Emerging trends: how is the Internet of Things (IoT) transforming our homes

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Abstract:

Objectives: *Explore the appeal and the adoption rate of Smart home solutions among Romanian consumers. Additional: Explore the awareness and usage of different Smart home solutions; identify drivers and barriers when it comes to different Smart home-solutions acquisitioning; explore the decision-making process and customer journey when it comes to deciding to purchase Smart home solutions; profile Smart home solutions users vs. intenders; identify and explore emerging trends in Smart home solutions.*

Prior work: As the technology has become more widely available, Romanians – ever vigilant about their home comfort and wellbeing – are increasingly looking for solutions to transform their home into a "smart" one. It's critical to understand how this increasing awareness of Smart home solutions will manifest itself in satisfying consumers' needs and motivating purchase. Approach: Our study was conducted in April 2017 through an online survey on our platform http://questia.ro covering 534 respondents. Results: Romanian consumers awareness for IoT is rather medium: a quarter of the respondents (29, 4%) heard about this concept. Out of those who are familiar with IoT, many are decrypting the concept as more connected to technology and less to one's personal life. Also, safety, money, and sustainability are less perceived to be related to the IoT, pointing out to the more problematic aspects that are brought in debates and research for this concept. Implications: This study will offer key insights and actionable recommendations for tech companies in leveraging consumers' increasing awareness, interest, and preferences in Smart home solutions, so as to be able to direct and adjust their product and marketing

strategies. It will also bring clearer understanding for researchers and professionals of the concept of Smart home. Value:The current paper assesses the potential of Smart home solutions in Romania, focusing on the new opportunities opened by IoT technology. The topic tackled is rather new in the Romanian market research field, clearly underlying the emerging developments in the field.

Keywords: *smart homes, internet and mobile data, IT&C.*

1. Introduction

In the last decade, a range of new digital technologies and services have entered the market, as a response to consumers' needs of being connected anywhere, anytime, on any device. All such smart devices or physical objects that are connected to the internet and are continuously emitting data and communicating with each other is called the Internet of Things (IoT) (Raut, 2016).

In the next years, we should be prepared for even more dramatic changes in the roles that technology will play in our daily lives. One of them is smart home technology, based on the IoT — a networked world of connected devices, objects, and people (Greenard, 2015). As Sandeep Raut (2016) beautifully pictures, imagine you are in 2020, your morning alarm is waking you, and the hidden sensors in the room will know you're getting up. The lights will slowly turn on and the thermostat will start warming the rooms you're about to use. In the kitchen, the coffee will start to brew, and your refrigerator will remind you which ingredients you'll need to pick up on your way back home from work. When you leave the house to work, you'll press a button via an app that will self-drive your car out of the garage. Right then, the security systems will turn on: the house doors will automatically lock, the appliances will switch to an energy-saving mode. On your way back home in the evening, your house will sense your arrival and will get ready for you - the thermostat will start warming things up, the garage door will open as you pull up, and your favorite music will start to play when you walk in. And here it is your smart home.

In the last years, there was an increase in the number of academic publications in the smart home domain. However, to date, no comprehensive overview and clustering of the core concepts used in these publications have been produced (Solaimani et al., 2013). Based on the review of the existing literature on the smart home, as well as on a public opinion survey conducted by Questia Group, this paper outlines the applicability and interest of smart home concept in Romania.

The first part of the paper defines the meaning of smart home and its benefits, as well as offers some already existing examples of smart home projects developed in Romania.

The second part of the paper focuses on the results of an online survey conducted by Questia Group in order to assess Romanians' awareness and interest in smart home solutions.

"Emerging trends: how is the Internet of Things (IoT) transforming our homes" addresses any academic and business audience who is interested in understanding the appeal of Smart home solutions in Romania.

2. Defining smart home

Several disciplines (e.g. robotics, artificial intelligence, service engineering, mobile computing) are involved in the Smart Home domain, while various perspectives (e.g. users, system, organization) are considered to identify and study a myriad of (design) issues (e.g. usability, affordability, privacy and security, interoperability and standardization, collaboration) (Solaimani, Keijzer-Broers and Bouwman 2013, 1). According to some authors (Solaimani, Keijzer-Broers and Bouwman 2013, 2) the few well-structured review publications with the aim of representing the Smart Home body of knowledge either focus on specific technology aspect or on sector-specific developments. Examples include assistive technologies, e-health projects, design requirements, laboratories, technologies for aging societies, energy management, location-based systems and user studies

By looking at the literature in this domain, a majority of publications adopt a technological approach., while others focus on the user-centric perspective to see context and user demands as leading factors for the development of 'Smart Living'. In addition, a variety of critical design issues (CDIs) have to be considered by researchers and practitioners in the development and provision of Smart Living concepts. CDIs are defined as variables that are perceived to be of eminent importance to the sustainability of the service of a product under development (Solaimani, Keijzer-Broers and Bouwman 2013, 3). By identifying publications on Smart Living through three search engines, i.e. Google Scholar, Scopus and Web of Science, between 1991 and 2013 from a wide variety of academic publishers, such as Elsevier's Science Direct, Emerald Library, Springer, JSTOR, Association for Computing Machinery/Institute of Electrical and Electronics Engineers (ACM/IEEE), Wiley InterScience, Information Society, Human Technology and Institute for Computer Science, Social-Informatics and Telecommunications Engineering. The results show that most publications fall under four main typologies: finance, service, technology, and organization (Solaimani, Keijzer-Broers and Bouwman 2013, 5-6), as follows:

- the service domain describes the customer value of a product or service offered by (a) provider(s). The customer value is determined by non-technical elements, like value proposition, service delivery, and distribution channels or after-sales services. Within the service domain, three main clusters are identified: service specification, service design and service provision (Solaimani, Keijzer-Broers and Bouwman 2013, 5). This approach is mainly non-technical;
- the technology domain contains the largest number of publications and discusses a large number of technical-related topics. These topics are the enablers or driving force behind many Smart Living Innovations. The seven central clusters that are identified in this domain are design and development, middleware, architecture, standardization, smart technologies, application areas and laboratories (Solaimani, Keijzer-Broers and Bouwman 2013, 5). Despite a large number of publications on architecture, almost nothing could be found with regard to business or enterprise architecture;
- the organization domain focuses on topics that are relevant to the emergence and governance of such value networks. Two main clusters are identified: partnership and governance. Partnerships focus on the creation

of collaborative networks, and governance focuses on managing the project or maintaining and sustaining the networked providers (Solaimani, Keijzer-Broers and Bouwman 2013, 5)

- the financial arrangements between all actors of the ecosystem (e.g. providers, suppliers, manufacturing, customers) are the foci of interest in the finance domain. Topics such as revenue, cost, investments, financial risks and pricing are some of the typical elements of the finance domain (Solaimani, Keijzer-Broers and Bouwman 2013, 8);

Adopting a service domain approach and less a technical one, we contribute to the literature in the domain, from a social marketing perspective. In this sense, the smart home essentially represents a house automation, with the use of new technology, to make the domestic activities more convenient, comfortable, secure and economical (Gunge, Yalagi, 2016). The home automation system consists of a user interface which has as main components a computer, mobile phone or tablet, through which one can control the respective system. The transmission is essentially made through wired connections or Wireless signal which controls the domestic appliances (e.g. electronic devices, lamps, ACs, heaters). In this paper, we use the broad definition provided by Aldrich (2003) and Solaimani, Keijzer-Broers and Bouwman (2013). In this sense, a Smart Home can be defined as a residence equipped with computing and information technology which anticipates and responds to the needs of the occupants, working to promote their comfort, convenience, security and entertainment through the management of technology within the home and connections to the world beyond and add healthcare, education and communication.

Among the most important advantages of smart home technology, we can mention (Raut, 2016;):

- **Security:** one can link the smart home system with local police or private security companies, and also control the access in the house from smartphone while being away;
- **Convenience**: one can link the domestic appliances via Wi-Fi and they send notifications or reminders in regards to food running forgetting to switch off the lights;
- **Energy Conservation:** one can save energy with all these connected devices, notifications and reminders sent;
- **Cost Effectiveness:** one can save up to 30% of his/her energy bill by using smart devices;
- **Accessibility:** one can monitor elders and disabled persons into their home, and provide assistance without limiting or disturbing the resident's daily routine, giving him/ her greater comfort, pleasure, and well-being;
- **Fun:** one can set his/her personal preferences and actions, then just sit back and enjoy using the latest in home automation technology.

On the other hand, there are also disadvantages perceived, such as:

- **Dependency:** one's home usability depends on the Internet connection, namely on its stability and speed; in the case of a signal dropdown, the system becomes unusable;

- **Privacy:** one can claim that living in an interconnected and interdependent house, in which each device knows at each point what you need might further affect one's privacy
- **Cost:** one can save money on his/ her electricity bill but, before going there, transforming the house into a smart home from system acquisitioning to actual installation can involve high costs.

Even if having in mind the benefits mentioned above, the smart home industry still has to demonstrate it can satisfy real user needs, in order to motivate consumers to buy its products and services. In order to do so, they can operate at three levels (Gann et al., 1999):

- As generic technologies, providing the basic, standard compatible building blocks – this type of solutions has already emerged in a number of households, people investing in basic smart devices such as smart electrical sockets or smart lighting in their traditional apartments/ homes
- For context-specific systems, adaptable to a wide variety of dwelling types – more complex systems, which might fit different house typologies
- Personalized systems, tailored to specific individual and household requirements – customized solutions transforming the houses into real, fully equipped smart homes

3. Smart home concepts – Orange Home

A number of smart homes have now been developed, all around the world. According to Statista[2], the global smart home market is forecast to reach a value of more than 40 billion U.S. dollars by 2020. The U.S. has the highest smart home penetration rate, followed by Japan and Germany. At this time, household penetration is at 5.7% in 2017 and is expected to hit 19.5% by 2022.

For the upcoming section, we will focus on the most important smart home projects developed in Romania. Still, according to Statista[3], the revenue in the Romanian smart home market amounts to 32 million U.S. dollars in 2017. Revenue is expected to show an annual growth rate of 53.5%, resulting in a market volume of 272 million U.S. dollars in 2022. Household penetration is below the world's average, at 1.5% in 2017, but it is expected to hit 9.6% by 2022.

In 2001, the mobile network operator Orange announced "Orange at Home" project, a smart house incorporating the latest technology built some 20 miles north of London, UK. it was intended to be more than a mere showcase, with plans for real families to move in and live with the smart home (Harper, 2006).

In 2015, it was also launched in Romania for consumer testing allowing users to monitor and control their homes from the distance through their mobile phones. The Orange Smart home solution includes 6 types of sensors – smoke sensor, movement sensor, flooding sensor, a sensor for door/window, smart plug and Wi-Fi

2 https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/ accessed 22.11.2017, 12:18

3 https://www.statista.com/topics/2430/smart-homes/ accessed 22.11.2017, 12:30

camera – connected to a central device. All these devices are wireless and easy to install. Monitoring and controlling the home from a distance will be possible by using the Orange Smart home on the phone or tablet, or an online platform on the PC. Based on their own needs, clients will be able to program the equipment for various actions and scenarios. For instance, users will be able to choose to receive SMS or e-mail alerts when the motion sensor is activated, but also to start video recording with the Wi-Fi camera (Bernovici, 2015).

Another telecom provider, Telekom, launched in July 2017 a demo smart home solution on the Romanian market, which provides a complete ecosystem for monitoring and controlling the home, even remotely, as well as IPTV (Internet TV) and connectivity services (Telekom Romania, 2017). According to the provider's website, the smart home solution was installed in a demo Vivid house located in the northern part of Bucharest and is based on the home centre central base connected to the Internet, which communicates wirelessly with the other smart home devices. The installation of the solution is thus non-invasive, with no holes in the walls and no cables. The initial setting of the Smart home system, as well as the setting of various scenarios and actions for sensors, are done through the dedicated application that can be accessed on laptop or PC. Then, the user will be able to monitor and to manage the system through the dedicated apps on smartphone and tablet. Depending on their specific needs and preferences, users can install sensors and control devices to automate, monitor and intelligently manage all home functions: the interior and exterior lighting system, automatic door opening or closing, socket control, water and gas control, flood detectors, smoke detectors, sensors for temperature, motion, brightness, vibration, blind automation, heating control, air conditioning control, TV, and audio system control (Telekom Romania, 2017).

Besides the two above mentioned examples of smart home projects developed by telecom providers, more and more people, especially in Bucharest are interested in devices turning their houses into smart ones.

4. Case study approach

This study is based on a research conducted by Questia Group, a young, fast-growing company with a digital presence on several continents. Questia's main domain activity is online polling, taking the pulse of societies as events unfold (Questia Blog).

The research was conducted between 20 and 21 April 2017, through an online survey among a representative online sample of 534 respondents, aged 18 and older. The research has +/- 4% margin of error, at a 95% confidence level. The margin of error takes into account the probability of a person to be part of the respective sample, and expresses the maximum expected difference between the true population parameter and the sample estimate of that parameter. For results based on the full sample, one can say with 95% confidence that the error attributable to sampling and other random effects is plus or minus the margin of error. The margin of error is larger for results based on subgroups in the survey.

5. Case study results

In this section, we present the results of the online survey aimed to assess Romanians' awareness and interest in smart home solutions. The first part dwells on the results regarding the Internet of Things (IoT), the second part focuses on smart cities and smart homes, while the last part assesses respondents' relation to smart devices.

Technology sector's development has grown at a high pace over the years, raising numerous debates over its implications to the way we live our lives, the way we want our cities to look like and how we can gain more sustainability for the future generations. Expert opinions are divided on this matter. For instance, telecommunications expert Kerry Hinton, former director of the Centre for Energy Efficient Telecommunications at the University of Melbourne, considers that the IoT will largely depend on the types of devices deployed and what they will be doing (Lewis, 2016). Thus, are people willing to adopt a more flexible lifestyle? If so, to what extend are they interested in such objects? What are their attitudes towards smart living? These are some of the questions this section offers answers to, along with other insights connected to the IoT and particularly smart homes. These aspects can definitely have an important impact both on consumer lifestyles, and their desire for aspirational products.

Romanian consumers' awareness for IoT is rather medium with a quarter of the respondents (29.4%) declaring to have heard about this concept. Youngsters (18-24), living in urban areas score the highest when it comes to IoT awareness. However, to most people, this concept is still unknown, even to those who are highly connected to the online environment.

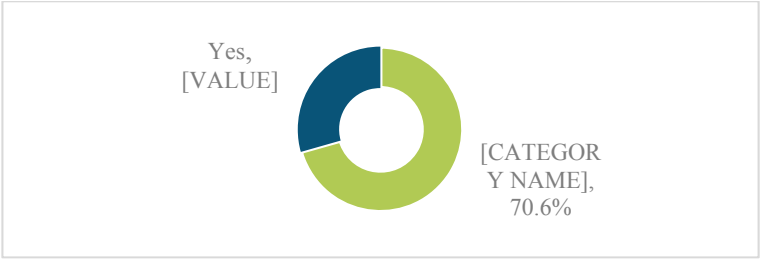

Figure 1. Internet of Things awareness.
Source: Questia Group

Even though the awareness level of IoT is not so high among Romanians, many challenging issues still need to be addressed and both technological, as well as social knots, have to be untied before making the idea widely accepted. Central issues are making a full interoperability of interconnected devices possible, providing them with a higher degree of smartness by enabling their adaptation and autonomous behavior, while guaranteeing trust, privacy, accessibility and security (Atzori et al. 2010, 2888).

However, potentialities offered by the IoT make possible the development of a vast number of applications, of which only a very small part is currently available to our society. There are many domains and environments in which new applications

would be likely to improve the quality of our lives: at home, while traveling, when sick, at work, when jogging and at the gym, just to cite a few (Atzori et al., 2010).

Out of those who said they have heard about IoT, most respondents associate it with advanced technology (63.7%), big data (60.5%), flexibility and adaptability to global technologies (59.9%), efficiency or saving time (54.8%) and improving the quality of life (40.8%). This aspect shows that for Romanians, IoT is portrayed in rather abstract terms, more connected to technology and less to one's personal life. Also, safety (be it physical or financial) and sustainability are less perceived to be related to the IoT, pointing out to the more problematic aspects that are brought in debates and research for this concept.

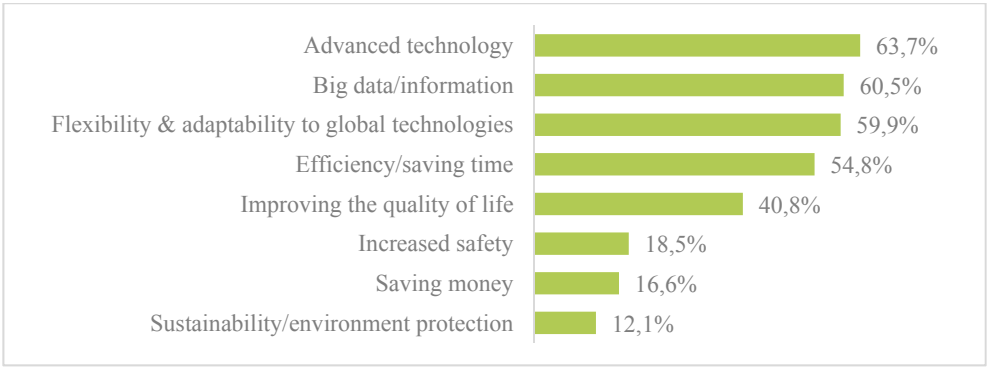

Figure 2. Internet of Things association.
Source: Questia Group

Asked to which extent they would use everyday things/objects that could be connected to the internet (such as doors, windows, lighting devices), almost half of the respondents (55.3%) said they would use them to a very large extent and to a large extent. This actually shows that, generally, people have a great interest in this topic.

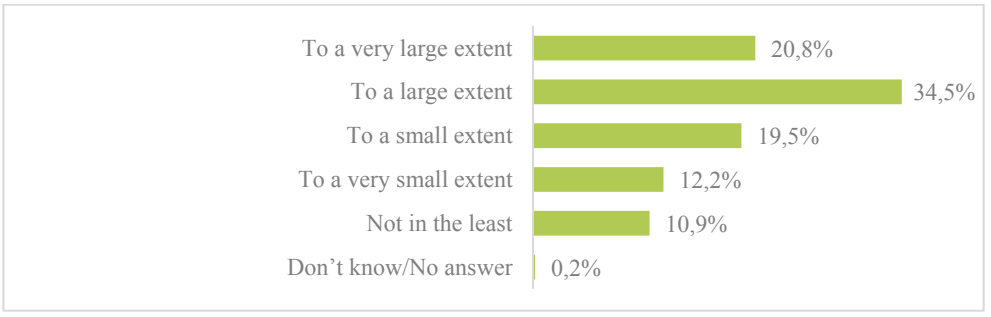

Figure 3. Internet of Things usage.
Source: *Questia Group*

The possibility of different appliances and devices to communicate with each other implies having different environments where a very wide range of applications can be deployed. These can be grouped into four domains: transportation and logistics,

healthcare, smart environment (home, office, plant) and personal and social domain (Atzori et al. 2010, 2793). Following these domains, we asked respondents to express their interest in smart cities, homes, and devices. In this sense, most respondents are very interested and somehow interested in smart technologies in the city (88.8%), smart homes (79.0%) and smart devices (81.0%).

Smart cities are defined by the International City/County Management Association (ICMA, 2016) as communities that use information and communication technology to enhance livability, workability, and sustainability. In this manner, the Romanian Ministry of Communications has released the Smart City Guide for Romania[4] in 2016, stating that Alba Iulia will develop the first smart city pilot-project.

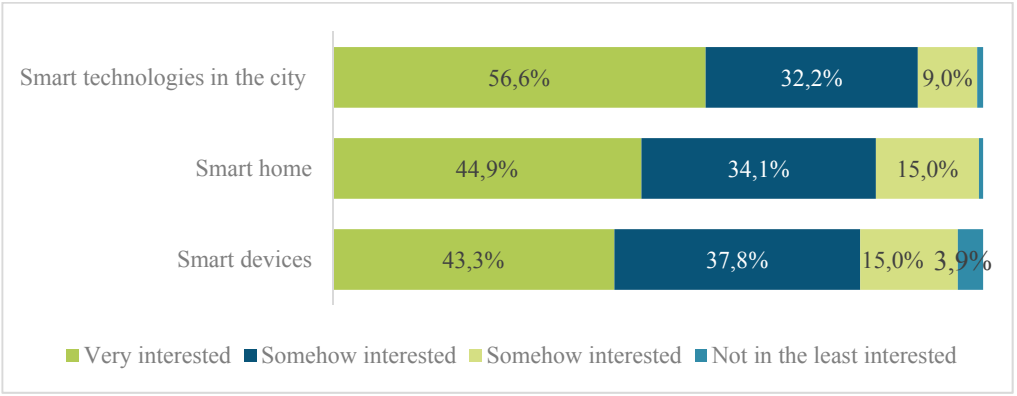

Figure 4. Interest in smart technologies.
Source: *Questia Group*

Real-time accidents/alerts (31.1%), street traffic lights depending on the traffic (23.7%) and public lighting with sensors (18.0%) are the top smart technologies that respondents consider having greater priority in the cities/communities. On the other hand, smart public transport and smart garbage cans have a lower priority in respondents' view. This insight can be correlated with the fact that respondents place safety and efficiency as priorities in their communities.

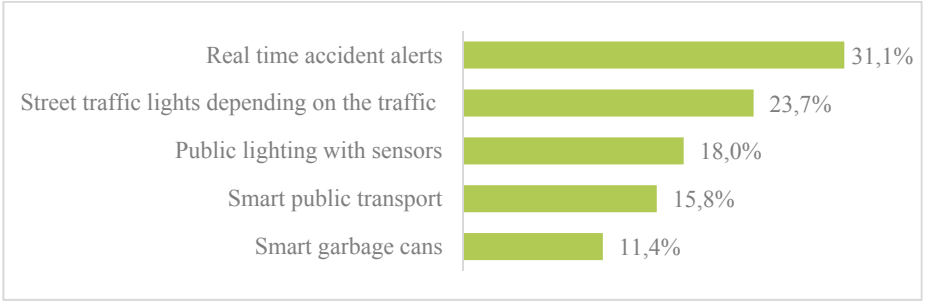

Figure 5. Priorities for smart technologies in the city.
Source: *Questia Group*

[4] https://www.comunicatii.gov.ro/smart-city-concept-2/, accessed 22.11.2017, 12:18

Regarding smart homes, as noted throughout this paper, they are considered homes equipped with lighting, heating, and electronic devices that can be controlled remotely by smartphone or computer. According to Mansfield (2104) and Gunge and Yalagi (2016), the prevalence of smartphones and tablets has meant that smart home technology started to gain real momentum and is becoming easier to use, more intuitive, and, importantly, affordable. When asked which different household systems respondents would like to be able to control remotely now or in the future, security systems (for video surveillance, fire/leakage alarm) scored the most important (51.0%), followed by a heating system depending on the seasons (32.4%). This shows that safety issues are top priorities for Romanians not only in their communities but also in their homes. Both in the city and in the households, smart alarms have higher scores as compared to other smart devices. Nevertheless, energy conservation is also a priority.

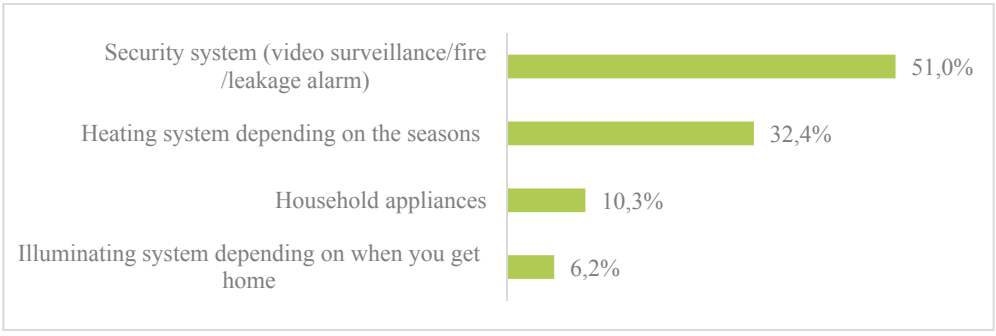

Figure 6. Smart home priorities.
Source: Questia Group

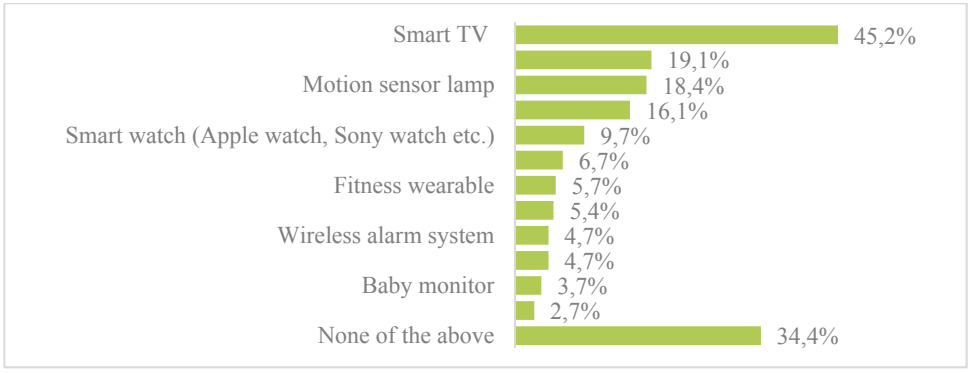

Figure 7. Smart technologies usage.
Source: Questia Group

In terms of what smart devices respondents already own, a substantial number of respondents own a smart TV (45.2%), some own smart lightbulbs (19.1%), motion sensor lamps (18.4%) and smart toothbrushes (16.1%). Only a few own smartwatches, VR glasses, and fitness wearables. This could be interpreted in the sense that efficiency is also a factor in choosing smart devices, over entertainment

and of course, money. On the other hand, 34.4% say that they don't own any smart devices in their homes. This means that lack of information, corroborated with costs and security issues could come as barriers to Romanian's ownership of IoT.

6. Conclusions

As Harper (2016) affirms, the late 20th and early 21st centuries have seen accelerating moves towards an interconnected society, with the "information society" bringing major changes in the ways we live. The need for appropriate technologies to allow users to participate in this newly emerged society is providing good grounds to the smart home concept. The combination of new communication networks and technologies, with the developments in end-user devices and appliances, as well as the growth of new electronic services for consumers is creating a perfect context for smart home technologies to further develop.

Our paper aimed at offering insights on the appeal and the adoption rate of Smart home solutions among Romanian consumers. In this manner, the first part of the article offered a literature review regarding 'smart living' – the Internet of Things (IoT), smart cities and smart houses. The second part focuses on analysing some examples of smart home projects developed in Romania. Next, we focused on the results of an online survey conducted in order to assess Romanians' awareness and interest in smart home solutions. Some additional aspects have been taken into account in the analysis, such as the awareness and usage of different Smart home solutions, the drivers and barriers when it comes to different Smart home-solutions acquisitioning, as well as exploring the decision-making process and customer journey when it comes to deciding to purchase Smart home solutions.

Consumers have basic needs revolving around convenience, simplification of tasks, safety, and security. Bringing the concept of smart homes to the mass market will require suppliers to clearly address these needs and demonstrate the additional functional and subjective benefits that the various technologies can deliver. This will require certain key barriers to be overcome, not least the lack of a coherent smart homes "industry". A number of players are beginning to position themselves to form the nucleus of such an industry, such as the telecom providers, energy companies, and architects.

However, a more ethical discussion is centered around smart homes as a concept accentuating the existing "digital divide", especially on the Romanian market. Only with the help of the above-mentioned industry players offering increased access to internet services across the country, a "digital bridge" will be created.

Although the awareness of IoT and smart related products is not that high, people show interest in enhancing their wellbeing and choosing services that offer them a feeling of convenience. Even more, to our knowledge, the study we have developed is one of the few conducted in Romania on such a topic, which can further put the basis of a deeper understanding of smart devices applicability among Romanian consumers. The above-mentioned results already identified some existing needs in terms of security, safety, comfort etc., but IoT concepts still have to tackle more new, unidentified consumers need in order to become relevant in usage.

On the other hand, business-to-business applications will probably capture more value than consumer uses (Manyika et. al, 2015), although consumer applications, such as fitness monitors and self-driving cars, attract the most attention and can create significant value. IoT has potential in developing economies, yet, it is estimated that it will have a higher overall value impact in advanced economies because of the higher value per use. However, developing economies could generate nearly 40%of the IoT's value (Manyika et. al, 2015), and nearly half in some settings. Capturing the full potential of IoT will require the result of synergetic activities conducted in different fields of knowledge, such as telecommunications, informatics, electronics and social science (Atzori, Iera and Morabito, 2010). In this manner, the study has its limits precisely because it tackles this issue from a social perspective and with lesser extent on the technical aspects. Moreover, the quantitative perspective rather offers a snapshot of the state of the art, while a qualitative perspective could have offered more insights on why respondents portray new technologies such as IoT and smart homes in abstract manners. What role does safety play in triggering people's interests, as well as what types of barriers, with the exception of costs, can affect people's perception and attitudes to this issue.

7. Considerations

The current report has been coordinated by Questia Group team and includes data from desk research, literature review and a public opinion survey. The analysis comprises key insights on Romanians interests in Smart home solutions.

The analysis and research findings are those of the contributing staff and should not be attributed to other sources. The data and analysis appearing in the report are compiled by Questia Group staff at the time of publication. Every effort is made to ensure, but not guarantee, their timeliness, accuracy, and completeness.

In manners of ethical considerations, we assured the respondents that the data are anonymously collected, with respect to confidentiality. Moreover, respondents have participated voluntarily to the survey. This research is independent and impartial, and was not financed by a third party.