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Optimizing the Relationship of Positive-Negative Effects for Smart Homes Technologies, with Technical and Economic Criteria

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Abstract

The new fifth generation networks will enable the creation of innovations that will bring incalculable value to our daily lives, affecting a wide range of industrial and economic sectors. The most important result of this new era could be attributed to the ever-increasing human-machine interaction. The transformation of urban areas has already begun with the simultaneous development of smart cities and our lifestyle. These changes affect the environment, which is being talked about so much because of climate change and the need to protect it. The goal is to reduce energy consumption while simultaneously reducing the environmental footprint, and without degrading the quality of life of citizens.

1. Introduction

The smart home is no longer considered a technology from the future. It is already here, but it is in a constant stage of development, adapted to new needs which are constantly changing. Crucial to the development of smart home technologies is 5G, which is essentially an umbrella of technologies that will provide high connectivity of devices at high speeds, both indoors and outdoors [1]. The evaluation of a construction, a product or a service presupposes responsible and conscious delving into the essence of the matter [2]. That is why we should emphasize that smart is not the house, which only has high-tech equipment and a remote command system, but smart is a construction when it is sustainable. A home is not smart if I can turn on the air conditioner from my mobile phone, but if there is a system that cuts off its cooling if a window or door is open. To emphasize that a window is not smart if it opens and closes with a movement of our hand, but if it opens and closes based on the temperature conditions and the content of particles and elements in the indoor and outdoor air. Furthermore, the behavior of the residents of the home also must be taken into consideration [3]. At this point it would be good to clarify the degree of intelligence of a building, which is determined by the criteria of sustainable construction. These are economic, ecological, social, constructional, technical, and topographical. There is also a considerable difference between smart home and an intelligent home that needs to be further explained. [4]

The scientific community has already announced for years about the real transformation of our lives that will result from the digitization of the daily services offered through the new technologies that will bring to light. Empowering the citizen's

relationship with smart buildings and smart homes, means that the delivery of medical care is upgraded, and the quality of life is improved in every sector and industry by the use and analysis of data for every small or large activity. Smart or intelligent home technologies have positive as well negative effects in the performance of a home or any residential and industrial building.

2. Historical Background Information

Smart home technology has come a long way in recent years, but the progression wasn't so quick when the first concepts came onto the picture. It is interesting to see some historical developments regarding the general concept of home automation. Because before the concept of smart homes the automated home had developed many automation technologies. In 1984, the term "smart home" was coined by the American Association of Home Builders! [5].

In the beginning of the 20th century many electrical appliances became commonplace in the home, and even longer before technology could really deliver on the promise of a futuristic home incorporating those appliances, controlled remotely. The 1933 "A Century of Progress International Exposition" (the "Chicago World's Fair") offered a look at the Home of the Future. Sure, it was designed to resemble something we'd still recognize today from science fiction, yet the interior failed to live up to the promise, simply because the technology didn't exist yet. After the 1940 invention of the electrical digital computer, the 1940s through the 1960s saw computer technology to grow to maturity. In 1966, ECHO IV was created by Westinghouse, which was the first true home automation device, controlling temperature and appliances. In the period of 2000-2020 several studies were reported in using smart home technologies [6].

The X10 Home Automation Project was developed in the middle of 1970s. The X10 devices worked with a building's existing AC wiring and controlled small appliances and lighting fixtures in houses and large buildings. In the 1980s changes for everyday consumer were developed: motion-sensing lights, automatic garage door openers, programmable thermostats, and security systems were now commonplace and affordable. In early 1990s, the Internet of Things (IoT) was born. In the same period Microsoft contributed its own version of how a future "smart home" should look and function. Microsoft predicted many things that today's smart homeowner takes for granted, such as security systems, environment controls, smart locks, and lighting controls. Throughout the 2000s, smart devices and systems have been evolving at a rapid pace. Today, IoT smart devices are more plentiful than ever, and the cost of "smart home" systems keeps dropping, making them an attractive option for homeowners. [7], [8].

About 200 billion smart home devices have been sold internationally to date, and the global market continues to expand at a rapid pace. The subsystems in a "smart home" are the following: Security systems, surveillance systems, lighting, and electrical appliances system. system of awnings, doors and blinds, leakage and consumption control system Ethernet network and computer system, satellite, and TV signal distribution system, audio and video distribution system, system of central management and supervision [8].

The transformation of urban areas has already begun with the simultaneous development of smart cities and our lifestyle (smart home & media). The amount of data been generated is 2.5

quintillion daily at the current rate. This rate is accelerating every day with the continuous development of the Internet of Things (IoT) and new smart devices aimed in long-term energy savings. Soon we will control every aspect of our home's functionality from a smartphone app and have the right insight into specific energy consumption figures and reductions due to smart home technologies.

3. Current trends on energy efficiency and savings for smart (intelligent) buildings

The last two decades the concept of an Intelligent Building (IB) and the home smart technology applications associated with its development gather a constantly increasing attention both at the residential and industrial sectors. Many definitions have been proposed to describe what an Intelligent Building (IB) really is, however, as the construction industry and communication technology develop, they change, constantly, the way the concept of the IB is being approached.

The goal of energy-efficiency in IBs is therefore to reduce the energy consumption or cost to the barest minimum without sacrificing occupants' comfort. IBs are designed and managed to meet changing environmental conditions, businesses, and other human needs. For this, computerized systems are used extensively. Such systems come in different names e.g. Building Automation System (BAS) [9], Building Energy Management System (BEMS) [10], Energy Management and Control System (EMCS) [11], Central Control and Monitoring System (CCMS) [12] and Facility Management System (FMS) [13]. In all these systems, energy is managed to achieve maximum output for the minimum cost. Light is switched on or off or dimmed as the need arise. Energy saving in an intelligent building is realized by controlling heating, ventilation, air-conditioning (HVAC), lighting, and anything that uses energy. Examples include lights and/ air-conditioning that are automatically switched off, and the room temperature being adjusted appropriately in an empty room. Enhancement of customer value is realized through taking into account the desires of the people in the building, for instance, by adapting the conditions in the room e.g. temperature and light intensity according to individual's personal preference(s). Series of computerized thermostats provide automatic control on the building's temperature based on mode (Day, Night, Away, etc.).

Today's technology ensures the ultimate comfort and at the same time saves money and time. Energy efficiency is the use of less energy to meet the same needs. Energy conservation is the reduction or sacrifice needs (of lower priority) of a service to save energy. Devoid of looking too far, businesses can find an abundance of lists and information offering smart ideas on building energy efficiency. However, many small to medium size organizations are challenged to find the necessary time, resources, and understanding of energy management. Save Energy Systems (SES) [14] recognizes the impact that time, resources, and smart building myths have on small to medium size organizations throughout the development and execution of smart building energy efficiency strategies.

4. Positive effects for smart homes technologies

The most important function provided by the "smart home" is the saving of thermal and electrical energy, which is achieved by fully controlling the heating of the house (thermal energy), and by implementing the various lighting programs that are put into operation, either the owner is at home or absent (electricity) [15]. The installed "smart controller" enables the monitoring of water

consumption and household appliances, to supervise the data for any period of time. This control system is on the alert and informs about any case of excessive consumption, wherever it comes from. Besides, "smart thermostats" constantly control the temperature level, as well as the smooth operation of heating and air conditioning. In the smart home, the operation of fire detection and automatic extinguishing are a high priority service for their owners. For this function, visible smoke or temperature rise sensors and temperature differentials can be connected to the system [16].

Smart homes can be easily upgraded, which is another plus when someone is thinking with an investment interest (and not only) in buying a residence. Given the increased levels of crime, most homeowners (detached houses or apartments) make sure to surround their homes with the best possible security measures, thus ensuring the safety of their family and their property [17]. Empowering the citizen's relationship with smart buildings and smart homes means that healthcare delivery is upgraded, and quality of life is improved in every sector and industry through the use and analysis of data. (Public health policies and the public care and welfare system are rapidly upgrading) [18]. It raises the purchase value of the property between 5% and 35%, depending on the number and type of smart devices to be used. This means a significant impact on the local economy and the real estate market.

5. Negative effects for smart homes technologies

Connected sensors provide a broad range of information that should be used in making key decisions. The edge node is the data source, and if recorded information is faulty and of poor quality, use of the data can do more damage than good. A smart home grid is also an electricity supply network that uses digital communications technology to react to changes in usage. With the increasing number of households and energy use, there is also a growing interest in monitoring data related to energy production, use or storage to maximize customer insight [19]. This is achieved with cloud-based applications. However, the cloud has some limitations. To monitor supply and demand in real time, and to use the data to predict both in advance, a vast number of sensors need to absorb information. Processing this in the cloud would be inefficient as it incurs a significant cost to transport and analyze the data, making these services expensive while also increasing the potential for delay in processing time. Smart devices generate a lot of data. The manufacturers of these devices store and process all this data in the online Cloud. There is no way to predict how we will control these vast powers that will accumulate disproportionately in the hands of economic advantage-seeking and increasingly greedy governments. Smart devices collect data about everyone and home or business and anyone who comes into contact [20].

They are prime targets for hackers, and they show a lack of authentication, unencrypted messages sent between devices, and a lack of verification or encryption of software updates. Routers can also be hacked causing massive data leaks. We know that smart IoT systems are typically controlled by smart applications based on events and commands to provide different forms of automation. In case of an error (bug) of the device or its programming by the user, incorrect commands may be given that will cause dangerous situations concerning the security or privacy of the user.

The promise of the Internet of Things is to simplify our jobs, secure our homes and transform our lives with assistants, automated tasks, and data insights through a new generation of connected devices that work seamlessly together. Many consumers, however, are losing faith in the

connected utopia as they struggle with set-up and setup issues and disjointed technical support involving multiple people across multiple companies. A major problem is also the absence of a uniform communication standard. Each Smart Home brand wants to create its own proprietary smart system, which results in a huge number of products to choose from, but which don't necessarily work well with each other if they are from different companies. Trying to be the priority, manufacturers try to lock users into their own protocol from which they will not be able to move or have to pay to continue using it. Due to the multiple ways in which networks can be designed and architected, not all smart homes are created equal. These ways can lead to their own security and privacy peculiarities, with common issues as well as vulnerabilities. Implementing basic information security protocols can significantly increase overall security in the smart home sector. Deliberate shutdown of devices by companies. Smart automation devices sold with the promise of tax-free subscriptions are rendered useless after the company decided to shut down the central servers the devices used to run [21].

6. Prerequisites and necessities

For a construction to be called smart, it should be designed and implemented according to the criteria dictated by the aforementioned reports of positive and negative effects. Starting from the selection of the services provided, to the planning of the details and the correct implementation and execution of the project. The value in a construction and a smart home is given by its energy footprint, durability over time, flexibility in use, losses during its lifetime and the degree of recycling after its end of life. Also value is given by the bioculture of the users and not by the luxury of the equipment. It is important for the planet and humanity to understand that value is given by livable quality and not by extreme quantity. Bioculture is achieved when, through construction, a person becomes one with his environment, the natural, the social, the cultural [22]. Livable quality is achieved when, through the exemplary life within the particular construction, qualitative value is added to the environment, contributing to the application of the principles of sustainability. Detailed planning, insistence on the selection of materials and services according to the criteria of sustainability, modeling of response to possible extreme situations, repositories of solutions for each case, recognizable integration into the environment, flexible multiple applications and intelligent interdependence of the necessary functions necessary to fulfill the criteria of sustainable building should be basic characteristics of the completeness of the rules of sustainability in the construction of smart houses. The manufacturing activity of smart homes needs the application of circular economy principles, as it is a very energy-intensive sector and uses a huge percentage of the extraction of raw materials. The term "circular economy", which has emerged in recent years more and more often refers to the rejection of the economic model (take-make-use-throw). This conclusion is supported on the one hand by the raw materials, which are declining irreplaceably, while on the other hand, the increasing consumption, as a result of the increase in the population of the earth and the consumer demand in relation to the technological explosion. The habit of a simple (one-dimensional) use of a product is an obsolete luxury. The same as the practice of mindless consumption, which are now deterrent options if we want the future to be sustainable [23]. Changing the way of thinking is now an imperative and the main demand of our time. That is why the industrial sector as a whole is called upon to manage positively for the environment and people issues such as: non-renewable sources of raw materials, emissions during the extraction and transport of raw materials, emissions during the manufacture of new products, lifetime of products and constructions, waste, resulting after the

end of the application of the products and constructions. The plastics sector plays an important role worldwide since they are based on virgin natural resources, they are not recycled and a significant amount of them end up in the environment having a great impact on the functioning of ecosystems. In addition, plastics are often used due to their low cost, easy remanufacturing, and vast and widespread use while having a wide range of applications in every smart home product and service provided. In this context, the adoption of circular activities in the plastics supply chain is considered necessary for the environment and society, while at the same time it is an opportunity for small businesses to develop in this sector. The circular economy provides the solution through existing practices from a different perspective. Thus, the re-use of products, the re-evaluation of materials, the new business (manufacturing) models, the repeated use and the cumulative value of each new service or product are necessarily recommended [24].

7. Discussion of Results

Several economic factors create safety problems because design choices based on cost and practicality compete with safety. The abuse of smart home services and applications should be considered certain according to the growing number of smart devices and homes as well as data that are transferred to data centers. In order to ensure social peace and successfully implement the effort to transform a traditional city and home into a smart one,3 goals need to be defined:

- More competitive economy.
- More sustainable and rational development of the economy.
- Tangible improvement of the pulps' quality of life through personalized solutions to their needs.

An analytical pollutant study is required, oriented towards the total lifetime of the products, starting from the extraction of the raw materials for the construction materials to be used, until the end of their lifetime. A detailed and literal application of sustainable building criteria and a prudent and consistent selection of construction materials, according to cost and pollution studies, are needed.

8. Discussion of Results

The changes in many sectors of the economy will be impressive and almost overwhelming. Scholars in the humanities view our transition to the digital world as a rapid acceleration in the evolution of the human species with negative consequences since they believe that in many cases the human interface and interaction will be lost.

The European Network and Information Security Agency (ENISA) published a report on the threat landscape and issued a good practice guide for the smart home and convergence media. According to the study, threat factors have been identified that reveal several sources of vulnerability and concern security of cyberspace. It is the biggest and most dangerous threat. A smart home probably sounds like a nightmare to those people who are not comfortable with technology and computers. One of the primary and key considerations in installing a smart home system is balancing the complexity of the system against its usability. If it is complicated then it is completely problematic and actually makes our lives harder not easier. When designing the system, it is important to consider a few factors:

i. What kind of components are part of the system?

ii. How intuitive will the system be to a non-user?
iii. Is the device really a necessity or just a fancy and potentially frustrating service.
iv. How many people should use the system?
v. Who will know how to operate the system? Who will know how to maintain the system and deal with failures?

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