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## Modifying UTAUT2 for a cross-country comparison of telemedicine adoption

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### ABSTRACT

The ongoing COVID19 pandemic has put digital health technologies in the spotlight. To gain a deeper understanding of patients' usage intentions of virtual doctor appointments, the present research adapts the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) by integrating perceived security and perceived product advantage, two known barriers to successful telemedicine adoption. Applying age-stratified sampling, an online survey was distributed to 800 citizens in Germany and the United States of America. 710 completed and valid questionnaires were subsequently analyzed using SPSS and AMOS (versions 24).

Significant, direct, and positive effects of performance expectancy, hedonic motivation, perceived security, and perceived product advantage on the behavioral intention to use virtual doctor appointments were found. The analysis of the moderating variables, age and gender, showed significant differences in user's performance expectancy and effort expectancy, and perceived product advantage, respectively. With virtual health care models on the rise, these results are important for stakeholders such as policymakers, governments, employers, but also physicians, and insurance companies as they offer clear recommendations to design telemedicine adoption strategies to ensure successful patient engagement.

### 1. Introduction

How people seek and consume health care-related information has changed drastically throughout the last decade due to the introduction of information and communication technologies (Yang et al., 2015; Bujnowska-Fedak, Waligóra & Mastalerz-Migas, 2019). The massive diffusion of the Internet, which has enabled people to become more active collaborators in matters of their own health (Díaz-Martín et al., 2020) entails that patients are no longer seen as passive recipients of medical advice and treatment (Soellner et al., 2014). In this digital revolution, the promotion of eHealth and telemedicine technologies has become a necessary and obvious undertaking (Wernhart et al., 2019). Telemedicine has developed from a niche application to playing a vital part in improving health care delivery in terms of access, quality, and convenience (Yang et al., 2015).

Considering the ongoing COVID-19 pandemic, health care systems all over the world have proven to rely heavily on telemedicine solutions. As Guitton (2020) states, online technologies are important to survive this health crisis and, as researchers are drawing their attention to investigate how technology impacts human behavior, academia needs to

play its part to find solutions to this situation. In this sense, it is crucial to ensure that people are willing, able, and ready to successfully engage and stay involved in new health care technologies. Virtual assistance has turned not only into an essential part of health care attention capable of offering relief for collapsed hospitals but is furthermore treated as a promising strategy in post-pandemic scenarios (Imenokhoeva, 2020 or Bharucha et al., 2021). Even more so, the need for a more generalized use of virtual health care approaches to avoid physical contact in hospitals is crucial to stop the spread of infections (Arrese, 2020; Blandford, 2020). As Bhatia et al. (2021) state, the adoption of digital solutions has accelerated during the pandemic. They observe that virtual visits spiked from 1.6% during the second quarter of 2019 to 70.6% in the second quarter of 2020 in ambulatory care in Canada. Similar results are observed by Mohammed et al. (2021), who report an increase of 59.9% in virtual visits or Bestsenny et al. (2021), who point out that telehealth utilization was 78 times higher in April of 2020 compared to February of the same year. They also highlight that, even though the demand for telehealth services has stabilized since the beginning of the pandemic, it has done so at levels 38% higher than before. As of February 2021, there is a differential uptake of telehealth depending on the speciality, with the

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highest penetration in psychiatry and substance use treatment, followed by endocrinology, rheumatology, and gastroenterology.

Regardless of the pandemic, telemedicine, known for its potential to increase both quality and access to health care and to significantly decrease direct and indirect medical costs (Gagnon et al., 2003; Sherwood et al., 2018) is an effective and efficient alternative to traditional in-office visits without forfeiting the loss of quality of medical care and attention (Newton, 2014; Gardner et al., 2014; Xue et al., 2015; Viers et al., 2015). Furthermore, its use in modern health care attention has been associated with enhanced patient satisfaction and improved efficiency (Sherwood et al., 2018). The possibility to offer more convenient and personalized attention (Rezaeibagha & Mu, 2018) is another reason to expand the use of telemedicine.

Following Beaunoyer, Dupéré & Guitton (2020), telemedicine interventions are particularly relevant in countries without universal and expensive health care coverage, which is the case of the United States of America. On the other hand, focusing on a country inside the European Union that is generally known to be pioneer when it comes to technology, Germans have shown to be reluctant to use telemedicine-related services, especially in comparison with their European neighbors (Osborneclarke, 2018). German authorities recognized a lack of clear regulations and telematic infrastructure as two of the main barriers to telemedicine implementation back in 2015 (Brauns & Loos, 2015) and Peine et al. (2020) points out that the extent of the current implementation, user acceptance, perception as well as technical and regulatory obstacles remain unclear and still hinder further expansion. In addition, Accenture (2020a) states that, whereas telemedicine use by clinicians in Europe is at 43% on average, Germany the is worst performing country with only 30% of medical staff relying on telemedicine solutions.

This proves the existence of barriers that slow down telemedicine adoption. Acceptance has been rather slow and Accenture (2020b) reports that the adoption of digital health technologies had even slowed down before the pandemic. Following Dockweiler & Hornberg (2020), it is crucial to include the needs of telemedicine users to guarantee a successful implementation. In line with this, recent studies (Verbraecken, 2016 or Kruse, 2018) state that barriers to telemedicine adoption can be found on both sides, meaning physicians and patients. Whereas many studies focus on physicians' acceptance of telemedicine services (Gagnon et al., 2003; Rho et al., 2014), Jewer (2018) points out the necessity to further investigate the factors contributing to patients' intention to use telemedicine related services. Focusing on the patient's side, privacy and confidentiality issues and doubts regarding effectiveness are treated as an important impediment for telemedicine adoption, alongside mere unawareness (Verbraecken, 2016; Kruse et al., 2018; Accenture, 2020).

The contribution of this paper is threefold. In the first place, it extends existing research on telemedicine adoption from a patient's point of view by integrating two new constructs into the Unified Theory of Acceptance and Use of Technology 2. Known and cited as UTAUT2, it is not only one of the most powerful models used to study technology adoption in a wide variety of contexts even despite its rather recent character (Herrero, San Martín & García de los Salmones, 2017), but is also a framework specifically developed to study technology adoption in end-user contexts (Jewer, 2018). As a novelty, this study integrates perceived security and perceived product advantage, two known barriers that hinder telemedicine adoption. This provides insights into the motivations to use this service and to test the validity of UTAUT2 in a different research context. Secondly, this study engages in a field of research that is becoming of growing importance not only for academia, but also for different stakeholders involved in the growth and proliferation of virtual health care models.

This investigation is structured as follows: the next section focuses on the literature review and the hypotheses development. The research method and results are presented subsequently. In the last place, conclusions, implications, limitations, and future research lines are detailed

and explained.

## 2. Literature review

### 2.1. The Unified Theory of Use and Acceptance of Technology 2 (UTAUT2)

Investigations on acceptance and use of new technologies are well-established (Venkatesh et al., 2016), with applications in multiple sectors and different products and services. Among the theoretical foundations is the Unified Theory of Acceptance and Use of Technology (UTAUT), originally developed by Venkatesh et al. (2003) as an integration of eight different theories (see Table 1). UTAUT has become one of the most cited baseline models of technology acceptance and use (Williams et al., 2011; Jang et al., 2016; Jewer, 2018, Bawack & Kamdjoug 2018). Even though it has been adapted to a wide variety of different settings and contexts, there still is a limited application to health care (Marakhimov & Joo, 2017; Jewer, 2018).

It is important to point out that UTAUT was designed to study IT adoption behaviors mainly in organizational settings (Venkatesh et al., 2003). In 2012, an extended version of UTAUT was published, intended to explain technology acceptance from the customers' perspective (Venkatesh et al., 2012), known and cited as UTAUT2.

UTAUT is composed of four core variables (effort expectancy, performance expectancy, social influence, and facilitating conditions) and four moderating variables (age, experience, gender, and voluntariness of use). UTAUT2 (Venkatesh et al., 2012) adds three constructs to better adjust to the customer setting: habit, hedonic motivation, and price value. Age, gender, and experience still act as moderating variables. Voluntariness on the contrary has been dropped, assuming that the decision to use a new technology is voluntary by definition for end-users (Venkatesh et al., 2012). Compared to its predecessor, UTAUT2 has led to a substantial improvement in the explained variance of both behavioral intention and technology use (Jang et al., 2016). Likewise the first version of UTAUT, UTAUT2 has been adapted to different contexts despite being a rather recent model (Herrero et al., 2017).

This was one of the main reasons for it to be selected as an appropriate theoretical foundation for this study. Furthermore, as Macedo (2017) points out, UTAUT2 offers a holistic and integrative focus on consumer settings. Additionally, and to the best of our knowledge, UTAUT2 has not been used in the context of end-user telemedicine acceptance. Therefore, studying patients' usage intention of virtual doctor appointments is a pioneer undertaking.

For the sake of this research, working with a sample with no previous experience was a deliberately taken choice to get a deeper understanding of the factors and barriers people perceive in telemedicine adoption. As a result, the price-value variable had to be dropped from the study since it is difficult to evaluate said relationship in a hypothetical medical scenario. Besides, health care is universal and "free" in Germany and many other European countries. This also led to the decision to consider usage intention as the dependent variable rather than

**Table 1**  
Theoretical fundaments of UTAUT.

Theory	Authors(s)	Year
Innovation Diffusion Theory (IDT)	Rogers	1962
Theory of Reasoned action (TRA)	Ajzen & Fishbein	1975
Theory of Planned Behavior (TPB)	Ajzen	1985
Social Cognitive Theory (SCT)	Bandura	1986
Technology Acceptance Model (TAM)	Davis	1989
Motivational Model (MM)	Davis, Bagozzi & Warshaw	1992
Model of PC Utilization (MPCU)	Thompson et al.	1991
Combined theory of planned behavior/technology acceptance model (C-TPB-TAM)	Taylor & Todd	1995

Source: own elaboration

actual use behavior and to the exclusion of experience as a moderating variable. The modified research model is depicted in **Image 1**.

In the following section, we will present the variables that compose the modified research model, as well as the corresponding hypotheses.

### 3. Hypotheses development

#### 3.1. Effort expectancy

Effort expectancy is defined by [Venkatesh et al. \(2003\)](#) as “the degree of ease associated with the use of a system” and is known to be a direct determinant of usage intention ([Venkatesh et al., 2003](#)). In fact, according to [Diño & De Guzman \(2014\)](#), effort expectancies are among the most prominent predictors of usage intention. In a health care context, studies even indicate that effort expectancy is one of the most important factors that directly influence usage intention ([Hoque & Sorwar, 2017](#); [Jewer, 2018](#); [Tavares & Oliveira, 2018](#)).

In the context of the present study, effort expectancy reflects the extent to which an individual finds a virtual doctor appointment easy to use. It is related to the level of effort that would be required to carry out an online consultation, meaning that the lower the effort, the higher the usage intention of said service. Understood in terms of ease of use, it is true that even though medical video appointments are a rather new form of assistance, they are mainly carried out by means of a videoconference, a technology people are already broadly familiarized with.

Therefore, the first hypothesis says:

**H1.** Effort expectancy has a positive, direct, and significant impact on the behavioral intention to use virtual doctor appointments.

#### 3.2. Performance expectancy

Performance expectancy is defined as the degree to which an individual believes that using a technology will help them to improve job performance goals ([Venkatesh et al., 2003](#)). [Venkatesh et al. \(2016\)](#) found that performance expectancy was the strongest determinant of a user’s behavioral intention to adopt a new technology.

In a health care environment, [Diño & De Guzman \(2015\)](#) found that performance expectancy was also one of the most important predictors of usage intention and [Rho et al. \(2015\)](#) stated that it significantly affects the intention to use a telemedicine service for diabetes management. Furthermore, authors such as [Phichitchaisopa & Naenna \(2013\)](#), [Kim](#)

[et al. \(2016\)](#) and [Jewer \(2018\)](#) also report a positive and significant relationship between performance expectancies and the usage intention of new health care-related technologies.

In the framework of the present paper, performance expectancy is interpreted as the usefulness and convenience of virtual doctor appointments in people’s everyday lives. Therefore, and based on the aforementioned, the second hypothesis states that:

**H2.** Performance expectancy has a positive, direct, and significant impact on the intention to use a virtual doctor appointment.

#### 3.3. Social influences

Social influences refer to the degree to which an individual perceives that important others believe that they should use a certain technology. Previous technology acceptance studies ([Kijisanayotin, Pannarunothai & Speedie, 2009](#)) show that the impact of social influences on the intention to use a new technology is positive and significant.

It has been suggested however that other people’s opinions will merely have a marginal ([Chang et al., 2007](#)) or no influence at all on people’s behavior when it comes to health care ([Phichitchaisopa & Naenna, 2013](#)), given its highly intimate and personal nature ([Chang et al., 2007](#)). Nevertheless, recent studies predicting patient’s behavior in health ICT acceptance report social influences as an important variable, since the opinion of peers and colleagues can indeed have a strong influence on peoples’ behavior ([Ashida, Wilkinson & Koehly, 2012](#); [Cimperman et al., 2016](#); [Jang et al., 2016](#)).

Being aware of the peculiar role of social influences in a health care context and the discrepancies found in the academic literature, it was decided to adopt the argument of authors such as [Ashida et al. \(2012\)](#) and aim to further investigate their role on people’s decision making. Therefore, the third hypothesis of this paper is proposed as follows:

**H3.** Social influences have a positive, direct, and significant impact on the intention to use a virtual doctor appointment.

#### 3.4. Facilitating conditions

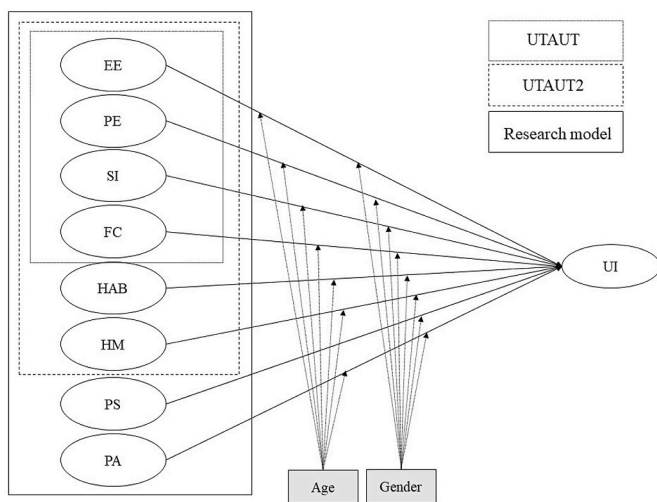
According to [Venkatesh et al. \(2003\)](#), facilitating conditions are the degree to which an individual believes that a technical infrastructure exists to support them during the use of a new technology. In the original version of UTAUT, facilitating conditions were hypothesized to be an antecedent of actual use behavior. This means that higher perceptions about the availability of resources, knowledge, and support increase the likelihood of using a new technology. In other words, facilitating conditions reduce perceived barriers in technology adoption in terms of support and assistance ([Blok et al., 2020](#)). In UTAUT2, facilitating conditions are postulated to directly affect the behavioral intention to use new technology ([Venkatesh et al., 2013](#); [Macedo, 2017](#)).

In a health care environment, [Rho et al. \(2015\)](#) point out the important role of facilitating conditions when people are faced with new technologies. This is stressed by [Jewer \(2018\)](#), who found that facilitating conditions are the variable with the highest explanatory power of usage intention. Again, [Duarte & Pinho \(2019\)](#) confirm the importance of facilitating conditions in a health care environment and stress that, due to the complexity of the context under study, they play a crucial role to foster the gradual acceptance and use of digital health technologies.

For the present study, it was decided to incorporate facilitating conditions because virtual doctor appointments are a rather new approach to obtaining medical assistance and the possible need for assistance during the process can be high, especially at the beginning. Considering this, it is important to further investigate if people perceive technology itself as a barrier, which would hinder the adoption process.

Therefore, hypothesis four says as follows:

**H4.** Facilitating conditions have a positive, direct, and significant impact on the intention to use a virtual doctor appointment.



**Image 1.** Research model. Note: EE: Effort expectancy; PE: Performance expectancy; FC: Facilitating conditions; SI: Social influences; HAB: Habit; PS: Perceived security; PA: Perceived product advantage; UI: Usage intention. Source: own elaboration.

### 3.5. Habit

Habit, the first construct incorporated into UTAUT2, is an unconscious or automatic behavior (Venkatesh et al., 2012). It can be seen as a result of prior performance or the extent to which people tend to act automatically because of learning. Habit can have an important impact on usage intention, since a continuous use of technology results in routine becoming more important than external factors (Miladinovic & Xiang, 2016).

In health care, Ravangard (2017) confirms the effect of habit on the intentions to use a laboratory portal, verifying that it significantly influences usage intention. There is, however, a lack of empirical work that investigates the importance of habit on the intention to use telemedicine services.

For the context of this study, it is interpreted as the possibility that virtual doctor appointments turn into a part of standard medical attention in the near future, possibly accelerated by the pandemic. Following Kim & Malhorta (2005), who postulate that habit is considered a result of previous experience, this relationship is expected to be particularly interesting since we are working with a sample without previous experience, where the inexistence of habit also entails no experience with the service under study.

Therefore, our fifth hypothesis states as follows:

**H5.** Habit has a positive, direct, and significant impact on the intention to use a virtual doctor appointment.

### 3.6. Hedonic motivation

Hedonic motivation is conceptualized as the feeling of cheerfulness, joy, or enjoyment and is a significant determinant of customer acceptance of technology and was found to be a critical antecedent of behavioral intention (Venkatesh et al., 2012; Alalwan et al., 2017; Chopdar et al., 2018). It is hypothesized that the higher the perceived hedonic motivation, the higher the intention to use technologies, products, or services (Chopdar et al., 2018).

In this context it is important to notice the nature of a virtual appointment: before the pandemic, they were mainly used in routine settings or in situations where patients and the health care provider were unable to physically meet, with particular emphasis on their convenience (no travel time, no waiting time at the office, no need to take time off at work, ...). Since the use of virtual health care has spiked during the pandemic, following Baudier, Kondrateva & Ammi (2020), virtual appointments can generate a certain degree of excitement, curiosity or enjoyment due to the use of a highly innovative digital health service. However, whereas needing a medical consultation is never a pleasure, the possibility to carry it out by the means of technology from home or the workplace may act as a motivator and increase the intention to use it.

Research on the relationship between hedonic motivation and usage intention is very scarce, especially in a health care context and further studies are necessary to consolidate this relationship (Macedo, 2017). To address this lack of empirical evidence, it was decided to include the construct of hedonic motivation in our study. Hence, the fifth hypothesis is proposed as follows:

**H6.** Hedonic motivation has a positive, direct, and significant impact on the intention to use a virtual doctor appointment.

### 3.7. Perceived security

Modifying UTAUT2 by adding new antecedent or moderating variables to better adjust to the context under study is a common approach (Vimalkumar et al., 2021). For the present study, it was decided to incorporate perceived security as another antecedent of behavioral intention to use virtual doctor appointments. In general, a key aspect to consumer participation in e-commerce is perceived web risk about sensitive information. Sailsbury et al. (2001, pp. 166) define perceived

web security as “the extent to which one believes that the World Wide Web is secure for transmitting sensitive information”. They argue that “there may be a perception of risk involved in transmitting sensitive information such as credit card numbers across the World Wide Web”.

Security-related factors play a crucial role in technology acceptance studies, and they are expected to directly affect attitudes and behavioral intentions (Khalilzadeh, Ozturk & Bilgihan, 2017). Shin (2009) shows that perceived security is one of the main predictors of usage intention of mobile payment services. Specifically, regarding the health care context, security issues are treated as a major barrier to engagement and adoption (Kruse et al., 2018).

Since health information is sensitive *per se*, the concept of perceived security can also be applied to the context under study: Telemedicine requires information security and privacy as well as physical safety (Garg & Brewer, 2011) and all information shared during an appointment underlies strict rules of doctor-patient confidentiality. Privacy refers to information that is shared between both parties and is key in conversations between them. With telemedicine applications on the rise, security concerns are one of the most frequently discussed topics in literature (Weißfeld, Goetz & Steinhäuser, 2021) and one of the core concepts for a successful telemedicine implementation (Hall, 2014).

Taking into consideration the aforementioned, it was decided to include perceived security in this study to find out the extent to which security concerns can be perceived as a barrier to telemedicine adoption or if people perceive the Internet as a secure means through which they can communicate with a health care professional. The following, seventh, hypothesis was proposed:

**H7.** Perceived security has a positive, direct, and significant impact on the usage intention of a virtual doctor appointment.

### 3.8. Perceived product advantage

Perceived product advantage commonly refers to the benefits that customers obtain from a new product (Langerak et al., 2004). According to Henard & Szymanski (2001), perceived product advantage is the number one cause affecting new product performance. Even more so, Langerak et al. (2004) highlight that it is the most important product characteristic in explaining product adoption and success. They found empirical evidence for the fact that it is a *conditio sine qua non* for positive and good product performance.

For companies interested in entering the telemedicine market, it is crucial to know whether customers perceive their service as advantageous and if by using it, they will receive benefits they would not get in a physical appointment. As slow adoption rates of telemedicine services are partially attributed to human factors, resolving technical, regulatory, and financial issues is only a fragment to guarantee a successful implementation over time. In line with this argument, Kho, Gillespie & Martin-Khan (2020) point out the importance of communication: Understanding and realizing the benefits and advantages of telemedicine significantly contributes to a successful implementation. Therefore, and to the best of our knowledge, there has never been a direct measurement comparing the specific characteristics of both ways of medical consultation, physical and virtual, to see how they are perceived by a patient. Finding out the precise pain points of the patient’s journey is crucial to ensure a successful adoption process.

In this context, it must be noticed that a virtual doctor appointment can and should not replace or substitute a physical encounter between a doctor and a patient. It may, however, be seen as useful in situations that do not necessarily require physical contact between both parties or where physical interaction is not possible.

Knowing the direct link between perceived product advantage and product performance, the last hypothesis of this study is formulated as follows:

**H8.** Perceived product advantage has a positive, direct, and significant impact on the usage intention of a virtual doctor appointment.

### 3.9. Moderating variables

The version of UTAUT2 used in this study has two moderating variables, age, and gender. The characteristics of an individual are important when it comes to explaining people's behaviors and according to Holden & Rada (2011), demographic variables are especially relevant in technology adoption. For this reason, two moderating variables, age and gender, were included in this research.

#### 3.9.1. Age

Age is a moderating variable in both UTAUT and UTAUT2 (Venkatesh et al., 2003; 2012) and it is important when analyzing acceptance, adoption, and use of new technologies. Following Venkatesh et al. (2012), the older a person gets, the harder it is to learn to handle new technologies. In line with this, Rogers et al. (2017) state that older people tend to be slower when adopting new technologies.

It is important to point out that age is an important factor to be considered, since, according to Kaba and Touré (2014), younger individuals can be more technology-ready and sensitive to new trends and therefore less likely to be influenced by technology characteristics and referents' opinions than older users. Previous research exists that has studied the importance of effort expectancy among older adults (Mag-samen-Conrad et al., 2015), indicating that there are significant differences regarding this variable among older and younger generations.

Zhao, Ni & Zhou (2018) mention the role of age on technology adoption in a health care environment. Considering the *status quo* of an aging society, it is vital to understand its moderating role. They indicate that age indeed acts as a moderating variable in the health environment: elderly people prefer easy-to-use technology and tend to reject more complex ones, quite on the contrary of younger people, who have more technology control and adapt to new technologies more easily. These authors also point out that research on the impact of age differences in health care is still scarce. Therefore, this investigation pretends to shed more light on the role of age in the acceptance of telemedicine use by means of the ninth hypothesis:

**H9.** The aforementioned relationships are moderated by age.

#### 3.9.2. Gender

A person's gender is also a key moderating variable in both versions of UTAUT (Venkatesh et al., 2003, 2012). In fact, it is of the most studied variables in technology acceptance in the academic literature, but with somewhat conflicting results. On one hand, gender theories suggest that differences between men and women cannot be attributed to a person's gender *per se* but develop because of societal and peer pressure. As a counterpoint, another research current states that gender differences do indeed exist and are quite significant. Knickmeyer & Belmonte (2005) suggest that these differences are inborn, with women having more prominent empathic characteristics and men being superior when systematizing.

Being aware of the conflicting results of gender in technology acceptance, further research is necessary (Padilla-Meléndez, del Águila-Obra & Garrido-Moreno, 2013 or Lu, Papagiannidis & Alamanos, 2019). Research on gender in a telemedicine environment is scarce but, as Reicher, Sela & Toren (2021) state, gender is a factor that may indeed affect telemedicine use, pointing out the need to further investigate this topic to avoid possible gender gaps in telemedicine implementation.

Given the opposed opinions on gender and a general lack of research in a health care context, this paper pretends to shed light on gender differences in a telemedicine adoption context. We, therefore, formulate the last hypothesis of this paper as follows:

**H10.** The aforementioned relationships are moderated by gender.

For the reader's comfort, all hypotheses that have been formulated in this paper are summarized in Table 2 and the full research model is shown in image 1.

Furthermore, in the following paragraph we will also offer a cross-

**Table 2**

Hypotheses summary.

H <sub>1</sub>	Effort expectancy has a positive, direct, and significant impact on the behavioral intention to use virtual doctor appointments.
H <sub>2</sub>	Performance expectancy has a positive, direct, and significant impact on the intention to use a virtual doctor appointment.
H <sub>3</sub>	Facilitating conditions have a positive, direct, and significant impact on the intention to use a virtual doctor appointment.
H <sub>4</sub>	Social influences have a positive, direct, and significant impact on the intention to use a virtual doctor appointment.
H <sub>5</sub>	Habit has a positive, direct, and significant impact on the intention to use a virtual doctor appointment.
H <sub>6</sub>	Hedonic motivation has a positive, direct, and significant impact on the intention to use a virtual doctor appointment.
H <sub>7</sub>	Perceived security has a positive, direct, and significant impact on the usage intention of a virtual doctor appointment.
H <sub>8</sub>	Perceived product advantage has a positive, direct, and significant impact on the usage intention of a virtual doctor appointment.
H <sub>9</sub>	The aforementioned relationships are moderated by age.
H <sub>10</sub>	The aforementioned relationships are moderated by gender.

Source: own elaboration

country comparison between the two nations under study, Germany, and the US, to find out if there are any particular differences among people's perceptions when it comes to using a virtual doctor appointment.

## 4. Research method

### 4.1. Instrument

This research is based on eight latent constructs, each one measured with items that have been adapted to the telemedicine context from the existing literature. More specifically, items used for the UTAUT2 originated from Venkatesh et al. (2012). Sailsbury et al. (2001) provided the items that were applied to measure perceived security and perceived product advantage items were adapted from Langerak et al. (2004). All items were measured on a seven-point Likert scale reaching from 1 ("I do not agree at all") to 7 ("I completely agree").

### 4.2. Data collection

Data for this research was collected through a Qualtrics online survey from 800 randomly selected participants in the United States of America and Germany, 400 in each country. Respondents belonged to the general population; no additional restrictions were added as the main objective was to reach a cross-section of the broad population under study.

Prior to this, the corresponding number of questionnaires necessary to obtain an age-stratified sample was calculated based on the latest data from the National Census Bureau for the US and the Statistisches Bundesamt in the case of Germany.

Participants under the age of 20 and older than 50 were excluded from the research. The final sample size was 710 since people with previous experience with virtual doctor appointments were deliberately left out. The sample characteristics are summarized in Table 3.

### 4.3. Results

Following Anderson & Gerbing (1998), a two-step approach was adopted in this study: in the first place, the proposed research model was analyzed by testing its reliability and validity, and then the structural model was assessed to verify the hypotheses.

A confirmatory factor analysis was conducted to examine the questionnaire for both validity and reliability. Data was subsequently analyzed for convergent validity, a measure that detects if each factor can be reflected by its own items (Gefen & Straub, 2000). Standardized item loadings, t-values, average variance extracted (AVE), composite reliability (CR) and Cronbach's Alpha ( $\alpha$ ) are listed in Table 3. As shown,

**Table 3**  
Sample characteristics.

N = 710		n	%
Gender	Male	270	38,0
	Female	440	62,0
Age	20–29	232	32,7
	30–39	221	31,1
	40–49	257	36,2
Income	<2.000€	392	55,2
	2.001€–3.000€	162	22,8
	>3.000€	156	22,0
Education	No education	6	0,8
	High school	565	79,6
	College	75	10,6
	Master's	63	8,9
	Doctorate	1	0,1

Source: own elaboration

all items are significant at the .001 level, the average variance extracted and composite reliability and Chronbach's Alpha values exceed the minimum thresholds of 0,5, 0,7 and 0,7, respectively (Bagozzi & Yi, 1988). Since all those requirements were met in this study, it can be concluded that the proposed research model has good convergent validity and satisfactory reliability values (Table 4).

On the other hand, discriminant validity reflects whether two factors are statistically different from each other (Gefen & Straub, 2000). Table 5 shows the results of the discriminant validity analysis. The square root of the average variance extracted (AVE) of each factor is higher than its correlation with other factors. Therefore, the factors of this study have satisfactory discriminant validity.

Structural Equation Modelling (SEM) was used to test the hypotheses, applying AMOS (version 24). In the first place, we assessed the model fit to assure an adequate adjustment between the model and the data. These indices, shown in Table 6, demonstrate a satisfactory fit of the proposed research model.

**Table 4**  
Reliability and validity.

Construct	Item	Li	Ei	Reliability		AVE	Validity	
				α	CR		t-Student	p
Usage intention	UI1	0,88	0,23	0,97	0,93	0,81	–	
	UI2	0,89	0,22				37,348	***
	UI3	0,94	0,12				30,175	***
Effort expectancy	EE1	0,93	0,20	0,93	0,94	0,83	–	
	EE2	0,92	0,16				34,092	***
	EE3	0,89	0,14				35,857	***
Performance expectancy	PE1	0,95	0,13	0,96	0,94	0,89	–	
	PE2	0,93	0,10				45,313	***
Social influences	SI1	0,93	0,14	0,97	0,96	0,90	–	
	SI2	0,95	0,09				45,365	
	SI3	0,96	0,07				47,292	
Facilitating conditions	FC1	0,77	0,41	0,91	0,85	0,72	–	
	FC2	0,82	0,32				19,237	***
	FC3	0,68	0,54				16,003	***
Habit	HAB1	0,91	0,18	0,92	0,94	0,85	34,490	***
	HAB2	0,93	0,14				42,204	***
	HAB3	0,93	0,13				–	
Hedonic motivation	HM1	0,92	0,15	0,92	0,97	0,85	–	
	HM2	0,91	0,17				36,691	***
	HM3	0,93	0,14				37,844	***
Perceived security	PS1	0,94	0,12	0,97	0,96	0,90	–	
	PS2	0,96	0,07				51,516	***
	PS3	0,95	0,11				46,981	***
Perceived product advantage	PA1	0,79	0,07	0,98	0,87	0,70	22,234	***
	PA2	0,86	0,26				–	
	PA3	0,83	0,30				25,533	***

Source: own elaboration

#### 4.4. Hypothesis testing

The results obtained regarding the relationships among the constructs in the research model are represented in Table 7.

Six out of the ten proposed hypotheses were accepted. Significant, direct, and positive effects of performance expectancy, hedonic motivation, perceived security, and perceived product advantage on the behavioral intention to use virtual doctor appointments were found. In this modified version of UTAUT2, the impact of effort expectancy, social influences, facilitating conditions and habit were, albeit positive and direct, not statistically significant.

Furthermore, this paper pretended to shed light on the relationship of age and gender in telemedicine adoption. To address this, invariance of the measurement scales was assured in both cases. This guarantees that possible differences among groups obey strictly to their perception and are not due to different interpretations of the measurement scale.

Regarding the first moderator, age, the sample was divided into two groups, people younger than and older than 35 years. This cutoff is justified in two ways. In the first place, the average age of becoming first-time parents is being increasingly postponed and women in their early thirties are forging their careers. This means that many parents around this age are likely to have small children and, following a report by the Children's Hospital of Philadelphia (2020), value the convenience of digital health tools for a wide range of pediatric consultation scenarios. In the second place, people at the age of 35 tend to be at decisive peak points of their career (Johanson, 2017) where "time is money" and the time-saving aspect of a virtual appointment is valued as one of the most important features.

Results indicate that hedonic motivation, perceived security, and perceived product advantage significantly predict usage intention in the younger group, whereas effort and performance expectancy, perceived security, and perceived product advantage are significant antecedents in the group of people older than 35. Significant differences were found regarding people's performance expectancy, with a stronger effect for people over the age of 35 (see Table 8a).

Taking a closer look at people's gender, the sample was divided into men and women. The significant variables that explain the intention to

**Table 5**  
Discriminant validity results.

	UI	EE	PE	SI	FC	HAB	HM	PS	PA
UI	0,871								
EE	0,794***	0,903							
PE	0,853***	0,824***	0,937						
SI	0,736***	0,755***	0,764***	0,944					
FC	0,597***	0,747***	0,574***	0,583***	0,749				
HAB	0,839***	0,798***	0,915***	0,747***	0,559***	0,917			
HM	0,788***	0,870***	0,783***	0,728***	0,745***	0,719***	0,909		
PS	0,802***	0,758***	0,722***	0,670***	0,520***	0,737***	0,713***	0,946	
PA	0,711***	0,786***	0,754***	0,708***	0,641***	0,743***	0,817***	0,658***	0,835

Note: EE: Effort expectancy; PE: Performance expectancy; FC: Facilitating conditions; SI: Social influences; HAB: Habit; PS: Perceived security; PA: Perceived product advantage; UI: Usage intention.  
Source: own elaboration

**Table 6**  
Model fit.

$\chi^2$	D.F.	$\chi^2/D.F.$	GFI	CFI	NFI	RMSEA
608,525	259	2350	0,911	0815	0,934	0040

Note:  $\chi^2/D.F.$ : ratio between chi-square and the degrees of freedom, GFI: Goodness of Fit Index, CFI: Comparative Fit Index, NFI: Normed Fit Index, RMSEA: Root Mean Square Error of Approximation.  
Source: own elaboration

**Table 7**  
Hypotheses testing.

Hypothesis	Supported or rejected
H <sub>1</sub> Effort expectancy has a positive, direct, and significant impact on the behavioral intention to use virtual doctor appointments.	0,058 (ns) R
H <sub>2</sub> Performance expectancy has a positive, direct, and significant impact on the intention to use a virtual doctor appointment.	0,288*** S
H <sub>3</sub> Social influences have a positive, direct, and significant impact on the intention to use a virtual doctor appointment.	0,004 (ns) R
H <sub>4</sub> Facilitating conditions have a positive, direct, and significant impact on the intention to use a virtual doctor appointment.	0,011 (ns) R
H <sub>5</sub> Habit has a positive, direct, and significant impact on the intention to use a virtual doctor appointment.	0,119 (ns) R
H <sub>6</sub> Hedonic motivation has a significant, positive, direct and significant impact on the intention to use a virtual doctor appointment	0,292*** S
H <sub>7</sub> Perceived security has a positive, direct, and significant impact on the usage intention of a virtual doctor appointment.	0,144*** S
H <sub>8</sub> Perceived product advantage has a positive, direct, and significant impact on the usage intention of a virtual doctor appointment.	0,121* S
H <sub>9</sub> The aforementioned relationships are moderated by age.	S
H <sub>10</sub> The aforementioned relationships are moderated by gender.	S

Note: S: Supported, R: Rejected, ns: not significant.  
Source: own elaboration

use virtual doctor appointments for males were hedonic motivation and perceived product advantage, and performance expectancy, hedonic motivation, and perceived security for female respondents. Significant gender differences were discovered in effort expectancy and perceived product advantage, with stronger effects in women in the first case and male respondents in the last one (see Table 8b).

A direct comparison between the two countries selected in this study was also carried out. Again, in the first place, the measurement scales were tested for invariance.

Regarding the American sample, performance expectancy, hedonic motivation, and perceived security turned out to be statistically

**Table 8a**  
Age differences.

Dependent variable	Independent variable	Estimate		Critical ratio
		<35	>35	
Usage intention	Effort expectancy	0,066	0017*	-0,328 (ns)
	Performance expectancy	0,054	0477***	1925*
	Social influence	-0,007	0032	0,408 (ns)
	Facilitating conditions	0,042	0002	-0,425 (ns)
	Habit	0,275	0057	-1019 (ns)
	Hedonic motivation	0,496**	0,286	-1071 (ns)
	Perceived security	0,162**	0,126**	-0,393 (ns)
Perceived product advantage	0,105*	0,126**	0,135 (ns)	

Source: own elaboration

**Table 8b**  
Gender differences.

Dependent variable	Independent variable	Estimate		Critical ratio
		Male	Female	
Usage intention	Effort expectancy	-0,164	0124	1856*
	Performance expectancy	0,200	0299**	0,562 (ns)
	Social influence	-0,064	0100	1599 (ns)
	Facilitating conditions	-0,063	-0,050	0108 (ns)
	Habit	0,889	0127	-0,666 (ns)
	Hedonic motivation	0,571***	0,285**	-1541 (ns)
	Perceived security	0,115	0203***	0,94 (ns)
Perceived product advantage	0,384**	-0,021	-2259**	

Source: own elaboration

significant while hedonic motivation, perceived security, and perceived product advantages significantly predicted usage intention of the German sample. As shown in Table 9, the direct comparison between German and US-American users revealed that the differences of the studied variables were not strong enough to be statistically different.

Lastly, the variance explained by the research model proposed was 85,3%. This represents a significant increase in variance explained compared to the original UTAUT2 model proposed by Venkatesh et al. (2012), showing that the model adjusts well to the context of this investigation.

## 5. Discussion

Focusing on the demand side, this paper aimed to deepen the analysis of the factors that influence an individual when deciding to use a



**Table 9**  
Cross-country comparison.

Dependent variable	Independent variable	Estimate		Critical ratio
		Germany	USA	
Usage intention	Effort expectancy	0,149 (ns)	-0,141 (ns)	-1478 (ns)
	Performance expectancy	0,170 (ns)	0,327**	0,906 (ns)
	Social influence	0,003 (ns)	0,136 (ns)	1234 (ns)
	Facilitating conditions	0,07 (ns)	0,023 (ns)	-0,465 (ns)
	Habit	0,16 (ns)	0,095 (ns)	-0,422 (ns)
	Hedonic motivation	0,219**	0,476*	1008 (ns)
	Perceived security	0,135**	0,220***	1,02 (ns)
	Perceived product advantage	0,256**	0,114 (ns)	-1034 (ns)

Source: own elaboration

virtual doctor appointment, using a modified version of UTAUT2. Regardless of the ongoing COVID-19 pandemic, telemedicine has been paving its way into standard health care attention for years and is here, now more than ever, to stay.

The modified UTAUT2 model proposed in this study helps extend its applicability to the telemedicine context. The empirical results show that two of UTAUT2s original constructs, performance expectancy, and hedonic motivation, have a significant, direct, and positive influence on usage intention of virtual doctor appointments. However, no empirical evidence was found to support a statistically significant influence of the other four constructs, namely effort expectancy, social influences, facilitating conditions, and habit. Empirical confirmation for the positive, significant, and direct influence of perceived security and perceived product advantage, constructs incorporated as a novelty in this study, was also found.

In this study, the inversely measured variable effort expectancy, meaning the degree to which using technology is perceived as easy to use, did not have a significant influence on telemedicine adoption. This could be due to the fact that the sample was made out of non-experienced individuals. Even though the items of the survey were written in conditional phrasing, imagining and evaluating the ease of use of an unknown service in a hypothetical surrounding is a rather difficult task.

As stated before, a medical appointment is a highly personal manner and hence, peer pressure can turn out to be less significant than in other non-medical surroundings. Therefore, social influences might not have been a salient construct in this study. Many people consider a medical appointment as an extremely private matter and, depending on the medical specialty or issue treated with the doctor, they might not even share details with close friends and/or family members. Since the only thing that changes in a virtual doctor appointment is the physical setting and not the fact of having (or needing) a medical consultation, it is explainable that an individual does not take into account the opinion their social surrounding has on the fact of having a doctor appointment over the Internet.

Facilitating conditions refer to the fact that users feel that they are technologically well enough equipped or might need help from others to perform a certain task. Given that in the present study we applied an age-stratified sampling, restricting the age of respondents between 20 and 50, the relationship did not turn out to be statistically significant. Carrying out a virtual doctor appointment may not be perceived as a difficult or challenging task because it is perceived as an extension of what people are already doing in different aspects of their personal lives, like using FaceTime or Skype to talk to their family (Brooks, 2016). It is possible to think of this as a positive outcome since technological issues are not perceived any more as a significant barrier to telemedicine adoption.

Regarding the statistically significant results obtained in this investigation, empirical evidence was found for the influence of performance expectancy, hedonic motivation, perceived security, and perceived product advantage on the behavioral intention to use virtual doctor appointments. The relevance of these findings needs to be pointed out for several reasons. In the first place, the two new variables specifically included in this study, perceived security, and perceived product advantage, had a significant impact on usage intention. Virtual doctor appointments are indeed seen as more beneficial in the direct comparison with a traditional doctor appointment. This gives important inside knowledge to the stakeholders of the telemedicine business. Even more so, the construct of perceived security comes in handy since it evidences that the Internet is perceived as a secure means to communicate with a health care professional.

The positive and significant influence of performance expectancy shows that people do recognize virtual doctor appointments as a useful tool to communicate with a health care professional. Furthermore, hedonic motivation points out that the respondents perceived them as an enjoyable, convenient, and pleasant tool to carry out a medical consultation over the Internet. This confirms once more that telemedicine is, indeed, a convenient complement to traditional doctor appointments.

As regards the moderating variables, age and gender, the comparison of people younger and older than 35 showed significant differences regarding their performance expectancy. The effect turned out to be stronger for the older group. Even though this might seem a bit surprising, it can be interpreted that older people tend to have more medical conditions (Berghoff, 2020) and might find it more feasible to better integrate medical attention into their everyday life thanks to virtual health care. Furthermore, this age group tends to enclose families with children, which is why they could value more the possibility to council family life with different medical obligations.

The second moderating variable, gender, revealed significant differences regarding respondents' perception of effort expectancy and perceived product advantage. Effort expectancy showed to be a stronger antecedent for females, which would initially contradict the theory that women are less likely than men to engage with new technologies. On the other hand, men perceived the virtual appointment as more beneficial than women, which may be because men tend to be more reluctant to see a medical professional (Sánchez & Himmelstein, 2016) and might see an online appointment as a viable alternative to not seeing a doctor at all.

No differences were found between the two countries that were compared in this study, Germany and the United States of America. Some of the main reasons alleged in Germany that inhibit a successful telemedicine development and implementation are billing and accounting issues, an unclear legal situation on remote treatments, and bureaucratic burdens and obstacles. Even though Hyder & Razzak (2020) point out a strong increase in telemedicine in the US due to COVID19, Holtz (2020) adds that telemedicine is in the spotlight due to the pandemic, but that it had been more advanced. The results of this investigation might therefore indeed imply that the need for action lies not so much with the individual, but with the authorities and policy-makers to ensure a successful telemedicine development.

It is particularly important to pay attention to the results of this comparison because they can and should be used to draw conclusions regarding the gradual telemedicine implementation in countries with less telemedicine use. Knowing that the US is one of the leading countries on the matter, it is crucial to closely observe the similarities and differences of people's perceptions. This knowledge might enable other countries with less digital health penetration or who are on the verge of decisive breakthroughs to design their telemedicine strategies accordingly and to learn from the more advanced nations.

## 6. Conclusions and implications

This section recaps the most relevant aspects of this paper, starting with a summary of theoretical parts and followed by the empirical conclusions of the research work carried out. The most relevant implications for different parties are also pointed out alongside.

Health care systems around the world stand at a crossroads. The new digital age is transforming this sector and the technologies related to eHealth are seen as one of the great hopes for health care-related services. More specifically, telemedicine is considered as a solid solution for this tense situation and proof of this is the fact that medical video consultations are a growing trend in the digital health market. The recent events regarding the COVID-19 pandemic have accentuated the need to root telemedicine into standard medical practice.

Therefore, it is crucial to analyze the factors that influence an individual when accepting telemedicine and to address the personal and mental barriers that cause people not to use telemedicine services. This usually happens either because they do not want to, do not know how to, or simply cannot do it. This study aims to identify the factors that determine the intention to use medical video appointments from the demand side, which has been less investigated.

Two countries with different cultures and different health care systems were deliberately chosen for this study. Whereas both countries are known to be technologically advanced, Germany has acknowledged deficits and difficulties in telemedicine implementation. The US on the other hand is known to be one of the most advanced countries when it comes to the use of eHealth and telemedicine. Furthermore, selecting a sample of individuals who had declared to have no previous experience with virtual doctor's appointments was a carefully made choice. This allows gaining a better insight into the factors that might be acting as a possible barrier in telemedicine adoption.

Conducting successful research in health care has a few issues that are uncommon in other sectors. As problem-solving and practical relevance is crucial, it is important to focus on ongoing problems with rigor and consistency (Cheon & Lee, 2020). UTAUT is knowingly one of the most dominant models to study technology adoption. Its successor, UTAUT2, was chosen as the theoretical model to address the objectives of this investigation. Apart from the original items of UTAUT2, two additional constructs were added to the model to get better and more detailed insight into the factors that lead an individual to adopt or reject telemedicine appliances: perceived security and perceived product advantage. Both are treated in the academic literature as known barriers to telemedicine adoption.

The results obtained and discussed in this paper confirm some of the traditional relationships included in UTAUT2 and show statistically significant influences of both perceived security and perceived product advantage. This is particularly remarkable for new companies that contemplate the telemedicine market as a new business opportunity. Considering the forthcoming challenges, our study may be used by managers, policymakers, and health care professionals to point the way for a successful telemedicine implementation in the future. Respondents did perceive the potential benefits of virtual appointments in terms of convenience and also consider them to be a secure means to communicate with a health care professional.

This study may also be useful for companies who contemplate promoting virtual health care for their employees since it is known to contribute to employee satisfaction and retention, as well as to reduce work absenteeism. Furthermore, virtual health care can present a critical opportunity for companies to establish a competitive advantage (Abrams & Korba, 2018).

Additionally, policy decision-makers and health care professionals can use the results of our study to develop a clear and unambiguous communication strategy of the benefits of telemedicine to foster, promote and engage society in the use of telemedicine. The results show that, for people to engage in using a telemedicine platform regularly, these need to be designed in a user-friendly and self-explanatory manner

to point out their ease of use.

Lastly, it is important to address that, besides the significant relationships that have been obtained in this paper, the non-significant results also give important information for the above-mentioned stakeholders when it comes to developing a successful telemedicine program. The result of effort expectancy is key information since it highlights the need to design clear and easy-to-understand telemedicine solutions that comprehensively adapt to patients' needs and expectations. As Kho et al. (2020) state, many barriers to a successful adoption come back to people's attitudes and perceptions. As many obstacles tend to remain stable over time, patients need to be guided through this process of change to assure their ability and willingness to participate in this digital health revolution.

Finally, through this investigation, UTAUT2 has been empirically validated in a rather under-researched setting. This proves, once more, its adaptability and well-rounded character.

## 7. Limitations and future research

There are of course certain limitations to this study that need to be addressed and acknowledged. In the first place, this paper deals with data obtained from a cross-sectional and not longitudinal study. It will certainly be interesting for future research to consider a longitudinal design, taking hence into consideration any changes in the target population of the study.

Technology is one of the most fast-moving sectors there is. This study only provides a snapshot of a situation that could already have changed again. It might, therefore, be seen as an appeal rather than a limitation, in line with the aforementioned possibility to undertake a study of the evolution over time in this area. It should also be of great interest to study the impact of the COVID19-pandemic in particular and not the mere passing of time, which of course also will affect the topic under study.

Knowing that this study used a modified and adapted version of UTAUT2, it could as well be interesting to apply the full version of the model to see the influence of price value once people have more experience with the service, a construct that has been omitted in this study. Since this study has been explicitly directed towards a group of non-experienced users, it would certainly be interesting to see how perceptions change over time.

Moreover, there is a series of multi-group analyses that could be applied in this context to obtain even more details on differences among age, gender, cultures, or even different stages of adoption or different types of motivation (hedonic vs. utilitarian, for example). Furthermore, future research could consider how and if a provider's gender affects telemedicine acceptance as this might be an important factor to consider, especially in certain medical specialties and/or scenarios.

Lastly, and knowing the significant importance of cultural backgrounds on technology adoption, future research might address country-of-origin and culture as an antecedent or moderating variable. This is likely to offer a deeper understanding of telemedicine adoption processes in an international context and to give insights on why certain cultures seem to be more reluctant to change in the health care sector.

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## Declaration of competing interest

None.

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