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Study on the perception of DIY in domotics in Portugal

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Abstract

The growth of the home automation market depends on technological innovations, rapid evolution of the Internet of Things and Do-It-Yourself (DIY) solutions. This project analysed the perception about domotics related to DIY in Portugal, intending to understand if smart home technologies are used and valued, which factors motivate their acquisition, their purpose and the advantages perceived by users. A questionnaire was used to collect data, resulting in an exploratory study based on data from a convenience sample. The model to evaluate this study was based on the constructs based on Technology Acceptance Models - TAM. From the results obtained, it was concluded that the respondents have a positive perception about domotics and its usefulness faced with DIY on the technologies that make a smart home. Regarding the acquisition and installation of technologies associated with home automation on their own, the respondents are divided, as half consider that they can do it autonomously and the other half only with the intervention of specialists in home automation.

Keywords: Domotics; home automation; Do-It-Yourself (DIY); smart home technologies.

1. INTRODUCTION

The growth of the home automation market worldwide has been progressive, so it is expected to continue to grow as indicated by the Fortune Business Insights report, which reveals that the global smart home market is forecasted to grow from $45.8 billion in 2017 to $114 billion by the end of 2025. The growth observed reflects the high number of internet users, the gradual acquisition of mobile devices and the growing concern with the reduction of energy consumption (Fortune Business Insights, 2019).

According to the statistics portal Statista (2019), revenue in the European smart home market is EUR 15,309 million in 2019, with an estimated annual growth rate of 20.5%, resulting in a market volume of EUR 32,251 million by 2023. In terms of comparison on a global scale, the United States of America (US) ranks first in the top five with a 33.2% penetration rate of intelligent home solutions. Norway (28.5%), the Netherlands (27.3%), Denmark (26.5%) and Sweden (26.3%) are in the top five. Portugal has a domotics penetration rate of 5.1 % (Statista, 2019). In Portugal, the domotics market revenue is 78 million euros in 2019, with an annual growth rate of 27.7%, culminating in a market volume of 208 million euros by 2023. As far as application areas are concerned, Statista's forecast (2019) shows growth in areas such as energy management, comfort and lighting, entertainment, control and connectivity, security with special emphasis on greater growth and

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adherence to intelligent appliances. According to the Statista (2019) study, most users are between 25-34 years (32.3%) and 35-44 years (24.9%) of these, 61.3% are men (Statista, 2019).

Wicked Smart Homes (2017) reports that the proliferation of DIY products has come to market, designed to make smart home technologies accessible to everyone, creating its own set of challenges. It has become increasingly difficult for consumers to differentiate between these DIY home automation products and professionally installed solutions, which tend to be more expensive (Wicked Smart Homes, 2017). However, if these features/solutions with numerous advantages have shown a great adherence at international level, this is not the case in the Portuguese market. Therefore, this study aims to understand what are the motivations for the Portuguese to adhere to domotics, being for that defined research objectives that allow to understand if the Portuguese are aware of the numerous advantages of use and easy integration, and if there is a lack of information about domotics systems.

2. RESEARCH OBJECTIVES

The main objective of this research is to obtain information about the perception of the Portuguese regarding DIY solutions in domotics, as well as about which are the socio-cognitive factors, the motivations, the advantages and disadvantages, the sources of information and the current or possible adhesion in the future to the technologies inherent to domotics. Regarding the specific objectives this study intends:

- To characterize the level of knowledge of consumers regarding domotics;
- To determine the purposes and perceived risks before the solutions of domotic applications;
- Verify which factors are more valued in the technologies that make a home intelligent, in order of relevance;
- Determine the degree of comfort in relation to the use of intelligent home technologies;
- Identify which scenarios they prefer to choose to install technologies that make an intelligent home; realize which are the barriers to the adoption of intelligent home technologies;
- Verify if socio-demographic factors influence the adhesion and intention to use technologies and applications of control and management of intelligent technologies; understand if the Portuguese are able to automate their own homes through DIY solutions;
- Identify what factors positively influence the adherence and recommendation of intelligent home technologies.

3. DOMOTICS AND DIY

The word domotics results from the conjugation of the Roman word "domus" with the word telematics, which refers to the automated control of something by robots, but which can be simplified

by the automation of the environment itself. The connection of the two words results in the definition of the automation process of the domestic environment. Currently, the concept of home automation refers to the control something in a centralised and/or remote way that allows it to be controlled autonomously (Stevan Jr. & Farinelli, 2018). According to Gebler (1997), the expression DIY in the USA, in an advertising action in 1912, became its widespread use in the 1950s. DIY is associated with several areas, such as law, health and ICT maintenance. In the different areas of activity, the term is used to refer to people who provide services for themselves, who would otherwise pay a professional to do so. However, conventionally the term DIY refers specifically to performing domestic maintenance or modification tasks without the paid services of a professional (Watson & Shove, 2005).

3.1. Evolution of domotics

According to Gebler (1997), the expression DIY in the USA, was first used in an advertising action in 1912, became its widespread use in the 1950s. DIY is associated with several areas, such as law, health and ICT maintenance. In the different areas of activity, the term is used to refer to people who provide services for themselves, who would otherwise pay a professional to do so. However, conventionally the term DIY refers specifically to performing domestic maintenance or modification tasks without the paid services of a professional (Stevan Jr. & Farinelli, 2018). In this context, it is important to distinguish between some concepts that are confused with the idea of residential automation, intelligence insertion and domotics. In the same way that these concepts are mixed with others (Stevan Jr. & Farinelli, 2018). Initially, as already mentioned, a Smart Home was synonymous with several names: home network, digital home, home automation and intelligent home. However, as we can see in Table 1, in mid-2010, it leans towards the combination of the Internet of Things - IoT - and the smart home with circumstantial awareness (Yang, Lee, & Lee, 2018).

YEARS	PHASE	TECHNICAL BACKGROUND	MAIN FUNCTION
1990s	Home automation	Broadband Internet	Home automation
2000s	Home network	Smart phones and APPs	Remote control and monitoring
2010s	Smart home	IoT and AI	Circumstantial awareness

Table 1 - Evolution of smart home services (Yang, Lee, & Lee, 2018)

IoT, instead of creating a network that connects people, is a network that connects things, that connects not only computers, smartphones and tablets, but also many other things. Once connected, everything can communicate with anything else, for a variety of useful purposes. A "thing" on IoT can be any object, large enough to contain a wireless transmitter (Wi-Fi, Bluetooth or any other wireless protocol) and unique enough to contain its own IP (Internet Protocol) address. This concept covers something as small as a paper clip or as big as a house (Miller, 2015). In recent years, several studies and applications have emerged in the field of home automation, directly related to the rapid

progress of the Internet of Things (IoT), mobile Internet, cloud computing, Big Data and other information technologies. IoT covers all devices and objects capable of establishing a permanent connection to the Internet, being possible to identify them on the network and communicate with each other (Centro Nacional de Cibersegurança Portugal, 2018).

Domotics, at the intersection of rapidly developing Internet technologies, mobile communication, sensor technologies, self-learning software and renewable energies, has changed considerably over the last few years. These developments are related to several factors, among which, the dynamic growth of IoT's broader market, the increase in capacities and lower prices of domestic infrastructures and intelligent devices, technological advances in sensors, better usability of mobile interfaces driven by ubiquitous smartphones and tablets, the growing motivation to conserve resources and use renewable energy, and also the entry into the market of multinational technology and consumer electronics companies (Kyas, 2017).

3.2. Types of systems

Domotic systems can include, but are not limited to, centralised or non-restricted control of security, lighting, air conditioning, audio-visual, voice communication and telecommunications, in addition to other systems that can provide the improvement of everyday life, such as convenience, comfort, energy efficiency and security. In the most advanced systems, all these systems can (or should) be interconnected and provide integration, intercommunication and connectivity. The numerous devices can be grouped into three classes: sensors, actuators and controllers. The sensors are used to feel or monitor the environment, the actuators are used to act on or modify the environment, while the controllers are devices or circuits responsible for receiving the information from the sensors and/or users, and decide according to pre-programmed conditions how the actuators should interact with the environment itself (Stevan Jr. & Farinelli, 2018).

Three types of residential automation systems can be defined in terms of interaction, whereby complexity is directly related to the degree of automation and the intensity at which the user will have to interact with it (Oliveira, 2016):

- **Autonomous or stand-alone systems**, subsystem or a specific device that can be switched on/off according to a predefined setting independently, based on modules connected to the mains, consisting of transmitter modules (desktop or wall keyboards) and receivers (connected to the device to be controlled). For this system, the protocol with technology known as X-10 is generally used.
- **System integration**, a single controller (a central) integrates the multiple subsystems with the limitation that each of them only works according to the wishes of its manufacturer. It allows the remote activation of lighting or appliances and the programming of schedules for automatic operations. Normally controllers such as smartphones and tablets are used.

- **Intelligent residence**, everything is customized to meet the specific needs of the user through a customized installation and developed by professionals in the area. Thus, the system no longer has a remote controller and becomes a unique manager. It needs structured cabling with centralized distribution box, light board and connectivity board to receive signal emission equipment such as voice, data, TV, internet, among others.

3.3. Do-It-Yourself (DIY)

According to Smart Home Publications (2015), Smart Home Technologies (SHT) is the fastest growing area of technology today, although it has taken longer to gain market expression, the increased use of DIY system is due to be significantly cheaper, so the use of SHT adapted to home lifestyles, increasingly affordable and easy to obtain (Clauser et al., 2015).

DIY is an analytically complex phenomenon, it can occur simultaneously as leisure or work, as consumption (of materials and tools) and production (of removals to the house). The analysis of DIY technology and practice allows us to relate in significant but relatively unexplored themes, which are nevertheless important to theorize consumption. There are six different stages within the intelligent DIY home use cycle: initial installation, motivation, implementation, routine use, routines and removal (Hu et al., 2016). It is possible to add intelligent home devices to a house, one at a time, or design an entire system and install it in just one weekend. Many people start with something simple, like a smart thermostat or a wireless security camera, and only then add other devices that they eventually want to integrate completely. The more devices and systems they integrate, the more automated the house will be. Existing technologies today are much more reliable than they were in the past, so they should also be easier to set up, i.e. you don't need a technology specialist to start an intelligent home project. Considering that today's intelligent home systems and devices are easy to install, easy to use, affordable and can be sized for large and small houses, even apartments, these no longer need to be confusing or intimidating, it is only necessary to understand the basics of how the technology works (Clauser et al., 2015).

4. RESEARCH MODEL

Establishing an analysis model that strengthens the research base is as important as the data collection itself. Considering that the present study covers the assessment of the acceptance of domestic smart technologies, this section of the article describes the model chosen, taking as a starting point how the Technology Acceptance Model (TAM) was adapted and this research from existing models.

4.1. Conceptual model

From the literature review, the possibilities of applying the different perspectives of TAM in the areas of intelligent house services combined with DIY were analysed and used as a basis for the development of the conceptual model elaborated in this work. Over the years, several types of TAM models were used and adapted, however, considering the specific application of the study of DIY solutions for intelligent houses, the most relevant concepts for this work were grouped in Table 2.

DIMENSION	FACTORS	AUTHORS
Technology acceptance model	Perceived ease of use	(Davis et al., 1989) (Venkatesh et al., 2003) (Davis, 1989)
	Perceived utility	
	Perceived usefulness	
Factors for smart homes	Perceived control	(Park et al., 2017)
	Perceived security	
	Perceived reliability	
	Satisfaction	
DIY behavioral factors	Perceived economic benefit	(Ritz et al., 2019) (Wolf & Mcquitty, 2013)
	Lack of perceived quality	
	Perceived limited availability	
Demographic	Household	Exploratory
	Education level	
	Age	

Table 2 – Dimensions and factors applied in the conceptual model

4.1.1. Hypotheses

The formulation of the hypotheses analysed in this work derives from the objectives of the study and the theoretical framework of the research carried out:

H1a - The intention of use relates positively to the household (Venkatesh & Davis, 2000).

H1b - Intention to use is positively related to education level (Venkatesh & Davis, 2000).

H1c - Intention to use is positively related with age (Venkatesh & Davis, 2000).

H2 - Perceived utility has a positive effect on intended use (Park et al., 2017).

H3 - Perceived ease of use has a positive effect on perceived utility (Park et al., 2017).

H4 - The perceived control has a positive effect on the perceived utility (Park et al., 2017).

H5 - Perceived safety has a positive effect on the perceived utility (Park et al., 2017).

H6 - Perceived reliability has a positive effect on the perceived utility (Park et al., 2017).

H7 - Intended use relates positively to satisfaction (Kim, Park & Chio, 2017).

H8 - Perceived economic benefit has a positive effect on intended use (Wolf & Mcquitty, 2013).

H9 - The perceived lack of quality is positively related to the intention of use (Wolf & Mcquitty, 2013).

H10 - Limited perceived availability is positively related to intended use (Wolf & Mcquitty, 2013).

4.1.2. Evaluation model

The evaluation model designed reflects the constructs drawn from the TAM models, with the intention of verifying the existence of a positive relationship between the intention to use and the following factors: household, level of education, age (demographic dimension). It is also intended to verify the positive correlation between the perceived utility in relation to the intention of use and the ease of use perceived in the perceived utility. Regarding perceived utility, it is intended to conclude whether there is a positive relationship between perceived control, perceived security and perceived reliability (intelligent house dimension). Regarding the constructs of DIY motivations, it is intended to positively relate the intention of use with the perceived economic benefit, the perceived lack of quality and the perceived limited availability. Finally, to verify if the intention of use relates positively to satisfaction. The evaluation model used can be seen in Figure 1.

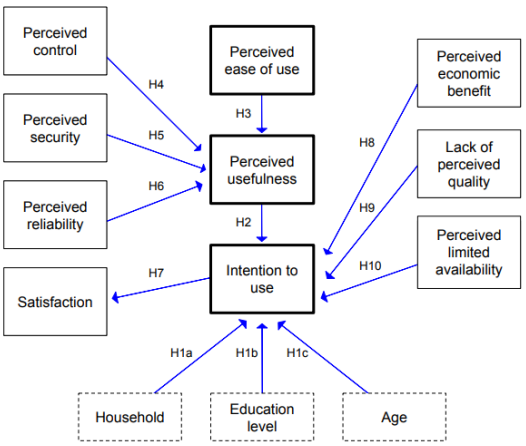

Figure 1 – DIY Research Model for Domotics

4.2. Data collection technique

The research method used was quantitative and the data collection technique was the questionnaire survey. The data collection typology selected was convenience sampling. The survey was carried out online from August 21 to September 13, 2019, being disseminated through social networks Facebook and LinkedIn in interest groups, and by email, being a sample for convenience.

5. RESULTS ANALYSIS

A total of 238 replies to the questionnaire were collected. Regarding the demographic characterisation of the sample, 47.1 % of the respondents are male and 52.5 % female. The most represented age group is 25 to 34 years old (39.5 %), followed by 35 to 44 years old (22.7 %) and 45 to 54 years old (16.4 %). Regarding academic qualifications, 45.4% of respondents have a degree, 33.2% have the 12th year of education level and 16.4% of respondents have a master's degree. Regarding the household, the dominant values are 3 (31.1%), 4 (26.5%) and 2 (23.9%) persons.

5.1. Adherence to domotics

Considering all respondents, 185 (77.73 %) know and know what the technologies that make an intelligent home consist of, and 53 (22.27 %) are not familiar with these technologies. Of the 185 respondents who are familiar with Home Automation, 74 (31.09 %) and 111 (46.64 %) do not have any type of Intelligent Home Technologies (SHT).

Regarding the 74 respondents who claimed to have SHT, the sample comprises a total of 291 technologies, this reflects that each respondent has an average of 4 SHT. The technology most used by the respondents is television (47), then lamps (37) and household appliances (37). However, we can also consider sockets (30 respondents), alarms or sensors (26), surveillance system (26) and sound system (22) as the most common technologies within the sample. Additionally, in the "other" field three respondents added drone, timer and heat pump by solar panels. Regarding the respondents who know the technologies, but do not have them at the moment 46.64 % (111) on the question "Why don't they have SHT?", the option "I haven't thought about it yet" was the most selected with 66 respondents (59.46 %), representing the largest percentage, secondly "I think it is unnecessary and a luxury" with 20 respondents (18.02 %). Regarding the "waste of money" response option, no response was obtained, which suggests that for the sample respondents, although they do not have any SHT, they do not consider acquisition a waste of money, demonstrating a neutral perception of price.

5.2. Control over smart DIY systems

Regarding the perception of technological behaviour, considering the level of comfort in relation to SHT, the capacity of autonomous installation and the preferential scenario for planning an intelligent home system, taking into account the 185 responses, the largest percentage is represented by those who declare themselves to be "more at least comfortable" with 41.6%, the remaining respondents tend to be more positive, with 35.7% who feel "very comfortable" and 15.1% "totally comfortable". 51.40 % of respondents 'feel able to install and use technologies in their home without any help from a specialised company', while 48.68 % do not. For those respondents who would most readily choose to automate their homes, the responses were as follows:

- 66 respondents (35.7%) - hire a team to make a custom installation with a single initial installation cost;
- 22 respondents (11.9%) - hire a team to install only a few technologies and then pay a monthly fee to be able to control;

- 10 respondents (5.4%) - buy and install on my own only the technologies I need and control through an application with a monthly fee and assistance:
- 87 respondents (47%) - to buy and install on their own some technologies and control autonomously through a free application.

5.2. Research results

From the validation and analysis of the research work carried out, namely the use of the ANOVA test and a Pearson correlation analysis of the constructs to verify the relationship between the variables, results were obtained that allow us to meet the objectives of the work, considering the universe of the sample collected (238 respondents), which can be seen in Table 3.

OBJECTIVES	RESULTS
Characterise the level of consumer knowledge of home automation.	In the universe of the sample, 77.73 % know and know what the technologies that make an intelligent home consist of.
Determine the purposes and perceived risks of domotic application solutions.	Improving quality of life (90.3%), comfort and convenience (90.3%), energy management (85.4%) and increasing safety (82.7%) were the purposes most classified as: "I agree", and "I totally agree". In terms of risks, increased reliance on technologies (70.3%), acquisition of non-essential goods (54.6%) and invasion of personal data privacy (50.3%).
Check which factors are most valued in the technologies that make a home intelligent, in order of relevance.	In descending order of relevance are data privacy, energy saving, easy to use and equipment quality.
Determine the degree of comfort when using intelligent home technologies.	Positive comfort 41,6 % of the sample reported feeling more or less comfortable while 35,7 % felt very comfortable.
Identify which scenarios they prefer to choose to install technologies that make an intelligent home.	The dominant preference is to hire a team to make a tailor-made installation with a single initial installation cost.
Understand the barriers to the take-up of intelligent home technologies.	Regarding the question of why they don't have SHT, the answer "I haven't thought about it yet" was the most selected.
Check whether socio-demographic factors influence the uptake and intended use of intelligent technologies and control and management applications.	The household factors, level of education and age, have not shown to have an influence on SHT adherence.
Understand if the Portuguese are able to automate their own homes, through DIY solutions.	51,40 % consider themselves capable of installing and using technology in their home without any help from a specialised company, while 48,68 % need help.

Table 3 – Results according to objectives

Following the correlations and tests performed, Table 4 presents the results of the validations of the hypotheses under analysis.

	HYPOTHESES	VALUE	VALIDATION
H1a	The intention to use is positively related to the household.	0,548*	Not validated
H1b	The intention to use is positively related to the education level.	0,778*	Not validated
H1c	Intention to use is positively related to age.	0,689*	Not validated

H2	The perceived utility has a positive effect on the intended use.	0,611**	Validated
H3	The perceived ease of use has a positive effect on the perceived utility.	0,509**	Validated
H4	The perceived control has a positive effect on the perceived utility.	0,507**	Validated
H5	Perceived security has a positive effect on perceived utility.	0,380**	Validated
H6	Perceived reliability has a positive effect on perceived utility.	0,303**	Validated
H7	A intenção de uso relaciona-se positivamente com a satisfação.	0,353**	Validated
H8	The perceived economic benefit has a positive effect on the intended use.	0,382**	Validated
H9	The perceived lack of quality is positively related to the intended use.	0,058**	Not validated
H10	The perceived limited availability is positively related to the intended use.	0,228**	Validated

* Significance – ANOVA; ** Pearson correlation.

Table 4 – Results of validation of hypotheses

6. CONCLUSION

The results of this study allow us to conclude that most of the respondents have knowledge about intelligent domestic technologies and perceive that these technologies improve their quality of life, considering that comfort and convenience were the most mentioned purposes for their use. On the other hand, it was highlighted as the main risk the increase of dependence on technologies. The most valued and privileged factors in relation to the use of SHT are related to energy saving, ease of use and equipment quality. Regarding the degree of comfort with the use of SHT, the majority feels comfortable with its use. Regarding the domestic automation scenario that they would choose more quickly, a large part prefers to hire a team to make a custom installation with a single initial cost. However, regarding DIY, half of the respondents consider themselves capable of installing and using the technologies in their homes without any kind of help from a specialized team. Thus, we can see that although there is comfort in the global use of technologies, there is not enough confidence to guarantee an intelligent home configuration on their own, which meets their preferences, opting at first for the services of specialized companies, but if necessary, there is premeditated knowledge of the operation (but divided into the sample) of the control of the technologies on their own account.

Taking into account the correlations of constructs, with the purpose of analysing the influence between the variables, the factor that proved to influence more the "intention of use" of SHT was the "perceived utility", which is in line with the results of other studies, there is the perception that these technologies speed up the execution of domestic tasks and that they are beneficial for routine, which influences the acquisition and recommendation of these technologies, and it is therefore important that the market receives more information on the advantages and functioning of SHT, contributing to a greater adherence by the Portuguese to the use of home automation.

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