

Extension to the Technology Acceptance Model (TAM): for elderly

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Abstract

This research was aimed at the use of technology by elderly, due to the national and global increase in this population sector, which has its own characteristics, since it is considered care for the elderly, a global trend.

For this reason, this article presents an extension of the TAM (Technology Acceptance Model), which is one of the most used models and has proven to be effective, to predict the use of any technology and in this case, providing a perspective focused on the older adult and in this new extension, external variables are integrated, establishing the relationship between the proposed variables and the variables of the original TAM model.

A questionnaire was used as instrument with 26 questions that evaluate the 8 proposed constructs 4 of the proposed external variables and 4 of the original model and two questionnaires proposed by the World Health Organization that evaluates the Basic Activities of Daily Living (ABVD) and Instrumental Activities of Daily Living (IADL), these instruments were applied to 146 older adults.

Due to the lack of response from INAPAM (Instituto Nacional de las Personas Adultas Mayores, National Institute of Older Adults), the surveys were applied in parks and neighborhoods where older adults attend.

With the results obtained, it was possible to demonstrate the validity, robustness and consistency of the extension of the original TAM model to assess the acceptance of Information and Communication Technologies by older adults.

Keywords: *Elderly, model, TAM, Information and Communication Technologies, extension*

1. Introduction

Elderly is a growing market for Information and Communication Technologies (ICT), specifically as users and buyers on the Internet. In Spain, the data indicates that Internet users aged 50 to 64 years old in 2011 were the ones who spent the most (1,148 euros on average compared to 991 euros in the next segment, from 35 to 49 years old). In addition, the increase in average spending made through the Internet

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between 2010 and 2011, only takes positive values for the intervals of 50 to 64 and more than 65 years (31.8% and 24.3%, respectively), while for the rest of the Internet user population, the average cost of Internet purchases decreased from 2010 to 2011. (Begoña PeralPeral, 2014)

The advantages of using the Internet and its applications are multiple: the social approach and active maturity, the possibility of tightening social networks or access to information on important aspects, such as health or social services. Regardless of age, people accept and adopt technology when it meets their needs and expectations. However, it seems that older people do not use ICTs as other younger segments, although that divergence is decreasing in time. The reasons for these differences are the lower access to the Internet, the negative influence of their Internet skills, the difficulty of learning due to sensorial, motor and cognitive changes, the difference in information needs or because there are alternative means to obtain information and other services. In some cases, simply, the Internet is a phenomenon that is indifferent to them.

If elderlies had fewer opportunities to access the Internet, they cannot appreciate its advantages, which will negatively affect its use and acceptance. However, it can be considered that there is heterogeneity in the group of older people regarding its use and acceptance, for example, the probability of commitment to the Internet increases in the case of younger people (McCloskey, 2006), those with a higher educational level and those who achieve a higher income. (Begoña PeralPeral, 2014)

For the justification of this work, a research on the state of the art of the use of ICT in Mexico was carried out. (Reyes Castellanos & Orantes Jiménez, IAIDRES, 2017).

1.1 Background

Older adults as users of Information and Communication Technologies (ICT) have needs and demands similar to those of people of other ages, that is, they require useful, functional, easy to manage and meaningful technology. Their access to it follows the same rules as in other groups, such as purchasing power or management capacity, among others. According to world statistics, the majority of computer and Internet users oscillate between 6 and 20 years of age and were born in the telecommunications era; on the contrary, users over 60 years old are a minority; nevertheless, there are more and more, which helps dispel the western stereotype towards this population group since it demonstrates its capacity to continue learning and adapting to aging.

The potential to bring technology to elderly, that is, people over 60 years old, is just as important as that granted by millennials (also known as Generation Y) and this was already seen by Cardiff University in 2003, in a study entitled "The age of

Information: the use of technology and communication in the daily life of older adults ".

Elderly also face numerous physical and mental restrictions, some of them related to age, such as decreased visual capacity, loss of short-term memory or the growing number of chronic-degenerative diseases, such as arthritis.

These conditions of age pose even more obstacles to overcome in the process of learning and mastering ICT. Coupled with this, they often experience higher levels of anxiety and have less favorable attitudes than younger people because of their higher levels of non-fatty acids, indicators of the body's metabolic response to stress.

Some activities with input devices such as the mouse cause difficulties for older adults, such as the simple actions of dragging, clicking or double clicking or moving objects. The unclear design of the screens, the programs or the Internet pages, as well as the small size of the font, the use of drop-down menus or a poor background in color confuses or frustrates them. There are even linguistic cultural impediments related to the terminology of computers. (León, 2017)

As can be seen, all these obstacles focus on structural accessibility and limit many elderly people in the use of computers, the Internet and smart devices (SmartTV, SmartPhone).

Regarding the economic aspect, it is not necessary to buy a computer to be a user, because at present there are several options, such as Internet businesses or institutions that offer this service free of charge to the elderly; example of this in Mexico is the National Institute for the Elderly (INAPAM).

However, it is also expected that there will soon be positive results and the scenario will change, since there is a great interest among producers, researchers, designers, suppliers and other stakeholders involved in the use of technology for the older adult.

Two key factors for this are the need for cooperation between different actors and the adoption of multidisciplinary approaches in research on aging and technology.

The increasing use of computers and the Internet has profoundly transformed the lives of older adults in terms of their health and possibilities for entertainment, among other things.

The knowledge of computer science not only compensates for the decrease of the physical and mental capacities related to age, it also plays an important role in the prolongation of independent life and the improvement of the quality of life.

Many of today's older adults have medium or low levels of schooling, have no contact with computer technology or their accessibility is minimal due to their high costs. (León, 2017)

In twenty or thirty years, the circumstances that govern the use of the computer by the older adult will be completely different, since many of today's young people will belong to this age group, with the difference that for various reasons the use of the computer has been learned.

Internet offers enormous possibilities for the elderly, but unfortunately it is a challenge if what is intended is their access.

Faced with this scenario, more and more technology companies are launching solutions or devices that meet the needs not only of the elderly, but also of the family that often cannot stay with them 24 hours a day, seven days a week.

Some of these are already available in Mexico, especially those that are applications for equipment such as smart phones and others, are analyzing the markets where they can have a better reception.

2. Justification for research

The increases in living standards and quality health have contributed to people living longer. However, the aging process presents certain challenges in the use of Information and Communication Technologies, these challenges are due to the degradation of the physical and mental faculties due to old age, even when people over 60 years have been found in use of ICT during their youth and middle age. It is observed, that the population is aging in a fast way; to this reality, we must add the exponential and rapid advance of new technologies in everyday life. This binomial is generating great interest and there are many studies on the use of information and communication technologies in the population of senior citizens aged 65 or older. (González-Oñate, F.-P. C.-L, 2015). This work seeks to create an extension of the TAM (Technology Acceptance Model) that allows to know the degree of acceptance of ICT by older adults; for this, the main requirements will be analyzed taking into account the needs of habits of use and consumption of new technologies in the elderly, but, above all, the level of knowledge and preparation they have. The purpose is to check if the media competence in technological matters of the elderly in Mexico is adequate, as well as to know the adequacy of the current audiovisual and kinesthetic offer. It is intended to develop own surveys and specialized authorship in which the habits of use and consumption will be obtained, as well as the interest or not on the part of the elderly in the learning of new technologies.

In Figure 1 (INEGI, 2016) it becomes evident that as the age increases, the use of Internet declines. For the group between 35 to 44 years old, slightly more than half (56.4%) perform some activity in the network and the proportion decreases to 41.3% among individuals 45 to 54 years old; only 17.6% of adults over 54 know and use this resource.

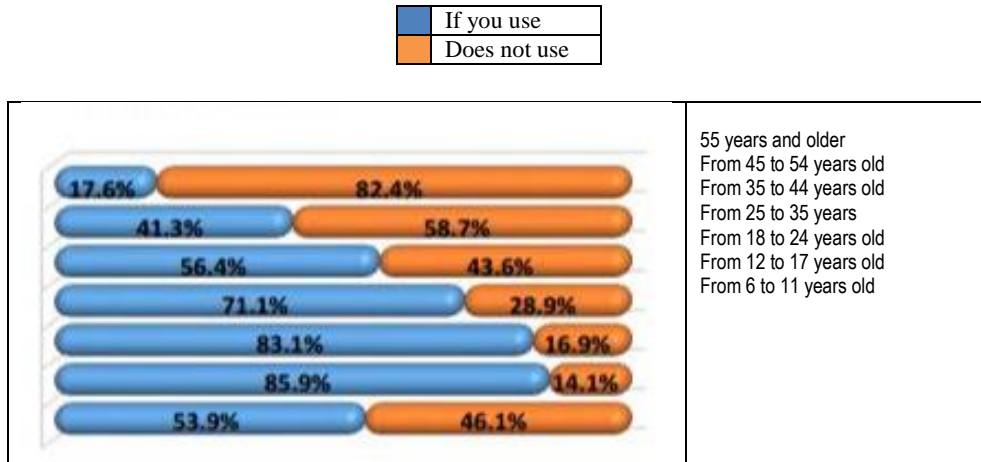


Figure 1. Internet users by age groups. (INEGI, 2016)

However, all citizens without exception have the right to information and communication, therefore, should be shared with older adults the idea that full access to the information society and new technologies, will favor their social integration and it will improve their quality of life, breaking down the barriers they face on a daily basis.

3. Technological acceptance

Information technology is generally believed to increase the productivity of an individual or a group of individuals, increase efficiency, encourage innovation and provide opportunities for organizations to increase the competitive power of individuals. The new generation of cheap, fast and powerful computers based on the information technology network is revolutionizing every aspect of society.

The acceptance of technology specifically by older adults is analyzed, when it comes to delving into the subject of older adults, there are two different aspects of the problem, although related. One is the access to ICT, the second the use they make or can make of ICT once they have accessed them. In fact, both issues can be considered as an evolution, as a personal process that every user of a technology must pass through (whether it is an ICT or not). Each of the phases involves different objectives and different intervention possibilities.

In the first phase, the problem is in putting the ICTs in contact with the new user, overcoming the possible obstacles that did not make it possible. The person who starts in ICT goes through a few moments of uncertainty. The objective of this phase is to get acquainted with some concepts and with new tools until we get to automate new procedures of use. In this phase, the person is very focused on this new learning, which becomes the goal of the task most of the time.

In this sense, the interventions try to facilitate this access of the elderly to ICT. To achieve this, it is essential to know the barriers that are preventing this group from having incorporation into the society of information similar to that carried out by groups of other generations.

Once the barriers are known, the necessary means can be implemented to overcome them and the process of access to ICT, learning the new 'language' of concepts and procedures, be consolidated in the shortest possible time, emphasizing the learner's own satisfaction in the learning process.

When the user has automated these basic procedures of use, it goes to the second phase: use. Technology ceases to become 'the task' to become the instrument through which other tasks that have nothing to do with it are carried out.

For example, when a person has already learned to search for information on the Internet, the same search process is no longer a problem to devote time to. The person can focus their efforts on using this knowledge already acquired to search for new information, going from worrying about the 'how are you looking' to orienting oneself to 'what I want to look for' and 'what I am going to do with what I find', problems that have nothing to do with technology.

In this way, the user can use ICT for many purposes: interact with other users, obtain services at a distance, deepen hobbies and interests, get informed, etc. ICT ceases to be an end in itself to become an instrument to achieve other ends.

In this sense, intervention with older people can come hand in hand with the creation of online resources that can be accessed and that meet the varied needs of the elderly.

When evaluating a training program for older people, whether it is ICT or any other topic, they must assess instrumental aspects, related to performance and degree of knowledge and skills acquisition, but absolutely not forget to value also its expressive effects, on motivation, interests and social relations.

3.1 Justification of the Technology Acceptance Model for this investigation

The Technology Acceptance Model (TAM) has been expanded and used continuously. Exist numerous research works were in what extensions of this model have been developed and how they have TAM.

TAM with respect to the TRA (Theory of Reasoned Action) and UTAUT (Unified Theory of Acceptance and Use of Technology) – see Table 1, is that these originate from social psychology and are designed to explain almost any human behavior, whereas the TAM focuses exclusively on the use of technological innovations and it seems, a priori, more appropriate to analyze this type of behavior.

It is observed that the TAM is easy to implement and better explains the intention of conduct than TB; On the other hand, the Theory of the Diffusion of innovations, although it is a quite structured theory, has a psychological basis and explains how the process of social change of any innovation is carried out, not only technological.

TAM presents some limitations that lead to the development of this research, most of the research has been conducted by measuring the TAM variables in relatively homogeneous groups, the groups of adults although they have homogeneity in terms of age, not so, as to the characteristics of aging; which limits the possibility of generalizing the results.

Another limitation that contributes to the proposed research is that the TAM model, even in its most updated version, has not included important variables such as age and gender.

Therefore, the objective is to generate a contribution in the sense of satisfying the limitations detected.

4. Theories and models of technological acceptance

Technology acceptance models can be seen as specialized applications of the Theory of Reasoned Action. In the area of information systems, attitudes are understood as the result of beliefs about the perceived characteristics of the system. It is important to note that the attitudinal models that are going to be presented focus mainly on the benefits of the information systems, partly forgetting the expectations of negative utility derived from the use of said systems. The models are based on describing the information processes that lead to the intentions of accepting or rejecting a technology. Attitudes towards an object or toward the performance of a behavior are formed after a process of conscious evaluation. This process of subjective evaluation has been described sometimes in a relatively simple way (with few criteria) and sometimes in a complex way (with many criteria and iterations). The evaluations are

based on the perceptions of the objects and on the expected consequences of the use of said objects. The expected consequences are based on beliefs of behavior, knowledge and sometimes, affection. Some models try to be purely cognitive and others include measures of emotions and feelings. Thus, for example, Davis (Davis, Bagozzi, & Warsaw, 1989) (Davis, 1989) formulated the Technology Acceptance Model as a cognitive process and developed a similar model three years later, including measures of intrinsic motivation such as amusement.

In Table 1, a synthesis of three models is shown, where their differences are described taking into account four criteria: the frame of reference, nature, structure and practical connotations.

5. Justification of the Technology Acceptance Model

The Technology Acceptance Model (TAM) has been expanded and used continuously.

One of the main differences between the TAM with respect to the TRA and UTAUT is that these originate from social psychology and are designed to explain almost any human behavior, whereas the TAM focuses exclusively on the use of technological innovations and it seems, a priori, more appropriate to analyze this type of behavior. On the other hand, the Theory of the Diffusion of innovations, although it is a quite structured theory, has a psychological basis and explains how the process of social change of any innovation is carried out, not only technological.

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6. Proposed model

The proposed model to evaluate the degree of acceptance of technology by older adults is an extension to the Technology Acceptance Model (TAM) in which the elements of the basic model that are Perceived Utility, Ease of Use, are integrated.

Perceived, Attitude towards Use, Intention to Use, and this basic model is extended with the incorporation of the following constructs: Habits (of the elderly), Aging, Facilitators and Subjective Standard.

Table 1. Comparative synthesis of TAM, TRA and UTAUT models.

Model	Framework	Character	Structure	Practical connotations
Technological Acceptance Model (TAM)	Its purpose is the prediction of the adoption of information systems as well as the diagnosis of design problems. It is based on indicators A) ease of use. B) Perceived utility. This model puts into question some of the variables traditionally studied by other models and justifies its position with the support of abundant empirical material.	It is a novel approach oriented towards the consideration of the dynamics of change, although referred exclusively to the technological field. However, it constitutes a theoretical and empirical challenge that must still be exploited.	This model does not specify stages or phases that must be fulfilled to assimilate the change; its main purpose is the prediction of the acceptance of technological innovation, so its interest is focused on the exploration of the variables for that purpose.	The TAM has shown great applicability in the development of guidelines for the introduction of technological systems in companies of all kinds and in the management of resistance to their regular use.
Theory of Reasoned Action (TRA)	Part of the assumption that human beings are capable of processing the information they generate to make relevant decisions.	According to this theory, the change could occur when the attitude to change is established by the existence of a belief about what such behavior could generate. If the person believes that the change can be beneficial, then he will be more inclined to adopt it. The approach is fundamentally psychological because of the role assigned to intrapersonal variables.	The structure of the model refers to the relationships between intentions, attitudes, and beliefs.	This theory has proven to be applicable to a number of aspects that involve the change of attitudes in the field of health and particularly in consumer behavior.
Unified Theory of Acceptance and Use of Technology (UTAUT)	Its objective is to evaluate the degree that an individual has the intention to use some system or information technology.	This theory affirms that both the expectation of performance and the expectation of effort are moderated by age and gender, both factors centered on the individual and that have been related to the success or failure of the adoption of Information Systems.	This model contains four main determinants of intention: the expectation of performance, expectation of effort, social influence and facilitating conditions; which is moderated by gender, age, whether it is voluntary or mandatory, and the previous experience of users.	It has a strong relationship between mobile technology and mobile services so that users perceive some functions in mobile devices satisfactorily.

In the Technological Context, the habits of older adults with a strong influence on the Perceived Ease of Use in this construct will be investigated on the social, family and work habits of each individual. In construct, it was proposed by Triandis

(Triandis & Gelfland, 1998) in his Theory of Interpersonal Behavior (TIB) and refers to the behavior that has been automated.

In the Individual Context, the aging construct that influences perceived utility is a relevant construct in the present investigation since not only will the chronological age of the individual be taken into account, but also the characteristics mentioned in chapter 2, specific to aging, the evaluation of these will give the proposed extension the feature of universality.

In the Organizational Context, the facilitators construct that originates in the TIB Theory and refers to the degree to which the individual believes that there is an organizational and technical infrastructure to support the use of technology that in this case in the organizational context will be located in the cultural centers of INAPAM (Instituto Nacional de las Personas Adultas Mayores, National Institute of the Elderly) in Mexico, the subjective rule construct that originates in the Theory of Reasoned Action (TRA) and assesses to what extent an individual believes that the people who are important to him or her will approve their adoption of a particular behavior.

Figure 2 shows the proposed model with external variables.

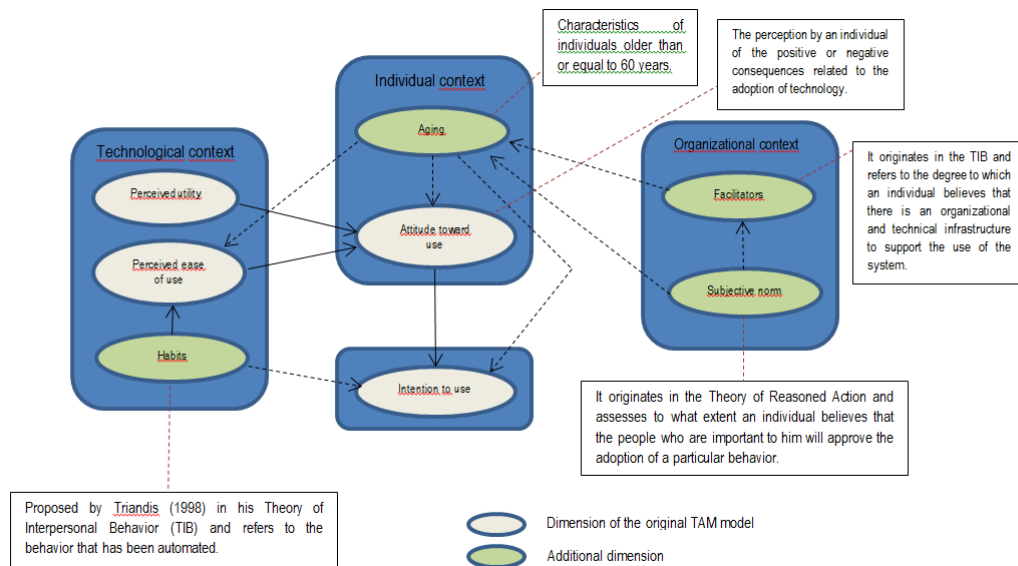


Figure 2. Proposed Model [Own elaboration]

7. Questionnaire

Using the constructs of the proposed model and through the variables necessary for its measurement, a questionnaire was developed to measure the level of acceptance of technology by older adults. The questionnaire that was applied is included in the Annexes section, below are the constructs of the proposed model detailing the questions and the measurement scale, the questions are listed as a whole in order to make the evaluation clearer and more precise.

Questions are measured on a Likert scale ranging from Strongly Agree to Strongly Disagree with a midpoint in Neither Agree, Neither Disagree.

Construct 1: Perceived usefulness

Q1 Most of the things that are now done with a computer could be done just as well without it

Q2 Cell phones and computers make people stop thinking

Q3 With a computer or cell phone could do interesting and imaginative things

Q4 Computers allow me to carry out my activities in a more productive and efficient way

Q5 It is worth spending time and effort to learn to use the computer, cell phone or internet

Construct 2: perceived ease of use

Q6 I find it easy to use the computer or the cell phone or the internet that are at my disposal

Q7 I find it easy to get computers or cell phones to do what I need to do with them

Q8 I need help to use the computer, cell phone or internet

Q9 I feel afraid to use the computer, cell phone or internet

Construct 3: Habits

Q10 It is important to learn something every day

Q11 I use my cell phone or computer to communicate with my family or friends

Q12 In my work experience use computer, internet or cell phone

Q13 I have explained the use of the computer, internet or cell

Construct 4: Intent to use

Q14 I'm afraid that when I use the computer I make mistakes that I cannot correct myself

Q15 I have thought many times about buying a computer

Construct 5: Attitude towards use

Q16 Computers, internet or cell phones are fun machines

Q17 I would only use a computer, internet or cell phone if they forced me to do it

Q18 I am looking forward to using the computer more often
Q19 If I had a computer, internet or cell phone I would use it
Q20 If someone taught me how to use the computer, cell phone or internet, I would continue to use it

Construct 6: Facilitators

Q21 The use of a computer, internet or cell phone facilitates communication with my family and friends
Q22 In the INAPAM center I attend there are computers with internet at my disposal
Q23 My family members motivate me to use the computer, internet and cell phone

Construct 7: Subjective Standard

Q24 Using the computer, internet and cell phone is important for my family
Q25 I like that my loved ones motivate me to use the computer, internet or cell
Q26 Encouraging to use the computer, internet or cell phone because my family and friends use them in Annex A shows the complete questionnaire

Construct 8: Aging

Although the group of older adults is very heterogeneous, typical degenerative effects common to (almost) all are observed: decreased vision, varying degrees of hearing loss, eye-hand coordination and psychometric impairments including difficulty with fine motor coordination, degenerative diseases including Arthritis, osteoporosis or joint stiffness, diabetes, cataracts or macular degeneration and optic atrophy. The decrease in sensory, movement or cognitive abilities can also be traced back to previously performed sports or professional injuries, as well as cerebrovascular accidents.

Aging is more than chronological and involves a series of changes. The Pan American Health Organization (PAHO) with the Regional Office of the World Health Organization (WHO) offers a detailed study and assessment instruments of functional status, evaluation of sensory alterations and techniques for communication, social assessment and evaluation of mental and emotional state. The results of the application of these instruments will allow determining the impact of aging on the perceived Utility, Attitude towards the use and the Intention of use, thus allowing determining the degree of acceptance of the technology due to this construct. The present investigation focuses on the evaluation of the basic activities of daily life (BADL) and the evaluation of the instrumental activities of daily life (IADL).

7.1 Validation of the instrument

The validation of the content of the instrument in this case the Questionnaire was carried out by means of 5 experts i.e. professionals of the area who have worked with the technology acceptance model (MAT) and for statistical reliability of the instrument, the R language will be used performing the necessary calculations.

7.2 Description of the instrument

The instrument used was a questionnaire of the Technology Acceptance Model, which contains 26 items with closed Likert-scale questions of five options (from Totally Disagree corresponding to 1 to totally agree that corresponds to 5) integrated in 8 variables.

8. Tests and results

To support the proposed model, the validation of each variable that integrates it was performed; with this objective, statistical analyzes were performed such as correlation, linear regression and Cronbach's alpha, the result of these analyzes allowed to prove that the model is consistent.

Content validity refers to the degree to which an instrument reflects a specific content domain of what is measured. It is the degree to which the measurement represents the measured concept. (Bohrnstedt, 1976) This domain is reflected, in the large amount of research that has been done on the model of acceptance of technology worldwide, in addition to all publications mentioning this model.

The validity of the instrument is probably the most important since it refers to the degree to which a measurement is related in a consistent manner with other measurements, according to hypotheses derived theoretically and that concern the constructs that are being measured. A construct is a measured variable that takes place within a theory or logical scheme. (Carmines, 1979)

All the statistical analysis was carried out in R Language, R is a programming language specially oriented to statistical analysis and to the graphic representation of the obtained results. It is a GNU project (GNU's Not Unix).

On the other hand, it is also important to mention the delivery of a training course "INTERNET USE FOR OLDER ADULTS" taught to 30 older adults.

The sample for the application of the questionnaire is 146 seniors.

The evaluation instrument was applied in parks and sites in Mexico City where older adults attend due to the lack of response from the cultural centers of INAPAM.

Based on the application of the questionnaire to the sample, the variables added to the TAM were validated. Thereby:

The Aging construct that was added to the original TAM model is observed to have an impact on the Ease of Perceived Use, the Intent to Use, the attitude toward Use, Habits, Facilitators and Subjective Standard; so it is shown that this construct which measures attitude in aging influences the acceptance of the technology.

The habits construct has a double impact on the Intention of Use and Attitude towards Use, demonstrating that the habits of older adults have an impact on the acceptance of the technology.

The facilitators construct impacts on the subjective norm, this indicates that the family and institutions or organisms like the INAPAM have a strong relationship so that the elderly have acceptance of the technology; this construct has a strong correlation in the Ease of Perceived Use and Perceived Usefulness.

The subjective norm construct has a strong correlation with the construct Aging and Facilitators, demonstrating that the fact that the family and institutions such as INAPAM encourage the use of technologies towards the elderly allows increasing their degree of acceptance of the technology.

9. Conclusions

The acceptance of Information and Communication Technologies continues to be a topic of interest since every day they continue to offer new technologies; these technologies are intended to be accepted by human beings to be used in all aspects of their lives.

Older adults are not alien to technology and with the increase of this population sector are increasingly research to adopt new technologies to the characteristics necessary for acceptance; technology providers are looking to generate hardware and software adaptable to the needs of older adults.

The success in approaching older people to new technologies is that they see the benefits themselves. The use of new technologies is neither mandatory nor can be forced at all.

The TAM model with the extension for older adults incorporates external variables that allow evaluating the acceptance of the technology taking into account the characteristics of the elderly and their vision towards information and communication technologies specifically the computer, the cell phone and the Internet.

The teaching of a computer course of 2 hours (100% practices), most of the elderly learned to use autonomously some basic features of Internet search for information, use of the YouTube application.

Elderly have the interest in learning something new every day, this was manifested by 100% of the respondents and with this, there is an excellent opportunity to bring them technology through constant and short-term practical workshops that allow them to maintain their interest and at the same time include them in participation in the information society.

Information technology (IT) allows members of the growing population of older adults to remain independent for longer, which is why research such as this one is so important since it allows giving guidelines of what should be strengthened from home for the acceptance of them by persons considered elderly.

However, while the technology becomes more and more pervasive, the age-related underuse of IT remains observable, since as could be demonstrated by the application of the questionnaire; for example, older people (60 years or older) have a significantly lower probability of using the internet than the average population. This age-related digital divide prevents many older people from using IT to improve their quality of life through tools, such as the provision of Internet-based services.

With this research, the intentions of the elderly with respect to the use of information and communication technologies such as the Internet and influential factors were identified.

Currently, this study shows that on the part of the elderly, there is a digital divide for the acceptance of technology, and we identify potentially effective paths for future research that help strengthen the elderly so that they have a greater presence in the use of technology.

There are other works such as that of (Bong, Bergland, & Chen, 2019) that, as their authors state, "Good quality of life is important for healthy aging. Studies have shown that although information and communication technology can improve older people's quality of life, their technology acceptance level is rather low", stating the importance of continuing research to support the improvement of the lives of older adults through the use of technology.

This research considers aspects of technology, social and health aspects that can be applied for the well-being of the elderly and, has been re-written for this publication, being previously published by the journal (Orantes-Jiménez, Reyes-Castellanos, & Sun, 2018) and must mentioned that the research is currently complete and can be consulted at (Reyes Castellanos , 2018).

9.1 Benefits achieved

This research has allowed an expansion of the TAM, through the identification of the characteristics that influence the development and use of ICT for older adults and it intends that future developments incorporate the necessary characteristics to be used by them.

In the research line of acceptance of new technologies, various models have been developed to explain the process of technological acceptance by users, the main model that has been used as a basis for these investigations has been the TAM (Gómez Ocampo, 2012), there are some studies where this model has been applied to different Information Technologies and its effectiveness has been proven, while other researches have gone further and have developed extensions of this model, identifying new external factors that intervene in the acceptance of technology that is being studied. For the case study, TAM does not include the variables of age and gender, so this work integrates them, since for example, age is necessary to validate the acceptance of ICT by older adults. It has been possible to identify the intrinsic external factors inherent to the case study, ICT use by older adults, presenting an extension of the TAM model that incorporates the variables of age and gender in the population of older adults.

The proposed model has been validated through a reliability, correlation and linear regression analysis.

It has been possible to propose a new extension of the Technological Acceptance Model focused on the use of ICT, specifically the computer, cell phone and Internet for older adults.

Based on the proposed model, a course was developed for the acceptance of technologies specifically for the topic "Internet aimed at older adults".

9.2 Future works

The results obtained are interesting, however the sample was only for older adults from urban areas, there was no opportunity to do it in the rural area, so a future job

would be to include older adults from rural areas, adapting the questionnaire instrument for it.

The proposed extension is focused on the use of ICT, specifically the computer, cell phone and internet, to evaluate the acceptance and use of these technologies by the older adult. This understanding does not include the characteristics of a particular ICT that allow evaluating the usability of this, since the acceptance is evaluated from the point of view of a finished product, even though it is not in the scope contemplated in this research, the measurement will be maintained under the assumption that the product was developed taking care of the usability characteristics for the target users. Include ICT usability for older adults.

The external variables considered could be expanded considering more characteristics or needs of the older adult, as well as the inclusion of other developed technologies.

Derived from the inclusion of new external variables derived by continuing to investigate the acceptance of technology by the older adult, it will allow the continuous validity of the proposed model to be realized.

Offer government agencies in Mexico an analysis to make decisions about support programs to include the elderly as a beneficiary of technologies such as tablets, laptops or personal computers.

Create training organizations aimed at the elderly in the use of Information and Communication Technologies while maintaining an evaluation of the proposed model.

Is also important to consider new contributions that may help to achieve the purpose of this research, such is the case of the work in the article of (Jarméus, et al., 2012), that although it is not focused on older adults, it is in the use of e-learning for the acceptance of technology, since the work mentions “he paper aims to increase the knowledge on how the acceptance regarding social media based E-learning 2.0 information systems for formal learning can be increased and how the acceptance affects the social learning experience” and they also mention “The paper analyzes information gathered from industry experts, practitioners and a live case to find how one can improve acceptance and thereby the social learning experience ”and this can be worked on so that the software can be accepted by older adults.

Finally, carry out similarity studies and data combinations to achieve other interpretations regarding the variables that make up the extension.

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