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Drivers of telemedicine use: International evidence from three samples of physicians

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Table of contents

Introduction....6
1. Hypothesis and model....7
2. Data collection, empirical methodology and validation....10
3. Empirical findings....16
4. Conclusions and discussion....21
Bibliographic references....24

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Abstract

The aim of the working paper is to analyse the determinants of telemedicine use. To that end, the study makes two basic contributions. First, it considers six working hypotheses in the context of technology acceptance models (TAMs). Second, it uses data obtained for three samples of 510 physicians: 113 in Spain, 118 in Colombia and 279 in Bolivia, and it performes binary logistic regression. In the three samples, it was found that the physician's level of ICT use in his/her personal life was the variable that had the highest explanatory power on telemedicine use. In the Spanish sample, the physicians' perceived ease-of-use of ICTs in clinical practice and propensity to innovate were the two other variables that determined telemedicine use, whereas in the Colombian and Bolivian samples, it was the level of optimism about ICTs. The results showed a more complete model that contemplated personal, usability and innovatory aspects in the explanation of telemedicine use in Spain, whereas the results for the Latin American samples indicated a more primary model in the explanation of telemedicine use, which was completed by an optimism factor that did not emerge in the Spanish sample.

Keywords

Telemedicine, Technology Acceptance and Adoption Models (TAM), Medical profession, Binary logistic model.

Introduction

In order to understand the drivers of telemedicine adoption, a range of methodological and disciplinary approaches have been employed. Technology-oriented research has noted that Roger's diffusion of innovations (DOI) theory and Davis's technology acceptance model (TAM) have been successfully used to understand the factors that explain the use of information and communication technologies (ICTs) by healthcare professionals (Masters, 2008; Jimoh et al., 2012). Information systems and social-oriented research has highlighted that clinical practice may be intimately interconnected to a range of digital devices and forms of information (Al-Gahtani and King, 1999; Berg and Toussaint, 2003; Gagnon et al., 2010), and to the ways that users use them in their private lives. Organisation-oriented research has shown that the structure of healthcare organisations, tasks, people policies, incentives and decision-making processes play a major role in explaining how medical professionals overcome barriers to ICT use (Lluch, 2011). Ethical and legal-oriented research has suggested that changes in the nature of the doctor-patient relationship, the status of health informatics and also the hardware/software providers tend to have an effect on ICT use by medical professionals (Kluge, 2011). Finally, usability-oriented research has shown that compatibility between clinical ICT systems and physicians' tasks, ICT support for information exchange, communication and collaboration in clinical practice, and interoperability and reliability also explain the success of ICT use in healthcare (Viitanen et al., 2011).

The incorporation of telemedicine into clinical practice has generated huge expectations as a means of healthcare cost containment, since it offers the potential to improve the efficiency and effectiveness of healthcare organisations, as well as the quality of the services provided (Ammenwerth, 2003; Chaudhry, 2006; European Comission, 2007; Keane, 2007). However, its use in day-to-day clinical practice is still limited (Broens et al., 2007; de Bont and Bal, 2008). There is general consensus that its slow, arduous implementation can be attributed to the lack of definitive scientific evidence supporting its positive impact on clinical practice (improved quality and effectiveness) and economic outcomes (improved cost-benefit) (Rigby, 2002; Grigsby, 2005; Poon et al., 2006; Broens et al., 2007; Jha et al, 2008; Roig and Saigí, 2009; Christensen and Remler, 2009; Ekeland, 2010; Murray et al., 2011).

In order to understand the effects of telemedicine use on health outcomes, it is crucial to analyse the prior step, that is to say, to perform an ex-ante analysis to determine what factors explain physicians' telemedicine use. Obtaining and comparing evidence on an international scale represents an important contribution to the

literature, in the sense that it will allow the determinants of telemedicine use to be evaluated.

In this context, this working paper analyses and compares the determinants of telemedicine use by samples of physicians from three countries. By doing so, the intention is to attain a two-fold objective. Firstly, to characterise and develop a typology of physicians according to their ICT use and expectations in their clinical practice and their personal lives. And secondly, to identify the determinants that foster or hinder the physicians' telemedicine use. In order to attain the latter part of the objective, we will perform a comparative analysis of three samples of physicians from three Ibero-American countries (Spain, Colombia and Bolivia).

1. Hypothesis and model

Technology Acceptance Model (TAM) is the theoretical system most widely applied to research into the acceptance of new information technologies in the professional sphere (Davis, 1989, 1993; Davis et al., 1989; Davis and Venkatesh, 1996; Venkatesh and Morris, 2000; Lee et al., 2003; Ma and Liu, 2004). In particular, the model has the capacity to robustly explain the intention to use ICTs, taking into account individuals' perceptions of technology: (1) perceived usefulness and (2) perceived ease-of-use (Venkatesh and Davis, 2000; McKechnie et al., 2006). Thus, the first two hypotheses of the study are:

H1. The perceived usefulness of ICTs in clinical practice explains telemedicine use.

H2. The perceived ease-of-use of ICTs in clinical practice explains telemedicine use.

Despite its widespread acceptance, this model has a series of limitations that mainly stem from the fact that it does not take the influence of other types of variables into account. Venkatesh et al. (2003) and Bagozzi (2007) underscored the need to increase the explanatory power of this model by incorporating additional variables. According to Davis, identifying variables like these in TAM can increase the explanatory power of the system users' acceptance (Davis, 1993; Venkatesh and Davis, 1996). This is particularly important to the development of TAMs in the field of healthcare. The consideration of variables relating to the individual, to his or her psychological or sociodemographic characteristics, and to his or capacity to be exposed to social influence is a standard feature. Consequently, the theoretical model

used needs to take into account contributions made by other models such as those: (1) tending to stress the importance of technology, such as Diffusion of Innovations model, DOI (Rogers, 1983); (2) tending to stress the importance of the user profile and of social influence (subjective norm), such as the Theory of Reasoned Action, TRA (Ajzen and Fishbein, 1980) and the Theory of Planned Behaviour, TPB (Armitage and Conner, 2001); and (3) that have a mixed approach, comprising elements that refer to both the user profile and to technology, such as Parasuraman's Theory of Technology Readiness, TR (Parasuraman and Grewal, 2000).

TR considers the need to incorporate user profile elements, in the sense of mental states resulting from facilitators or inhibitors, which together have the potential to determine people's predisposition towards using new technologies. In this respect, the third hypothesis is:

H3. The user's optimism about technology explains telemedicine use.

Similarly, we must consider that while each person's stance on technology is different, in a group of people each stance can be situated on a continuum ranging from strongly positive to strongly negative. Thus, people's stances, as situated on this continuum, are correlated to their propensity to adopt and use new technology. In this respect, the fourth hypothesis is:

H4. The user's propensity to innovate explains telemedicine use.

Finally, it should be noted that physicians use ICTs in their professional and personal lives. As an ICT user, the medical professional may use technology with differing degrees of intensity and frequency. It would seem clear that an individual who uses ICTs intensively is more likely to adopt them in his or her clinical practice. Hence the need to incorporate the intensity of ICT use as an explanatory factor of telemedicine use. In this respect, the fifth hypothesis is:

H5. The ICT user profile of the physician – as an individual, in his or her personal life – explains telemedicine use.

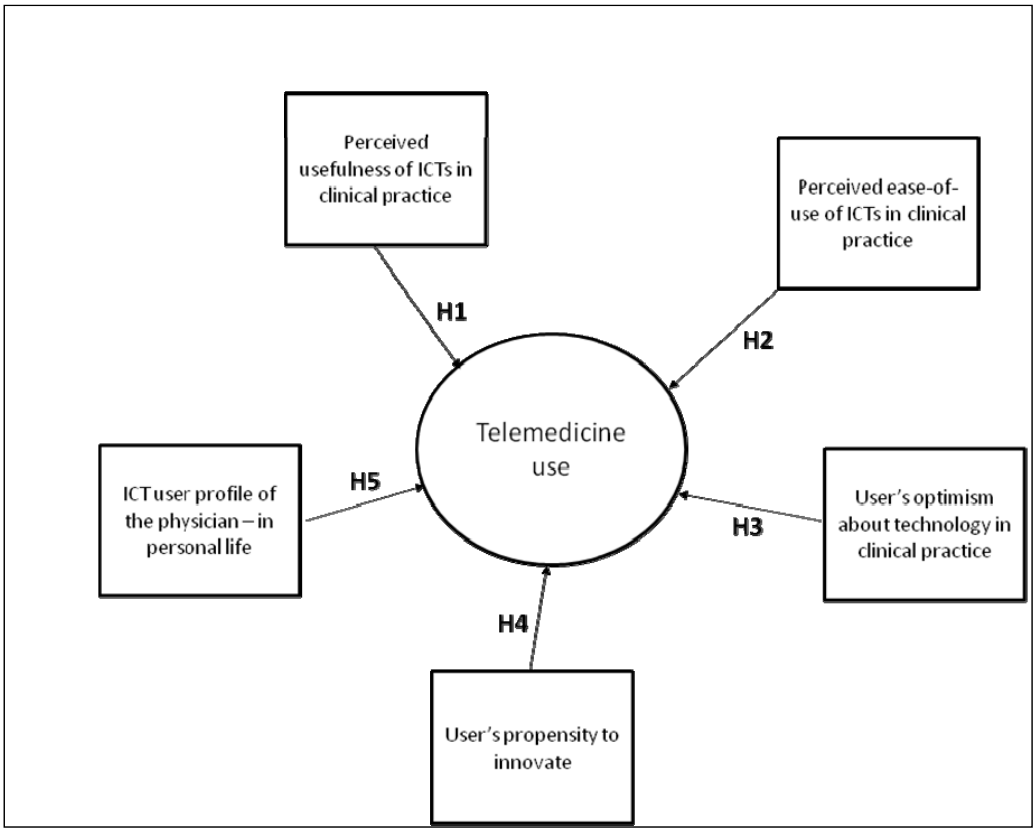
In addition to the determinants identified above, we should lastly stress the importance of the geographical, legal, social, cultural and economic contexts of the territory to the adoption of ICTs in clinical practice (Fitgeral et al., 2008). The digital divide refers to the existence of varying degrees of ICT implementation and adoption in different countries. Economic circumstances clearly influence the quantity and quality of technological equipment and infrastructure. In some sectors, social and cultural

aspects also play a key role (Ammenwerth et al., 2003), as do other circumstantial variables such as experience and training (Agarwal and Prasad, 1999). Depending on the country being analysed, the above model can be expected to show significant differences, and this is proposed in the sixth hypothesis:

H6. The degree of ICT implementation in the country's healthcare system explains the importance of each of the determinants of the physician's telemedicine use.

A summary of the proposed model and hypotheses is shown in figure 1.

Figure 1. Drivers of telemedicine use model



Source: Own elaboration.

2. Data collection, empirical methodology and validation

In this section, the proposed model (figure 1) relating to the determining factors of physicians' telemedicine use in their clinical practice is tested. To do that, three samples of physicians from three countries with varying degrees of implementation of ICT use in clinical practice were taken as the reference: Spain, Colombia and Bolivia. The study compares samples of physicians from different territories with varying levels of development according to the economic indicators provided by the International Monetary Found, IMF for 2012 and 2014 (IMF, 2014).

Spain, a developed country belonging to the European Union, with a GDP of US$1,340.266 billion and GDP per capita of US$30,740 in 2012 according to IMF estimates. According to the official statistics provided by the Spanish Ministry of Health, Social Services and Equality (MSSSI, 2014), spending on public healthcare, including long-term care, was €58.466 billion. This represents 71.2% of the country's total healthcare spending, which is €82.064 billion. As a percentage of GDP, total healthcare spending in Spain is 8.4%. According to data provided by the World Bank (World Bank, 2014), the mean annual percentage of GDP spent on healthcare in the 2009-2013 period was 9.3%. Colombia, a developing country with a GDP of US$365.402 billion and a GDP per capita of US$11,284 in 2012. The lack of official statistics for public healthcare spending in Colombia means that we have taken the figures provided by the World Bank as the reference indicator. That institution states that, for the 2009-2013 period, mean healthcare spending as a percentage of GDP was 6.8% (World Bank, 2014). Bolivia, a country with low level of development and a GDP of US$26.749 billion and a GDP per capita of US$4,996 in 2012. Table 1 shows the specifications for the three studies conducted.

Table 1. Specifications for the studies conducted in Spain, Colombia and Bolivia

	SPAIN	COLOMBIA	BOLIVIA
Sampling universe	356 physicians from hospitals, healthcare services and research centres of the Canary Islands Health Service	184 physicians affiliated to the Society of Surgery Service, San José Hospital of Bogotá	350 physicians from hospitals and healthcare centres in Sucre
Sample	113	118	279
Interview	Self-administered questionnaire	Self-administered questionnaire	Self-administered questionnaire
Margin of error	7.6% p=q=95% confidence level	5.4% p=q=95% confidence level	2.7% p=q=95% confidence level
Fieldwork	January-June 2012	February-April 2012	August-September 2011

Source: Own elaboration.

The use of a methodology and working tools that have already been validated within an international project is a strength of this work. The Ibero-American Cluster for University Collaboration on Health (CICUS, reference C/030942/10), is an international scientific cooperation project led by the Open University of Catalonia (UOC) in accordance with the criteria set out in the Scientific Research and Inter-University Cooperation Programme (PCI) between Spain and Latin America, funded in full by the Spanish Agency for International Development Cooperation (AECID).

The mission of the CICUS project is to promote and develop innovation, research, technological and academic cooperation programmes in the field of Health Sciences through the collaborative networking of the various centres forming part of it. The CICUS vision is to become a space of excellence that facilitates networking for the creation and sharing of state-of-the-art knowledge on new forms of healthcare based on the integration of ICTs, which respond to the challenges posed by the socioeconomic changes of the 21st century.

The project began in 2010 with the participation of the UOC (Spain), Simón Bolívar Andean University (UASB, Bolivia) and the Central University of Ecuador (UCE, Ecuador). Performing an analysis of the situation regarding the participating countries' ICT use in the field of healthcare was one of the first goals set. A qualitative methodology was chosen, and a questionnaire was designed as the data collection instrument.

A review of the literature together with the healthcare professionals' experience served as the basis to create the study variables and the metrics used in the first version of the instrument. The final questionnaire was organised into four blocks of questions: (a) sociodemographic and professional background; (b) opinions about ICT and Internet use in the field of healthcare; (c) degree of ICT and Internet use in general; and (d) degree of IT-system, ICT and Internet use at work. The instrument was validated following a pre-test. This was done through a pilot experience, applying the questionnaire to 48 postgraduate students (all healthcare professionals) on the master's degree program in Public Health and in Clinical Pharmacology offered by UASB's Health Area. The experience in question took place across two months during the academic year (from 10 May 2011 to 15 June 2011). The instrument was tested and modified in accordance with the suggestions made by the respondents.

Besides the UOC's Health Sciences Studies and the UASB's Health Area, two new organisations took part in it: (1) the Canary Islands Health Service (SCS); and (2) the Society of Surgery Service, San José Hospital of Bogotá, Colombia. The same questionnaire was used for all three samples, thus ensuring that the variables measured and the metrics used were exactly the same. A preliminary questionnaire was sent for revision to the other two organisations participating in our study (the Canary Islands Health Service, SCS and the Society of Surgery Service, San José Hospital of Bogotá, Colombia). The purpose of this stage was to finalize the drafting, content and general design of the questionnaire, and to test both the instrument and its

suitability to the contextual characteristics of each country. So, between 9 and 27 January 2012, the questionnaire was sent for revision and adaptation to several healthcare professionals with academic and practical experience of information systems at the Canary Islands Health Service, SCS. And a similar experience was implemented in Colombia between 23 January and 7 February 2012. After the instrument and had been tested and modified in accordance with the respective experts' suggestions, we proceeded with the study in the three samples of physicians from the three countries in question.

The survey was anonymous and optional. Throughout the process, all the necessary procedures were implemented to safeguard the confidentiality of the information and the anonymity of the participants in all study materials. The participants were also informed about the potential restrictions in relation to the confidentiality of the information provided.

Both the research methodology and the tool designed in the CICUS project were used to conduct this study. In Bolivia, the study was conducted in hospitals and healthcare centres of the urban and rural districts of the municipality of Sucre. It had 115 healthcare establishments (87% primary care, 8% secondary care and 5% tertiary care), where a total of 350 physicians practised. The healthcare professionals were contacted in person between August and September 2011. After explaining the reasons for and aim of the study to them, they were asked to collaborate by answering the survey, which they had to complete by hand. All the healthcare professionals freely agreed to collaborate in the research. Data collection was concluded in mid September, with a total of 279 completed surveys. The survey data were then entered manually into electronic database for exploitation. This was done through the collaboration of postgraduate students on the master's degree programmes in Public Health and in Clinical Pharmacology offered by UASB's Health Area.

In Spain, the study population consisted of medical professionals of all profiles affiliated to the field of healthcare within the SCS, comprising a total of 356 physicians across healthcare centres, secondary care hospitals and research centres/universities, who received an invitation to take part in the SCS online survey by e-mail. The fieldwork was carried out between 31 January and 28 June 2012, with a total of 113 completed surveys.

Finally, the Society of Surgery Service at San José Hospital of Bogotá had a staff of 184 physicians, who attended to an average of 161,000 patients per year in outpatient services. On 13 February 2012, the medical director of the Society of Surgery Service, San José Hospital of Bogotá, sent an invitation to take part in the online survey by e-mail to the 184 healthcare professionals. The fieldwork was carried out between 13 February and 30 April 2012, with a total of 118 completed surveys. No mechanism to incentivise the healthcare professionals' participation was implemented in any of the three cases. Table 2 shows the variables used in the study.

Table 2. Study variables

VARIABLE	DEFINITION	SCALE
TELEMEDICINE USE	ICT use for diagnosing, monitoring and treating patients in situations where those involved are separated by place and/or time	Dichotomous variable. 0=No; 1=Yes. The variable is additive, and considers ICT use for the purposes of contacting national and international professionals, of exchanging valid information for diagnosing, monitoring and treating patients, and of disseminating research activities with the aim of improving people's health
EASE-OF-USE OF ICTS IN CLINICAL PRACTICE	Degree to which the physician considers that using ICTs in clinical practice means that less efforts will be required to perform his or her tasks	Categorical variable. 1=Perceived ease-of-use is nul; 2=Very low; 3=Low; 4=Average; 5=Quite high; 6=High; 7=Very high
PERCEIVED USEFULNESS OF ICTS IN CLINICAL PRACTICE (PUICTCP)	Degree to which the physician believes that using ICTs in clinical practice improves his or her performance in an activity in the short term	Metric variable obtained from exploratory factor analysis. The original variables included in the analysis are measured on a 5-point Likert scale. The variables making up the factor are those indicating how the physician perceives that using ICTs enables errors to be controlled when performing an activity, or a patient's evolution to be monitored
OPTIMISM	Degree to which the physician considers that using ICTs in clinical practice will enable him or her to obtain benefits or reduce effort in the future	Metric variable obtained from exploratory factor analysis. The original variables included in the analysis are measured on a 5-point Likert scale. The variables making up the factor are those indicating how the physician perceives that using ICTs enables relationships with patients to be improved and better treatments to be recommended
PROPENSITY TO INNOVATE	The individual's propensity to innovate in his or her day-to-day work using ICTs	Categorical variable. 5=The individual Totally agrees; 1=Totally disagrees
LEVEL OF ICT USE	Degree to which the physician uses ICTs outside work	Dichotomous variable. 0=His or her ICT use is Low; 1=High

Source: Own elaboration.

The multidimensional nature of the variables perceived usefulness of ICTs in clinical practice and optimism suggested that exploratory factor analysis (EFA) should be performed to calculate them. EFA is a data dimensionality reduction technique. Starting with the analysis of a set of original variables, it seeks to determine the smallest number of dimensions capable of explaining the maximum amount of information contained in the data (Fabrigar et al., 1999).

In order to extract the factor dimensions, seven variables were considered in total. Each of them was related to the physicians' perceived benefits of using ICTs in their clinical practice. After calculating the factor dimensions, it was found that the factor loadings of certain original variables did not exceed the recommended value of 0.5, thus suggesting that they should be removed from the study. Table 3 shows the variables used to perform the factor analyses for the three samples of physicians. It

also shows the factor scores obtained, the percentage variance explained by each factor, and the component transformation matrix.

Table 3. Main factor analysis results

	SPAIN		COLOMBIA		BOLIVIA	
VARIABLES	**Optimism**	**PUICTCP**	**Optimism**	**PUICTCP**	**Optimism**	**PUICTCP**
Looking up medical or health-related information on the Internet improves the doctor-patient relationship	0.769	-	0.842	-	0.826	-
Looking up medical or health-related information on the Internet improves knowledge of the patient and facilitates his or her treatment	0.753	-	8.73	-	0.802	-
The existence of computerised data allows the evolution of the patient's clinical status to be viewed	-	0.613	-	0.918	-	0.549
With excessive ICT use, there is greater control of errors	-	0.640	-	0.577	-	0.938
% variance explained	38.562	33.362	41.888	29.980	39.903	30.174
Eigenvalue	1.825	1.052	1.878	1.202	1.934	1.022
Cronbach's alpha	0.760	0.740	0.701	0.721	0.760	0.830
Correlation matrix	Correlated variables, values higher than 0.5		Correlated variables, values higher than 0.5		Correlated variables, values higher than 0.5	
KMO index	0.581		0.615		0.669	
Bartlett's test of sphericity	59.407***		65.864***		144.915***	
Measurement of sample adequacy	Coefficients between 0.62 and 0.80		Coefficients between 0.62 and 0.80		Coefficients between 0.62 and 0.80	
Component Transformation Matrix	1	2	1	2	1	2
1	0.797	0.605	0.878	0.480	0.826	0.563
2	-0.605	0.797	-0.480	0.878	-0.563	0.826

Source: Own elaboration.

In order to confirm the technique's goodness-of-fit for the three samples, various statistical tests were performed in accordance with the proposals by Nunnally and Bernstein (1994), Bilodeau and Brenner (1999) and Fabrigar et al. (1999). The analysis of the sample correlation matrix for the three analyses performed showed that the variables were highly intercorrelated. In every case, the correlation coefficient values were higher than 0.5. Likewise, the Bartlett's tests of sphericity values were high

(59.407 for the sample of Spanish physicians, 65.864 for the sample of Colombian physicians, and 144.915 for the sample of Bolivian physicians). This indicated that the null hypothesis of multivariate normality was rejected in every case, thus confirming that the variables were highly interrelated. Furthermore, in every analysis, these results had significant Chi-square values (at the 99% confidence level) and low correlation matrix determinant values (0.582, 0.564 and 0.59 for the samples of Spanish, Colombian and Bolivian physicians, respectively). This confirms that the variables considered in the different studies were intercorrelated, and could be expressed as a linear combination of other variables.

In addition, the statistical technique's goodness-of-fit was established for each of the samples analysed. In order to do so, the existence – or not – of a high number of partial correlation coefficients other than zero was checked using the Kaiser-Meyer-Olkin (KMO) coefficient. It should be noted that the KMO index is used to compare the magnitudes of partial correlation coefficients; the lower its value is, the higher the partial correlation coefficients' values are, and consequently the less appropriate it is to perform EFA (Bilodeau and Brenner, 1999). According to the proposal made by those authors, coefficient values equal to or higher than 0.5 are acceptable. As shown in Table 3, the values obtained for the samples of Spanish, Colombian and Bolivian physicians were 0.581, 0.615 and 0.669, respectively. The technique's goodness-of-fit was therefore confirmed for the analyses performed on the three samples.

The previously mentioned factors were extracted using the principal component extraction method. The principal component extraction method consists in estimating the standardised factor scores of the first K-components, and in obtaining the factor loading matrix by calculating the correlations between the original variables included in the study and the factor components obtained as a result. Likewise, this method also makes it possible to comply with the principle of parsimony, where the number of factors obtained is optimal. In order to determine this number of factors, the principal component extraction method uses Kaiser's rule, which calculates the eigenvalues of the R correlation matrix and takes the number of eigenvalues higher than 1 as the number of factors (Fabrigar et al., 1999).

Finally, the Varimax rotation procedurei was used to obtain, from the initial solution matrix, another matrix whose factor loadings made it easier to interpret. The Varimax rotation method is the one that enables the most extreme factor loadings (near 1 or -1) and other loadings near 0 to be obtained. By doing so, it simplifies the interpretation of the factors because the positive or negative sign indicates the type of association between the variable or the factor, whereas the loading value indicates the strength of the relationship.

As shown in Table 3, each of the different analyses performed enabled two factors to be obtained. Taking into account the initial variables considered in the analysis, the factors were identified with the constructs optimism and perceived usefulness of ICTs

in clinical practice. In the three analyses identified, the factor called o*ptimism* had a higher eigenvalue and explained a higher percentage of total variance.

The factors obtained from the three analyses performed were then used as explanatory variables of the healthcare professionals' level of telemedicine use. Hence the need to know what the values of the factors in each observation were, and to calculate the factor scores from them. Using the regression method, which estimates the F matrix through the least square method, a set of factors was obtained for each sample, which: (a) had a high correlation with the original variables used in the study; and (b) were pairwise intercorrelated.

Finally, it should be noted that using the above-mentioned factors as explanatory variables of the proposed theoretical model meant that the reliability of the metric scales had to be calculated. As shown in Table 3, the Cronbach's alpha coefficient value obtained for each of the constructs was high. It was higher than 0.70 in every case. According to Nunnally and Bernstein (1994), this indicator must have values higher than 0.7 in general, and 0.6 in the case of new scales. Thus, it is possible to assume that the scales used were reliable. Additionally, the content and construct scales' discriminant, convergent and nomological validity were also addressed. With regard to the content, the scales were developed following a major review of the literature.

Furthermore, prior to performing binary logistic regression analysis, it was considered expedient to know whether the distribution of the variables analysed was normal. The Kolmogorov-Smirnov test was therefore applied. The test was found to be significant at the 99% and the 95% confidence levels for all the variables. The null hypothesis of variable normality was therefore rejected for all the variables in the three samples analysed. To a large extent, this was explained by the use of 5-point Likert measurements scales, and of factor scores obtained beforehand to measure the constructs perceived usefulness of ICTs in clinical practice and optimism (Jamieson, 2004; Lubke and Muthen, 2004).

3. Empirical findings

Regarding the physician's profile, in the three samples analysed it was found that the majority was male (almost 60%). In the sample of Spanish physicians, almost 40% were over 50 years of age and had been in post for a considerable length of time (44.4% had over 20 years' experience). In comparison to this profile, the physicians in the Colombian sample were younger; 59.9% were between 40 and 50 years of age. Finally, the physicians in the Bolivian sample were younger still; 58% were under 40 years of age (see table 4).

Irrespective of origin, in more than half of the cases analysed it was found that the medical professional had a permanent contract or was even a career civil servant, and worked mainly in secondary and tertiary care hospitals.

Table 4. Descriptive analysis of the physicians' characteristics (percentages)

		SPAIN	COLOMBIA	BOLIVIA
Gender	Male	67.3	60.2	40.5
	Female	32.7	39.8	59.5
Age	<40 years	14.2	59.0	50.6
	40-50 years	30.1	27.3	33.3
	50-60 years	46.0	8.6	12.9
	>60 years	9.7	5.1	3.2
Workplace	Healthcare centre's central services	8.3	-	-
	Research centre University	0.9	23.7	-
	Tertiary care hospital	46.9	37.3	13.3
	Secondary care hospital	8.0	13.7	56.6
	Healthcare centre	35.8	31.3	30.1
Occupation	Administrative post	18.5	26.2	8.9
	Non-administrative post	81.4	73.7	91.0

Source: Own elaboration.

Regarding the physician's relationship with technology, and his or her perceptions and personal and professional use of it, significant differences between the three samples were found. These differences appeared to stem from the individual's profile and the country where he or she worked.

The results obtained after performing several analyses of variance (ANOVA), where gender, age and the post occupied by the physician in the healthcare institution were taken as factors or independent variables, and the physician's degree of optimism and propensity to innovate, perceived usefulness of ICTs in clinical practice and perceived ease-of-use of ICTs in clinical practice, level of ICT use and telemedicine use were dependent variables, suggest interesting results. In order to facilitate data analysis and sample comparison, the age and post variables were dichotomised. Consequently, it was considered that young professionals were under 45 years of age, and the level of responsibility associated with a medical professional's post was higher when he or she performed managerial, directorship or operational group manager functions.

Regarding the sample of Spanish physicians, gender was found to have an influence on perceived usefulness of ICTs in clinical practice, level of ICT use in personal life and telemedicine use. In particular, men had a higher level of ICT use in their personal lives and more telemedicine use in their clinical practice. In contrast, women had a greater perceived usefulness of ICTs in clinical practice. In every case, the mean value for the group and each sub-group was considered moderate. Also in

every case, the relationship between the variables was significant at the 95% confidence level.

On the other hand, the medical professionals over 45 years of age had a greater propensity to innovate, whereas those occupying posts of responsibility had a greater perceived usefulness of ICTs in clinical practice. In both cases, the value of the variables was significant at the 90% confidence level. Regarding the variable post, it should be noted that the two groups differed considerably in size – one was almost five times bigger than the other – so the mean value of the variable for the total sample had a strong bias towards the group of professionals not occupying posts of responsibility.

In the sample of Colombian physicians, it was found that men also had a higher level of ICT use in their personal lives and more telemedicine use in their clinical practice. In both cases, the value of the variables was moderate, being significant at the 95% confidence level. However, medical professionals occupying posts of responsibility had more telemedicine use in their clinical practice, in a population where the number of medical professionals not occupying posts of responsibility was three times higher than those who did. The value of the variables was significant at the 90% confidence level. Taking into account the ages of the individuals in the sample, no significant differences between the mean values of the variables were found.

Finally, in the sample of Bolivian physicians, once again it was found that men had more telemedicine use and a greater perceived usefulness of ICTs in clinical practice. In both cases, the value of the variables was moderate, being significant at the 99% and 95% confidence levels, respectively. No significant differences were found as regards Age in a population where the number of professionals under 45 years of age was two times higher than those over 45. However, significant differences were found as regards the posts they occupied. In a population where the proportion of medical professionals occupying posts of responsibility – such as chief or general manager of medical staff – was 1 to 10, medical professionals occupying posts of responsibility had more telemedicine use and a greater perceived ease-of-use of ICTs in clinical practice. Once again, the value of the variables in both cases was moderate, being significant at the 99% and 95% confidence levels, respectively.

In order to test the hypotheses proposed above, a binary logistic regression analysis was performed. Table 5 shows the results for the three samples. The goodness-of-fit of the three samples was high, as confirmed by the values and levels of significance reached by the Chi-square statistics and the Hosmer-Lemeshow test. Moreover, the values of Nagelkerke's statistic indicated that the three samples had explanatory power. The value of this statistic was 29.5% for the Spanish sample, 25.1% for the Colombian sample, and 19.7% for the Bolivian sample.

Table 5. Sources of telemedicine use in Spain, Colombia and Bolivia physicians (binary logistic regression)

SPAIN	B	S.E.	WALD	DF	SIG.	EXP(B)
PERCEIVED USEFULNESS OF ICTS IN CLINICAL PRACTICE	-0.136	0.247	0.303	1	0.582	0.873
EASE-OF-USE OF ICTS IN CLINICAL PRACTICE	0.693	0.356	3.782	1	0.052	2.000
OPTIMISM	-0.348	0.245	2.019	1	0.155	0.706
PROPENSITY TO INNOVATE	0.618	0.371	2.775	1	0.096	1.856
LEVEL OF ICT USE	3.071	1.103	7.750	1	0.005	21.572
CONSTANT	-8.368	2.471	11.464	1	0.001	0.000
Chi-square: 28.229, sig. 0.000; Hosmer-Lemeshow test: 19.273, sig. 0.013; Nagelkerke R Square: 0.295						
COLOMBIA	**B**	**S.E.**	**WALD**	**DF**	**SIG.**	**EXP(B)**
PERCEIVED USEFULNESS OF ICTS IN CLINICAL PRACTICE	-0.199	0.250	0.635	1	0.426	0.819
EASE-OF-USE OF ICTS IN CLINICAL PRACTICE	-0.033	0.168	0.037	1	0.847	0.968
OPTIMISM	0.913	0.297	9.424	1	0.002	2.492
PROPENSITY TO INNOVATE	0.192	0.270	0.503	1	0.478	1.211
LEVEL OF ICT USE	1.234	0.532	5.370	1	0.020	3.433
CONSTANT	-2.359	1.056	4.992	1	0.025	0.094
Chi-square: 23.490 sig. 0.000; Hosmer-Lemeshow test: 15.564, sig. 0.035; Nagelkerke R Square: 0.251						
BOLIVIA	**B**	**S.E.**	**WALD**	**DF**	**SIG.**	**EXP(B)**
PERCEIVED USEFULNESS OF ICTS IN CLINICAL PRACTICE	0.050	0.145	0.117	1	0.733	1.051
EASE-OF-USE OF ICTS IN CLINICAL PRACTICE	0.185	0.263	0.497	1	0.481	1.204
OPTIMISM	0.468	0.144	10.540	1	0.001	1.596
PROPENSITY TO INNOVATE	-0.151	0.223	0.460	1	0.498	0.860
LEVEL OF ICT USE	2.335	1.056	4.893	1	0.027	10.332
CONSTANT	-2.224	1.375	2.618	1	0.106	0.108
Chi-square: 20.704, sig. 0.000; Hosmer-Lemeshow test: 13.905, sig. 0.084; Nagelkerke R Square: 0.197						

Source: Own elaboration.

The Spanish sample had a high goodness-of-fit, explaining more than 29% of the dependent variable's variance. Of the independent variables analysed, only level of ICT use, ease-of-use of ICTs in clinical practice and propensity to innovate had a significant effect. In particular, the healthcare professional's level of ICT use outside work was the variable that had a higher explanatory power. In order of importance, it was followed by the variables ease-of-use of ICTs in clinical practice and propensity to innovate. In both cases, the value of the variables was moderate, being significant at

the 95% and 90% confidence levels, respectively. Taking into account these results, it is possible to conclude that hypotheses H2, H4 and H5 were confirmed for the Spanish sample.

Regarding the Colombian sample, the goodness-of-fit was high, albeit lower than the previous case. Of the independent variables analysed, only the professional's level of ICT use and optimism about the effects of ICTs on clinical practice were significant. In particular, in the same way as in the previous case, level of ICT use was the variable that had a higher explanatory power. At some distance, it was followed by the variable optimism with a beta value of 0.913, being significant at the 99% confidence level. Taking into account these results, it is possible to conclude that hypotheses H3 and H5 were confirmed for the sample of Colombian healthcare professionals.

Finally, the Bolivian sample had a lower goodness-of-fit, and a lower explanatory power of the dependent variable. Of the independent variables analysed, only level of ICT use and optimism had a higher explanatory power and level of significance within it. The variable level of ICT use had the greatest weight, with a very high beta coefficient, being significant at the 95% confidence level. Optimism was second in order of importance, with a relatively low explanatory power, being significant at 99%. Taking into account these results, it is possible to conclude that hypotheses H3 and H5 were confirmed for the Bolivian sample.

A comparative analysis of the three samples showed that there were significant differences in the importance of the explanatory variables considered, thus confirming hypothesis H6. To sum up, table 6 shows the accepted and rejected hypotheses for each of the samples.

Table 6. Accepted and rejected hyphoteses for the Spanish, Colombian and Bolivian physicians' samples

HYPOTHESES	SPAIN	COLOMBIA	BOLIVIA
H1. The perceived usefulness of ICTs in clinical practice explains telemedicine use	Rejected	Rejected	Rejected
H2. The perceived ease-of-use of ICTs in clinical practice explains telemedicine use	Accepted	Rejected	Rejected
H3. The user's optimism about technology explains telemedicine use	Rejected	Accepted	Accepted
H4. The user's propensity to innovate explains telemedicine use	Accepted	Rejected	Rejected
H5. The ICT user profile of the physician – as an individual, in his or her personal life – explains telemedicine use	Accepted	Accepted	Accepted
H6. The degree of ICT implementation in the country's healthcare system explains the importance of each of the determinants of the physician's telemedicine use	Accepted	Accepted	Accepted

Source: Own elaboration.

4. Conclusions and discussion

Research into the uses of technology in the field of health usually distinguishes between the analysis of the determinants of use (ex-ante research) and the analysis of the outcomes of use (ex-post). While most studies have focused on the outcomes of technology use, it should be noted that ex-ante analysis is important for several reasons. First, because it provides evidence of the drivers and barriers explaining technology use (or not). Second, because understanding the factors that explain use means that it is possible to influence the outcomes of such use.

In this sense, the aim of this study was to explain the determinants of telemedicine use by samples of physicians in three countries: Spain, Colombia and Bolivia. Obtaining and comparing evidence on an international scale from an ex-ante analysis determining which factors explain physicians' telemedicine use allow the common and distinct aspects of its use to be identified. To that end, a theoretical model based on a modified TAM was used as the analysis tool. A qualitative methodology was chosen, and a questionnaire was designed as the data collection instrument. The questionnaire was sent to the populations (universes) of professionals working for the healthcare organisations taking part in the study (356 physicians in Spain, 184 physicians in Colombia and 350 physicians in Bolivia). The samples obtained were 113 physicians from Spain, 118 physicians from Colombia and 279 physicians from Bolivia, with margins of error (maximum indetermination p=q=95%) of + 7.6% for Spain, + 5.4% for Colombia, and + 2.7% for Bolivia. In the three samples, the physician's level of ICT use in his her personal life was the variable that had the highest explanatory power on telemedicine use. This is understandable because telemedicine can be considered an advanced ICT use. Thus, if a physician uses ICTs in his or her personal life, he or she will be more likely to use them in his or her clinical practice too. However, despite the fact that it was the most important variable in all three samples, the value of its coefficient varied considerably. The highest coefficient was found in the Spanish sample (β=3.071; p=0.005), followed by the Bolivian sample (β=2.335; p=0.027) and the Colombian sample (β=1.234; p=0.020).

In the case of the Spanish sample, telemedicine use was also determined by the physicians' perceived ease-of-use of ICTs in clinical practice (β=0.693; p=0.052) and propensity to innovate (β=0.618; p=0.096). The results showed a clear relationship between level of ICT use in personal life, perceived ease-of-use of ICTs in clinical practice and propensity to innovate in the explanation of telemedicine use by physicians in Spain. The combination of these three factors indicated a more complete model that contemplated personal, usability and innovatory aspects in the explanation of telemedicine use in Spain.

Regarding the Colombian and Bolivian samples, the variables explaining telemedicine use were: level of ICT use in personal life, as mentioned previously, and

the level of optimism about ICTs (β=0.913; p=0.002 in Colombia and β=0.468; p=0.001 in Bolivia).

Unlike the behaviour observed in the sample of Spanish physicians, the results for the Latin American samples indicated a more primary model in the explanation of telemedicine use. Despite the fact that level of ICT use in personal life was also the main explanatory component, telemedicine use in Colombia and Bolivia was not explained by either ease-of-use of ICTs in clinical practice or propensity to innovate. The explanatory model was completed by an optimism factor that did not emerge in the Spanish sample.

The most plausible explanation is the notorious inequalities in the field of health in Latin America, where a variety of factors limit access to high-quality, timely healthcare, such as the scarcity of human resources, medication, equipment, infrastructure, and cultural and geographical accessibility to healthcare services (Rodrigues and Risk, 2003). And Colombia and Bolivia are no exception to this. In a context plagued by deficiencies such as these, it would seem logical to think that physicians should be more optimistic about telemedicine's potential to resolve those deficiencies. In Spain, however, where there is a greater implementation of ICTs in the field of healthcare, optimism about telemedicine's potential was no longer important, ceding ground to ease-of-use of ICTs in clinical practice and the physicians' propensity to innovate.

Two substantive conclusions can be drawn from this work. First of all, the considerable value that the variable physician's l*evel of ICT use* – as an individual, in his or her personal life – has in the main explanatory power on t*elemedicine use*. Second, our findings suggest that t*elemedicine use* can also be determined by other factors of healthcare services (such as the lack of human resources, infrastructure, equipment, medication, and cultural and geographical accessibility) and the level of ICT implementation in the field of healthcare, conferring different models in the explanation of its use.

These results have revealed the need for a dynamic approach to the design of telemedicine use, especially when it targets a variety of end-users. Hence the importance of conducting studies prior to using telemedicine, and attempting to identify which of the above-mentioned variables could exert an influence and how. Research is confronted with the challenge of producing such evidence, a prerequisite for the generalised adoption of telemedicine (Norris, 2002; Bellagio eHealth Evalution Group, 2011). In this respect, it is reasonable to assume that the variations in barriers to technology adoption have more to do with local factors than technology infrastructure development. This scenario poses a considerable challenge for the formulation of public policies and strategies by States, where decisions on telemedicine use should not be avoided. Its potential to reduce access limitations and improve the health sector's efficiency can therefore be considered a two-fold positive aspect of incorporating telemedicine use into healthcare.

The study presented in this article has several limitations, particularly the empirical approach taken, the lack of a time series, and the variables and restrictions imposed on the analysis. However, the availability of three samples of physicians from three different countries (Spain, Colombia and Bolivia) was an excellent opportunity to analyse the determinants of telemedicine use. In this respect, and bearing in mind the importance of this type of analysis to healthcare organisations, the availability of (a) more data on other groups of physicians to widen the comparison, (b) a time series, (c) better indicators, and (d) new analyses relating the determinants of telemedicine use to its outcomes would suggest that new approaches could be taken. In addition, the study's sample limitations are of particular note. Although the comparison made is relevant, increasing the number of observations to improve the representativeness of the samples, for both the set of physicians and for the healthcare systems, will be a future line of study in our research programme.

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Resumen

El objetivo del documento de trabajo es el análisis de los determinantes de uso de la telemedicina. Con este objetivo, la investigación realiza dos aportaciones básicas. En primer lugar, y en el contexto de los modelos de aceptación de la tecnología (TAM), se plantean seis hipótesis de trabajo. En segundo lugar, se utilizan datos obtenidos para tres muestras de 510 médicos (113 en España, 118 en Colombia y 279 en Bolivia) y se contrasta una regresión logística binaria. Para las tres muestras analizadas se ha obtenido que el uso de las TIC por parte de los médicos en su vida personal es la variable que presenta mayor poder explicativo en el uso de la telemedicina. Para la muestra de médicos en España la facilidad percibida en el uso de las TIC en la práctica médica y la propensión a innovar completan los determinantes del uso de la telemedicina. Por su parte, para las muestras de médicos en Colombia y Bolivia, el nivel de optimismo sobre las TIC completa la explicación del uso de la telemedicina. Los resultados obtenidos nos sugieren un modelo más completo, que contempla factores personales, de usabilidad y de innovación en la explicación del uso de la telemedicina en España, mientras que los resultados para las muestras latinoamericanas nos sugieren un modelo más primario, que contempla un componente de optimismo que no emerge en la muestra española.

Palabras clave

Telemedicina, Modelos de adopción y aceptación de la tecnología (TAM), profesión médica, modelos logísticos binarios.

Resum

L'objectiu del document de treball és l'anàlisi dels determinants d'ús de la telemedicina. Amb aquest objectiu, la investigación realitza dues aportacions principals. En primer lloc, i en el context dels models d'acceptació de la tecnologia (TAM), es plantegen sis hipòtesis de treball. En segon lloc, s'utilitzen dades obtingudes per tres mostres de 510 metges (113 a Espanya, 118 a Colòmbia i 279 a Bolívia) i es contrasta una regressió logística binària. Per a les tres mostres analitzades s'ha obtingut que l'ús de les TIC a la vida personal per part dels metges és la variable que presenten un major poder explicatiu de l'ús de la telemedicina. Per a la mostra de metges a Espanya, la facilitat de l'ús de les TIC a la pràctica mèdica i la propensió a innovar completen els determinants d'ús de la telemedicina. De la seva banda, per a les mostres de metges de Colòmbia i Bolívia, el nivell d'optimisme sobre les TIC completa l'explicació de l'ús de la telemedicina. Els resultats obtinguts ens suggereixen un model més complet, que contempla factors personals, d'usabilitat i d'innovació en l'explicació de l'ús de la telemedicina a Espanya, mentre que els resultats per les mostres llatinoamericanes ens suggereixen un model més primari, que contempla un component d'optimisme que no emergeix a la mostra espanyola.

Paraules clau

Telemedicina, models d'adopció i acceptació de la tecnologia (TAM), professió mèdica, models logístics binaris.

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