Managing Knowledge Through the Internet of Everything on an Example of Smart Estate

Leszek Kieltyka
Czestochowa University of Technology, Poland
leszek.kieltyka@pcz.pl

Abstract: The paper presents the research pertaining to various forms of communication conducted in so called smart housing estate. The estate has been fitted with various types of equipment (sensors, tags, transducers), whose task is to provide information. The collected information is a source of knowledge that can be further utilised to ensure efficient management of buildings and the possibility of their communication with the environment. The issues presented in the paper pertain to the analysis of major situational phenomena that occur in a smart estate. The main tool of knowledge management constitute digital operations characteristic of the Internet of Everything. The considerations cover, among others, forms of monitoring of the most important areas of the estate, primarily with regard to ensuring the safety of the residents. By utilising smartphones one can acquire knowledge about monitoring own premises (outside and inside), opening hours of individual shops, post offices, chemists, libraries, etc. The knowledge gathered in this way allows for an insight, among others, into current timetables of all means of communication. It also allows for tracking emergencies with a possibility of informing the relevant services in advance. The paper presents the research that has been conducted among the persons that live in a smart estate, as well as persons who intend to dwell in one. The analysed issues included: residents' knowledge about smart home solutions, areas in which residents utilise smart home solutions. managing the collected knowledge so as to introduce energy saving appliances. The paper refers to the advantages of utilising smart communication systems in residential buildings in a smart estate. It presents utilisation of the IoE in communicating with any element of a smart home in a smart estate through internet service based on cloud computing. It also characterizes the most vital elements of smart estate management. In a symbolic manner it presents elements, devices, equipment, objects, which based on the accumulated knowledge can be controlled through application of intelligent communication systems operating based on the concept of the Internet of Everything.

Keywords: knowledge management, Internet of Everything, smart estate, knowledge awareness

1. Introduction

We ourselves decide whether we will be able to enjoy the benefits of communication technology implemented, among others, based on the Internet of Things (objects), Internet of Everything or Industrial Internet of Things. The Internet of Things is a natural consequence of technological development and pursuit to automate processes that do not require human participation, processes that are indispensable for the functioning of the contemporary world, or contribute to relieving human burden.

The currently exposed area where ICT and informatic technologies are being utilised is the Internet of Everything (IoE). This is a term for a network of people, processes, data, and objects connected to the Internet. The Internet of Everything in its present shape has not been an outcome of a genius brainchild. This is an arbitrary set that utilises developing in a longer period of time electronic and digital forms of communication. The IoE makes use of the existing and developing communication technologies, including the technologies of savings and reliability, especially for the operations of gathering, transfer and security of data, which are embedded in the utilised system. It makes use of data collected in Cloud Computing, ICT, software agents technologies, and multiagent systems (Kiełtyka, 2013), technology of semantic networks, multimedia technologies (Kiełtyka, 2020), technology of virtual organisation of actions (Kierzkowski, 2013), etc.

The underlying objective of the consideration pertaining to smart estate is creating smart spaces, including municipal ones, in various areas: transport, products, buildings, energy systems, quality of the environment, health, and other related to everyday life. The foundation for the development of smart spaces is provision of technology that will ensure their implementation, through smart communication in the course of the management process. The set of technologies utilised in the Internet of Everything is based on tools, systems, and sensors that allow communication of a smart estate with the user. Smart spaces accumulate knowledge that is utilised by both teams of professionals and dedicated systems that govern the processes of controlling proper zones of a smart estate. Therefore, knowledge management in this area takes place based on the associative form of the sense of homo sapiens and professionally designed computer systems.

A smart estate is an integration of ever more efficient digital telecommunication networks, omnipresent in smart sensor and markers, and in software (compared to knowledge and cognitive competencies). The stressed "intelligence" cannot exist separated from other systems of an estate. There exists a growing network of overlapping connections to mechanical and electric systems installed in the buildings, systems embedded in household appliances, transport systems, electrical networks, water supply and sewerage systems, and security systems of estate residents. These sets of information constitute knowledge, which is utilised for optimum management of processes undergoing in a smart estate.

The population of smart estates has been growing dynamically in the world. This requires development of an estate system for managing the collected knowledge, which can optimise its development and decrease maintenance costs in the long run. A new problem that requires a detailed analysis is the level of spatial and economic changes of estates resulting from utilisation of advanced technology (Kiełtyka, 2017). Dynamic development and rational use of latest technologies will improve the quality of public services, saving time and money, and ultimately will improve the quality of life in the estate and will allow it to obtain the status of entirely smart one. However, these assumptions are impossible to fulfil without the utilisation and participation of communication systems, where the Internet of Everything plays one of key roles. Communication systems in a smart estate will make possible, among others, managing the accumulated knowledge through:

- introduction of an integrated system of visual monitoring,
- creating an open-access zone of wireless Internet,
- participation of the dwellers in the operation of a smart estate,
- pro-environmental solutions in estate transportation,
- application of multifunctional estate cards for the dwellers,
- management of heating/gas/water network,
- running estate bake/car/trailer rentals,
- introduction of transport systems for traffic management,
- solutions of sustainable public construction,
- creation of Park&Ride zones,
- managing energy networks – smart grid, smart metering,
- promoting car-sharing solutions.

A dynamic development of devices with access to the network through the internet has caused that communication systems can decide based on the collected information about users whether to advise their appliances (fridge, washing machine, radio, central vacuum cleaner, heating, etc), what and how they should do in given time, without the interference of users themselves (Cha, 2016).

2. Role of knowledge in a smart estate

The IoE means that it is necessary to leave the previous practices where the prediction model was built based on collected data, and then applied in operation for as long as it preserved its required qualitative parameters. Tools should ensure smooth integration of new data and incorporating it into analyses. To achieve the sufficient business effect, it is enough to create a forecast or present data in the form of a decision tree, which will constitute a basis for determining objects of knowledge application. A device equipped with sensors sends measuring data to a central system, where it is gathered and analysed. The accumulated in such a way knowledge can be actively used while managing standard processes and occasional phenomena that occur in a smart estate.

Knowledge engineers can interpret the undergoing communication processes and based on them develop analytic models that facilitate, through current and accumulated knowledge, for instance, prediction of failure occurrences, identification of malfunctions in operation of machines, or simply their imperfect use. They work in the area of "knowledge discovery", and outputs of their activities, in the form of created models constitute a starting point for developing automation and intelligence of the system itself (Zhang, 2017). This will allow a solution to react instantly in an event of data occurrence that signals a failure and take appropriate steps, e.g. inform a service team. From the business perspective such a system not only minimises stoppages but also optimises the work of service teams or the amount of ordered spare parts. Significant advantages are also noticeable in the area of developing by companies services and products competitive with the markets they operate on.

In the developing world of interconnected and communicating one with another objects there is space for developing payment platforms by adding another level of possible automation and autonomy in the Internet of Everything. This will ultimately create an opportunity to provide more complex and tailored to the needs of customers financial services, amending, for instance, currently applied credit models. The role of the accumulated in this way knowledge is indispensable for further optimum management of process that undergo in a smart estate.

3. Management tools in smart objects

Platforms of telecommunication networks may offer a possibility of collecting data – also consumer one, for instance, from the smart home area, analysing it and making decisions on its basis. In combination with the possibility to utilise the already existing informatic network this constitutes a comprehensive platform that allows other companies to build IoT services (Singh, 2017). Utilising such a solution decreases the market entry cost related to introduction of a new product or service, and permits to use a mature and rich in functionality platform already from the very beginning of conducting the activity.

An incredibly uncomplicated application of the idea of the Internet of Everything Controlled with one button, simplifies the entire process of ordering goods, and simultaneously guarantees customer loyalty and cyclicity of orders. By equipping selected objects with selective markers, we can provide detailed information about the product directly to customers smartphones, and what follows obtain priceless knowledge about their interests and preferences.

The Internet of Everything is the next step of information revolution. Similarly to the emergence of social media it has impacted the way we organise our lives and significantly modified business models. Achieving greatest business and financial benefits of utilising the Internet of Everything is possible owing to the ability of processing data created in this new world. Business analytics offers techniques and tools that facilitate building of useful knowledge, and modern solutions are effective in making real time decisions based on fast and large streams of data (Cha, 2016). Organisations that would like to incorporate into their business models solutions form the domain of the IoE should not be discouraged by lack of skills or essential technology. The analytics that is supposed to release business values int the Internet of Things has been probably already applied by them. Competencies and tools are identical as the ones applied in Big Data class solutions. As always, also in this case, the key to success in controlling a smart estate will be the ability to find innovative applications in the new space or adapting the experiences observed in other industries.

A smart object needs to be fitted with a device with a sensor, which is capable of collecting specific information from the surroundings, and transmit it further. These can be objects fitted with various types of sensors that monitor: temperature, vibration, humidity, motion, noise, GPS, etc. (Dybowski, 2018). A smartphone or smartwatch can also play the role of a transmitter that sends commands. The difference lies in the fact that data is not downloaded automatically but is a result of user's action (e.g. click, voice command, set time of activation). Examples may include: smart bands monitoring heart rate, a sheet with a motion detector, or a beacon that senses human motion.

Contrary to the commonly accepted name the Internet of Everything (IoE) is actually not the Internet of "everything" but a set of more or less structured data utilised in a particular communication (Bard, 2014). But for the data, which is the basic product for the IoT, its main product would be merely electronic waste. The Internet of Everything is not what is seems to be at first glance. The gigantic anthill of smart-objects and sensors that communicate one with another, with an equal share of homo sapiens, having a closer look it turns out to be primarily the world of radically new data (Kiełtyka, Zygoń, 2018).

4. Examples of IoE utilisation – smart home, estate, city

We need a tool that will be able to receive the transmitted signal, process it and evoke a particular reaction. This can be a smartphone, tablet, smartwatch, or a computer, which will display specific information, but also another thing that will automatically perform a particular action, e.g. unfolding roller blinds integrated with home-automation system, traffic lights adjusted to traffic intensity, or a library book displaying a reminder about the return date.

Currently, one can find on the market a range of technologies that enable transmission of information between two objects, beginning with the most popular ones such as Wi-Fi or Bluetooth, and finishing with NFC or Z-WAVE (utilised, for instance, in building control systems). Thousands of information exchange processes will occur every second in the developed world of the Internet of Everything, and the communication between devices will frequently run multiway – using a greater number of transmitters and receivers, and using the resources of accumulated beforehand knowledge. For instance, in Figure 1 the author presents in a symbolic way elements, devices, equipment, objects that can be controlled and managed with the use of communication systems whose operation is based on the Internet of Everything. A set of smart homes creates a smart estate, which makes use of the forms of formerly accumulated knowledge for governing activities that occur in it, and also uses internet connections handled by Cloud Computing (Sroczan, 2020).

A vital challenge is the issue of privacy felt by end users. What they expect is a widely understood improved security of themselves and their close family, increased control over the possessed appliances and devices, as well as comfort and economy. These benefits can be easily provided by technological solutions for smart management of devices and appliances and energy saving at home.

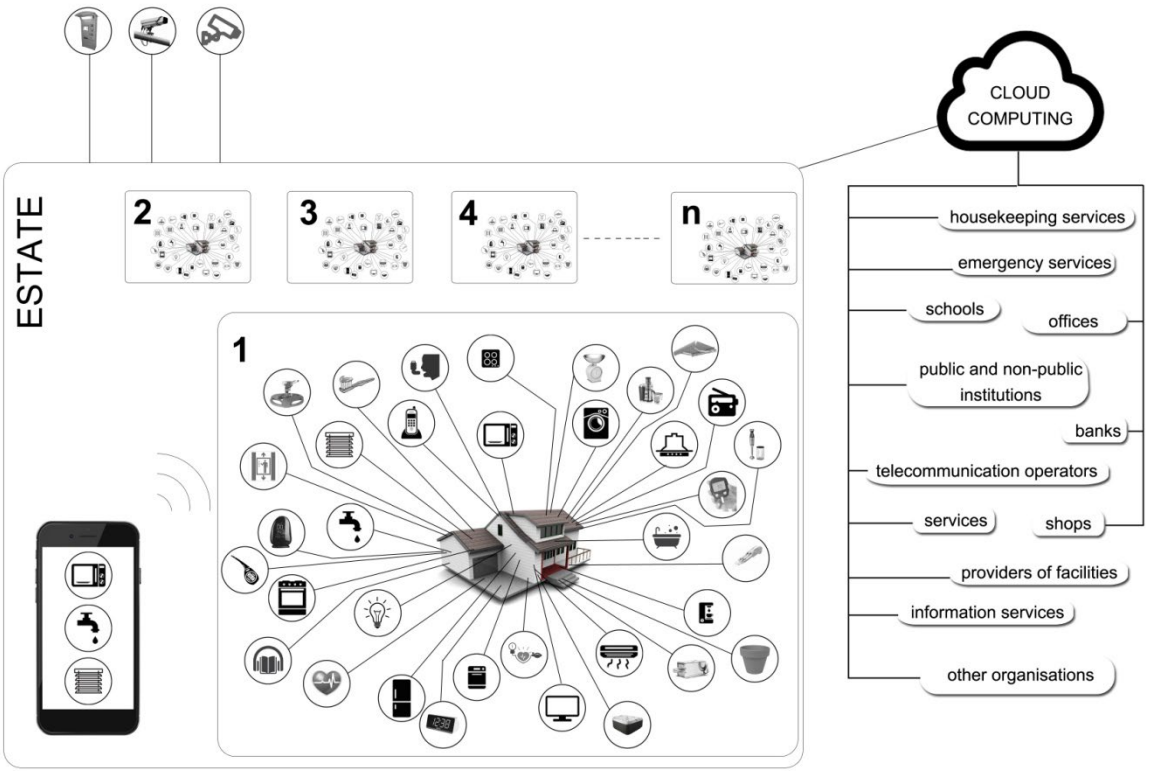

Figure 1: Examples of IoE utilisation for communication of any elements of smart home in a smart estate through a webcam handled by Cloud Computing. Source: Own elaboration.

5. Potential areas of IoE solutions application

Primary areas of implementing the concept of the „Internet of Everything" include (Kokot, 2015):

- Smart environment monitoring – in this scenario a key role plays a vast network of sensors that collect data on temperature, wind, rainfall, level of rivers, etc. (Kiełtyka, 2019). Collecting and real-time processing of this data allows to detect anomalies that may constitute a threat to human life. This activity is the least visible from the customer perspective. It is aimed at anthropogenic environment security and its operations comprise automated systems for ongoing monitoring.
- Smart energy – comprises a series of solutions that allow for management of utilities. It includes monitoring of individual consumption and also the processes of its production and usage. The analysed energy sources include renewable and non-renewable ones, mainly such systems as: solar, wind, thermal and water management.

- Smart metering – concern, among others, automation of the processes on the side of the recipient, instant billings for actually consumed resources, a possibility of changing the tariff, blocking the installation, collecting statistical data related to supplied and consumed energy, ongoing monitoring.
- Smart health – comprises a wide spectre of applications used for health and physical activeness monitoring. It allows for patient security monitoring (both in hospital and at home). It offers, for example, sleep control (through smart mattresses) or teeth control (through smart toothbrushes).
- Smart industry – comprises the area that enters the solutions related to particular industries of the national economy. The possible application areas may include: resource level monitoring (water, liquid fuels, gas), storage facility condition monitoring, machine diagnostics, working conditions or product processing (Jelonek, 2020).
- Smart production – similarly to smart industry it comprises solutions that are entering particular sectors of the economy. The IoT and IoE solutions handle both issues related to agriculture, farming or crops, to production line control, product rotation control in shelves of supermarkets or control in storage facilities and warehouses.
- Smart transport – belongs to key segments that support the economy. It comprises logistic processes support, among others, for the following areas: transport location, controlling transport conditions, conditions of material storage and transport organisation.
- Smart water management – comprises a wide range of issues related to administering and managing environmental resources in the ecosystem, essential for the environment functioning. Thanks to the IoT and IoE it is possible to manage in real time processes of water supplies, starting with the control of its fitness for consumption and manner of storage, through supplies and seal of water supply systems, to monitoring consumption by end users.
- Smart city – a special area for monitoring and organising all the key processes pertaining to functioning of cities, from traffic to public security diagnosing. The area of particular analysis are the levels of: noise, lighting, pollution, parking space load, vibrations or tourist information (Ahlgren, 2016).
- Smart building and its surroundings – consist in smart management of the building and its surrounding. It comprises a whole series of facilities that may be used both at the individual as well as industrial level: property monitoring, movement sensors, smart watering, thermostats, etc. Possible solutions include control of external and internal conditions. Monitoring can also include information on a particular location of threats (e.g. smoke, fire, CO_2).
- Smart flat – covers a whole series of individual expectations, solutions and applications. Most of the expectations are related to household appliances. For instance: fridges (informing about the content, expiry date, need for re-supply), washing machines (enabling energy consumption in lower tariffs), cookers (allowing for remote settings of the oven), humidifiers (ensuring proper air humidity especially for small children). Solutions in this category allow for control of utilities usage (controlling light bulbs, thermostats, air-conditioning) and security (child supervision, cameras, alarms).
- Smart life – comprises a whole range of consumer solutions aimed at convenience and security. They include, for example, shopping support (compliance with habits, monitoring the contents of allergens, expiry date), remote control of equipment to prevent accidents, weather conditions monitoring (temperature, smog, humidity, atmospheric pressure, wind force and rainfall) or personal belongings protection (wallets, jewellery, watches, mobile phones).

The more important abovementioned areas that absorb objects and people that reside in a smart estate utilise the standard forms of managing the knowledge that has been accumulated there.

6. Most essential elements of management system utilised in smart estate buildings

Some of the essential elements that can be applied in smart buildings offered while constructing a smart estate include

- Motion Sensor – a wireless motion sensor that measures light intensity and room temperature. It comes equipped with an embedded accelerator, which detects a change of position or an attempt to open the door or window. The sensor in the Motion Sensor permits to adjust dynamically the operation of lamps to the amount of natural light. It is capable of setting best lighting parameters for the residents and space around the building saving the energy (Barbancho, 2019).
- Door/Window Sensor – a sensor of opened doors, windows, gates with an embedded probe for temperature measurement. It can ideally fit in any interior. Its task is to warn users if windows, garage

gate, doors inside and on the outside of the building, and entrance gate to the estate have been left open. Another feature of the sensor is sending information about approaching change of the weather.

- CO, CO_2 Sensor – very sensitive, certified sensor of carbon monoxide and carbon dioxide that detects even slightly increased amount of carbon oxide, which in the longer perspective can affect the comfort of residents or even the whole estate. It cooperates with other devices of the system and so creates a smart structure of active security.
- Flood Sensor – a sensor that combines several useful functions selected with regard to security and comfort of use. It serves as: flood sensor, temperature sensor, sensor detecting construction deformations in rooms. It is equipped with a light and acoustic alarm, which instantly inform users about incidents. The sensor is fitted with electrovalves that block water influx and minimise the effects of a plumbing failure.
- Heat controller – a sensor for controlling room temperature. The thermostatic head based on room cubature calculates the time it needs to reach the temperature desired by the user. The thermostat can be controlled manually, remotely, with voice or application. The device can operate in accordance with a schedule defined by the user, which can be adjusted to particular rooms (Orłowski, 2020).
- Intercom – a multifunctional and smart device that „sees" and „hears" perfectly. Recording messages makes it similar to the answerphone. Even in the event when user is not . at home Intercom will notify them about being visited at that time. The device with the assistance of the system or user makes it possible, for instance, to let somebody inside the house/flat during the owner's absence.
- Switches – one of the key smart elements of managing home. It proves useful in numerous places and is versatile. It makes it possible to activate and disactivate household appliances, lighting, or power in electrical sockets. Thanks to the function of "power metering" it provides accurate information on energy consumption. It can also turn on the majority of household appliances at any time or automatically turn them off in the event of a failure by cutting off and restoring power in the socket. Devices that work in standby mode influence significantly home budget.
- Roller Shutter – an actuator that enables users to control domestic devices such as electric rollers, canopies, blinds, curtains, recuperation, air-conditioning or gate. Calibration of the module permits vision cameras and gate wings to be precisely placed in the position chosen by user.
- Home Centre Lite – a control room of a smart home, a compact control centre that managers the devices of the FIBARO system with the use of an intuitive application. It offers a possibility of controlling home conveniently thanks to the bespoke application and voice assistants Amazon Alexa, Google Assistant and Apple Siri, and Messenger.

7. Awareness of knowledge utilised in smart estate - research

The Smart Home system controls smart flats and smart buildings. The Smart Housing Estate system comprises communication systems of all the buildings in an estate, and the Smart City system is utilised to control smart cities. These systems based on the knowledge obtained from deployed sensors transmit registered information to a collective database and users of smartphones, tablets or notebooks. Thanks to Smart Housing Estate solutions users and persons managing a smart estate can react instantly should unforeseen situations occur.

To determine the usefulness of the analysed and presented in this paper solutions a survey has been conducted. It reflects the transformations undergoing in the information society (Kierzkowski, 2020). The survey included close-ended questions of single and multiple choice. More than 200 respondents from all age groups filled in the questionnaire in the electronic form. Generally, the questions were aimed at obtaining information about the possibility of applying smart solutions.

The respondents' answers to the question about the areas in which they use smart home solutions have been presented in Figure 2.

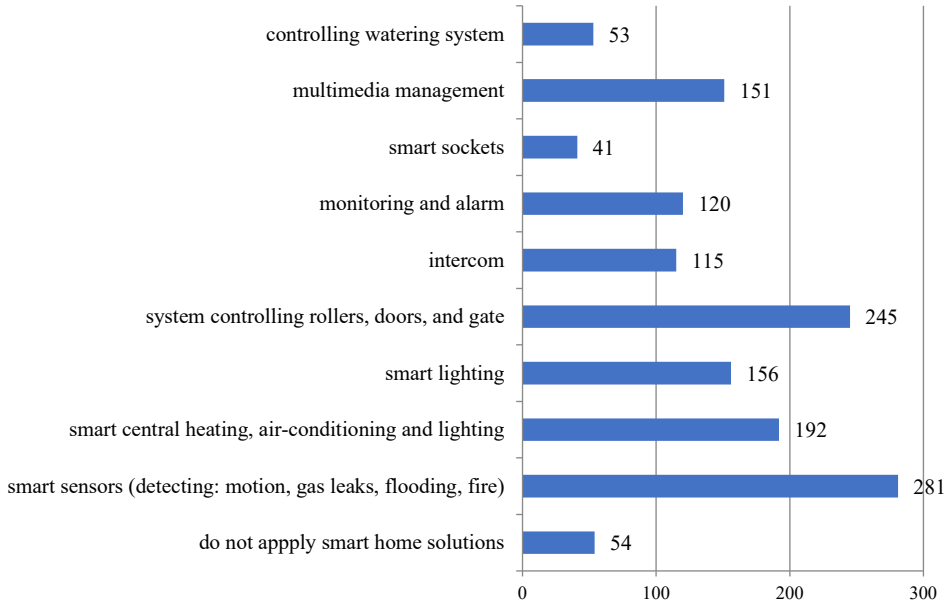

Figure 2: Areas in which respondents use smart home solutions

The great majority of the respondents utilises smart sensors that detect: motion, gas leaks, flooding, fire. Other used sensors include roller control systems for rollers, doors, and gates. The least interest concerns controlling smart electrical sockets.

Another issue presented to the respondents was the question about motivation to purchase a house or flat in a smart estate. Results of the survey have been presented in Figure 3.

The prevailing number of answers indicated improved standard of life, technological possibilities that make everyday life in a house/flat in a smart estate easier, and a willingness to change the hired flat into an own one.

A vital issue was also asking the respondents about the most important functions that in their opinion a smart estate should fulfil. The answers to this question have been presented in Figure 4. The respondents believe that the most important functions that a smart estate should fulfil to its users include: improvement in the quality of life, significant sense of security and convenience of use ensured by implementation of modern ecological solutions.

While analysing the possibilities of managing the knowledge obtained through various types of sensors deployed in a smart estate the respondents were asked to indicate the most important, in their opinion, element of a smart estate that dominates and is the final argument for living in one. The answers related to this issue have been presented in Figure 5. The most frequently indicated in the conducted conversations and the completed survey questionnaires include: efficient security system for the residents and monitoring system of a smart estate. The least attention was paid to the platform of communication with the residents.

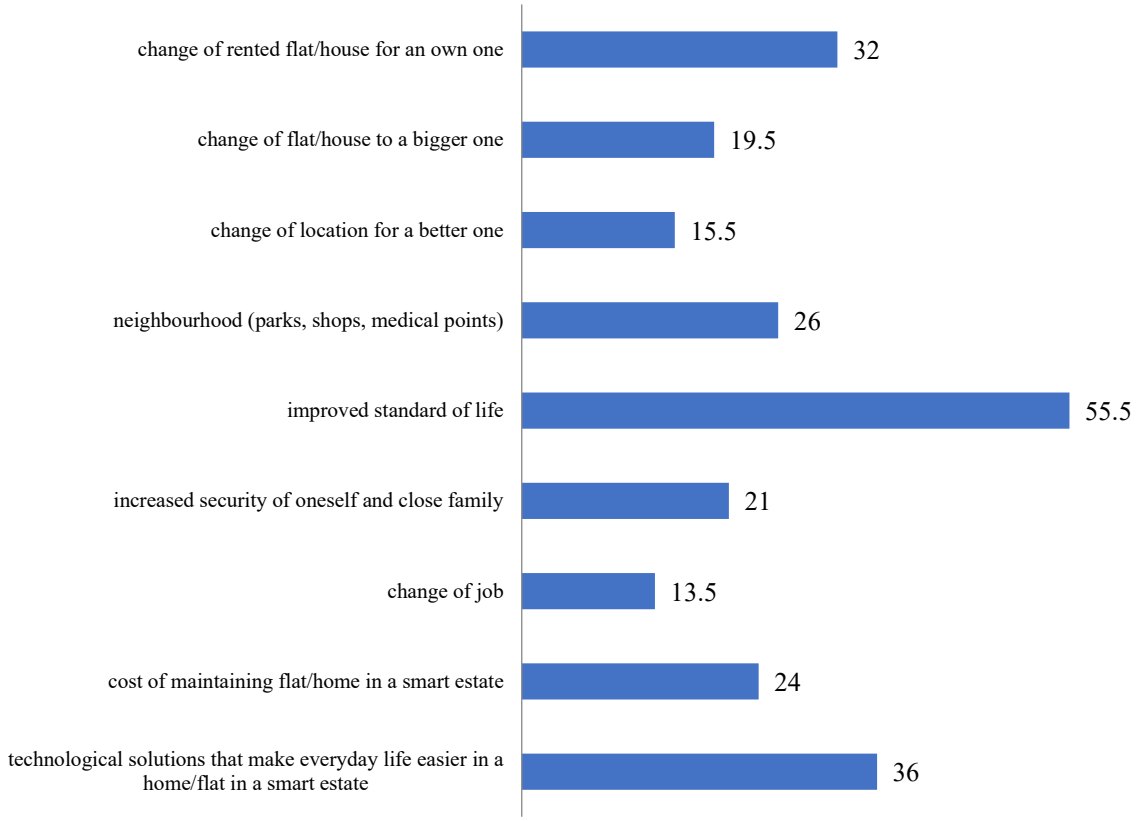

Figure 3: Motives for purchasing a house/flat in a smart estate

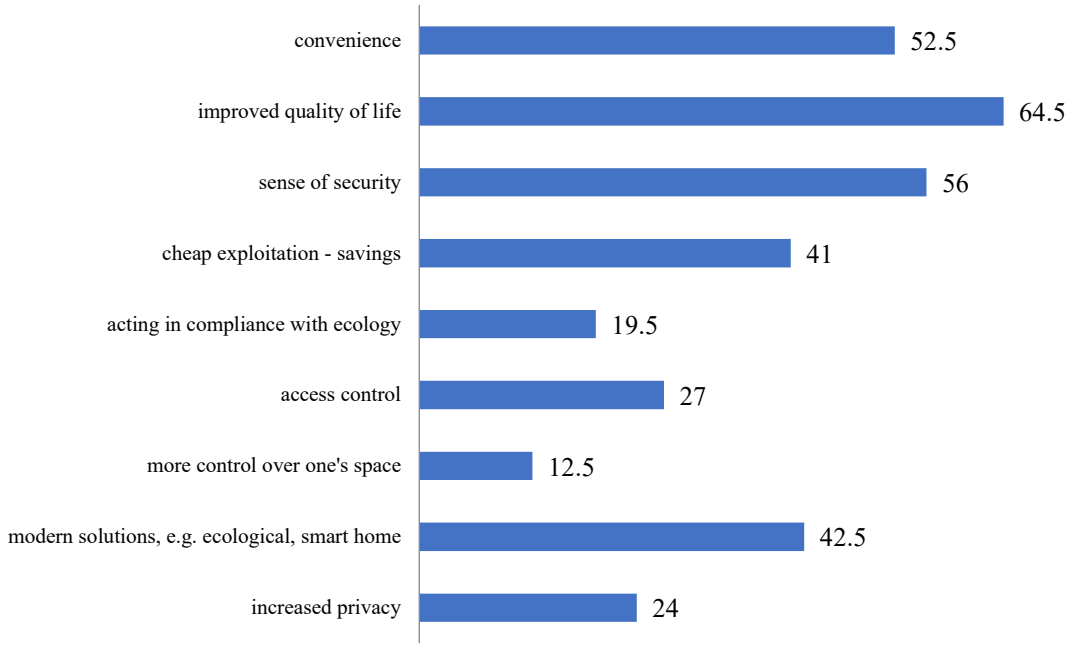

Figure 4: Most important functions of a smart estate

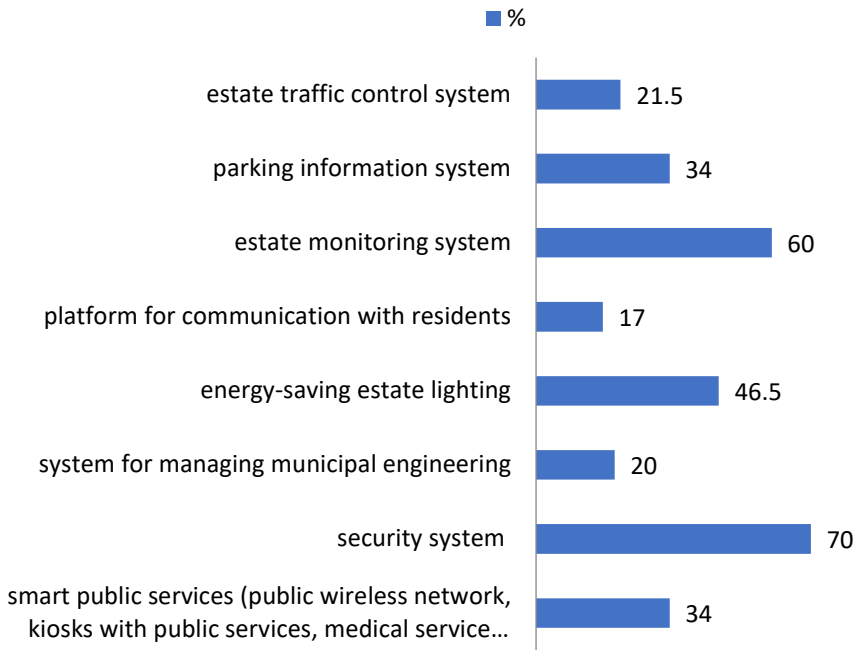

Figure 5: Most important elements of a smart estate indicated by respondents

In an attempt to determine an indispensable knowledge database accumulated in the systems that control a smart estate the author has also analysed further surveys directed at respondents who would intend to live in a smart estate and those already living in one. Apart from the already presented ones, some of the most relevant covered such queries as:

- - What special features should characterise a smart estate,
- - Would you accept an increased cost of purchasing a flat in a smart estate equipped with energy-saving devices (photovoltaics, recuperation, water protection, recycling, etc.)

8. Summary

The conducted research has demonstrated that not only the possible to use knowledge but also the already gathered one is fully utilised by smart communication systems applied in managing a smart estate. Internalisation of the capacities of smart communication systems based on the Internet of Everything ensures proper management of knowledge based on the collected information, which translates into a better management of market offer with regard to customer preferences. Implementation of the concept of a smart estate that utilises smart communication systems is an open and continued task. In the paper the author has presented in a symbolic way elements, devices, objects, equipment that utilise a knowledge database and are controlled with the use of digital communication systems based on ever more frequently applied the Internet of Everything. Potential areas where the capacities of the IoE can be utilised outline the scope and importance of such procedures as: security of anthropogenic environment, statistical visualisation of using available utilities, individual monitoring of health condition of residents living in a smart estate, transport, management of environmental resources in the ecosystem, public security diagnosis, controlling consumption of utilities, weather conditions monitoring or personal property protection. Issues related to utilisation of information communication systems that create a certain knowledge repository while managing processes in a smart estate clarify the explored in the literature on the subject area of application and capabilities of smart communication systems controlled with the use of the concept of the IoT.

References

Ahlgren B., Hidell M., Ngai E. C.-H. (2016), *Internet of Things for Smart Cities: Interoperability and Open Data.* Journals & Magazines, IEEE Internet Computing Volume: 20, Issue: 6, Nov.-Dec. p. 52 – 56.

Barbancho J., Ropero J., Luque J., Caraballo A., León C. (2019), Social Parking: *Applying the Citizens as Sensors Paradigm to Parking Guidance and Information*, Departamento de Tecnología Electrónica, Universidad de Sevilla, 41011 Sevilla, Spain, Department of Software Engineering and Business Solutions, Soltel Company, 41092 Sevilla, Spain, Published: 20 November.

Brad B.S., Murar M. M. (2014), *Smart Buildings Using IoT Technologies*, „Constructions of Unique Buildings and Structures", No.5 (20), p. 17.

Cha S., Ruiz M.P., Wachowicz M. (2016), et.al. *The role of an IoT platform in the design of rel-time recommender systems.* Proc. of IEEE 3rd World Forum on Internet of Things, p.1-6, USA.

Dybowski P., Kurz D. (2018), *The analysis of the possibilities to control temperatur in a building using the TELETASK system automation*, Przegląd Eletroniczny, R. 94, nr 4, s. 180-186.

Jelonek D., Nitkiewicz T., Koomsap P. (2020), *Soft skills of engineers in view of industry 4.0 challenges*, Conference Quality Production Improvement–CQPI 2 (1), p. 107-116.

Kiełtyka L. (2013), *Wykorzystanie systemów eksperckich w zarządzaniu wiedzą*. ZN Politechniki Łódzkiej, seria „Organizacja i Zarządzania" nr 1148, z. 53, s. 119-130.

Kiełtyka L. (2017), *Inspiracje i innowacyjność w zarządzaniu współczesnymi organizacjami,* Przegląd Organizacji, nr 7, s. 32-37.

Kiełtyka L. (2019), *Application of the Internet of Things and Internet of Everythings in the activites that implement the concept of ecosystem*, Przegląd Organizacji, nr. 6, s.39-43.

Kiełtyka L. (2020), *INTERNET bazą multimediów w biznesie*, Wydawnictwo Dom Organizatora, Toruń 2020, s. 432.

Kiełtyka L., Zygoń O. (2018), *Współczesne formy komunikacji – jak zarządzać z wykorzystaniem Internetu Rzeczy i wszechrzeczy,* Przegląd Organizacji nr. 2, s. 24-33.

Kierzkowski Z. (2020), *Kierunki przemian w społeczeństwie informacyjnym Przegląd problemów zmagań z nowoczesnością.* Przegląd Techniczny, nr 9-10, s. 29-31.

Kierzkowski Z. (2013), *Wieloaspektowy rozwój technologii społeczeństwa informacyjnego i przemiany strukturalne organizacji działań*, Biuletyn Organizacyjny i Naukowo-Techniczny SEP „Spektrum", nr 3/4, s. 4-8.

Kokot, W., Kolenda, P. (2015). Czym jest Internet Rzeczy. [w]: M. Grodner, W. Kokot, P. Kolenda, K. Krejtz, A. Legoń, P. Rytel, R. Wierzbiński, Internet Rzeczy w Polsce (s. 8–11). Warszawa: IAB Polska.

Orłowski, C., Cygert, D., & Nowak, P. (2020). Continuous improvement process model for supporting the construction of Internet of Things system design environments. In *Communications in computer and information science* (pp. 424–435). Springer. https://doi.org/10.1007/978-981-15-3380-8_37

Singh K. J., Kapoor D.S. (2017), *Create Your Own Internet of Thinsg*, A Survey of IoT Platforms. IEEE Consum. Ele. Mag., 6/2017.

Sroczan E. (2020), *Funkcjonalności instalacji budynku prosumenta udostępniane przez chmurę i Internet 5G*, Elektro Info 3, s. 20.

Zhang Y., Wen J. (2017), *The IoT electic business model: Using blockchain technology fr the internet of things*, Peer-to-Peer Networking and Applications, Springer US, No 7.