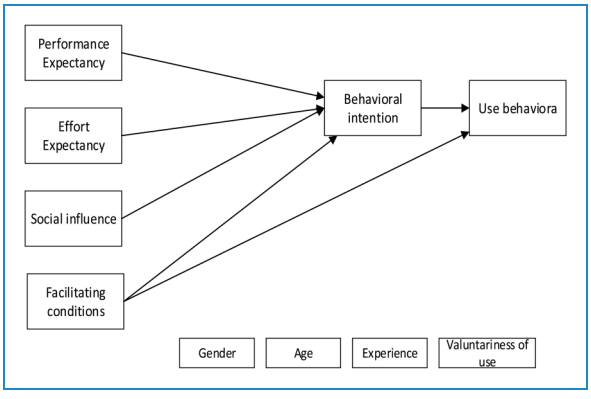


**Figure 2.** The unified theory of acceptance and use of technologies (UTAUT).

In this new UTAUT model (Figure 2), the authors estimated that the determinants of the intention to use the technology can be grouped into four dimensions: 'performance expectancy', 'effort expectancy', 'social influence' and 'facilitating conditions'.

'Performance expectancy' is defined as the degree to which an individual believes that the use of a system will help him achieve performance gains at work, 'effort expectancy' is defined as the degree of ease associated with using the system, 'Social influence' is defined as the degree to which an individual perceives it to be important for others to believe that he or she is using the new system, and 'facilitating conditions' is defined as the degree to which an individual believes that there is an organizational and technical infrastructure to support the use of the system. One of the major interests of UTAUT compared to previous models of acceptance is the fact of integrating four moderating variables, three of these variables are individual and relate to the sex, age and experience of the user, the fourth moderating variable is organizational and refers to the voluntary or compulsory nature of the use of technology.

## 3 Acceptance and use of telemedicine, previous work:

Many efforts have been made by researchers to assess, predict and analyze the acceptance and use of telemedicine. TAM and UTAUT are among the most widely used models in this field, researchers have tried to extend these two models to increase their explanatory power, either by introducing variables from other theoretical models, or by examining the antecedents or moderators of their original variables.

Chau et al.[2] examined the acceptance of telemedicine technology by physicians following a theoretical comparison approach, he assessed the extent to which the TAM model, the theory of planned behavior (TPB) and an integrated model (TAM-TPB), could explain the decisions of physicians to accept telemedicine. Based on responses from 408 physicians, the two models were assessed in terms of overall fit, explanatory power, and their causal links. Overall, the results suggest that TAM may be more appropriate than TPB for examining physician acceptance of the technology. And that the integrated model cannot provide significant additional explanatory power. The results of the study suggest that the variable 'perceived usefulness' of TAM appears to be the most important factor affecting the acceptance of telemedicine technology by physicians. This finding implies that physicians tend to be pragmatic in their decisions about accepting technology, focusing on its usefulness, in other words, a physician is likely to accept (or use) a technology when it is deemed useful to his practice.

Croteau et al.[6] used an extension of the TAM to examine factors that might affect physicians intention to adopt telemedicine technology with the addition of four variables. (The two variables 'situational support' and 'perceived effort' to further explain the variable 'perceived ease of use' of TAM. And the two variables 'image' and 'Perceived voluntariness' to further explain the variable 'Intention to use' TAM). The study was conducted with two groups of physicians who, at the time of the survey, were about to use telemedicine technology, the group was made up of physicians from a large urban health care facility involved in clinical, teaching and research activities. An intranet solution for teleradiology and teleconferencing had been set up and these physicians had not received any training in this technology. Group B was made up of physicians from rural areas who received training just before using the telemedicine network that linked 43 sites in the same region. The results of the study indicated that for both groups, the variable 'perceived usefulness' is positively related to the intention to adopt telemedicine technology. For variables added to the original TAM model: the variable 'situational support' was not significantly related to 'perceived ease of use', on the other hand, the variable 'perceived effort' had a significant impact on 'perceived ease of use' in the case of group A physicians, this result can be explained by the fact that they did not receive any training before, unlike group B which received it. And for the two variables added to explain the TAM 'intention to use' variable, the variable 'image' did not have a significant impact while the variable 'perceived voluntariness' did not have a significant impact on physicians' intention to use telemedicine technology.

After the introduction of nationwide telemedicine infrastructure in Germany, the project was delayed by more than five years, following massive resistance from German doctors, Dünnebeila et al.[13] conducted a study to fully understand the factors accepting telemedicine technology by ambulatory care doctors. The study was based on an extension of TAM as a theoretical framework with the addition of six variables to the original model ('perceived importance of IT use', 'perceived importance of data security', 'perceived importance of documentation', 'e-health awareness', 'standardization of healthcare practices', 'medical referral process') these variables were used to further explain the two TAM variables 'perceived usefulness' and 'perceived ease of use'. The results of 117 doctors showed that the original TAM variables are very significant in explaining the doctors' intention to use telemedicine technology in German ambulatory care. After the extension of the original model, all the added elements had a significant influence on 'perceived usefulness' and 'perceived ease of use'.

In a pilot teledermatology study conducted in Spain, Orruño et al.[29] examined the main factors in physicians' intention to use teledermatology using an extension of the TAM model, with the addition of four variables to the original model ('compatibility', 'habit', 'subjective norms'

and 'facilitators or facilitating conditions'). A total of 171 physicians responded to the questionnaire. The results of the study showed that the original TAM was able to predict physicians intention to use teledermatology, and that its two variables 'perceived usefulness' and 'perceived ease of use' were both significant. With the addition of the four variables, the model became more powerful but only the variable 'facilitators or facilitating conditions' was significant among the four.

In a clinical trial of home telemonitoring conducted in the Basque Country (Spain), the same extension of the TAM was used by Gagnon et al.[5] to examine the factors that could influence the intention of healthcare professionals to use a remote monitoring system.93 health professionals from the cardiology, pneumology and internal medicine departments of a tertiary hospital took part in this study. The results of confirmed those of Orruño et al.[29] that the original TAM is capable of predicting the intention of using remote monitoring, but only the variable 'perceived usefulness' was significant, and that after the extension of the TAM model with the addition of four variables, the model has always remained significant and it has become more powerful, and the only significant variable in the modified model was 'facilitators or facilitating conditions'.

With small modifications in the research hypotheses, Asua et al.[30] also used the same extension of TAM to examine factors that might influence the intention of health professionals to use a telemonitoring for home care patients with heart failure and / or chronic lung disease. 268 professionals (122 general practitioners, 15 pediatricians and 131 nurses) in a primary health care region in Spain participated in the study. Its results confirmed the results of[5] and[29] that the original TAM is capable of predicting intent to use telemonitoring. However, the extended model, which included other theoretical variables, was more powerful. 'Perceived usefulness', 'compatibility', and 'facilitating conditions' were the main predictors of intention.

Francesc et al.[31] used another extension of TAM with the addition of three variables to the original model ('Optimism', 'propensity to innovate', 'level of IT use'), to examine factors that might influence doctors intention to use telemedicine technology in three different countries: Spain, Colombia and Bolivia. The objective is to obtain and compare data on an international scale to better assess the determinants of the use of telemedicine in different contexts. In Bolivia, the study was carried out in urban and rural hospitals and health care centers in the municipality of Sucre, in a population of 279 doctors in total. In Spain, the study was conducted within the Canary Islands Health Service, with a population of 113 doctors. Finally, in Colombia, the study was carried out within the surgical service company of a hospital in Bogotá, with a population comprising a total of 118 doctors. In all three contexts, Francesc et al. found that the variable 'level of IT use' by the doctor in his personal life was the variable that had the greatest explanatory power regarding the use of telemedicine. In the Spanish context, the variable 'perceived ease of use' by IT physicians in clinical practice and the variable 'propensity to innovate' were the other two variables that determined the use of telemedicine, while in the Colombian and Bolivian contexts, it was the variable 'optimism' that was significant.

In Belgium, and to cope with the aging of the population (17% aged 65 and over), a web application allowing healthcare professionals and health establishments to monitor the needs and functioning of vulnerable people, or in a complex care situation has been implemented. Vanneste et al.[32] used an extension of UTAUT with the addition of three variables ('anxiety', 'self-efficacy', 'attitude towards the use of technology') to examine the factors that influence the intention of healthcare professionals to use this web application in three different healthcare settings (home care, nursing home, acute hospital care for the disabled elderly) the above variables had already been abandoned by (Venkatesh et al.). The results of the study showed that only the variable 'facilitating conditions' of the original UTAUT model had a significant influence on the intention of healthcare professionals to use the web application. Similarly, for the three variables added to UTAUT only the variable 'self-efficacy' had a significant influence on the intention of health professionals.

Rho et al.[14] used an extension of the TAM model to examine the factors that impact the acceptance and use of telemedicine by Korean physicians with the addition of four variables to the original model ('accessibility of medical records', 'self-efficacy', 'perceived incentives', 'accessibility to patients'). A survey was conducted and structural equation modeling was applied to assess the empirical validity of the model and the causal relationships within the model using data collected from 183 doctors. This study demonstrated that the acceptance model of telemedicine services was feasible, and could explain the acceptance of telemedicine services by doctors. The results of the study confirmed the validity of the original TAM, the perceived usefulness of telemedicine had a direct impact on the behavioral intention to use it, and the perceived ease of use had a direct impact on the perceived usefulness and behavioral intention to use it. For new variables added to the TAM: 'accessibility of medical records' and 'accessibility of patients' had a direct impact on the perceived usefulness of telemedicine, 'self-efficacy' had a significant positive effect on 'perceived ease of use' and 'perceived usefulness of telemedicine', and 'perceived incentives' have been shown to be important with respect to the intention to use telemedicine technology.

Cilliers et al.[12] conducted a study to examine the factors that contribute to the acceptance of telemedicine by health professionals in a province in South Africa

qualified among the poorest provinces in the country, and telemedicine technology has already been implemented but not used by end users. Cilliers et al. Used the original TAM as a framework for analysis, and the results of the study showed that the variable 'perceived usefulness' is the most significant in understanding the acceptance of healthcare professionals of telemedicine technology.

In Nigeria, and faced with the shortage of health professionals Adenuga et al.[11] conducted a study to examine the factors that influence the use of telemedicine technology by using an extension of the UTAUT model with the addition of the variable 'financial incentive' to the original model. The results of the study showed that the variables 'performance expectancy', 'effort expectancy', 'facilitating conditions' of the original UTAUT, in addition to the added variable 'financial incentive', had a significant positive effect on the behavioral intention of Nigerian clinicians to use telemedicine technology.

Bunnell BE et al.[33] conducted a study to understand what motivates mental health care providers to use telemedicine in the USA, according to researchers this type of study is essential to optimize telemedicine use, especially during this unprecedented period of the Covid-19 pandemic. The researchers used the original TAM model as a framework for analysis, and the study results showed that this model can be a useful framework for understanding telemedicine acceptance behavior, but features of other models (notably UTAUT) may increase understanding of telemedicine acceptance behavior.

Social distancing brought about by the Covid-19 pandemic has enabled a rapid transition to digital technologies, Molfenter T et al.[34] conducted a study to examine the factors of acceptance of telehealth by healthcare professionals during and after the pandemic in the USA. The researchers used the original TAM model as a framework for analysis and the results of the study showed that according to the TAM, perceived utility and ease of use are variables that influence the acceptance intent of telehealth technology by healthcare professionals.

Table 1 provides a summary of the studies reviewed in this paper.

**Table 1.** Summary of studies review.

| Authors and year | System | The model used | Target audiences | Country | Sample size |
|---|---|---|---|---|---|
| Y.K. Chau et al. 2002 | Telemedicine | TAM<br>TPB<br>Integrated model TAM-TPB | Physicians | Hong Kong | 408 |
| Croteau 2002 | Telemedicine | TAM modified | Physicians | Canada | 127 |
| Dünnebeila et al. 2012 | e-health | TAM modified | Physicians | Germany | 117 |
| Gagnon et al. 2011 | Telemonitoring | TAM modified | Physicians and nurses | Spain | 93 |
| José Asua et al. 2011 | Telemonitoring | TAM modified | Physicians and nurses | Spain | 268 |
| Orruno et al. 2011 | Teledermatology | TAM modified | Physicians | Spain | 171 |
| Francesc et al. 2014 | Telemedicine | TAM modified | Physicians | Spain | 113 |
| | | | | Colombia | 118 |
| | | | | Bolivia | 279 |
| Vanneste 2013 | A web application | UTAUT modified | Health professionals | Belgium | 282 |
| Rho 2014 | Telemedicine | TAM modified | Physicians | South korea | 183 |
| Cilliers 2014 | Telemedicine | TAM | Health professionals | South Africa | 57 |
| Adenuga 2017 | Telemedicine | UTAUT modified | Doctors and nurses | Nigeria | 252 |
| Brian, E.B. et al. 2020 | Telemedicine | TAM | Telemental health providers | USA | 177 |
| Todd, M. et al. 2021 | Telehealth | TAM | Health professionals | USA | 242 |

## 4 Proposed model of acceptance of telemedicine technology:

After this literature review, the model proposed (Figure 3) therefore in the context of this study is an extension of UTAUT with the addition of additional variables. For the original UTAUT, we used the variable 'performance expectancy', 'effort expectancy', 'the facilitating conditions' and 'The behavioral intention', we chose these variables because they had the highest level of support in previous research, and we did not use the variable 'Social influence' because it lacked support and relevance.

The choice of the UTAUT model is made on the basis of its explanatory power. While the eight models explained, between 17% and 53% of the variance in intention to use information technology, UTAUT would account for a variance of 70% for intention to use and 50% for use. It is for this reason that Venkatesh et al. present it as the best model for explaining the user's intention to use a technology.[1] For Khaoula Debbabi[35] the UTAUT model is considered as a considerable contribution to research. It synthesizes several years of research on the acceptance and use of new technologies by grouping together several variables having significant effects on user behavior.

Based on the results of previous work reviewed, we believe there is a need to define additional variables to the UTAUT model that may influence the behavioral intention of healthcare professionals. In this sense, and to ensure the rigor of the research, we included variables which were examined and which were found to be significant in more than 50% of the cases. This methodological decision allowed us to extend the UTAUT model with the following variables 'perceived incentive', 'compatibility' and 'level of IT use'. And as it is proposed in the work of Gagnon et al.,[5] Orruno et al.,[29] and Asua et al.[30] our model includes three dimensions: the individual context, the technological context and the organizational context.

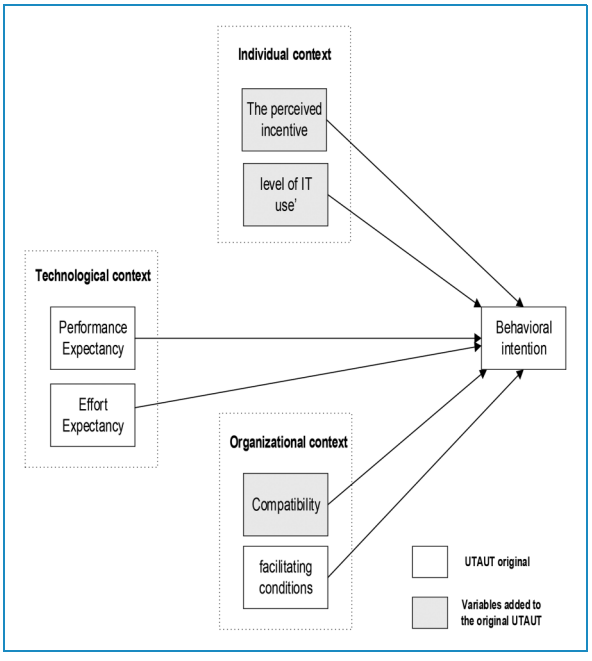


Figure 3. The proposed model of acceptance of telemedicine technology.

## 5 Conclusion and future direction:

The introduction of telemedicine technology in the hospital arena has potential benefits for improving the delivery of health services. However, very few systems are implemented and used by healthcare professionals. As part of this literature review based on the two models TAM and UTAUT, we found that there are not many studies on the factors that impact the acceptance and use of telemedicine technology compared to other fields. That is why we are proposing this conceptual model for the acceptance and use of telemedicine technology by healthcare professionals. We based ourselves on a review of the literature of the different models of acceptance of new information technologies in general and in the hospital sector in particular, in order to identify the determinants of the acceptance of these technologies. This review of the literature guided us in the construction of our conceptual research model based on the UTAUT model.

This attempt to develop a conceptual model will be followed, first, by an exploratory study and an empirical test through the development of a questionnaire in a second step. The goal is to do more research to help understand the needs of end users before disposing of the system itself.

**Author Contributions:**

**Correct ethical approval:** Not applicable, because this article does not contain any studies with human or animal subjects

**Guarantor:** Mohammed Rouidi

**Contribution ship:** MR collected and analyzed data, and prepared the manuscript, AE and AH critically revised it. All authors approved the final version of the manuscript for submission

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**ORCID iD:** Mohammed Rouidi https://orcid.org/0000-0002-9721-0623

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