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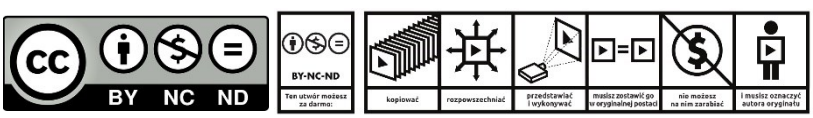

Wersją pierwotną Kwartalnika Naukowego „Organizacja i Zarządzanie" jest wersja papierowa

CONTENTS

ADVANTAGES OF IMPLEMENTING PROJECT MANAGEMENT IN ENTERPRISES

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Introduction/background: This article presents the advantages of using project management in an enterprise. The article is developed on the basis of a literary review including the results of the author's own research.
Aim of the paper: The goal of the article is to identify the main advantages for the introduction of project management in an enterprise.
Materials and methods: The method of writing the article is a literary review, which was made on the basis of research materials from international scientific journals. As an example, the author considers the public sector of the Republic of Kazakhstan.
Results and conclusions: Based on the literature review described in the article, the results obtained from the implementation of project management at enterprises allow to reveal in more detail the advantages of using project management. However, the existing problems faced by some enterprises still remain a barrier to achieving certain goals of the enterprises themselves. Based on the author's own research, the article examines the indicators of the implementation and use of project management on the example of the public sector of Kazakhstan. Problems in the implementation and use of project management in the public sector are based on the lack of necessary national standards, qualified specialists and not high involvement of the state authorities in the implementation of project management. According to these problems, recommendations are given that can help solve some problems and improve the overall project management system in the public sector.

Keywords: Project management, national standard, project management in the public sector, project management in Kazakhstan.

1. Introduction

The experience of human civilization is defined by various standards. According to the definition, a standard is a document established by an authorized body, custom or by common consent as a model (PMBOK, 2017, p. 2). Project management is applied everywhere and to everything. By following the algorithm when implementing projects, a person or a team achieves success. If we turn to the definition, project management is the application of

knowledge, skills, tools and methods to the work of the project to meet the requirements imposed on the project (PMBOK, 2017, p. 10). Many countries with advanced economies have been using project management for quite a long time, and for these countries project management is a system that is used in their daily and professional life (Alibekova, 2012). According to A.F. Tsekhovoy (Tsekhovoy, 2014), project management has acquired a systematic character and provides certain results that are tangible. In this connection, the popularity in the world is growing. Currently, project management is not limited exclusively to projects, it can also be used to manage any objects, even without having a project shade. For example, project management in Kazakhstan contains a multifunctional approach and has been widely used in the public sector of the country. Interest in the application of project management methods in Kazakhstan has grown in recent years in all sectors of the economy (Martsenyuk, 2018). According to I. Adizes, "Management is democracy in decision-making and dictatorship in their implementation" (Levyakov, 2021). The introduction of project management requires taking additional measures aimed at changing the presented approach to the project management of the enterprise, attracting qualified specialists in the field of project management and possibly adapting the organizational structure and culture. At the same time, knowledge and experience in the field of implementation and application of the project management system are required (Almaty: KazgovINTI, 1993).

Thus, the approaches of project management can be adapted to any culture. Project management is a flexible tool for achieving the goals set by any enterprise. It is worth noting that the introduction of project management is necessarily associated with additional financial costs, as well as the cost of a certain amount of time and resources, the use of project management brings many advantages to enterprises, positively affecting their final result.

The article is organized as follows. The next section describes an analysis of the implementation and use of project management based on a literary review. Additional benefits about project management are described in Section 3, after which the next section discusses a number of reasons for implementing project management in the enterprise. At the end of the article, the author gives recommendations on the implementation of project management in state structures.

2. Analyses of research on the implementation of project management in an enterprise

The vast majority of key studies and publications show that the advantages of using project management related to their implementation and development have a positive impact on enterprises (Aleksandrov, 2017). A significant amount of research in the field of project management has been devoted to the factors of success in projects (Ika, 2009). For example,

Muller and Turner (Müller, Turner, 2010) investigated the importance of managerial skills and attitudes for the success of the project. Gemunden and others (Gemünden et al., 2005) investigated the impact of autonomy on the success of a project when developing a new product. Other studies have focused on common success factors in projects, such as the study conducted by Murphy (Murphy et al., 1974), Pinto and Slevin (Pinto, Slevin, 1987), Cook-Davis (Cooke-Davies, 2002). In recent years, there has been a growing trend to take into account factors that represent important values in projects, such as trust, commitment, loyalty and openness (Schein, 1990; Anantatmula, 2010; Andersen, Dysvik, Anne, 2009; Maurer, 2010; Belassi, Kondra, Tukel, 2007; Small, Walker, 2010; Hussein, Hafseld, 2016; Zidane, Hussein, Gudmundsson, Ekambaram, 2016) Fortune and White (Fortune et al., 2006) reviewed many publications that focus on critical success factors in the project management literature in order to study the correspondence between these publications with respect to project success. Wateridge et al. (Wateridge, 1995) concluded that there is limited agreement in the literature on the factors influencing the success of the project. The lack of agreement on the factors influencing the success of the project prompted researchers to focus on the use of a conditional approach to determine the success factors in projects (Hanisch, 2012). For example, Shenkhar et al. (Shenhar et al., 2002) distinguish between general and specific factors of project success. The work of Rolstados et al. (Rolstadås et al., 2014) and Shenkhar and Dvir (Shenhar et al., 2007) showed that in order to achieve success, it is necessary to adjust the way of project management in order to adapt it to the project context. According to Larsen and Myers (Larsen et al., 1999) an important conclusion from recent studies of project success suggests that projects are not always unique and may have different contextual factors and a different degree of these contextual factors at different stages of the implementation process. Therefore, each project requires a different approach, depending on the degree of each characteristic of the project and the stage of implementation.

Sylvius and Schipper (Schipper et al., 2018) are of the opinion that sustainability concepts should be integrated into the way projects are planned, organized, executed, managed and regulated. This perspective of sustainable development in project management (Novak et al., 1984) has turned into the concept of sustainable project management, which is defined as "planning, monitoring and control of project implementation and support processes, taking into account the environmental, economic and social aspects of the resource lifecycle, processes, results and effects of the project, aimed at realizing benefits for stakeholders and implemented in a transparent, fair and ethical way that includes active participation of stakeholders".

Based on the general theory of management developed by leading foreign researchers (N.A. Vitke, A.M. Omarov, T. Parsons, A.I. Prigozhin, A. Fayol etc.), it can be noted that flexible, organic, adaptive control systems can be effective. The conceptual justification of the adaptive approach as a scientific approach is studied, for example, by N.A. Zaruba. The author determines that the concept of adaptive approach in management is based on the idea of "adaptation", which is considered in science as a strategy of adaptation (Zaruba, 2014).

The concept of an adaptive approach in management, in her opinion, is that in real life, the strategy of any organization (institution, etc.) is a combination of the most profitable courses of action, taking into account factors not only external, but also internal environment. According to the author, management actions are aimed at actively using the strengths of the system and simultaneously braking, and this can also manifest itself in ignoring and containing the negative trends of the system.

N.A. Zaruba notes that "there is a need to understand the adaptive management process as the one based on an adaptive approach that contributes to obtaining the desired results through managerial influences based on the use of flexible management methods" (Zaruba, 2012).

According to Aarseth W., Ahola T., Aaltonen K., Økland A. and Andersen B. (Aarseth et al., 2017) the number of studies devoted to the integration of sustainable development in project management in the field of project management is only growing. A well-thought-out project management system increases the efficiency of the enterprise as a whole, and also allows to minimize the risks of the project (Al-Kilidar, Davis, Kutay, Killen, 2011). To structure the tasks assigned to the enterprise, there is a need for a centralized structural unit that could unify the tasks of the project and conduct all the activities of the enterprise. To do this, enterprises create a project management office. In organizations, the Project Management Office (PMO) plays a leading role in project management standards, methods and practices (Carboni, González, Hodgkinson, 2013). According to the majority of opinions that project management is considered as a tool for guaranteed achievement of results, many enterprises in Kazakhstan, decided to implement and use existing methods and approaches in project management, without creating something new for the country. For Kazakhstan, project management is currently an important tool in achieving the goals set by the Government of the Republic of Kazakhstan. Project management is especially important for the implementation of large projects of national importance in the country. However, it is not possible to use all the mechanisms of project management in the public sectors, since there is a general problem in the absence of clear algorithms and mechanisms for project implementation. As a result, there is lack of efficiency or a complete failure of the project deadlines. In this regard, since 2017, the Government of the Republic of Kazakhstan has been actively engaged in the implementation of Project Offices in ministries in various sectors of economic activity. One of the most popular industries where the introduction of a Project Office is primarily necessary is the information technology industry. In the era of rapid digitalization of Kazakhstan (Pererva, 2017), Project offices began to be actively created in ministries. The author's own research has shown the presence of 18 ministries in Kazakhstan, where Project offices have started functioning in only three ministries. As for local executive bodies, only four of the existing 17 have established Project Offices.

One of the first successful examples of the implementation of project management in the state structures of Kazakhstan is the Prosecutor General's Office of the Republic of Kazakhstan. The initiator of the transformation of the Prosecutor General's Office of the Republic of

Kazakhstan was the head of this department. By his order, a Project office was formed in 2016. The functions of the Project Office of this department are to monitor the implementation of projects and tasks of the change program, provide methodological support and assistance to project teams, implement project management standards and tools, and develop a system for motivating project personnel. The work in the Prosecutor General's Office was structured, where the system of its work developed the following rules: at the initial stage, employees form a list of problems, then in the project office they structure the list and develop a project passport, which indicates the resources spent on the project, roles, benchmarks and the expected result. Finished projects are defended before a board consisting of members of the change team. The project passport, which is a kind of contract between the management, which acts as the customer, and the project manager in this case is in the role of the performer, allows to maintain continuity in the implementation of goals and objectives, if the performer changes. When the contractor has any questions, he returns to the project office, where he is consulted. The entire methodology developed in the Prosecutor General's Office is based on the experience of the department, combining tools based on PMBOK, PRINCE2 and other national standards. As a result of the transformation of this department, the Prosecutor General's Office has achieved a higher level of communication when interacting with other state bodies. The visible result of the changes made it possible to automate criminal cases into an electronic format (Nikolayeva, 2018).

The experience of the Prosecutor General's Office has shown that Kazakhstan's state structures have a potential in the field of project management. In 2017, the “Regulations of Project Management in the Government of the Republic of Kazakhstan” was adopted, which became an impetus for the further introduction of Project offices at Kazakhstani enterprises.

3. Advantages of implementing and using project management

There are many studies on the advantages of implementing and using project management. Project management provides an opportunity to move from ideas to results, providing a wide range of tools and methods that can make projects successful. Today, individuals, organizations and countries are interested in project management, becoming a separate profession with excellent opportunities for career growth, with bachelor's, master's and certification programs (Chmielarz, 2015; Hobbs, 2009).

The use of project management can also provide other benefits for enterprises. Among the most important ones described in the literature are marked in Figure 1.

Figure 1. The benefits of using project management in an enterprise.

In addition to the advantages of project management at the enterprise, the use of information technologies developed specifically for project management allows to implement the planned project more efficiently and with the least risks. Information technology is a strategic auxiliary function in organizations that exists to help organizations achieve their intended strategic goals. This plays a crucial role in the activities of organizations. As a result, organizations continue to invest in IT technologies in order to work better, remain competent in the global market and make a profit (Joslin, Muller, 2016).

The role that information systems play in supporting organizational processes and maintaining the competitive advantages of modern enterprises has been analyzed by many authors (Toffolon, 1996; Dewett, Jones, 2001; Gurbaxani, Whang, 1991). These authors demonstrated how information systems affect organizational characteristics and results. In particular, Dewett and Jones emphasize that information efficiency and information synergy are among the main advantages in project management that increase productivity, and identify five main organizational results of the use of IT that embody these advantages. In addition, these authors discuss the role that information systems play in regulating the relationships between organizational components, including structure, size, training, culture and inter-organizational relations (Lucas, Baroudi, 1994).

4. Recommendations for the implementation of project management in state structures

Improving the efficiency of the public administration system is the key to sustainable economic growth in many countries. In the modern community, the development of Kazakhstan is in improving and modernizing the approaches of the public administration system through the introduction of project management. For successful project management in the state structures of Kazakhstan, it is necessary to identify several recommendations that can significantly affect the state management system (Algiev, 2013).

Development of national standards in Kazakhstan. In market conditions, representatives of professional management schools are engaged in research, analysis and systematization of modern experiences and methods of project management, as well as the development of standards. Guidelines and standards are the basis for the international and interdisciplinary nature of project management (KazInform, 2020). In the world practice, project performers carry out their work in accordance with a single methodology and the requirements of standards. The standard is more voluntary in nature. This is confirmed by the definition of the term “standard” in the Law of the Republic of Kazakhstan “On Technical Regulation” of November 9, 2004 (Law of the Republic of Kazakhstan No. 603-II of November 9, 2004). However, in accordance with this law, a standard is a document that, for the purpose of repeated and voluntary use, establishes rules, general principles and characteristics for objects of technical regulation. Currently, international organizations engaged in the development of project management standards are improving the competencies, knowledge, and skills of project managers by creating unified standards. Table 1 presents project management standards of various levels that describe and combine all generally accepted approaches in the implementation of state programs and projects.

Table 1.
Common standards used for the management of state programs and projects

Name	Developer	Status
ISO 21 500:2012. ISO – International organization for standardization	International Organization for Certification (ISO)	International
ICB IPMA – International Competence Baseline of the International Project Management Association	International Project Management Association (IPMA), Switzerland	International
PRINCE2 (PRojects IN Controlled Environments)	OGC – The Office of Government Commerce, Great Britain	International
A Guide to the Project Management Body of Knowledge (PMBOK)	PMI — Project Management Institute, USA	International
P2M – The Guide book for Project and Program Management for Enterprise	Project Management Association of Japan – PMAJ	National
GOST R 54 869-2011 – Government standard "Project management. Project Management Requirements"	Russia	National
ST RK ISO 21500 – 2014. "A guide to the project management"	Kazakhstan	National
AS/EN/JISQ 9100 – "Quality management systems. Requirements for aviation, space and defense organizations"	International Aerospace Quality Group (IAQG) AS 9100 in North America, EN 9100 in Europe, and JISQ 9100 in Asia	Industry-specific

Note: GOST – Government standard, ST RK ISO – International organization for standardization Standard Republic of Kazakhstan

In recent years, special attention has been paid in the Republic of Kazakhstan to the development of national standards for project management, taking into account foreign experience (Shymkent Panorama, 2020). Since January 1, 2016, the national standard ST RK ISO 21500 – 2014 "Project Management Guidelines" has entered into force in the Republic of Kazakhstan. This standard can be used in organizations of any type, including public, private or public, and for any type of projects, regardless of complexity, size and duration. An important role in public project management is played by the PRINCE2 standard, developed by The Office of Government Commerce (OGC) of the United Kingdom. The PRINCE2 methodology is used in the state structures of Kazakhstan and has certain visible results in its application (Esengeldieva, 2015). However, this methodology has not yet received increased attention. Within the framework of the standards indicated in Table 1, it is necessary to note their effectiveness in state structures in the world community and their possible usefulness in state structures of Kazakhstan (Regulations of Project Management, 2021). Taking into account the specifics and features of project management standardization in Kazakhstan, the following conclusions can be drawn: apply the classification of project management standards in Kazakhstan, divide by the scale of action (international, national (state), industry and corporate standards), and divide by detail into basic and professional qualification standards), which will be structured in all state structures of Kazakhstan as a result.

Certification in the field of project management in the state bodies of Kazakhstan. The domestic management, which is still found in the state structures of Kazakhstan, does not allow a comprehensive approach to project management. Preparation and certification in the

field of project management is an important step forward. Professional certification in the field of project management can contribute to the successful professional development of a state body (KazInform, 2015). The value of certification lies in the following aspects:

- it is based on Kazakhstan and international standards recognized in Kazakhstan, takes into account the best practices and trends in the development of certifications in the world;
- corresponds to the national system of professional qualifications and the main project roles in state and commercial organizations;
- provides the basis for a system for improving and maintaining the qualifications of managers and specialists at the corporate and industry levels;
- corresponds to the time and tasks.

In state structures, the full implementation of project management will serve as a continuity to actions and changes due to changes in internal and external factors (Bassam, 2019). Project management will allow state bodies to monitor any emerging changes in the world, to offer clearly formulated methods to take them into account. Employees of public services should be not just performers, but participants in decision-making processes, which implies the delegation of some powers of the authorities. It is necessary to move from the traditional hierarchical structure to the horizontal one, that is, it implies the use of team management, where certain powers are transferred from the head of the department to the head of the team. Thus, the responsibility for achieving the project goal is distributed among all participants and is not concentrated in the hands of one manager who stands above the others. The application of the project approach will contribute to the transition to management models of commercial companies, that is, a change in the corporate culture and style of work of the authorities, which will lead to timely fulfillment of tasks, the effectiveness of joint activities of various departments and compliance with a high level of discipline. Professional managers can assist state institutions in the implementation of any projects, select and adapt project management models for a specific project. Thus, mandatory certification of employees of state structures will help to improve the work of state structures, increase the flexibility and transparency of their work.

5. Conclusion

Project management has a positive impact on the functioning of the enterprise, in particular on the organizational culture and structure of the enterprise. Project management has acquired a systematic character and provides certain results that become tangible at enterprises. The described advantages associated with the use of project management are an important reason for its implementation at enterprises, including at enterprises with a state structure that

strive to achieve a number of goals set by the Government of the country. Improving the quality of project management, the desire to better adapt to changing conditions, limiting the costs associated with the implementation of individual project risks, or the desire to better use potential opportunities are factors that motivate enterprises to implement and develop a project management system. However, in many cases, the decision to implement project management is also influenced by external factors, such as the lack of national standards, qualified specialists, and budget funds for the implementation of a project management system at the enterprise.

Kazakhstan is considered as an example of the implementation of project management in the public sector. The problems in the project management of the public sectors of Kazakhstan are mainly based on the lack of specific algorithms and mechanisms for managing projects of national importance. Qualified specialists are also the foundation for achieving maximum results in the implementation of state projects. However, for the full implementation and management of projects in the public sectors of Kazakhstan, it is necessary to apply a number of recommendations that will facilitate and structure the work of state activities. The adoption of national standards contributes to repeatedly and voluntarily establish rules, general principles and characteristics for the objects of organizations. For this purpose, Kazakhstan pays special attention to the methodologies of project management of foreign experience. One of the results for project management is the adopted national standard ST RK ISO 21500-2014 “Project Management Guidelines”, which can be used in organizations of any type, including public, private or public, and for any type of projects, regardless of complexity, size and duration.

In general, the project approach and the introduction of national standards will allow synchronizing the activities of public administration structures in Kazakhstan. For correct project management, it is necessary to possess the basic project management tools that can be used in the implementation of state projects. In this case, government employees need to learn popular project management methods, for example, the PRINCE2 methodology, which is highly adaptable to the Kazakh state management structure. The use of tools and approaches of this methodology can allow the implementation of state projects of various scales. At the same time, it is necessary to increase Project offices in the ministries of the Republic of Kazakhstan, where there are still no such offices. To date, Project offices have been created only in 3 ministries out of 18 existing ones. The project Office will be a centralized department in the ministries providing support for project management in the ministries.

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CONCEPT OF USING ELECTRIC CARS IN THE IMPLEMENTATION OF "LAST MILE" DELIVERIES

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Introduction/background: The article is devoted to the possibility of "last mile" deliveries by electric cars with a permissible total weight of up to 3.5 tons.
Aim of the paper: The aim of this article is to determine whether, with the technology currently available from electric car manufacturers, it is possible to use these vehicles for "last mile" deliveries.
Materials and methods: The article contains a literature study of industry publications and the most important legal acts in European Union and in Poland. At the same time, the available issues in the field of "last mile" deliveries and the currently available technology of electric cars were analyzed.
Results and conclusions: As a result of research based on the adopted assumptions for the implementation of "last mile" deliveries and the technical parameters of the currently available electric vans, the article presents a newly developed simplified algorithm showing the relationships between the time and number of unloading in relation to the length of the delivery routes. At the same time showing that the currently available technology of electric cars allows for the implementation of this process with their use.

Keywords: last mile deliveries, electric vans, urban logistics, energy storage, clean energy.

1. Introduction

Last mile deliveries pose an increasing challenge to logistics, which has to meet increasingly demanding customers who expect almost immediate delivery. Due to the increasingly deteriorating condition of the natural environment, transport needs, especially in intensively urbanized areas, must be met while reducing the level of nuisance related to the emission of pollutants and noise. On a daily basis, solutions such as electric delivery vans, energy storage and renewable sources available, often at the place of their demand. Currently, every major car manufacturer has already introduced electric cars to its production profile and at the same time, we can observe very intensively researching and developing of fast charging and storage of electricity technology.

In the presented concept, the electric car, apart from the goods intended for transport, also charges its electricity storage in the transhipment city terminal. Then it delivers the goods to the final customers or the so-called last mile points such as "parcel lockers" on its route, after which it returns to its departure or other suitable city transhipment terminal or logistics center.

Logistics in the era of the growing global problem of accelerating greenhouse processes caused by the increase in environmental pollution. Growing greenhouse gas emissions and the constant exploitation of non-renewable energy resources can significantly accelerate these processes. It seems that logistics is one of the key disciplines that can contribute not only to the inhibition of the above-mentioned harmful effects on the environment, but through integration with modern technologies from various fields, lead to an increase in the pace of work and research aimed at almost complete stopping or reversing unfavorable trends currently observed on a global scale.

The broadly understood logistics through transport and related infrastructure has a significant impact on the development of individual regions. The most urbanized regions are most affected by the problem of environmental pollution, including air pollution. Due to the fact that the end recipients of the final products, statistically, most often live in the most urbanized areas, it is there that the increase in the intensity of logistics processes is an inevitable phenomenon. This is especially true of both developed and developing areas. Naturally, the more urbanized an area, the more vulnerable it is to negative influences caused by transport, therefore it seems necessary to optimize logistics processes related to transport.

2. Theoretical background

The "Strategy for Sustainable Transport Development until 2030" shows that in some urban areas the traffic of cars and trucks should be limited, inter alia, by building ring roads. The infrastructure for alternative fuels will also be developed to ensure that vehicles powered by such fuel can be used more widely in urban traffic. The use of zero-emission vehicles in last mile connections for urban freight services will be promoted. The research carried out as part of this study concerns the flow of goods as part of the last stage of the delivery of goods and materials carried out via a logistics network operating in the urbanized area, taking into account technologies using renewable energy sources.

Due to the fact that the most urbanized areas are most often both the source and the recipient of the goods sent, the problems of distribution and transport in metropolitan areas related to the problems of the so-called Last mile.

Detailed description of the term "last mile" presented by (Mantey, 2017) is one of most often used in logistics to refer to goods transported from the distribution center that is closest to the final recipient. The name itself suggests a distance of exactly one mile, but in fact it is often from several to several dozen miles.

Difficulties in the implementation of the so-called logistics "last mile" result from the ever-increasing density, as we reading in (Branch, 2018) which we observe in urban areas, as a result of which we are dealing with a continuous increase in both the final collection points and the complication of the delivery planning process itself. In addition to urbanized areas, of course, we observe a very high intensity of road traffic, which has a negative impact on the delivery time. In addition, last mile transport issues are undoubtedly problems of sustainable transport of goods in the city's logistics system.

The ways of transporting presented by (Civitas, 2015) goods in the city are becoming an increasingly important issue, as no city is able to meet the consumption needs of its inhabitants without having to import goods from outside the city's logistics system. Last mile logistics in the supply chain becomes an important element.

As we reading in (Klich, 2018) the operators of the last mile are usually the suppliers of letters, parcels and food on the phone. The research conducted for e-Commers Polska shows that the most frequently chosen form of delivery is courier transport directly to the address indicated by the customer.

Due to the necessity to build relatively short shipping sections and the possibility of direct delivery of goods to collection points, the main means of transport used in last mile logistics is a delivery truck. (Szołtysek, 2005) notes that the problem of meeting the transport needs of goods in large cities and agglomerations is difficult.

As (Cichosz, Pluta-Zaręba, 2018) writes the investment outlays on IT systems, infrastructure and people that would have to be incurred in order to improve or re-create a distribution system that would allow entrepreneurs operating in a virtual space to reach a dispersed customer base, would be enormous. That is why many enterprises entrust their "last mile" service to specialized companies.

The condition of the natural environment in cities (Tundys, 2013) is extremely important and requires both maintaining it at an undeteriorated level and striving to improve it. This means that environmental aspects must always be taken into account when designing an urban logistics concept. These assumptions are intensively supported by European Union directives, which we can see in a significant number of EU projects aimed at meeting the relevant environmental requirements in cities.

The essence of the problem is raised by Directive 2009/33/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of clean and energy-efficient road transport vehicles. It requires contracting authorities, contracting entities and certain operators to take into account the energy factor and environmental impacts during the entire life cycle of the vehicle, including energy consumption and emissions of CO2 and certain pollutants,

when purchasing road transport vehicles, in order to promote and stimulate a clean market and energy-efficient vehicles, increasing the share of the transport sector in Community environmental, climate and energy policies.

Another example of EU policy aimed at clean urban transport is Directive 2014/94/EU of the European Parliament and of the Council of October 22, 2014. on the development of alternative fuels infrastructure. The aim of which is to establish a common framework for measures relating to the development of alternative fuels infrastructure in the European Union in order to minimize dependence on oil and reduce the environmental impact of transport. This Directive lays down minimum requirements for the development of alternative fuels infrastructure, including recharging points for electric vehicles and refueling points for natural gas (LNG and CNG) and hydrogen, to be implemented through the national policy frameworks of the Member States, and common technical specifications for such points. charging and refueling, and sets out user information requirements. One of the most noticeable projects is the project of introducing environmental zones in cities. Areas in cities to which only well-defined and marked vehicles have access. Germany has very advanced projects in this regard, which introduced the so-called "Green Zones" referred to as Umweltzone. Only such cars and trucks are allowed to enter these zones, which are marked with a special badge, the type of which depends on the exhaust emission standards met by these vehicles. When entering a given zone without a badge, drivers can expect a high penalties.

In Poland, work is also underway on the inevitable introduction of the so-called "green zones", which is the subject of work on the amendment to the act of January 11, 2018 on electromobility and alternative fuels. According to the new assumptions presented in 2021, the obligation to introduce zones will result from the results of the inspection by the Chief Inspector of Environmental Protection, which will show that the permissible average annual level of air pollution with nitrogen dioxide (NO2) is exceeded. However, in this assumption, the provisions on the permission to enter the zones with combustion vehicles that meet certain Euro standards have disappeared, which can clearly mean that only "zero-emission" cars are allowed.

Undoubtedly, the factor contributing to the growing importance of these problems is the fact of the constantly progressing urbanization, which affects urban logistics by increasing both the number of urban units and the number of inhabitants and their population density in a given area. According to data presented by the United Nations, the degree of urbanization in Europe is currently as high as (74%), while in North America this rate is as high as 84%. According to the data presented by the polish Central Statistical Office (GUS), in the last decade the urbanization index for Poland oscillated in the area of 60%, of which in the Śląskie Region it exceeded the average for Europe, ranging from 76% to even 78%.

The degree of urbanization is quite accurately reflected by the DEGURBA indicator used to classify local administrative units into three groups of units: "cities", "small towns or suburbs" and "areas rural". This classification is based on measuring the population density and geographic continuity (neighborhood) in grid cells with a resolution level of 1 km^2 (kilometer

grid). For this purpose, a grid typology with a resolution level of 1 km^2 (kilometer grid) is used (this typology groups the grid cells into "urban centers", "urban clusters" and "rural grid cells"). The three types of local administrative units (LAUs) are defined as follows:

- cities (densely populated areas): local administrative units where at least 50% of the population lives in 'urban centers',
- small towns and suburbs (moderately populated areas): local administrative units where less than 50% of the population lives in "urban centers" and at the same time less than 50% of the population lives in "rural grid cells",
- rural areas (sparsely populated areas): local administrative units where more than 50% of the population lives in 'rural grid cells.

As we can see in Figure 1, the Śląskie and the area of the Upper Silesian Economic Area is, according to the DEGURBA indicator, the largest and most urbanized area of Poland.

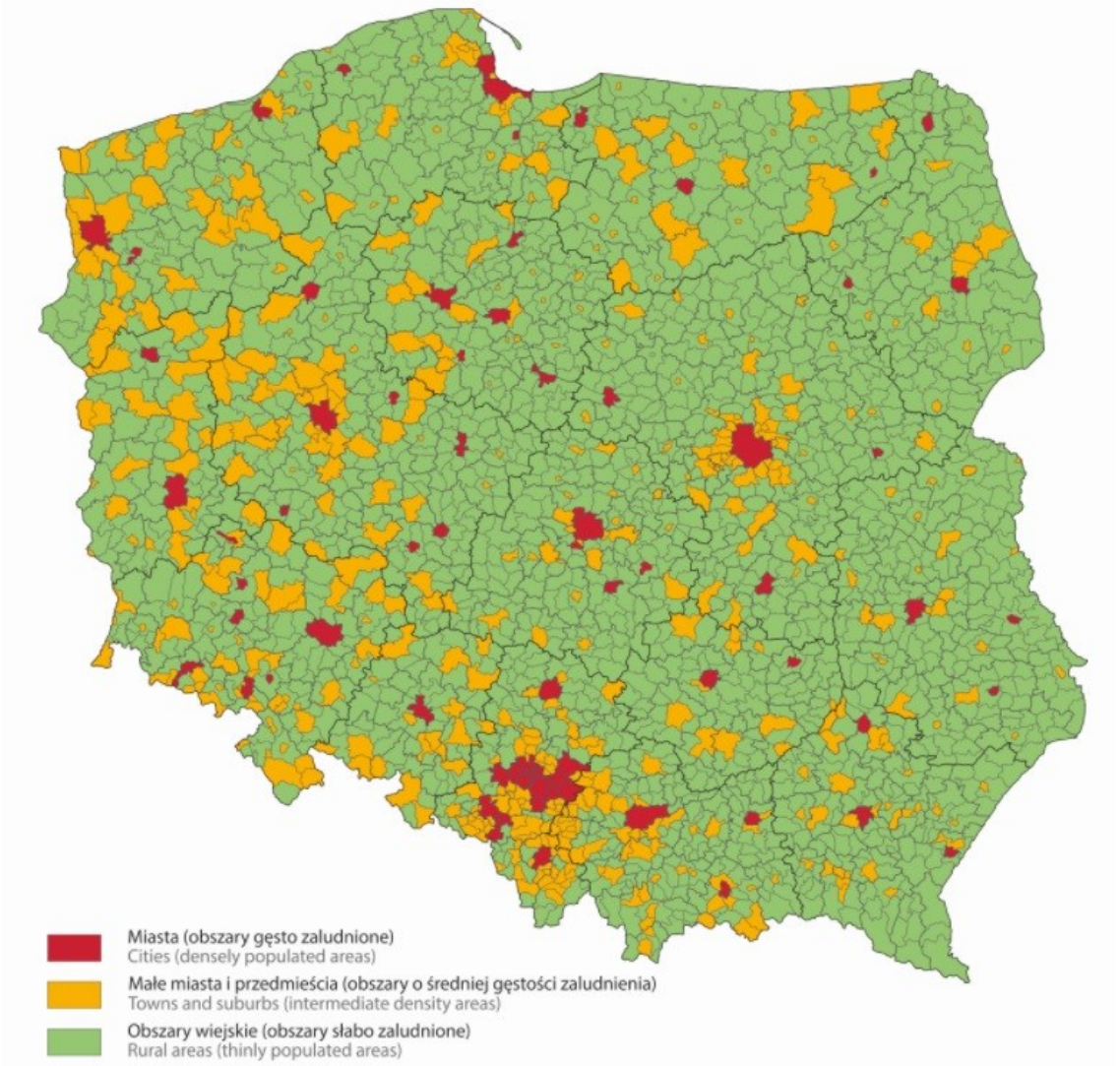

Figure 1. Types of communes in Poland according to the degree of urbanization in 2018. Source: https://stat.gov.pl/statystyka-regionalna/jednostki-terytorialne/unijne-typologie-terytorialne-tercet/stopien-urbanizacji-degurba/.

3. Method

To answer the question whether electric cars can be used in order to implement the last mile in the most urbanized areas we have to check possibility of electrical vehicles in delivery of the last mile. The technical data of exemplary producers of electric cars weighing up to 3.5 tons, which can be used for the implementation of "last mile" transport, was analyzed and an algorithm was proposed. It was taken into account input data such as total working time, the total driving time, average speed in an urbanized area, loading time, number of loads, number of unloading, average unloading time and total time without driving. Above information allow to calculate the average number of kilometers traveled, which allows to answer the above question.

Presented algorithm can only be used for an initial answer to the question whether a given vehicle is capable of performing the tasks set for it. Due to the fact that it takes into account many factors that may affect the results of calculations, such as the topography of a given area, the actual available energy depending, for example, on discharge time as a function of temperature, drive efficiency depending on the driving culture of the driver (acceleration and braking). The article presents, however, the assumed computational experiments and presents the obtained results.

Here, the basic assumptions adopted during the consideration of the possibility of using the concept of using electric cars for the implementation of transport tasks, the so-called Last mile. It was assumed that the typical total working time of a delivery vehicle operating as part of the delivery of goods in an urbanized area is eight hours. In addition, it was assumed that the average time of goods release, in which the vehicle is not working, i.e. it does not consume the previously stored electricity, is 10 minutes. The vehicle is loaded with a loading center which is at the same time an area with available infrastructure that allows for charging the vehicle both in real time, using the energy available from the use of renewable sources and traditional network sources. In addition, it was assumed that the loading time is an average of 30 minutes in a daily cycle, while the average vehicle speed during the delivery will never exceed 50 km/h, which is also conditioned by the restrictions applicable in built-up areas as to the maximum permissible speed.

Example of the electric vehicle range characteristics depending on the constant speed with or without the use of air conditioning and heating we can see in Figure 2.

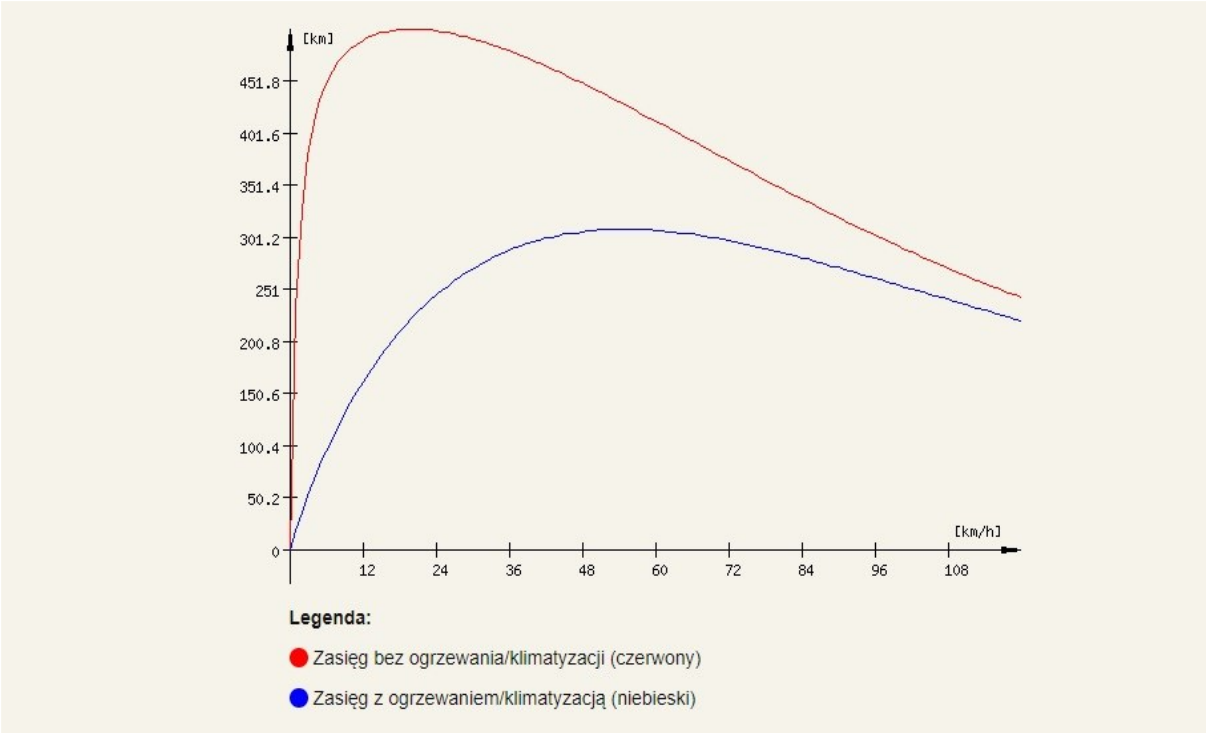

Figure 2. Example characteristics of the range of an electric vehicle in speed function source. Source: https://samochodyelektryczne.org.

The assumptions of the model, the purpose of which is to answer the question of how many stopping points and what time of stoppage is permissible with the currently available electric car technology in the context of last mile deliveries, are presented in Table 1 below.

Table 1.
Parameters and function determining the length of the route

Parameter	Function
Tjs	Tc – Tr
Tr	(Ir * Trs) + Tz
S	(Tjs/60)*Vsr

Note: See Description of variables in table 2.

Source: own study.

In the presented model, the goal is to obtain information on the maximum length of the route that an electric car can cover when performing tasks related to the implementation of "last mile" transport in an urbanized area. Parameters were adopted in the form of constant and variable values, which are presented in Table 2.

Table 2.
Parameters taken into account in determining the length of the route

Parametr	Parameter description	Unit
Tc	total working time	[sec]
Tjś	average driver change/drive time [sec.]	[sec]
Vsr	average maximum speed of the vehicle	[km/h]
Tz	loading time	[sec]
Ir	number of unloading	[ilość]
Tr	downtime	[sec]
Trs	average unloading time	[sec]
S	kilometers traveled	[km]

Source: own study.

Below presented sample calculation in order to carry out the computational experiment, the technical data of some of the electric van cars available on the market, were adopted for the implementation of transport tasks in the area of the "last mile" and presented in Tabel 3.

Table 3.
Sample parameters of selected electrical motor vans

Model	e-NV2001	e Berlingo2	e-Partner3
Motor power KM	109	136	136
CapacitykWh	40	50	50
Range (WLTP) – Urban cycle distance km	301	285	275
Permissible total weight of the vehicle	2220	2 366	2 366

Source: https://www.motofakty.pl/artykul/peugeot-e-partner-citroen-e-berlingo-van-pierwsze-jazdy-wrazenia-dane-techniczne-i-ceny.html; https://ev-database.org/car/1546/Citroen-e-Berlingo-M-50-kWh; https://poland.nissannews.com/pl-PL/releases/release-426214151.

As we can observe, the information provided by the manufacturer confirms the assumptions presented in the characteristics of the electric vehicle range depending on the constant speed indicated in Figure 2 of this article. They directly show that in city mode the range of such a car oscillates around 300 km. In addition, we can see that the landing time with a standard 6.6 kW car charger is 7.5 hours, which should be fully enough to charge the vehicle even twice in the 8/24h operation mode.

It is necessary to include into account the changes in battery capacity with regard to temperature dropping, as we read in (Mazan, 2020) with a tendency to lose the capacity level at lower temperatures. Based on the results of the change in the capacity of the batteries used in electric cars we can see a strong influence of the ambient temperature on the capacity of the batteries up to 13% for a temperature of -30°C.

It should be noted that the number of hours a year in Poland when the temperature drops below -10°C during the day often does not exceed several dozen hours per season.

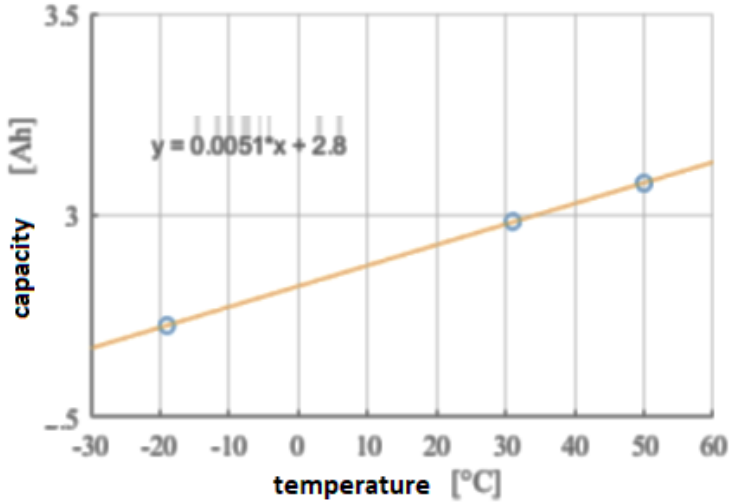

Figure 3. Dependence of lithium-ion battery capacity on temperature change. Source: Mazan B., Detka T. (2020). Eksperymentalne badanie wpływu temperatury ogniwa litowo-jonowego na pojemność i dokładność obliczeń stopnia naładowania. Napędy i sterowanie. Warszawa.

When analyzing the technical documentation of, for example, a Berlingo car in a mixed city cycle at -10°C, the vehicle's range drops from 285 to 215 km, which is a decrease of 24%.

Table 4 presents a selection of 10 sample data sets – the sets have different average loading times and standstill times. It was possible to obtain the optimal ranges for these two parameters, assuming that the maximum permissible route that an electric car can cover is 300 km/day. During the calculations, a large correlation was noticed between the average time of unloading and the number of unloading in the maximum length of the route.

Table 4.
Data of random different average loading times and unloading times

Average unloading time	Number of unloading	Average daily distance
3	30	300.00
4	22	301.67
5	18	300.00
6	15	300.00
7	12	305.00
8	11	301.67
9	10	300.00
10	9	300.00
11	8	301.67
12	7	305.00

Source: own study based on the assumption of 8 hours of vehicle operation and an average maximum speed of 60 km/h.

4. Results and conclusions

In above article presents the results obtained by means of a newly developed simplified algorithm determining the possibility of using electric cars depending on the number of kilometers that can be traveled on the one hand, and on the other hand, the number and duration of unloading occurring at that time. The obtained results can be treated as satisfactory due to the fact that they confirm the possibility of using electric cars to perform "last mile" transport tasks with certain assumptions and limitations resulting from the specificity of electric drive systems.

As (Czerwiński, 2005) writes, it is undoubtedly important here to take into account the problems faced by the automotive industry in connection with the increased demand for comprehensive management of energy resources (Dyczkowska, 2012). Analyzing road, rail and inland waterway transport for the transport of goods, the lowest consumption of energy resources and carbon dioxide is observed in rail transport, and the highest in road transport.

Conclusions: due to new restrictions in the field of pollutant emissions and the introduction of so-called ecological zones in city centers, to which only strictly defined and marked vehicles have access, it is necessary to analyze and revise the approach to deliveries at the most urbanized areas. After analyzing the problem, it can be concluded that, while maintaining the appropriate assumptions, it is possible to make last mile deliveries using electric cars already widely available on the market.

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THE ATTITUDES OF YOUNG POLISH CONSUMERS TOWARDS ENERGY COSTS OF SMART PRODUCTS

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Introduction/background: The attitudes of young Poles towards smart products and their relationship with the costs of energy supplying smart products are the main research objects in this paper. The smart products market is developing very dynamically, including both simple everyday utility products and durable goods with a significant unit value. The authors point out the existence of a cognitive gap regarding the connection between attitudes towards smart products and attitudes towards using electricity. The authors emphasize that the use of smart products requires universal access to the possibility of topping up these products.
Aim of the paper: The study aims to diagnose the attitudes of young Poles towards the location of power sources for smart products and the formalization of access to this power (determining the payer), which will allow in the future to conduct educational activities in the field of optimizing the use of natural resources (energy) as well as marketing activities of smart product suppliers.
Materials and methods: The research was conducted on a group of young Poles in 2021 as online questionnaire. The presented results refer to pilot study in Poland. According to the authors, they have a high level of originality, as there are no previous studies in this area known. In turn, the social and economic problems related to the amount of energy consumed and its costs is a civilization challenge across the world.
Results and conclusions: The results indicate disproportions in the knowledge and attitudes of young Poles towards costs of energy supplying smart products. Research hypotheses were positively verified. Young consumers do not see energy for smart products as "something" that has a price and must be paid for (access to it). The conducted research shows that young buyers are not conscious energy buyers and are not aware of the costs of purchasing energy. Moreover, according to the respondents, both now and in the future, access to electricity (sources of energy) that allow powering smart products should be free and universal. Electricity is a product that has a price, and most likely the cost of energy will increase. Hence, it is important to conduct campaigns to make young consumers aware of the cost of energy and the relationship between the use of smart products and energy costs.

Keywords: energy costs, smart products, young consumers, Poland.

1. Introduction

Smartphones, i.e. multifunctional devices that have replaced traditional telephones, are an example of a new product category called smart products. This category, as will be discussed later in this paper, covers a wide range of products, but the common feature that is the focus of this paper is that they require the use of electricity. Electricity is a market product that has a price, but access to this product is specific – it is "invisible". Plug the cable into the socket and it's done!

Since in the process of socialization a person gets used to the market behavior, according to which receiving a product or service requires paying for it, a person (including young customers who are in the center of interest in this paper) is aware of the costs of obtaining products that meet his needs. The authors of the presented study put a question:

"Are young people aware of the costs of obtaining energy?"

At the same time, electricity is a product related to environmental protection issues, hence the next research question is:

"Do young customers perceive a relationship between the use of smart products (requiring electricity) and environmental protection issues"?

The issue of pro-ecological customer attitudes in various age groups has been of interest for many years. There are also several studies on the pro-ecological attitudes of young buyers. The research focuses mainly on waste segregation, the use of disposable packaging (mainly plastic bottles), and supporting the development of renewable energy.

Analyzing the literature, no studies dedicated solely to the attitude of young buyers to electricity were identified, including the costs of using energy in a household, the costs of using energy as an element of product use. In this context, the authors intend to try to fill the research gap in this area.

The research aims to diagnose the attitude of young Polish consumers to the costs of electricity, in particular, to identify the perception of the costs of energy supplying smart products. In this research project, the authors present these attitudes as an element of purchasing attitudes and analyze them in connection with the pro-ecological attitudes of young consumers in Poland.

The conducted research shows that young buyers are not conscious energy buyers and are not aware of the costs of purchasing energy. Moreover, according to the respondents, both now and in the future, access to electricity (sources of energy) that allow powering smart products should be free and universal.

In addition, the research results allowed the formulation of methodological recommendations for future research on the relationship between smart products and electricity. According to the authors, this will allow for the development of future research in this area and the formulation of practical recommendations supporting the development of smart products.

2. Smart products

The term “smart product” has become popular in everyday life among technology experts, scientists, also politicians. As the idea of smart products is interdisciplinary, the concept itself develops in close relation to the terms like the Internet, the Internet of things, new technologies. In general terms, a smart product is linked to the Internet and it allows the exchange of information about its users, environment, and about the product itself. The group of products that are called smart is very broad: from industrial equipment, home appliances, medical equipment, motor vehicles, to even smart packaging that can report on the location and condition of the product it protects (e.g. RFID systems used in retailing). The popularization of the use of products that we have defined as smart prompted researchers to scientific interest in this product category. The term "smart" is also used differently, e.g. "smart city". At the same time, the smart city fits in the broadly understood context of our research, because it is a concept about the use of information and communication technologies to increase the efficiency of urban infrastructure.

As Porter and Heppelmann (2014) defined, smart, connected products have three core elements: physical components, “smart” components, and connectivity components. Physical components comprise the product’s mechanical and electrical parts. Smart components comprise the sensors, microprocessors, data storage, controls, software, and, typically, an embedded operating system and enhanced user interface. In many products, software replaces some hardware components or enables a single physical device to perform at a variety of levels. Connectivity components comprise the ports, antennae, and protocols enabling wired or wireless connections with the product.

Raff, Wentzel, Obwegeser (2020) have made a comprehensive conceptualization of smart products and, in addition to a broad review of the subject literature, they presented four distinct archetypes: 1. digital, 2. connected, 3. responsive, 4. intelligent. The mentioned authors emphasized that smart products are cyber-physical products that not only possess software-based capabilities but have a distinct material nature.

It is not the purpose of this paper to analyze smart products as such. Although the topic is very interesting, it will not be discussed further. Interest in these products results from the dynamic development of this category and its entry into areas of life that were diametrically different in the past (not related to the use of modern technologies). Smart, connected products are emerging across all manufacturing sectors. What is of particular interest to the authors of this paper, these products have one thing in common – the need for the use of electricity. These products do not exist without access to energy. And this is the main focus of this study. The authors additionally pay attention not so much to the connection with the use of energy, but to the fact that the possibility of using these products depends on access to energy. Therefore

we underline that the common feature of all these products is the addiction to access to electricity.

Additionally, according to the authors of this study, an important feature of smart products is the combined physical and non-material form of the product, connection with software as an inseparable element enabling the use of the product, connection to the Internet (more and more smart products require constant access to the Internet; many smart products can also function in offline mode).

And regardless of whether the smart product is a "regular" phone – a smartphone, an electric scooter that can be rented freely in the city, an electric bicycle, a pressure monitoring wristband, a Thermomix cooking device, credit card, or a different cashless payment system, a complicated smart home system or navigation, allowing you to quickly find the right way to your destination, all these products have one thing in common – using them requires power – energy. They need to be charged, plugged in. Some of these products have their power source, allowing them to function autonomously (battery), but even in this case, the time of its operation is limited and the battery after discharging requires replacement or (more often) recharging. To sum up: smart products depend on access to energy. There are no products on the market that would "charge themselves" and work as a kind of perpetual motion machine. Energy, in the sense of electricity, has become an inherent element of using smart products.

Therefore, as mentioned earlier in the paper, the general question posed by the authors is: are the users of smart products aware of the connection between the use of smart products and energy costs?

An important argument for researching smart products is their importance for the young generation. Behavior and consumption habits change with each generation. The currently observed trend is not only the dynamic increase in the importance of technology products related to IT and the Internet (i.e. "smart products"). The age at which children initiate the use of IT technologies is decreasing. According to research conducted in Poland in 2021, 41% of children started using a mobile phone at the age of 7-8, and 11% at the age of 5-6 (Report: Badanie konsumenckie dzieci i rodziców, 2021). In turn, in 2019 research was carried out in Polish schools of various types, from primary schools (including children from 6 years of age) to secondary schools (young people up to 19 years old), indicating that almost 94% of young people use a smartphone. Young people spend an average of 4.2 hours a day using the Internet (Raport: Nastolatki 3.0, 2019). The youth from secondary schools (15-19 years old) attended on average 4.5 hours and younger children, from primary schools (6-14 years old) – 4 hours on average. So it is visible that the young generation is brought up in the company of constant access to the Internet, of which 65% declared that they listen to music in this way, 62% - watch movies, 61% - contact friends and family, 59% use the media social networks and over 50% do their homework.

Since children are brought up today with constant access to the Internet, they are surrounded by products that are directly related to this access, and as young adults, they will also represent such behaviors.

Once again, however, we return to the question already posed: are the young users of smart products aware of the connection between the use of smart products and energy costs? Are young people using smart products aware of their dependence on access to energy and do they understand that energy is the same product as food that must be paid for? Without electricity, the Internet (and related products) will not work.

3. Customer behavior

When talking about products or services, we also talk about the processes of their acquisition. They can be delivered to users in the processes of commodity-for-commodity exchange or the classical processes of market exchange: commodity for money. Users can also receive access to products and services as part of public services, free of charge. Examples include medical services that can be accessed on the market (private health care) or through public health care (publicly funded). Regardless of how products and services are accessed, their users represent specific purchasing behavior.

Consumer behavior significantly shapes their attitudes, which can be positive, negative, or neutral. Expressing one of these attitudes is very individual and conditioned by the respondent's situation and relationship with the object (Rudnicki, 2012).

Attitude, according to the definition taken from social psychology, is understood as the permanent attitude of an individual towards someone or something. This attitude includes three components: cognitive, affective, and behavioral (Lindzey, Aronson, 1985), with the above-mentioned elements interacting with each other.

Attitudes are built by cognitive and emotional processes as well as behavioral tendencies (DeLamater, 2014). Getting to know them is important because attitudes are difficult to change, and they make people who like or dislike something, strive for something or avoid it (Armstrong, Kotler, 2016).

The customers' behavior results from innate and acquired (still modified) needs and aspirations, the satisfaction of which is a combination of conscious and unconscious processes and emotional factors (Gracz, Ostrowska, 2014).

To understand the impact of attitudes on customers' behavior, Ajzen, Fishbein, Lohmann, and Albarracín (2019) additionally made a distinction between attitudes toward physical objects, or groups of people, institutions, policies, events, or other general targets and the second type – attitudes toward performing specific behaviors concerning an object or target (using the physical object). These attitudes will be referred to as "attitudes toward a behavior".

This distinction is interesting for the research reported in this paper. What is the attitude of young Polish customers to access electricity (i.e. to a physical product)? What is the ratio of young Polish customers to paying for the use of electricity (attitudes toward a behavior)?

The analysis of the literature on the subject indicates the existence of a research gap in the field of understanding the customer attitudes towards smart products, including the attitude of young consumers to smart products which issue is completely unrecognized.

Zied and Chouk (2016) concentrated on the resistance to smart products. Priporas (2020) investigated the influence of smart technologies on the decision-making process. The relatively wide interest of researchers is attracted by the behavior of smartphone buyers. Of course, smartphones are one (and main) example of smart products, but there are many products in this category. Guan et al. (2021) presented research results with insights into the diffusion of innovation theory and provides retailers launching smart products (research based on a smartwatch) with a better understanding of their target young customers' purchasing behavior. Won-jun et al. (2018) underlined that there is a lack of understanding about consumers who buy and use smart products. They concentrate their research on smartphones and underlined that adaptability and multi-functionality have a significant influence on perceived product smartness and consumer satisfaction.

Among the multithreaded research problem undertaken in this paper, it was decided during the brainstorming session that, for this research, three dimensions of attitudes of young consumers towards smart products were adopted:

- cognitive – the tested element of which was the respondent's knowledge of energy costs, its consumption, and saving,
- affective, the manifestation of which in this study was the assessment of the possibility of using and supplying smart products,
- behavioral, which was examined through the declared behavior regarding the daily use of smart products recharging and the validity of the energy consumption criteria in the case of the purchase of smart products.

Additionally, when designing research tools, an important element of the analysis was the distinction introduced by Ajzen et al. (2019) into the attitude to the physical product (electricity) and the attitude towards using this product (in our case: bearing the costs of using electricity).

4. Pro-ecological attitudes of young Polish customers

As has been emphasized many times in this paper, the issue of using smart products is related to the use of another product - energy. Energy is the same market product, traded on the market, buy and sell transactions, it has its value (price) and specific access conditions.

Why are we interested in energy (electricity)? The issues of interdependence between various products are of research interest from various disciplines. In the case of the research presented here, the interest in energy stems from the dependence of modern society on access to energy. As a "product" it has become a very important element of international trade. It is obtained from various sources and used in various forms. The issue of natural resources that are a source of energy is also a critical issue of modern civilization. In this article, we are interested, on the one hand, in energy, understood as electricity, and, on the other, in linking energy use with the natural environment. There is a widespread discussion in society on the need to protect the natural environment, and the issue of the depletion of natural resources, especially energy resources, is also widely discussed. Do we represent pro-ecological attitudes by developing purchasing behavior that makes society dependent on electricity (and these are smart products)? This provocative question is not the subject of research directly in this paper, but the authors attempt to analyze the pro-ecological attitudes of young customers. And they ask whether young customers, as promoters of smart products, are aware of their dependence on electricity? Do they understand that without access to energy, they are not able to meet the needs that they satisfy today with smart products? If there is a shortage of natural energy sources, or – in a less catastrophic dimension, the society will have to significantly limit the use of energy due to its shortages (depletion of natural resources), the use of smart products may (hypothetically) be subject to limitations. The authors' question is whether young consumers see a relationship between environmental protection and the use of products that require electricity?

The pro-ecological attitude is the result of acquiring knowledge and ecological sensitivity of a conscious man (Jarosz, Brol, Jarzębska, Nowińska, Przewoźnik, 2014). The main components of environmental awareness are precisely defined contents, attitudes, and emotions about the natural environment (Kwiatek, Skiba, 2017). These attitudes are shaped throughout life and can change over time. However, their beginning is derived from the process of socialization that the individual goes through from an early age in the family. And then with the knowledge that he develops in the process of training education. Summing up, we can observe pro-ecological attitudes in various age groups, including young people.

In Poland, research has been conducted on the environmental awareness of its inhabitants for many years. They mainly come down to the areas of knowledge and attitude to the natural environment, its protection, waste management, i.e. behaviors and attitudes related to how Poles get rid of waste (waste segregation), how they save energy in households, what is their attitude towards renewable energy sources, how they manage water (methods of saving water in households). Many studies refer to purchasing attitudes and behaviors towards food (preferences for organic products) as well as concerning packaging (plastic bottles, additional product packaging) (Report: Badanie świadomości i zachowań ekologicznych mieszkańców Polski, 2020; Radzymińska, Jakubowska, Mozelewski, 2015).

The studies, conducted periodically by the Ministry since 2011 (Report: Badanie świadomości i zachowań ekologicznych mieszkańców Polski, 2020), indicate a growing social awareness in the field of environmental protection. Actions in the field of waste segregation policy and optimization of water consumption in households should also be assessed positively. The importance of pro-ecological activities in Polish society is evidenced by the fact that among the three areas in which, in their opinion, the country has the most problems to be solved, the respondents by the Ministry mention environmental protection (as indicated by as many as 52% of respondents).

Despite the observed growing pro-ecological attitudes, they are not satisfactory and we cannot say that we are dealing with the great concern of Poles for the natural environment. Many research results indicate the lack of optimal attitudes and pro-environmental behavior of Poles (Stefaniuk, 2021; Report: Green Generation 2.0, 2021; Report: Postawy ekologiczne. Badanie postaw i opinii Polek i Polaków, 2020; Report: Barometr ekologiczny Polaków, 2020).

In the context of the research conducted in this paper, we are primarily interested in the pro-ecological attitudes of young Poles, especially in the context of energy. When it comes to the attitudes of young Poles, interesting results can be found in the study by Kwiatek and Skiba (2017). In their research, Kwiatek and Skiba verified the specific attitudes and behaviors of young Poles. They most often repeated statements about saving water (turning off the tap when brushing your teeth, shower instead of bathing, even watering the plants previously collected rainwater, etc.) and electricity (switching off the lights in unoccupied rooms, chargers, or other devices electric). The surveyed youth also declare that they are active in the field of waste management and waste segregation (very often and often (65%).

The pro-ecological attitudes of Polish youth were investigated by Gajewski (2007). The results of these studies indicate pro-ecological behavior (e.g. saving water) declared by young Poles. However, an in-depth analysis of the results shows that young Poles do not see and do not understand the relationship between your action and the environment. This is due to the low-level practical knowledge, unaware of the consequences of one's behavior, the materialistic paradigm of existence, and the thoughtless satisfaction of one's own consumption needs.

As the literature review showed, relatively few empirical studies have been conducted to identify the attitude of young people to the use of electricity, as well as the relationship between the use of smart products and the use of energy and bearing the costs of its use. In this context, the authors emphasize that the conducted research, although currently of a pilot nature, fills the cognitive gap. They will contribute to a better understanding of buyers' attitudes and behaviors and cross-relationships between products (smart products vs. energy).

5. Research method

As a result of the literature analysis, review of available research results, brainstorming and expert discussions (a group consisting of educators and management practitioners from waste management companies), two research hypotheses were formulated:

H1: For young consumers, energy (as access to power from smart products) is something natural. At the same time, when we mean "natural", we do not refer to the origin of the natural environment, but the perception of the right to accessibility and universality of this accessibility. Just as oxygen for humans is essential for life and it is obvious for people that it is widely available to everyone, for young people access to energy/power is something obvious, common.

H2: Young consumers do not see energy as a product/service that has a price and must be paid for (access to it).

The study was conducted in two phases. Phase 1 was designed to pre-test the questionnaire. Phase 2 consisted of a study designed to collect and analyze information gathered from students' responses.

The idea of the questionnaire used in the research was modeled on the questionnaire and the scale of Vitell and Muncy (Vitell, Muncy, 2005). These studies on ethics in the behavior of young people (students) were also used in the studies by Grzesiuk and Wanat (2010). Ultimately, the questionnaire used in the research project on the perception of energy costs reported in this article consists of 25 questions, including 3 metric questions (gender, year of birth, field of study). The respondents were asked to indicate their answers on a 5-point scale, where "1" meant strongly disagree and "5" – strongly agree. The questions relate to three spheres that define the attitude of young consumers to energy: knowledge, attitudes, and behavior.

The questionnaire was prepared online on the docs.google.com platform. The research was conducted in the first half of 2021.

In phase 2, the questionnaires were made available to the students during their classes (classes were online; questionnaires also online). The research was deliberate and participation was voluntary and anonymous. In total: 201 completed questionnaires were collected, including 151 filled in by students of economic faculties and 50 filled in by students of other faculties. The results were analyzed in two categories: 1. data collected among students of economics and 2. among students of other fields of study (mainly pedagogy and law).

Assuming that the order of magnitude of the success probability p is not known, the minimum number of units was 201 with the following assumptions: significance level = 0.01, the maximum error of the estimate d = 5% (u = 2.7434).

Students represent the generation of young people born in the 1990s and at the beginning of the 21st century. In both groups of students, the majority were women: 75% among students of economics and 74% among students of other faculties. Among Polish students in general,

women also predominate – ca. 58% (GUS: płeć studentów, 2020; Szkolnictwo wyższe i jego finanse w 2019, 2020).

The authors of the research project are aware that the students do not fully represent the generation of young consumers. This generation, like other age groups, is diverse. It is possible that the results of the research are influenced by the place of residence of the respondents (students are mainly residents of large cities) and the level of education, and thus, probably, the pro-ecological awareness of the respondents. The educational profile of the surveyed group may also be important. However, the discussed research results are not analyzed as a representative sample. The authors are developing a wide research project in the area of the use of smart products by young consumers. In further research, the experience from the reported surveys will be used.

After the research was conducted, its results were compiled and analyzed, and conclusions were formulated. Basic statistical tools were used, i.e. mean, standard deviation, median, mode, they use an Excel spreadsheet.

6. Research results

The questions asked to the respondents referred to specific situations, using examples of smart products (e-bike, laptop, smartphone), potentially used by young people. Additionally, questions with an example of an electric kettle were included. Although this product does not belong to the group of smart products, its use requires an electrical connection. It was used in the research questionnaire as a kind of reference product, allowing for the verification of energy consumption attitudes and behavior.

To verify the H1 hypothesis, two questions related to the respondents' knowledge, five questions allowing to characterize their attitudes, and four describing the respondents' behavior related to powering smart products with energy were used.

More than half of the surveyed students of economic faculties (64%) know the number of electricity bills in their homes, but at the same time every fourth of them admitted that they did not have such knowledge. Therefore, it cannot be unequivocally stated that they are conscious energy buyers, which is confirmed by the average rating of 3,5 with the standard deviation of the sample 1,41. The respondents' housing status was not taken into account in the analyzed research project. According to Eurostat data (Eurostat 2019), 75 percent of young Poles aged 16-29 live with their parents. And according to the research of the Educational Research Institute (Herbst, Sobotka, 2014) from 2014, more than half of the students in Poland lived with their parents in the last year of their studies. The fact of living with parents who are likely to bear the main burden of the cost of maintaining the apartment may lower respondents'

awareness of the cost of utilities in the apartment. This issue will be considered in future research.

The survey shows that young Poles do not know about new solutions that will save them money/reduce expenses. It is possible that due to the low popularity of innovative solutions, an example of which was e-bike, almost 75% of respondents could not assess the relationship between the cost of using an electric bike and the price of a public transport ticket. At the same time, however, they rather agree with the statement that in the future the use of these devices will be widespread. The e-bike results are surprising because respondents were students, usually living in cities where such solutions are available.

According to the respondents, both now and in the future, access to energy sources that allow powering smart products should be free and universal. Only about 14% of the respondents do not agree with this opinion.

Such opinions of young Poles are unambiguous, additionally verified by a reverse question (charging a smartphone in a public place should be paid).

The respondents do not use the option of charging their smartphones in public transport for fear of being discharged or because of a lower price. On the other hand, half of them recharge their devices at universities/at work, and almost 70% are aware that they do not bear any financial costs.

To verify the H2 hypothesis, six questions related to the respondents' knowledge were used, one question characterizing their attitudes, and four describing the respondents' behaviors related to powering smart products with energy.

Smartphones are the most popular type of smart product with Internet access among young people in Poland (Eurostat 2021). And having a smartphone is common in the group of young people (over 94% in 2018). Therefore, the obtained results concerning this type of solution are not surprising. Most of the respondents indicated that they know exactly what fees they pay per month (75%) and what their Internet limit is (78%). These reviews received the highest average score (4.0).

The respondents do not have such knowledge concerning other smart products. In the case of a laptop, 69% do not know the monthly cost of electricity with the dominant rating of 1 for the entire group. An additional question checking the respondents' knowledge of the level of electricity consumption by home furnishings that they use daily was the question about the electric kettle. A definite answer was given by every fourth respondent, but less than a third of them marked it correctly.

The questionnaire also included questions about energy saving daily, which were formulated in the form of affirmative and negative. The distribution of answers and the dominant ratings allow us to state that about half of the surveyed students of economic faculties are aware of the need to save energy and pay attention to it daily. However, over 68% disagree with the statement that there should be charges for using the power supply of mobile devices offered in public places. The standard deviation is one of the lowest, which would mean high

consistency of the answers provided. At the same time, with an average grade of 2, it can be stated that the surveyed students are against it or, possibly, have no opinion, which means that people ready to pay for energy supplied in this way are in a clear minority.

The declared attitudes of the respondents do not indicate that they are highly aware of energy consumption, and thus its cost. More than half of them do not turn off the devices when they are not using them (mainly at night), and during their last purchases of smart products less often than every fifth student of economics took into account its energy efficiency. Based on the obtained results, it cannot be clearly stated whether the respondents are aware of the cost of energy consumption by performing daily, simple activities such as boiling water. The answers are fairly even on the "agree and disagree" side (M = 3).

The results presented above concern students of economic faculties. The results of the conducted research do not indicate the existence of differences in attitudes towards smart products and the use of electricity between students of economic faculties and non-economic faculties (mainly law and pedagogy).

The responses of non-economists represent very similar attitudes to students of the economic faculties, except for the answer to the question about the cost of using public top-up/top-up sites. In this case, respondents are more cautious/hesitant than respondents of economic faculties. They also showed somewhat less certainty in assessing the future use of urban e-bikes.

Regarding H2, responses of non-economists differed on one point in the area of knowledge (they are more confident in their knowledge of the limit they have in smartphones (average = 4.24, D = 5) and in almost all in the area of attitudes, although these differences, apart from using an electric kettle, they are small. However, there were no differences in the area of attitudes.

The lack of differentiation in the knowledge of respondents from individual groups regarding energy costs is in contradiction with the adopted hypothesis. The authors assumed that students of economic faculties would represent more mature attitudes (and knowledge) regarding the prices/costs of products purchased on the market. However, this preliminary assumption has not been positively verified.

7. Discussion and Conclusions

The results show, on the one hand, that young Poles declare that they know the energy costs incurred by their households, and on the other hand, they believe that in public places it should be possible to power laptops and smartphones free of charge.

The results, apart from the cognitive values, also allow for the formulation of methodological recommendations and will allow for the conceptualization of future research in the area of connections between the use of smart products and energy.

In terms of methodology, we propose to group factors in the "knowledge" category:

- Group 1: direct costs, identifiable costs related to the use of smart products (including the cost of purchasing a physical product, the cost of purchasing software, the cost of Internet access);
- Group 2: household electricity costs (cost of powering smart products).

Additionally, we propose two cross-sections of Group 1 and Group 2 analysis:

- Dimension 1: Costs incurred directly by young Poles;
- Dimension 2: Household costs (electricity).

The attitude of young Poles to smart products and their relationship to energy access and charging/power costs should also be analyzed in the future concerning the development of electromobility (electric cars, electric buses). According to the data of the Electromobility Meter (Report: Electromobility Meter, 2021), at the end of the first quarter of 2021, a total of 22,291 electric cars were registered in Poland. Although the number is not impressive, in Q1 2021 the number increased by 3,555 vehicles, which is an increase of 107%. compared to the same period in 2020. The group of respondents included in the discussed research will probably make decisions about buying a car soon. The attitude of these future buyers to electric cars will largely determine the development of this market and, more broadly, the transformation of social mobility.

As customers constantly gain new knowledge about the market, their definition of value keeps changing. Today young Poles grow up and become mature consumers (also with age). Their needs and attitudes towards products are changing. It can therefore be assumed that along with gaining new knowledge about smart products, the value they will represent for (currently) young Poles will change over time. In a sense, these products will grow with the young consumers surveyed today.

This is important cognitively and in the context of business recommendations. Today we are researching young consumers who use a smart product. In the future, these young Poles will become adult market participants and – probably – potential users of advanced smart products such as electric cars. According to the authors, producers of electric cars should be particularly interested in the attitude of young Poles to electricity. The availability of smart products charging/power stations, charging ports, sockets, connectors, plugs, and their spatial arrangement in the field is one of the critical elements of the development of electric cars. According to the authors, parallel to this accessibility, one should also observe the attitude of young Poles to the costs (fees) for using this energy made available. The presented research results indicate that concerning the smart products currently used by young Poles (i.e. smartphones, laptops), they believe that it should be possible to power these devices free of charge in public places.

During the implementation of the pilot research, we also formulated a proposal of directions for further research related to the attitudes of buyers vs energy cost. The direction of research in the area of smart cities and the attitudes of young people towards the cost of living in a smart city seems particularly interesting. The experience of many products available on the market bearing the "eco-products" logo shows that the costs of such products are usually higher. Are young consumers willing to pay higher living costs in the name of being eco-friendly? E-bike, which was used in research as one of the examples of smart products, is a product that is relatively unknown and unknown outside large cities. But the electric bicycle is a product that has been on the market for several years. What are the attitudes of young buyers towards such products? An electric bicycle requires interaction with energy. The cost of energy to use the product and pro-ecological attitudes reappear - you can reduce energy consumption by using a classic bicycle. Are young buyers aware of the consequences of the home bidet and environmental consequences of the development of products such as an electric bicycle?

Summing up, young consumers do not represent homogeneous attitudes towards smart products and their awareness of energy costs and the connection between smart products and the costs of acquiring access to energy is very low. According to the authors, this is an important and interesting direction of research, both in the context of eco-friendly attitudes and the development of new product categories.

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ARTIFICIAL INTELLIGENCE AND BLOCKCHAIN FOR SMART CITY

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Introduction/background: In this article, we want to focus on two very important aspects of a Smart City, which is the use of artificial intelligence and Blockchain in the functioning of cities.
Aim of the paper: The aim of the article is to assess the possibilities of using those technologies implementation of public tasks and in everyday contacts of the public sector with stakeholders.
Materials and methods: The article is theoretical and is based on a review of the literature and examples in the implementation of Artificial Intelligence and Blockchain technology in a smart city.
Results and conclusions: Artificial Intelligence and Blockchain have great potential to support the development of smart city. The dissemination of these technologies is indicated by the Gartner curve for Digital Government Technology. AI (Autonomus Vehicles) and Blockchain are the most impact technologies on government organizations over the next 5 to 10 years AI and Blockchain can provide significant benefits to many areas of the city's functioning: it is a huge database for collecting and analyzing. Blockchain consensus methods allow greater transparency and less susceptibility to manipulation, they increase the tendency of stakeholders to participate and intensify social initiatives.

Keywords: smart city, artificial intelligence, blockchain.

1. Introduction

Smart city are technologically advanced cities where intelligent subsystems connect people and organizations. These cities are able to use large data sets to offer stakeholders real-time access to high-quality public services and thus improve the quality of life in the city. Economic growth is supported by information and communication technologies. They not only improve city management, but also (and maybe above all) stimulated social participation and the sharing idea (Kitchin, 2015). Smart cities are often called digital cities based on new technologies, where ICT solutions, internet of things, big data, cloud computing and Industry 4.0 become reality (Washburn et al., 2010; Albino et al., 2015; Klein, Kaefer, 2008). Omnipresent sensors are changing the way of movement in urban space, increase safety and allow the collection of

large data sets that can be analysed using Artificial Intelligence (AI) algorithms. They allow the city to communicate with its own infrastructure, monitor the movement of its residents and respond to it. As a result, the city's conditions can be optimized. AI has been designed to efficiently collect, analyse and correctly interpret data and respond to it without any human interaction. Although Artificial Intelligence is far from independence for now, but it can learn and constantly improve its activities by collecting and analysing new data that requires appropriate storage and transmission. Blockchain technology is helpful in this regard, as its distributed registry architecture means that data is stored simultaneously on all network nodes. This allows for complete decentralization of data, making access to them more efficient and more "democratic".

Over the past 10 years, Artificial Intelligence and Blockchain have become technologies that promise significant and even ground-breaking innovations. The idea of combining these two technologies in creating a smart city is particularly intriguing. It engages intelligent human capital (Shapiro, 2006; Giffinger et. al., 2007; Lombardi et al., 2012), because only people are able to create and use intelligent solutions for the benefit of the general public. It also indicates the need to develop smart governance, whose task is to create the environment of cooperation and creation of conditions for participatory performance of public tasks.

According to forecasts, the potential benefits of combining Artificial Intelligence with Blockchain can be counted in billions in the near future. These two technologies can develop separately, but together they have bigger potential. As complementary technologies, they can provide significant benefits for all areas of smart city, from Big Data analyzes, through health care and financial services, to social participation and public-private partnership. Blockchain offers artificial intelligence a huge database for collecting and analysing data that remains safe and unchangeable even in case of failure. Blockchain consensus methods allow greater transparency of relations between stakeholders. They also guarantee the confidentiality of data transfers without compromising privacy and security, and less susceptible to manipulation.

Given the above, the purpose of this article is to present the role and significance of Artificial Intelligence and Blockchain in creating of smart city (Fig. 1). The first part presents the concept of smart city from the perspective of ICT technology development, which gave impetus to the development of Artificial Intelligence and Blockchain. In the second part AI functionalities supporting the creation of smart city will be presented. Subsequently, the potential of Blockchain technology and its areas of application in smart city was pointed out. The summary presents the problems that AI and Blockchain can solve and the challenges that integration of both technologies face.

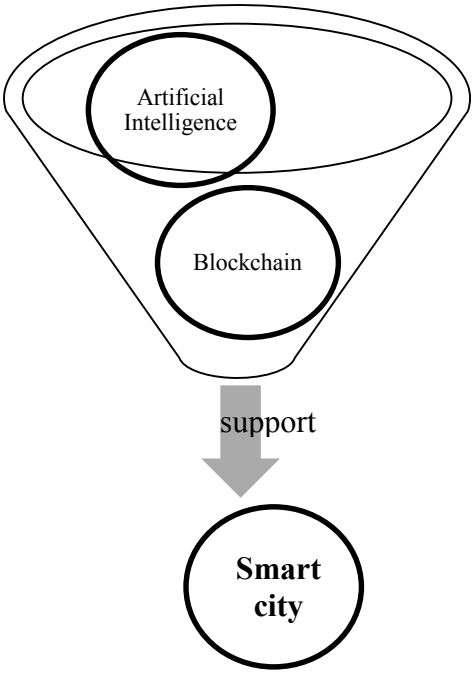

Figure 1. AI and Blockchain as elements supporting Smart City development. Source: own work.

2. Literature review – smart city in the context of ICT Technologies

Although the concept of "smart city" is becoming more and more popular, thus a generally accepted definition has not yet developed. Analysis of the literature in this area allows to distinguish two description ways: 1. city based on ICT (Hollands, 2008; Komninos, 2008), 2. a new paradigm in the city's development, where the key role is played by human and social capital, education and the environment (Neirotti, De Marco, 2014; Giffinger, Fertner et al., 2007; Lombardi, Giordano et al., 2012; Caragliu, Del Bo, Nijkamp, 2009). The technological smart city trend is reflected, among others in the definition of T. Bakici, E. Almirall and J. Wareham (2013), according to which „smart city as a high-tech intensive and advanced city that connects people, information and city elements using new technologies in order to create a sustainable, greener city, competitive and innovative commerce, and an increased life quality". Similarly, IBM defines a smart city: „A city is an interconnected system of systems. A dynamic work in progress, with progress as its watchword. A tripod [infrastructure, operations, people] that relies on strong support for and among each of its pillars, to become a smarter city for all" (IBM, 2015). This definition includes three key features of smart city: 1. instrumented i.e. the presence of ICT solutions in the city (sensors, mobile devices), 2. connected, i.e. the availability of connections between the real and virtual world, using instrumentation and (3) intelligent, meaning the ability to use new technologies in the city's development process (Harrison, Eckman, Hamilton, Hartswick, Kalagnanam, Paraszczak and Williams, 2010).

Proponents of this approach say that cities will be on the verge of a revolutionary breakthrough and will become cities of dreams. Each sphere of life will be digitized, and applications, algorithms and artificial intelligence will reduce congestion, prevent crime and create free public services (Giffinger, Fertner et al., 2012). But will it really be like that? Is the reconfiguration of the city into technological problems enough to make us feel good in the city? Probably not.

The reconstruction of the basics of urban life and city management taking into account only the technological perspective will rather lead to the fact that cities will be superficially intelligent, and deeply full of injustices and inequalities. That is why in local government practice and scientific discourse, the second trend of understanding smart city, which goes far beyond its technocratic perception, increasingly dominates. In this approach, technological solutions only support smart city. Thanks to them, it is easier to combine information and political vision into a coherent program of improving the city and its services. New technologies are an instrument for creating cities that are able to combine physical and social capital, provide better services and good quality infrastructure. This approach is reflected in the definitions of A. Caragliu, Ch. Del Bo and P. Nijkamp (2011), who write: "We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance". Also N. Komninos (2008), who write „(Smart) cities as territories with high capacity for learning and innovation, which is built-in the creativity of their population, their institutions of knowledge creation, and their digital infrastructure for communication and knowledge management"[1]. From the perspective of the considerations in this study, this approach to smart city seems the most justified. It combines the social and economic dimension, takes into account the need to develop the city while maintaining the principles of sustainable development.

In the context of using ICT, smart city can be defined as "information technology combined with infrastructure, architecture, everyday objects, and even our bodies to address social, economic, and environmental problems" (Towsend, 2013). A smart city is defined as a city in which ICT is merged with classic infrastructures, coordinated and integrated using new digital technologies (Batty, Axhausen et al., 2012). Mitchell M. defines smart city as "intelligence based on the increasingly effective combination of digital telecommunication networks (the nerves), ubiquitously embedded intelligence (the brains), sensors and tags (the sensory organs), and software (the knowledge and cognitive competence)" (Mitchell, 2007). This does not exist in isolation from other urban systems or connected to them only through human intermediaries.

[1] A wider review of the definition of smart city presents: (Albino, Berardi, Dangelico, 2015).

Thanks to the use of ICT, all elements of the city (economy, transport, living, management, education, medicine) can become smarter; can improve the functioning of existing infrastructure and change the approach to planning and urban design. Creating a smart city using Artificial Intelligence and Blockchain will solve some of the city's problems, e.g., in terms of energy efficiency, reducing the arduousness of production processes for the urban environment, making better use of city resources, regulating congestion through an intelligent transport network, increasing the scope of social participation and transparency between stakeholders providing public services.

3. Artificial Intelligence of the future of smart city

Artificial intelligence is a field of computer science that deals with the creation of intelligent devices and machines that will have the ability to respond just like human. Although its history dates back to the 50s of the last centuries (McCarthy, Minsky, Rochester, Shannon , 2006; Kar, Dash, 2018), it was only the progress in designing computing power to store and process large data sets and the potential of the Internet allowed AI to become one of the most powerful technologies of the century. In artificial intelligence, so-called machine learning plays an important role, because it is the basis for the development of learning systems. It is thanks to them that rational and logical reasoning of machines that are able to adapt to changing situations is possible. Importantly, the development of artificial intelligence is parallel to the development of cognitive science, i.e., research on intelligence and the functioning of the human brain. This allows to explore the possibilities of computer-human cooperation. Modern computers, like the human brain, rely on neural networks that deal with the enormity of data, skillfully transforming it. For this reason, they use machine learning, image recognition and natural language processing. Thus, machines equipped with the AI platform[2] are able to collect information from the environment and using logic identify actions with the highest probability of success (Mnih, Kavukcuoglu et al., 2015; Bughin, Hzan et al., 2017).

Artificial Intelligence finds application in many areas of life, including increasingly in smart city, determining its development in all functional areas (smart economy, smart mobility, smart environment, smart people, smart living, smart governance). Examples of smart city support by artificial intelligence algorithms is presented in Table 1. The use of AI is key from the point of view of striving for sustainable urban development. Thanks to AI applications it is possible to optimize the city system, e.g., by monitoring energy consumption (Adio-Moses, Asaolu, 2016) or creating efficient and intelligent transport systems (Agarwa et al., 2016). Infrastructure solutions are already emerging that are capable of introducing automated

[2] Examples are Netflix and Amazon, which use AI to personalize recommendations for millions of subscribers around the world.

operation of urban systems. Thanks to AI platforms it will be possible to introduce autonomous cars to the streets, track the level of air pollution, as well as more efficient and easier management of the urban lighting system. Argawa et al. (2015) emphasize that AI is not only a solution that facilitates the design of urban systems, along with the scheduling of the city's transport or energy system but can also be used to optimize flows. Artificial Intelligence will allow the prediction of road conditions and congestions, generate reports in real time on accidents and other road incidents. This makes it easier to take routine decisions in the field of control and increase traffic flow, especially in those areas of the city that are in danger of congestion.

Table 1.
Examples of smart city support by Artificial Intelligence Algorithms

Smart city dimensions	Examples of AI possibilities
Smart economy	Optimization of city infrastructure, energy and water saving, editing of building maintenance costs, sharing economy
Smart mobility	Autonomous vehicles, prediction of traffic parameters, traffic light control, Information about free parking spaces, reduction of external transport costs, reduction of congestion
Smart environment	pollution reduction, reduction of water and energy consumption, smart bins
Smart people	Create Artificia Intelligence, participation in the public life
Smart living	Smart buildings, intelligent healthcare, prevention of hospitalization, virtual assistance, crime prevention, increasing residents' safety
Smart governance	Participate in decision making, public-private-partnership, Chatbots and automatic replies, e-consultations, crowdfunding

Source: own work.

Thanks to AI, traffic management systems in the city will transform from static to dynamic systems. They will allow to adapt to current conditions in real time, taking into account different types of transport. The introduction of Artificial Intelligence to e.g., a traffic light control system and building a platform for processing interactive data will allow monitoring and predicting traffic behaviour. It will also develop communication plans for different scenarios, allowing for a smooth adaptation to changing conditions. AI can also be a basis for the development of new systems of cooperation for fleet operators and management of cities, enabling e.g. sharing information in real time about traffic congestion or air pollution. As a result, the system will prevent build-up of problems before they occur. A model of traffic management using AI based on neural networks prepares decisions based on the received input data and selects the most appropriate solution for the traffic situation (Fig. 2). Moreover, traffic management systems based on AI can create time plans for intersections, reducing the phenomenon of congestion problems and suggest alternative routes (De Oliviera, Neto, 2013). They can even plan compulsory travel times (to work, school) by activating the alarm clock early. The use of AI in vehicles will allow them to communicate directly with the infrastructure, which will smooth out journeys in urban areas.

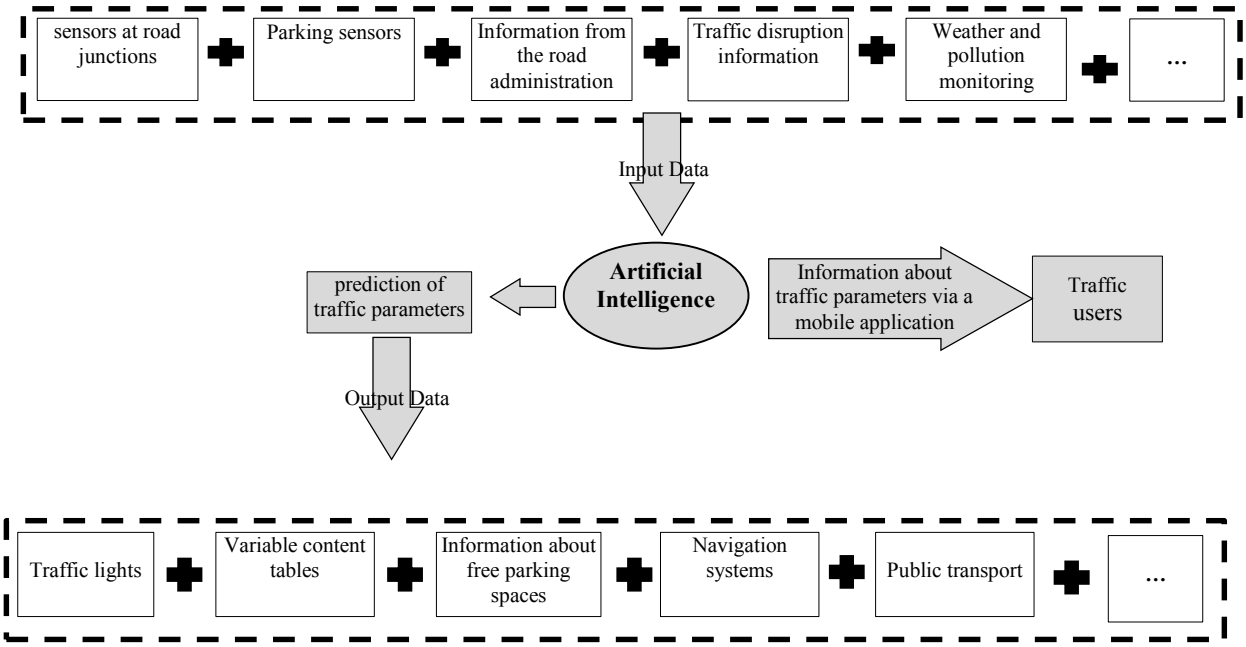

Figure 2. Model of traffic management using Artificial Intelligence. Source: own work.

Artificial Intelligence's capabilities are not limited to traffic management and control. They cover a wide range of applications, from medical diagnostics, through controlling robots and chatbots, to virtual assistance. An example could be predicting places and periods of increased crime, allowing for more efficient planning of city guard and police interventions. Ongoing monitoring of the internet can be an instrument of prevention against attacks on the safety of residents. Big Data analysis and AI predictive capabilities allow better management of operations during emergencies. What's more, AI allows to prevent breakdowns and overloads of energy, water supply, etc. infrastructure and optimize its maintenance. The use of AI in smart buildings allows to implement hundreds of sensors that monitor our preferences and habits. It combines several duties into one control centre - with one remote control or application, which allows to control the operation of air conditioning, ventilation, central heating, lighting, alarm, door locks and home monitoring. This makes it easier to manage and reduce energy consumption. After installing the appropriate sensors (e.g., movement, humidity, light, gas), the system can automatically lower the temperature inside the house, e.g., after opening the window, turn off the light by itself or disconnect unused devices from the power supply, while informing us of any adverse events (Skouby et. al., 2014).

Artificial Intelligence also supports the functioning of the public sector and smart governance. Facilitates contacts with stakeholders and improves service for residents. Chatbots and automatic replies allow to redirect matters to the appropriate departments and create documents in repetitive matters. The issuing of official documents will be monitored. To exclude racist aspects, origin, education, age, gender or beliefs AI can monitor the issuance of decisions on issues of social welfare, as well as search for documents from municipal databases and seem repetitive administrative decisions. It can also use the data provided by

residents, increasing their readiness for social participation. From the perspective of smart governance, citizen participation is key. AI by sharing administrative decisions, e.g. in Blockchain, can significantly increase the transparency of relations between stackeholders, and thus the involvement of citizens in city management.

4. Blockchain in the development of smart city

Blockchain is an innovative technology based on a distributed and widely available data register, which is a collective book of accounts. It allows to save information about each transaction in the form of data blocks that combine into an integral chain. Each block has a unique signature, impossible to forge, and each action must be confirmed by a private key, i.e. a string of characters known only to entities directly involved in the transaction. Only the private key owner can initiate changes (Iansiti, Lakhani, 2017). Blockchain is considered the safest technology for data recording and storage. It allows to associate transactions with computational logic (users can configure it). It is used to record of information about economic events and all financial operations carried out between transaction partners. Blockchain technology uses cryptographic methods to prevent making corrections once entered information without the knowledge of other participants in the system (Pilkington, 2016). That means (Kauf, 2019):

- transaction transparency – every transaction and all its contents are visible to everyone who has access to the domain of a network participant. Each node (user) has a unique alphanumeric character that identifies it. Users can remain anonymous or if transactions occur between block addresses – reveal their identity;
- records irreversibility – once the transaction has been entered into the database, no changes can be made, any modifications are visible to other network participants. The data entered is chronologically and available to everyone.

Blockchain allows the development of relations between entities in a distributed manner, without involving middlemen, coordinators or planners. It does not allow falsification of data and is resistant to manipulation. Blockchain technology supports the functioning of smart city in all its dimensions. Specific implementations of blockchain technology, such as smart contract, smart assets or digital identity facilitate not only the contracts agreements with contractors, but also control of task performance. Based on Smart Contracts and block chains, decision making systems can optimize the activities of entities involved in creating public value, and public e-procurement can prompt the public sector to use negotiated tendering procedures more often. Transaction transparency is a source of benefits for the public sector; allows to increase the efficiency and effectiveness of relationships with contractors and optimize the distribution of Smart Assets. Smart Contracts and Blockchain-based voting, decision, and

negotiation support systems enhance and optimize the operation of the Smart Community (Nasulea, Mic, 2018). Smart city benefits from increased productivity thanks to automated interactions with e-Citizen and optimized distribution of Smart Assets. Fig. 3 presented Blockchain Technology as an integrator of smart city entities. Blockchain allows access to the registry for all members of the community. Everyone has its own synchronized copy of a common book (Blockchain register).

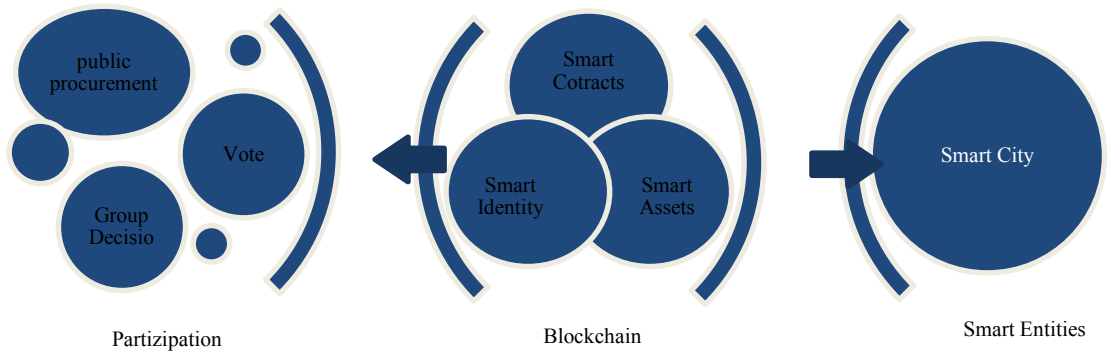

Figure 3. Blockchain Technology as an integrator of smart city entities. Source: own work.

Blockchain technology guarantees high resistance to data manipulation. It secures all stakeholders' access to real and current information. By transforming resources into Smart Assets, smart cities can track the origin and movement of goods (e.g., pharmaceuticals) throughout the value chain for Citizens. This reduces fraud in the distribution of goods and the reaction almost immediately after the detection of the irregularity. Blockchain allows the measurement and recording parameters, which are stored and transported goods, and this is particularly important in the case of sensitive goods (those pharmaceuticals). Stored values are unmodifiable. Thus, Blockchain is an effective tool for supplier verification by smart governance.

Because the choice of supplier in the implementation of public tasks is based on public procurement, it is worth to point out the benefits that Blockchain technology can bring in this area. This technology can contribute to: 1. increasing their efficiency and transparency, 2. reducing fragmentation, and thus the benefits of economies of scale, by implementing a unified electronic platform. It can be assumed that online public procurement processing will become a common practice in the next decade, not only on a local but also on a global scale. The extension of the network will allow, among other banks located in various places around the world to easily send certified electronic guarantees on behalf of the supplier. Blockchain technology will change the conditions for participation in tender procedures. Everyone who wants to participate in the implementation of public tasks will have to use electronic means of communication[3]. This will allow faster and more transparent verification of submitted

[3] From October 2018, all tender procedures from the so-called EU thresholds are implemented using electronic means of communication.

applications. It will create a significant barrier to submitting discounted offers, as once entered data cannot be changed. Each modification will be visible and will require the approval of other stakeholders.

Participation in public e-procurement will force suppliers to have a Digital Identity. The one created using the Blockchain protocol can be used as an electronic signature. Currently, the most interesting application is the Estonian e-Residency program, enabling the user to create a digital identity. It can be used, among others to set up a business by citizens outside the European Union. The combination of digital identity with intelligent assets also opens up the possibility of authorizing resources that are owned by the individual. Those registered in the Blockchain protocol can be used to initiate transactions on our behalf. In practice, this means, for example, automatic planning of technical inspections by public transport vehicles.

Blockchain also agrees to authenticate the digital identity of citizens, and this creates the opportunity to participate in local, regional or national elections, without leaving home. Blockchain guarantees both voice secrecy and verifiability of the number and legality of voters. The chain of blocks will allow every citizen to control the vote. In Blockchain, the citizen remains anonymous, and his voice is public. Due to the dispersion of the database, it cannot be hacked, and it is not threatened by any IT system failures. The voter can vote from any place where he gains access to the network practically from any device that has the character of a computer – which eliminates the risk of extortion of votes, adding them to polls, creating false identities, etc. This way of voting ensures greater confidence in the electoral process, reduces costs and enables decisions to be taken directly by the constituency.

Blockchain technology could also contribute to greater public involvement in the city's life and functioning. In a smart city, decisions do not have to be made as a result of voting, because the classic majority voting system can be replaced by decision systems that require the consent of a larger part of the community. In this case, important social problems could be discussed until the community reaches consensus (Nasulea, Medintu, 2015). In addition, it opens wide opportunities for social initiatives (Crowdfunding).

Although Blockchain technology has a number of applications and allows for various variants of direct democracy, the scope of its use is conditioned by the level of awareness of Smart Governance, or rather policy makers. These relevant laws and ordinances may support or inhibit the use of Blockchain technology. At the moment, it is crucial to create legal regulations that will allow cities to create Smart Contracts that do not require a paper version and a notary signature.

5. Conclusion

The considerations presented in the article show that Artificial Intelligence and Blockchain have great potential to support the development of smart city. They are the most promising innovative technologies, the use of which is almost limitless. The dissemination of these technologies is also indicated by the Gartner curve for Digital Government Technology. It follows, that AI (Autonomus Vehicles) and Blockchain are the most impact technologies on government organizations over the next 5 to 10 years (Fig. 4).

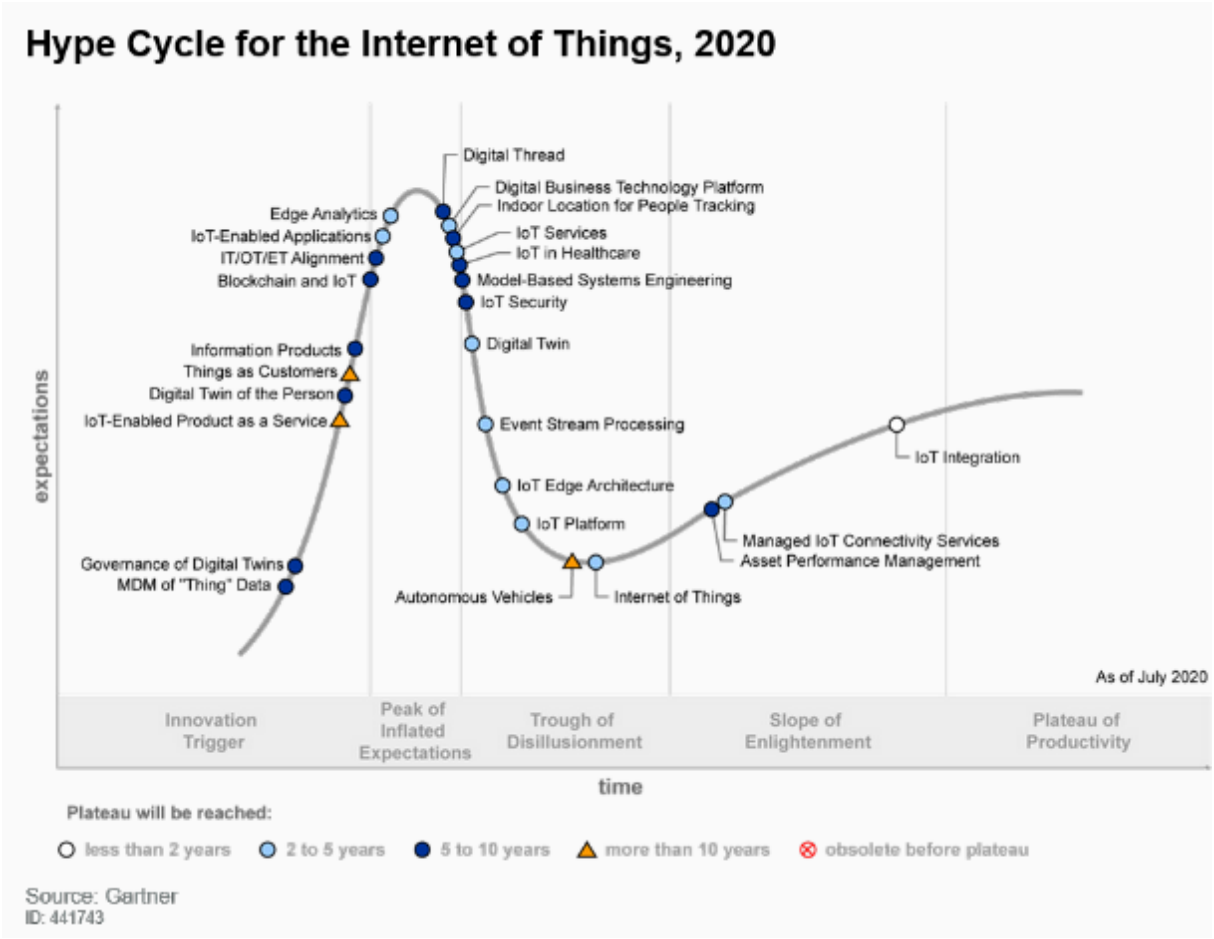

Figure 4. Hype Cycle for the Internet of Things 2020. Source: https://lhpeurope.com/flexibility-in-the-industrial-internet-of-things-iiot/, 14.01.2021.

As complementary technologies, AI and Blockchain can provide significant benefits to many areas of the city's functioning. The earliest concepts of combining AI and blockchain relate to data analysis. Blockchain offers artificial intelligence a huge database for collecting and analysing, as well as centralized data sets. Those in Blockchain stay safe and unchangeable even in the event of a failure. Blockchain consensus methods allow greater transparency and less susceptibility to manipulation. Thus, they increase the tendency of stakeholders to participate and intensify social initiatives. The solutions shown predispose these technologies to the rank of breakthrough innovations, often referred to as destructive technologies.

This is due to the fact that any technology that revolutionizes the current order is destructive. In this case, however, we should refer it rather to the creative destruction that Schumpeter wrote about (1942). Blockchain will transform public services by providing a transparent, authoritative register of public sector transactions and reduce conflicts between public and private sector entities. Artificial Intelligence will be used to serve residents, issue administrative decisions or manage city traffic.

Though the capabilities of AI and Blockchain are huge, their integration still faces many challenges. One of the sources of concern is the issue of privacy, especially when it comes to potentially sensitive data and applicable laws.

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INNOVATION AND MEASURING OF INNOVATION – EMPIRICAL RESEARCH OF COMPANIES IN SERBIA

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Introduction/background: The application of innovative business strategies is considered to be a very prominent tool when it comes to improving the company's competitiveness on the (global) market, which can be of a special significance for the economy growth in developing countries. The measuring of innovation is thus seen as an important activity in this context, both for theoretical and practical tests.

Aim of the paper: The main goal of the research, whose results are shown in this paper, was to investigate the level of the innovation strategies implementation in companies in Serbia, according to the specialized INNOVATE model.

Materials and methods: For the research purposes, the questionnaire was constructed, based on the previously determined 21 innovation management dimensions. The observed sample included 106 companies in Serbia, of various sizes, activities and structures. The data were processed by a statistical program IBM SPSS.

Results and conclusions: The research results indicate the main problems that Serbian companies are facing in order to improve their innovative capacities: focus on the domestic market, lack of innovation strategy, insufficient business networking, short-term planning, inadequate management system, technological backwardness, and the differences among companies of different activities and small-scale and big-scale companies in regard to the levels of the innovation capacity dimensions application. It is also shown that the expectations regarding the business growth depend on the characteristics of the company.

Keywords: innovation, innovation capacity dimensions, the growth expectation.

1. Introduction

Innovation refers to something new, original, or improved. From an economic point of view, innovation implies the application of new and improved ideas, products, services and processes that create benefits for one organization and/or society. Innovations are not exclusively represented by new devices, ideas or methods, but they can also refer to modifying business models and adapting to market or technology changes. Currently scientific progress and innovation play a decisive role in economic and social development in

the world, since the new features of the contemporary economy include the globalization of innovation, production and trade. Innovation has been widely recognized as the main driver and first impetus for a sustainable regional or national economic growth, and the main global competency driver, especially for emerging economies, since it's no longer a useful tool for them to depend on international trade or labor-intensive work such as manufacturing (Chen, Viardot, and Brem, 2019).

According to EU strategic documents, innovation is defined as one of the priority goals in general, since it has been recognized as the key factor for achieving smart, sustainable and inclusive economic growth, both on national and regional levels (Beraha and Đuričin, 2020). When it comes to innovativeness, the countries of the Western Balkan region are at a disadvantage in comparison with the European Union member states, although they have undergone significant changes and economic transformations since the beginning of the 21st century. Therefore, there is a strong need in Western Balkan Countries, as developing countries, for a systematic promotion and development of innovation culture and innovativeness. In 2005 Innovation Law was introduced in Serbia, followed by several national strategies, which was an important contribution to strategic planning of innovation activities, with the aim to transform Serbia to an entrepreneurial economy, fostering innovation, improving human resources and cultivating a general business environment for innovation. According to several reports on this matter (*Global Competitiveness Report*, *Innovation Union Scoreboard*, and *Global Innovation Index*), innovation is among the undeveloped dimensions of Serbian competitiveness (Lalić, Ćirić, Gračanin, and Anišić, 2019). Nevertheless, the results of a recent research indicate that Serbia also has the accessible islands of excellence, which represent modest but promising achievements for the transition to the innovation-driven economy in the future (Mosurović Ružić, Miletić, and Dobrota, 2021). According to Global Competitiveness Report, which ranks countries based on the Global Competitiveness Index, in 2017 Serbia essentially improved its ranking – it ranked 78th, compared to 101st in 2013 (Savić, Pitić, and Lazarević, 2018). And according to Global Innovation Index, an indicator for annual ranking of countries by their capacity and success in innovation and innovative activities, during the period from 2009 to 2019 Serbia's ranking progressed from 97th to 57th place on the rankings (130 in total) (Dašić, Dašić, Atanasković, and Pavićević, 2020). According to the European Innovation Scoreboard (EIS, 2020), which provides a comparative analysis of innovation performance in EU countries, other European countries, and regional neighbours, Southeast-European countries are either modest or moderate innovators, since they consistently innovate below 50% of the EU average. Southeast Europe has been economically falling back while simultaneously politically integrating with the EU (Radojević, 2021). According to the data for the year 2021 (EIS, 2021), Serbia's innovation score in 2021 was below the European Union average, with an index score of 66. Compared with 2014, Serbia's innovation performance relative to the European Union has improved over time (https://www.statista.com/…). In regard to this,

Serbia is recognized as Emerging innovator (innovation leader, strong innovator, moderate innovator), with the value of innovation index of 74,52 compared with the highest ranked Switzerland, 162,28, and the lowest ranked Ukraine 33,58 (https://ec.europa.eu/research…).

Despite the improvements and the increasing awareness of the importance of innovation development, there is still a need for improvement of innovation practices in Serbia. Therefore, in further development of Serbian innovation potentials, it is crucial to counteract the lack of skilled and specialized workforce in the field of innovation management (Lalić, Ćirić, Gračanin, and Anišić, 2019).

2. Theoretical background

2.1. Innovation in the context of economy

The term innovation was first used by the economist Joseph A. Schumpeter in the 1930s to describe the conversion of ideas and knowledge into new and commercially successful products and services (Schramm, 2017). In this manner, innovation can be considered the processes of implementing problem-solving ideas into use, to sustainable value creation outcomes. In other words, it is the first economic application of a new solution to the problem, which is then spatially and temporally distributed to the market. Innovation means an invention, and it is usually interpreted as the introduction of new and improved ideas, strategies, products, services, and business organization models. It implies the planned application of information, imagination, and initiative in gaining greater value from the existing resources, and includes all the processes by which new ideas are created and converted into useful products, in order to meet the needs and expectations of customers. In regard to this, it can be stated that innovation is the production of new goods or qualities which bring benefits to the company, and are relevant to the market (Medearis, 2009; Sousa, Ferreira, and Vaz, 2020). In recent years, innovations have become the essential source of competitive advantage, establishing companies in an extremely competitive world by providing better connections with emerging markets, and the opportunities to create new innovations (Salam, Senin, Sheeraz, and Zainab, 2020; Massis, Frattini et al., 2016).

Research and innovation are considered to be the most important driving forces of socio-economic development, since they have huge potential to cope with global challenges, including the actual sustainable development goals (Štrbac, Kutlača, and Semenčenko, 2020). According to Geoffrey Nicholson, research is the transformation of money into knowledge; innovation is the transformation of knowledge into money (Schramm, 2017). Innovation is considered an essential driver of economic growth (Hasan, and Tucci, 2010). It is a crucial factor of company's economic performance and competitiveness, and an essential instrument

for business performance improvement and company growth, especially in case of emerging economies and economies in transition. Enhancing innovation potential and innovativeness and keeping up with the fast pace of technological changes is highly recommended in order to increase competitiveness on both macro and micro levels, regarding the national economic growth and competitiveness and business performances of companies, respectively (Lalić, Ćirić, Gračanin, and Anišić, 2019). Both developed and developing countries are trying to build up their national innovation system with the aim to achieve sustainable industrial upgrading and economic growth. According to the analysis, the mainstream model of corporate development has evolved from an effective through a quality and flexible, to an innovative company. Commonly, an innovative company makes a consistent effort to seek new breakthroughs in the area of its specialty to reduce cost, improve quality and flexibility, and provide the market with products of outstanding price, quality and performance (Chen, Viardot, and Brem, 2019). Innovations are realized through improvements in the field of technology, processes (improving the quality of products or services, increasing safety, reducing scrap etc.), work organization (which reduces production and administration costs, increases productivity or utilization of equipment or time etc.), marketing etc. It implies a long-term intangible assets investments, that will generate profits in the future.

The accelerating innovation has significantly influenced the global economy (Malanowski, Tübke, Dosso and Potters, 2021). The national economy's ability to create and implement innovations has become a key determinant of countries' economic progress, and very important for a society's successful adaptation to increasingly rapid scientific, technological and economic changes. The results of the research confirmed the strong connection between the Innovation capacity index and the achieved level of economic development of countries (Cvetanović, Andrejević Panić, and Kostić, 2020). In every society, especially in developing countries, innovation and entrepreneurship is a sign of progress and development as it has an impact on social, cultural, and economic development (Lalić, Ćirić, Gračanin, and Anišić, 2019). Addressing the issue of specialization in the research and development field and innovation is particularly crucial for regions/countries that are not leaders in any of the major science or technology domains. Many would argue that these regions/countries need to increase the intensity of knowledge investments in the form of high education and vocational training, public and private research and development field, and other innovation-related activities (Foray, David, and Hall, 2010). Concerted efforts are being made to induce European enterprises to spend more on research and development field with a view to boosting economic performance through enhanced innovation (O'Sullivan, 2010). The importance of innovation as a factor in the economic development is constantly growing. According to experts, 2/3 of the economic growth of the developed countries should be associated with the introduction of innovations (Oksanych, 2021).

2.2. Innovation management

After WWII innovation was generally considered to be essential to the economic and technological survival of nations and companies alike, which led to an increasing scientific research into innovation management and its widespread use. Innovation management implies the new methods of developing plans, systems, and procedures that transform the tasks of leaders, and include other employees and staff of the organization. In order to complete the transformation of idea to market value, innovation management needs careful design in terms of strategy, organization, resource and culture (institution), which means the organizational reconstruction and regularization of management activities are interacted to continuously promote the evolution of the company (Chen, Viardot, and Brem, 2019). However, it has been shown that different socio-economical contexts demand different approaches to the innovation management. The increasing importance of innovation has been forcing companies to improve their innovation management (Ortt, and Van der Duin, 2020). It has been shown that the global economy, combined with the uncertain global stock markets, has already started to erode many of the traditional views of organizational and strategic management practices. The innovative management practices include a complex decision-making process, which combines top-down with bottom-up approaches, centralized with decentralized decisions, and relevant degrees of information asymmetry between management and employees involved in technical functions (D'Andria, and Savin, 2018). According to the Green Paper on Innovation from the European Commission (EIS, 1996), the concept of successful production, assimilation, and exploitation of novelty, is structured around three pillars: the renovation and enlargement of the range of products and services and the associated markets; the creation of new methods of production, supply, and distribution; and the introduction of changes in management, work organization, and skills of the workforce, in a word−organizational innovation (Sousa, Ferreira, and Vaz, 2020).

Organizational innovation means applying new principles to the production of goods and services, new structures and processes, and introducing the new values, attitudes, and mindsets. It refers to new management models and work organization forms, but also to the development of skills and the creation of knowledge, with the aim to increase effectiveness and efficiency of work, cooperation and coordination within the company, and the company's ability to adapt to changes. There are some additional factors of the same importance: employees training, organization of work, the involvement of people in the innovation process, and how the company learns and shares knowledge (Sousa, Ferreira, and Vaz, 2020). In the economic system, entrepreneurship is the most obvious instance of a knowledge-based institution (Stichweh, 2018). In the light of changes toward a knowledge-based economy, where intangible assets and human capital play an increasingly major role, the innovative practices are considered of a great importance (D'Andria, and Savin, 2018). The development of information technology have changed the economic development model,

and theories based on knowledge development are becoming increasingly important. This is why creation of a knowledge-based economy determines the growth of interest in innovations and the possibility of using them as a tool for building a competitive advantage (Oksanych, 2021). The knowledge management is considered highly relevant to innovation in companies today because of its importance for the economy development, since it forms a basis for innovation and underpins effective decision making within contemporary organizations. There is the derived focus out of information and knowledge towards innovation and collaboration across boundaries. The most important factors for establishing a successful knowledge-for-growth base, particularly those relevant for developing countries, include: institutional quality, financial market sophistication and macroeconomic stability; well functioning local product markets; international openness through foreign trade; the implementation of new technologies and ICT availability and use; education and human resource development, the quality of education and training; innovation capacity drivers, such as university-industry links, IPR protection (Veugelers, and Mrak, 2010).

Many researchers acknowledge the positive impact of innovation on the company (Salam, Senin, Sheeraz, and Zainab, 2020). The success of the innovative practices implementation and innovative culture development in a company can be conditioned by the company's internal factors, such as the size of the company, the workforce knowledge, and the structure of the company (Sousa, Ferreira, and Vaz, 2020). Methods for evaluating innovative ideas and innovations in companies must include technological and economic criteria. In order to be useful, an innovative idea must be effective, and it has to solve a particular problem or to satisfy a particular need. Innovation can improve the development of original concepts and the innovative company provides proactive, confident attitude to take risks and do the activities necessary for the realization of new ideas. The results of the research on the sustainable industry practices in Serbia showed the importance of innovative practices implementation (Mosurović Ružić, Miletić, and Dobrota, 2021). The various types of product-service innovations are illustrated in Figure 1.

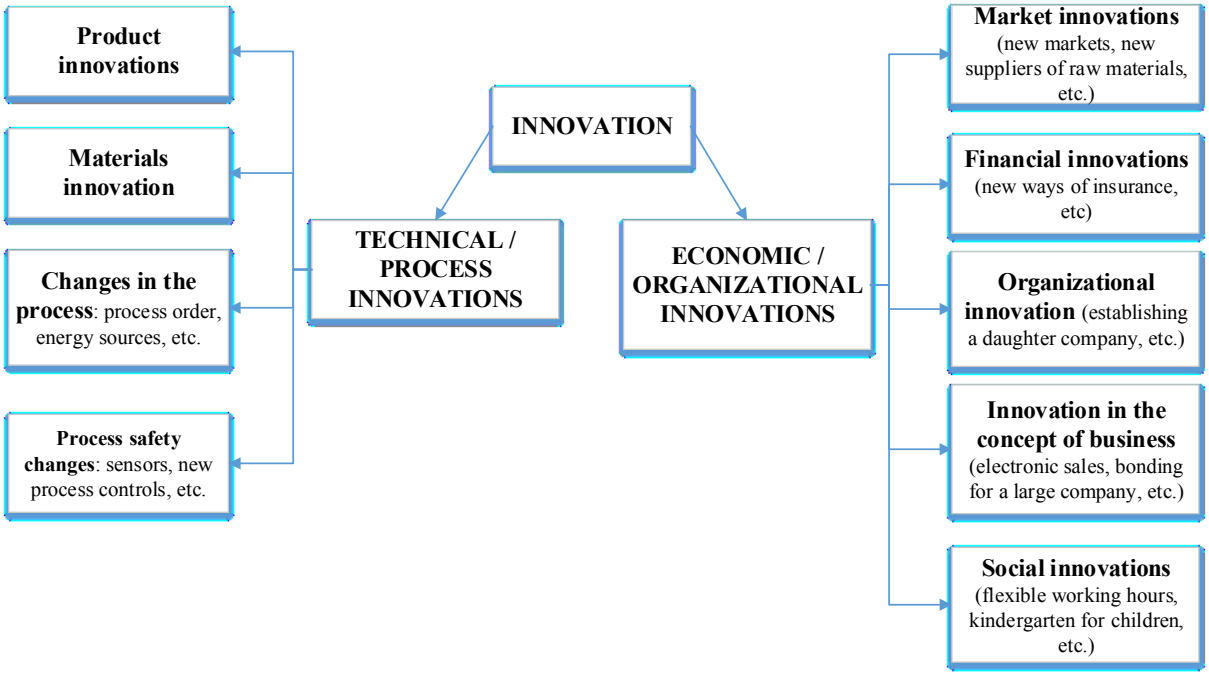

Figure 1. Product/service innovation.

3. The innovation measuring

The innovation measuring is an important activity both for theoretical and practical tests. The purpose of innovation measuring is to balance previous achievements with predictive measurements of potential outcomes of innovation through corporate capabilities. The evaluation of the performance of the innovation process has a number of very specific characteristics. The problem is how to manage different perspectives when it comes to radical and incremental innovations, which can ensure financial profitability in the short term. Some experts recommend three types of criteria for measuring success in innovation: technical, economical and others. The innovation capacities managing in practice relates to the understanding of how to gain access and collect data and information necessary to enable the learning and decision-making on the optimal innovation management. Important aspects or critical innovation factors such as ideas, knowledge, motivation, etc. cannot be measured directly because of their intangible nature. It was shown that companies rarely follow the information they need to systematically collect and evaluate innovation ideas, even those with very different methods and perspectives, and this makes it difficult to compare and measure the performance of innovations between companies and organizations. The evolution of the measurement of innovation is presented in Table 1.

Table 1.
The evolution of innovation measurement

The first generation Input indicators (1950-1960)	The second generation Output indicators (1970-1980)	The third generation Innovative indicators (1990)	The fourth generation Process Indicators (2000 plus emerging focus)
• Research and development expenditures • Scientific and technical personnel • Capital • Tech intensity	• Patents • Publications • Products • Qualitative changes	• Innovation surveys • Indexing • Benchmarking innovation capacity	• Knowledge • Intangibles • Networks • Demand • Clusters • Management techniques • Risk/return • System Dynamics

Source: http://www.tiec.gov.eg/backend/Reports/MeasuringOrganizationInnovativeness.pdf, 2011, p. 10.

3.1. INNOVATE: an innovation assessment tool

The assessment of innovation allows the company to understand its overall general innovative potential and identify the eventual business risks in the future. Another possibility provided by modern tools is the comparison of performance with respect to other similar companies. INNOVATE is an innovation diagnostic tool that encourages businesses to improve their innovation management in order to improve their competitiveness. It was created with the support of the CIP (https://ec.europa.eu/cip/; The Competitiveness and Innovation Framework Program) and SECEP (https://www.eubusiness.com…; Support to Enterprise Competitiveness and Export Promotion) – the projects funded by the European Union. It was used within the project of the European Entrepreneurship Network in which the consortium of Serbia also participated. The INNOVATE tool was designed to achieve two goals:

1. To assist the owner/manager of the company in assessing the current position of the company in relation to the 21 dimension of innovative management,
2. To improve the decision-making process on how to take the company to a higher level.

The way a company perceives innovation is considered to be one of the key factors of the innovative practices implementation and development (Aleksić Mirić, Petrović, and Aničić, 2019). For the research purposes, the 21 dimensions of innovation management were identified, regarding the innovation strategy of the company, the ideas management, the attitude towards change, the product development strategies, the technology application levels, the intellectual property rights, the customers and products data collecting, the horizon of the market, the growth expectations, the awareness of the situation on the market, planning methods, the decision making process, the general management and the information technology application (IT), the external advice acceptance, investment in innovation and growth, the employees qualifications and training, the links with academia, networking in business and the issues related to the reputation of the company. The aim of the research was

to investigate the level of the innovation capacities in Serbian companies. In regard to the aim of the research, the following hypotheses were defined:

H1: The innovation capacities dimensions are equally represented in Serbian companies.

H2: The implementation levels of certain innovation capacities dimensions in Serbian companies vary depending on the characteristics of the company.

H3: The expectations regarding company's growth are correlated with the level of innovative capacity dimensions.

H4: The expectations regarding company's growth depend on the characteristics of the company.

4. Methods

The empirical research was conducted in 2021, on a sample of 106 companies of different size and activity, Table 3. For the purposes of the research, the specialized questionnaire was constructed based on the 21 innovation management dimensions, with the aim to examine the levels of the innovation strategies implementation in Serbian companies. The questionnaire was divided in two parts. The first part covered 6 questions concerning the general information of the company (the number of employees, the annual capital turnover, the activity, year of establishment, the ownership structure and headquarters). The second part of the questionnaire consisted of 21 questions directly related to the 21 dimensions of innovation management. The innovation capacities of the companies were first observed through the examination of the levels of the innovation management dimensions implementation in practice, then the differences between the innovation management dimensions implementation in practice, shown by the examination results, were observed in relation to the number of employees and the annual capital turnover.

The data was processed with the IBM SPSS Statistics 25 software package. The results were prepared in the MS EXCEL 2013 software. The following 21 variables were considered in regard to the 21 dimensions of innovation capacities, which were presumed to affect the innovative capacity of companies according to INNOVATE diagnostic tool: Innovation strategy, Management of ideas, Attitude towards change, Product development cycle, Application of technology, Intellectual property rights, Database of clients and products, Market horizon, Expectations regarding the growth of the company, Market awareness and perception, Planning, Decision making, Management systems and information technology (IT), Acceptance of external advice, Internal investment in innovation, Financing growth, Qualifications of employees, Training of employees, Relationships with the academic environment, Business networking, Reputation, shown in Appendix. The assessment was carried out on a scale from 1 to 4, where 1 indicated the lowest level of the evaluated variable,

and 4 the highest level. As we worked with nominal and ordinal variables, the median was chosen as a measure of central tendency, and a statistical non-parametric method of variance analysis Kruskal-Wallis test was used to test the hypotheses.

Table 2.
The characteristics of companies

Number of employees	**Number**	**%**
Less than 10	45	42.5
10-49	28	26.4
50-249	21	19.8
250-700	7	6.6
more than 700	5	4.7
In total	106	100.0
Annual capital turnover (in thousands EUR)	**Number**	**%**
Less than 10	11	10.4
10-200	22	20.8
200-500	32	30.2
500-1000	12	11.3
More than 1000	29	27.4
In total	106	100.0

The annual capital turnover of companies in relation to the number of employees is presented in Table 3.

Table 3.
The annual capital turnover of companies in relation to the number of employees

Number of employees	**Annual capital turnover (in thousands EUR)**					**Total**
	Less than 10	**10-200**	**200-500**	**500-1000**	**More than 1000**	
Less than 10	10	16	14	5	0	45
10-49	0	4	12	4	8	28
50-249	0	2	3	3	13	21
250-700	0	0	2	0	5	7
More than 700	1	0	1	0	3	5
Total	11	22	32	12	29	106

5. Results and discussion

5.1. The innovation capacities of Serbian companies: the 21 innovation management dimensions value analysis

In order to test H1, the median value was observed, as the measure of central tendency, for the 21 dimensions of innovation management in Serbian companies, Table 4.

Table 4.
Median of the innovative capacities dimensions (range 1-4)

Innovative capacities dimensions	N	Median
Innovation strategy	106	2,00
Management of ideas	106	3,00
Attitude towards change	106	3,00
Product development cycle	106	3,00
Application of technology	106	2,00
Intellectual property rights	106	2,00
Database of clients and products	106	3,00
Market horizon	106	2,00
Expectations regarding the growth of the company	106	2,00
Market awareness and perception	106	3,00
Planning	106	2,00
Decision making	106	2,00
Management systems and IT	106	2,00
Acceptance of external advice	106	2,00
Internal investment in innovation	106	2,00
Financing growth	106	2,00
Qualifications of employees	106	2,00
Training of employees	106	3,00
Relationships with the academic environment	106	2,00
Business networking	106	2,00
Reputation	106	2,00

The highest value was obtained for the following variables: Market awareness and perception (3 – We investigate market opportunities and threats every year; Management of ideas (3 – We collect and review the ideas of all employees and all clients); Attitude towards change (3 – We actively strive for change in the way we work); Product development cycle (3 – We measure time to market exit for most of our new products and services); and Employee training (3 – We have training programs for several selected individuals from our firm). The obtained value for the other variables was 2 (1-4), descriptively presented in Appendix. According to the obtained results, H1 was not confirmed, meaning that the 21 dimensions of innovation management are not equally represented in Serbian companies.

5.2. The 21 innovation management dimensions implementation levels, in relation to the size of the company in terms of number of employees and the annual capital turnover

Due to the modern technological changes which have enabled the emergence of companies with a small number of employees and large capital turnover, we observed the level of linear correlation for the size of the company, in relation to the number of employees and capital turnover.

The relationship between the size of the company expressed in terms of number of employees and capital turnover was investigated using the Pearson linear correlation coefficient. The coefficients of correlation are most often interpreted by Cohen (1988): if r is between 0.1 and 0.29, it is a weak the correlation; if r is between 0.3 and 0.49 it is a correlation of mean strength, and if r is between 0.5 and 1.0, it is a strong correlation.

In the observed case, a strong positive correlation was obtained between the two variables, r = 0,550, with a large number of employees following a large turnover of capital.

5.2.1. The innovation capacities dimensions in relation to the number of employees: Kruskal-Wallis test

In order to test H2, the innovation capacities of companies were examined in relation to the number of employees. In regard to the number of employees, companies were grouped into micro (less than 10), small (10-49), medium (50-249), large (250-700), and very large enterprises (more than 700). According to the statistical non-parametric method of variance analysis, Kruskal-Wallis test, in relation to the number of employees the statistically significant differences were obtained for the following variables: Attitude towards change, Database of clients and products, Market horizon, Market awareness and perception, Planning, Internal investment in innovation and Financing growth, Table 5. The descriptions of the innovation management dimensions for which the statistically significant differences were obtained are presented in Appendix.

Table 5.
Kruskal-Wallis Test: The innovation capacities dimensions in relation to the number of employees

Kruskal Wallis Test, Grouping Variable: Number of employees							
	Attitude towards change	Database of clients and products	Market horizon	Market awareness	Planning	Internal investment in innovation	Financing growth
Kruskal-Wallis H	14,912	9,565	10,101	11,402	11,781	9,384	15,698
df	4	4	4	4	4	4	4
Asymp. Sig.	0,005	0,048	0,039	0,022	0,019	0,052	0,003

Depending on the number of employees, statistically significant differences were obtained for the following dimensions of innovative capacities: Attitude towards change, Database of clients and products, Market horizon, Market awareness and perception, Internal investment in innovation, and Financing growth. The nature of these differences is presented in Table 6.

Table 6.
The innovation capacities dimensions characteristics differences in relation to the number of employees

Number of employees	Planning	Market horizon	Market awareness and perception	Internal investment in innovation	Financing growth	Attitude towards change	Database of clients and products
Less than 10, n = 45	Every 12 months we make a plan for the next year (2)	The market for our products or services will cover Serbia (2)	We examine market opportunities and threats every year (3)	We work on the development of new products/ services based on commercial contracts (2)	Our growth is tied solely to our profits (1)	We actively strive for change in the way we work (3)	We will offer products and services to many customers (3)
10-49, n = 28	We look 2-3 years ahead in making the annual plan (3)	The market for our products or services will cover Serbia (2)	We examine market opportunities and threats every year (3)	We regularly co-finance research and development projects (3)	We will use limited loans (debt refinancing) to enable growth (3)	We actively strive for change in the way we work (3)	We will offer products and services to many customers (3)
50-249, n = 21	We look 2-3 years ahead in making the annual plan (3)	The market for our products or services will cover Serbia (2)	We examine market opportunities and threats every year (3)	We regularly co-finance research and development projects (3)	We will use limited loans (debt refinancing) to enable growth (3)	We know we need to change but we don't know how (2)	We will offer two/ three products to selected customers (2)
250-700, n = 7	We look 2-3 years ahead in making the annual plan (3)	We will focus on meeting the needs of our local market (1)	We rely on customer feedback to maintain market awareness (2)	We regularly co-finance research and development projects (3)	We use various forms of financing for innovation, including risk capital (4)	We know we need to change but we don't know how (2)	We will offer two/ three products to selected customers (2)
More than 700, N = 5	We have a lot of work to do and we don’t have time to plan ahead (1)	We will focus on meeting the needs of our local market (1)	We rely on customer feedback to maintain market awareness (2)	We work on the development of new products/ services based on commercial contracts (2)	We are considering new ways to finance company growth (2)	We know we need to change but we don't know how (2)	We will offer two/ three products to selected customers (2)

In the case of micro companies, with less than 10 employees, of which 42.5% are in the sample, market awareness and perception is very good, since they state to examine market opportunities and threats every year, as well as the attitude towards change, because it is easier to see the need for change and make changes when it comes to fewer employees. They have very good developed database of clients and products, and they intend to offer

products and services to many customers. At the same time, these companies have struggles with financing growth, since the company growth is tied solely to the profits of the company. They make plans only for one year ahead, and they work on the development of new products/services based on commercial contracts.

The companies with 10-49 employees, of which 26.4% are in the sample, showed fairly high assessment levels for the observed dimensions of innovative capacities, except market horizon, since it was predicted that the market for the company's products or services will only cover Serbian market. They look 2-3 years ahead in making the annual plan, examine market opportunities and threats every year, regularly co-finance research and development projects, and actively strive for change in the way they work. They plan to use limited loans (debt refinancing) to enable growth and to offer products and services to many customers.

In companies with 50-249 employees, of which 19.8% are in the sample, the implementation levels of some innovation capacities dimensions were assessed as fairly high, such as Planning, Market awareness and perception, Internal investment in innovation, and Financing growth. These companies state to look 2-3 years ahead in making the annual plan, examine market opportunities and threats every year, and regularly co-finance research and development projects. When it comes to the growth financing, they plan to use limited loans (debt refinancing) to enable growth. The dimensions Attitude towards change, Database of clients and products and Market horizon are at a lower level, since these companies, although aware of the necessity to change, don't know how to do it, and they plan to offer only two/ three products to selected customers on the market that will cover Serbia.

In the case of companies with 250-700 employees, of which 6.6 % are in the sample, Financing growth dimension showed the highest assessment values, and these companies state to use various forms of financing for innovation, including risk capital. Internal investment in innovation is also very high assessed, since these companies regularly co-finance research and development projects, as well as Planning, as they state to look 2-3 years ahead in making the annual plan. On the other hand, Market horizon dimension assessment value is at the lowest level, and these companies only plan to focus on meeting the needs of the local market.

The overall innovation capacities dimensions implementation levels in companies with more than 700 employees, of which 4.7 % are in the sample are lower than in the previous cases. Planning and Market horizon dimensions assessment were at the lowest level, since these companies stated to have a lot of work to do and don't have time to plan ahead, and focus on meeting the needs of the local market solely. The other innovation capacities dimensions showed low assessment levels. These companies rely only on customer feedback to maintain market awareness, work on the development of new products/services based on commercial contracts, and plan to offer only two/three products to selected customers. They are considering new ways to finance company growth, and they are aware of the fact that they need to change, but they don't know how.

The nature of the differences in the dimensions of innovative capacities, for the variables for which statistically significant differences were obtained by the Kruskal-Wallis test, presented as mean ranks, are shown in Table 7.

Table 7.
Number of employees – Kruskal-Wallis Test: Ranks

	Number of employees	N	Mean Rank
Attitude towards change	Less than 10	45	60,00
	10-49	28	60,34
	50-249	21	44,29
	250-700	7	26,50
	More than 700	5	33,20
Database of clients and products	Less than 10	45	60,49
	10-49	28	56,50
	50-249	21	45,36
	250-700	7	31,93
	More than 700	5	38,20
Market horizon	Less than 10	45	56,86
	10-49	28	57,86
	50-249	21	53,60
	250-700	7	39,93
	More than 700	5	17,50
Market awareness and perception	Less than 10	45	62,74
	10-49	28	53,00
	50-249	21	45,83
	250-700	7	32,79
	More than 700	5	34,30
Planning	Less than 10	45	45,46
	10-49	28	65,30
	50-249	21	56,21
	250-700	7	65,14
	More than 700	5	32,10
Internal investment in innovation	Less than 10	45	44,63
	10-49	28	64,25
	50-249	21	59,00
	250-700	7	59,14
	More than 700	5	42,10
Financing growth	Less than 10	45	41,19
	10-49	28	63,89
	50-249	21	58,69
	250-700	7	75,21
	More than 700	5	53,90

It can be concluded that the attitude towards change is the most prominent in companies with less than 50 employees, which could be expected, given that it is easier to manage activities that require change, if they involve a smaller number of people. These companies have the highest level of dimension market awareness and perception, as well as the customer and product database. Market horizon is showed to be is the highest in companies with less than 250 employees. The best planning strategies are showed in category of companies with less than 50, and 250-700 employees. The companies with 10-49 employees proved to have

the largest internal investment in innovation. Financing growth is most prominent in companies with 250-700 employees.

5.2.2. The innovation capacities dimensions in relation to the annual capital turnover: Kruskal-Wallis test

For further testing of hypotheses H2, the innovation capacities of companies were examined in relation to the annual capital turnover. In regard to the annual capital turnover, the following classification was made: companies with small annual capital turnover (< 10.000 EUR), medium annual capital turnover (10.000-200.000 EUR), moderately large annual capital turnover (200.000-500.000 EUR), large annual capital turnover (500.000-1.000.000 EUR), and very large annual capital turnover (1.000.000 < EUR). According to the statistical non-parametric method of variance analysis, Kruskal-Wallis test, in relation to the annual capital turnover the statistically significant differences were obtained for the following variables: attitude towards change, database of clients and products, and relationships with the academic environment, Table 8.

Table 8.
Kruskal-Wallis Test: The innovation capacities dimensions in relation to the annual capital turnover

Kruskal Wallis Test, Grouping Variable: Annual capital turnover			
	Attitude towards change	**Database of clients and products**	**Relationships with the academic environment**
Kruskal-Wallis H	12,975	20,336	13,052
df	4	4	4
Asymp. Sig.	0,011	0,000	0,011

The nature of the differences in the dimensions of innovative capacities, for the variables for which statistically significant differences were obtained by the Kruskal-Wallis test, presented as mean ranks, are shown in Table 9.

It can be concluded that the attitude towards change is the most prominent in companies with the annual capital turnover in the category of 500.000-1.000.000 EUR, of which 11.3% are in the sample, and these companies also proved to have the database of clients and products at the highest level. The best relationships with the academic environment are shown in companies with the annual capital turnover in the category of 10.000-200.000 EUR, of which 20.8% are in the sample.

Table 9.
The annual capital turnover: Kruskal-Wallis Test: Ranks

	Capital turnover (EUR)	N	Mean Rank
Attitude towards change	< 10.000	11	64,00
	10.000-200.000	22	53,48
	200.000-500.000	32	56,11
	500.000-1.000.000	12	70,63
	More than 1.000.000	29	39,57
Database of clients and products	< 10.000	11	68,41
	10.000-200.000	22	53,43
	200.000-500.000	32	62,00
	500.000-1.000.000	12	64,92
	More than 1.000.000	29	33,79
Relationships with the academic environment	< 10.000	11	45,36
	10.000-200.000	22	68,36
	200.000-500.000	32	55,38
	500.000-1.000.000	12	32,63
	More than 1.000.000	29	51,88
	Total	106	

It can be concluded that the obtained differences in the level of innovative capacities are different when the size of the company is observed through the number of employees and through capital turnover, although these two characteristics are highly correlated. From the above, it can be stated that hypothesis H2, according to which the implementation levels of certain innovative capacities dimensions in Serbian companies vary depending on the characteristics of the company, was confirmed.

5.3. The growth expectations in relation to the innovation capacities dimensions levels

In order to test H3, the correlation of the expectations regarding the growth of the company and the innovation capacity dimensions was examined. The coding regarding the growth expectations of the company was carried out as follows: 1 – We do not expect the growth of the company; 2 – We expect a modest business growth; 3 – We planned and allocated a budget for a gradual increase in business; and 4 – We expect our business to grow rapidly. Pirson's correlation was observed (r), Figure 2. According to Cohen (1988), a strong positive correlation was obtained between the variable “Expectations regarding company growth” and the following variables:

- Management systems and use of IT (r = 0.505).
- Business networking (r = 0.510).
- Innovation strategy (r = 0.544).
- Market horizon (r = 0.521).

A positive correlation of mean strength was obtained between the variable “Expectations regarding company growth” and the following variables:

- Attitude towards change (r = 0.455).
- Management of ideas (r = 0.408).

- Training of employees (r = 0.479).
- Intellectual property rights (r = 0.426).
- Internal investment in innovation (r = 0.382).
- Application of technology (r = 0.367).
- Product development cycle (r = 0.346).
- Qualifications of employees (r = 0.366).

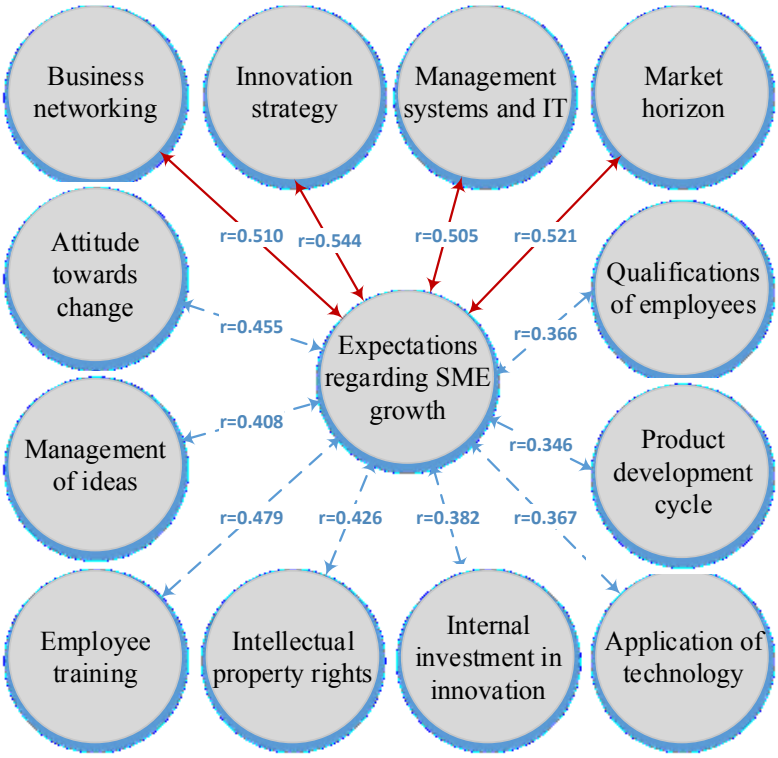

Figure 2. The strong correlations between the innovation capacity dimensions.

The obtained results showed that the companies which expect their business to grow in the future have a developed innovation strategy. Their market horizon transcends the local and regional markets, and these companies show tendencies to expand their business to the international level. In accordance to this, these companies have established a quality management system and developed business networks. In addition to this, a strong positive correlation was obtained between the variables Database of clients and products and Attitude towards change, r = 0.591, which is explained by the company's flexibility to respond to different market demands.

The existence of a strong and moderate correlation between growth expectations and the dimensions of innovative capacities, hypothesis H3, according to which the expectations regarding the company's growth are correlated with the level of innovative capacity dimensions, was confirmed.

5.4. The growth expectations in relation to the characteristics of the company

In order to test H4, the growth expectations in relation to the characteristics of the company were examined. First, the central tendency measure for the company's expectations regarding its future growth by activities was observed. Since these are nominal and ordinal variables, the median was chosen as a measure. The results showed that the differences in expectations regarding the future growth of the company depend on the activity the company is engaged in, Table 10. It can be noticed that the distribution of companies by activities is not uniform, and this should be considered when interpreting the results.

Table 10.
Median for the company's expectations regarding its future growth by activities

Activity	N	Median
IT	6	"We expect a modest business growth"
Production	38	"We planned and allocated a budget for a gradual increase in business"
Agriculture	4	Between "We do not expect the growth of the company" and "We expect a modest business growth"
Construction	4	Between "We expect a modest business growth" and "We planned and allocated a budget for a gradual increase in business"
Services	38	"We expect a modest business growth"
Trade	8	"We expect a modest business growth"
Energy	4	Between "We expect a modest business growth" and "We planned and allocated a budget for a gradual increase in business"
Consulting	4	Between "We do not expect the growth of the company" and "We expect a modest business growth"

Then, the growth expectations levels were examined in relation to the activity the company is engaged in. The results showed that the expectation of rapid growth is present in companies whose activities are related to production, services, trade and construction, Figure 3.

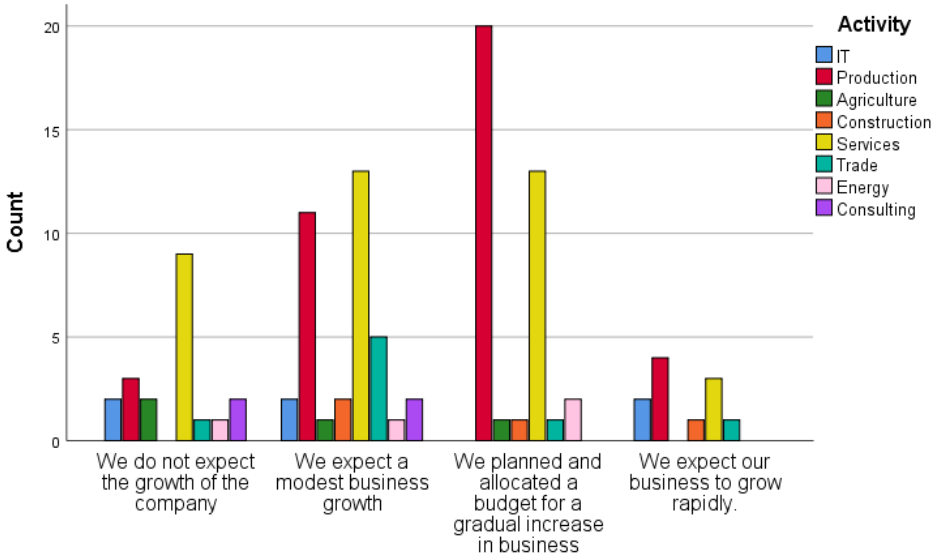

Figure 3. The expectations regarding company growth by activities.

When it comes to the growth expectations levels in relation to the number of employees, it is shown that the expectation of rapid growth is present in companies with less than 250 employees. Generally, the largest number of companies expect a modest business growth, Figure 4.

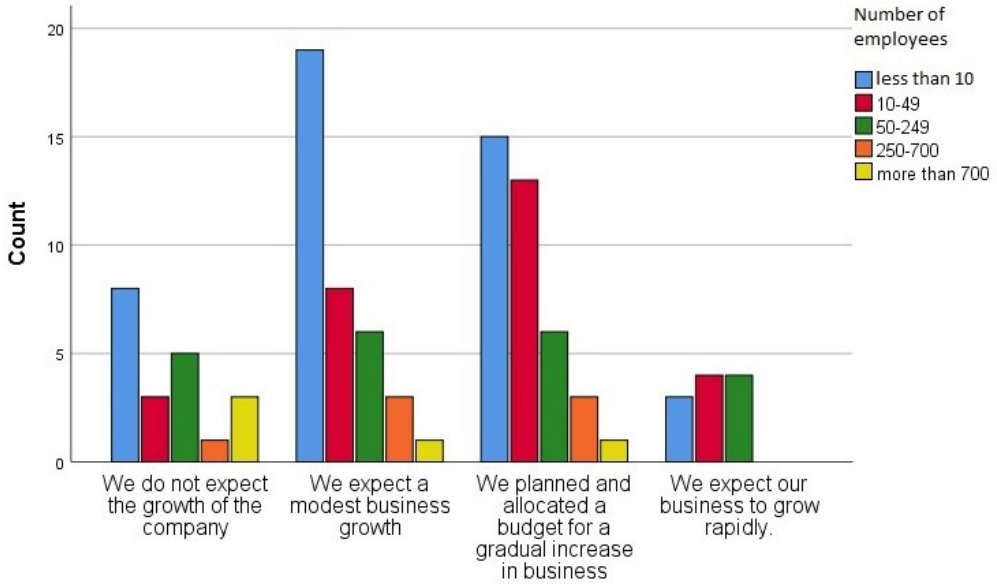

Figure 4. The expectations regarding company growth in relation to the number of employees.

In relation to the annual capital turnover, the highest growth expectations levels were obtained in companies with the annual capital turnover in the range 10.000-500.000 EUR, and over 1.000.000 EUR, Table 13 and Figure 5.

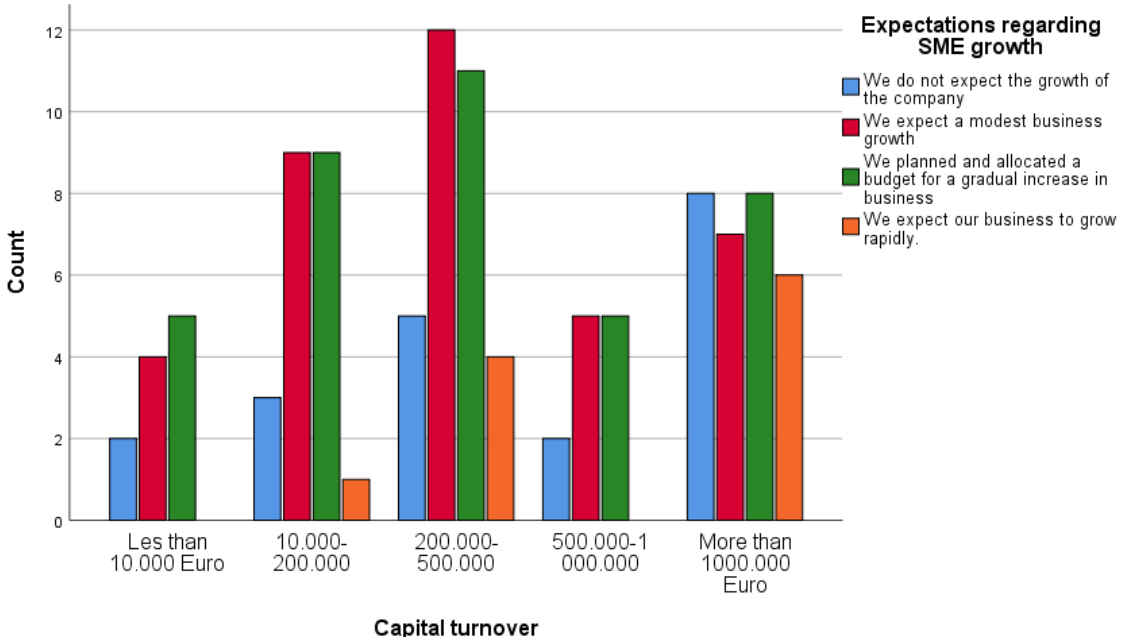

Figure 5. The annual capital turnover and the expectations regarding company growth crosstabulation.

The obtained results showed that the expectations regarding company growth depend on the characteristics of the company: the size of the company and the activity the company is engaged in. This confirms H4.

6. Summary

The research results showed that companies in Serbia differ in regard to the innovation capacities depending on the size of the company, in terms of number of employees and the annual capital turnover, which is in accordance to the results of the previous research (Sousa, Ferreira, and Vaz, 2020). According to the number of employees, the micro companies are very well aware of the situation on market. They are open to changes and they intend to collaborate with many clients in the future. But due to the modest capital turnover, these companies are facing struggles with financing growth.

In the case of small companies, all the innovation capacities dimensions are at an intermediate level, except market horizon, since they are oriented only on domestic market. Compared to micro companies, they show much better results in regard to financing growth.

The medium-sized companies are less open to change compared to small companies, and instead of collaborating with many customers, they plan to offer only two/ three products to selected customers on domestic market. At the same time, they are very engaged in growth financing and the innovation investments.

The large companies showed exceptional results in regard to financing growth, better than in any other company category. They also invest in innovation and make plans for several years ahead, but these companies only plan to focus on meeting the needs of the local market, as well as the very large companies, which can be seen as a little unexpected.

The very large companies do not plan ahead, because they feel that the amount of work they currently have does not require planning. Other dimensions of innovation capacity are lower, which was not expected. It can be speculated that they create a kind of monopoly on the local market for certain, sought-after products.

Generally, in relation to the number of employees, it was shown that the category of companies with the biggest disproportion of innovation capacities implementation levels is the category of large companies, with 250-700 employees, which have the highest innovation capacities when it comes to growth financing, and the lowest when it comes to market horizon, compared to other categories of companies. The biggest difference in some innovation capacity dimension implementation levels among companies was obtained for the Financing growth, which achieved the highest result in large companies, and the lowest result in micro companies, with less than 10 employees. Market horizon also showed the lowest implementation levels in large companies, as well as in very large companies, with more than

700 employees, together with Planning. The large companies generally showed the lowest innovation capacities implementation levels, compared to other categories of companies. It can be concluded that smaller companies, in regard to the number of employees, are more open to changes. They have good market horizon and awareness, planning strategies and clients and products database, and they invest in innovation. The larger companies have more advantage when it comes to financing growth, but they also showed to be very engaged in planning.

The innovation capacity dimensions in relation to the annual capital turnover significantly differ when it comes to the attitude towards change, clients and products database and the relationships with the academic environment. The results showed that the companies with the annual capital turnover in the category of 500.000-1.000.000 EUR, are most open to changes, but they also show the least links with academia. In the case of companies in the category of over 1.000.000 EUR, the attitude towards change is the least represented, and they also have the less developed clients and products database. The companies in range of less than 10.000 EUR have the clients and products database at the highest level. The best collaboration with the academia is shown in companies with the annual capital turnover in the category of 10.000-200.000 EUR.

When it comes to the growth expectations in relation to the innovation management dimensions implementation levels, the obtained results showed that companies which expect their business to grow in the future implement an advanced innovation strategy, especially in the fields of market horizon and business networking, and well-developed management systems with the accent on IT sector. The results also showed that the growth expectations depend on the characteristics of the company. The rapid growth is expected in companies whose activities are related to production, services, trade and construction, with less than 250 employees, and with the annual capital turnover in the range 10.000 – 500.000 EUR, and over 1.000.000 EUR.

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Appendix

21 innovation capacity dimensions implementation levels:

1. Innovation strategy
    1. We do not have an innovation strategy
    2. We need to introduce innovation as part of our company's strategy
    3. We have an innovative strategy that our management understands
    4. Our innovative strategy is an integral part of the company's overall strategy, and employees, customers and suppliers have a clear picture of it.
2. Management of ideas
    1. We do not have any official method for generating and evaluating ideas.
    2. Our ideas are generated by a research and development group.
    3. We collect and review the ideas of all employees and all clients.
    4. We have introduced a systematic process for collecting and managing new ideas, from multiple internal and external sources, including suppliers, customers and users.
3. Attitude towards change
    1. We hesitate to change anything in case it goes wrong.
    2. We know we need to change but we don't know how.
    3. We actively strive for change in the way we work.
    4. We expect to be involved in the process of constant change.
4. Product development cycle
    1. We do not monitor or measure the time required to develop a new product or service.
    2. We monitor the development time of a new product or service in relation to the plan.
    3. We measure time to market exit for most of our new products and services.
    4. We measure the time to market and the time to start making a profit for all our products and services.
5. Application of technology
    1. Our products and processes are based on traditional technology.
    2. We embrace new technologies when they prove successful.
    3. Our company is one of the technological leaders in our sector.
    4. We are responsible for the development of new technologies in our field.
6. Intellectual property rights
    1. We do not use trademarks, patents or design rights in our company.
    2. We are looking for a way to legally protect our technology, know-how and reputation.
    3. We expect our business to be protected through several different types of intellectual property.

4. Our technology and reputation is already protected by approved patents and registered trademarks.

7. Database of clients and products
    1. Our business will depend on one product/customer.
    2. We will offer two/ three products to selected customers.
    3. We will offer products and services to many customers.
    4. We will have a wide range of products and a large customer base.
8. Market horizon
    1. We will focus on meeting the needs of our local market.
    2. The market for our products or services will cover Serbia.
    3. We will mostly do business with clients from Europe.
    4. We will mostly do business with clients from developed countries all over the world.
9. Expectations regarding the growth of the company
    1. We do not expect significant turnover growth.
    2. We expect a modest increase in business.
    3. We have planned and allocated a budget for gradual business growth.
    4. We expect our business to grow rapidly.
10. Market awareness and perception
    1. We do not try to analyze the market and its trends.
    2. We rely on customer feedback to maintain market awareness.
    3. We examine market opportunities and threats every year.
    4. We constantly pay attention to market opportunities and threats.
11. Planning
    1. We have a lot of work to do and we don’t have time to plan ahead.
    2. Every 12 months we make a plan for the next year.
    3. We look 2-3 years ahead in making the annual plan.
    4. We do strategic planning for 5 and more years.
12. Decision making
    1. All major decisions are made by the owner of the company.
    2. The owner seeks advice from employees when making key decisions.
    3. Our company is run by a small team of directors.
    4. Our board consists of executive directors and directors who do not have executive power.
13. Management systems and information technology (IT)
    1. There is no management system in our company.
    2. We are aware of the need for a Plan/Implementation/Verification/Action to improve performance as well as the use of information technologies.
    3. We strategically use management and IT systems to ensure the implementation of the tasks required to achieve commercial goals.

4. We use management systems and IT as part of a strategy in search of continuous improvement and development of innovations.

14. Acceptance of external advice
    1. We rarely ask for external help.
    2. We occasionally use the services of local business support services.
    3. We used the expert advice of some experts.
    4. We often seek advice from experts in business or technology.
15. Internal investment in innovation
    1. We do not have a budget for innovation.
    2. We work on the development of new products/ services based on commercial contracts.
    3. We regularly co-finance research and development projects.
    4. Every year we reinvest some percentage of sales revenue in certain innovative projects and activities.
16. Financing growth
    1. Our growth is tied solely to our profits.
    2. We are considering new ways to finance company growth.
    3. We will use limited loans (debt refinancing) to enable growth.
    4. We use various forms of financing for innovation, including risk capital.
17. Qualifications of employees
    1. Our employees do not have recognized qualifications.
    2. Most of the employees have professional qualifications.
    3. A small number of employees have diplomas or professional qualifications.
    4. Most employees have university degrees/professional qualifications.
18. Training of employees
    1. There is no need for our employees to attend any courses.
    2. Some employees go to trainings if a suitable course is indicated.
    3. We have training programs for several selected individuals from our company.
    4. Appropriate training programs are available to all our employees.
19. Relationships with the academic environment
    1. Our company is not affiliated with colleges or universities.
    2. We have contact with the local college.
    3. We are trying to connect with the university.
    4. We have established strong ties with academic institutions.
20. Business networking
    1. We are not members of any business or technology network.
    2. We have some contacts with business/technology networks.
    3. We are active in numerous business/technology networks.
    4. We are leading participants in the development of the business/technology network.

21. Reputation
    1. We did not try to promote the activities of our company.
    2. We try very hard to promote the activities of our company.
    3. Our company is well known in our business sector.
    4. Our company is recognized worldwide.

RELATIONSHIP BETWEEN PROJECT TEAM PERFORMANCE AND KEY PROJECT SUCCESS FACTORS

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Introduction/background: This paper explores the relation between a concept of project key success factors, popular among project management practitioners, with the operational performance of the project delivered by its team.
Aim of the paper: This paper presents research, which answers the question if teams working with the support of project key success factors achieve better performance.
Materials and methods: Literature research was conducted, which covered both the subject of team performance and project success. This led to the definition of project team performance and analysis of its relationship with project success. The literature on key success factors was analysed in a historical overview from 1967 to 2020. The empirical research covered the correlation between project success factors and project team performance.
Results and conclusions: The analysis of the results showed that each of the team performance components is associated with other group of success factors: project time with collaborative atmosphere (parent organisation-related factors), project quality with professional competence of project team members (team-related factors), project cost with clearly defined objectives (project-related factors).

Keywords: Project success factors, project team performance, project management, human capital management.

1. Introduction

Working in a project, project-based organisation, temporary employment, flat organisational structures are no longer a trend or a near future, but a contemporary reality, well rooted in the nowadays economy. Even agile methods in project management are no longer a curiosity, but a commonly used management style in a wide spectrum of project types. However, even if not new or not so fresh as it used to be 10-20 years ago, subject of project team performance, its measurement and factors is still important. Arguably it will be important as long as project management lasts, as there is always room for improvements in management, if only because of ever-changing projects` environment.

But what exactly is a project team performance? Who measures it and when? And what about the success? Does a good performance equal to a project's success? These questions, yet simple and with a rather straightforward answers at a first glance, are not so obvious after a longer consideration. To start with the first one, more questions arise. Especially a team seems to be a problematic subject, as its constitution can take place at the very beginning of the project life cycle, but also after the planning phase, not mentioning the team's structure evolution along the way until the project is finished. Moreover, the team structure itself adds more analytical layers, as it can imply having or not having a project manager among the team members. Self-organizing team is an enormous research subject itself. So, as shown, there are no simple questions when project team performance is considered. But, aside from this argumentation, each of those questions is crucial, when it comes to the project team assessment. Especially a matter of project success and its relation to the team performance seems to be an interesting research subject. This is because a success tends to be a wide, multi-dimensional construct, whereas performance characteristics are rather quantitative and, relatively, easily interpretable. Success also sounds better than performance. And this is not of a negligible importance. As Belbin's model of team development example shows, even unproven theory can become popular with a good sounding name – in this case "Forming-Norming-Storming-Performing".

This paper addresses the relationship between key project success factors and project team performance. It is important, because the project team performance is a component of project success and as such should be affected by key success factors. The research was focused on the question, if teams which work in better conditions, in terms of project key success factors, achieve better performance measured in the quality, cost and time. Literature research was conducted, which covered both the subject of project team performance and project success. This led to the definition of project team performance and analysis of its relationship with project success. The literature on project key success factors was analysed in a historical overview from 1967 to 2009. The empirical research covered the correlation between key project success factors and project team performance. A post analysis of the results was made, with the use of the most recent research on the subject from years 2019 – 2020.

The goals of the article are: 1. to present the relationship between project team performance and project team success, 2. to present the relationship between project team performance and key project success factors. The first goal is covered in the literature review section. The second goal was the subject of empirical research and is covered in the method, results and conclusions sections.

2. Literature review

2.1. Project team performance

Project evaluation is complex and depends on the evaluator, as well as the time of evaluation.

According to Trocki's (2013) concept of project evaluation system, there are 3 levels on which projects can be evaluated. These are levels of: the project, the project's parent organisation, the parent organisation's environment. The level of the project and project's parent organisation are the intra-organisational levels, whereas the third one extends beyond the organisation.

On each of those levels, evaluation can be made according to the following criteria: purposefulness, feasibility, performance, efficiency, quality, usefulness. Although all of them are important for the evaluation, only the criterion of performance is considered in this paper. Performance can be further divided into three categories: operational performance, basic performance, and strategic performance.

Strategic performance is a measure of project's overall, long-term impact. Specifically, it explains to what extent strategic objectives were achieved. Such objectives transcend the project's parent organisation. Their origin lays in the primary need, to which fulfilment, strategic objectives are formulated. For them to be achieved, many separate but complementary projects may have to be launched. A good example are projects funded by European Union programmes. None of such projects can achieve the strategic objective on its own, but their combined impact can lead to its achievement (Aid Delivery Methods, 2004). Unfortunately, strategic performance is difficult to quantify (Trocki, 2012).

Basic objectives are formulated on the organisation's level, based on the strategic objectives. This type of an objective refers to the internal need of the organisation, which, however, should somehow respond to the primary need from the strategic level. Basic performance measures how well basic objective was completed assessing mid-term project's results (Trocki, 2012).

Although satisfying the primary need laying behind the strategic objective, as well as basic needs may require more than one project, there can be situations where a single undertaking is enough. In such cases only the time frame of evaluation will exceed the project's life cycle, but additional projects will not affect the evaluation results.

None of the above objectives, however, is a subject of the project's team concern. This is because of two reasons. First one is the time of measurement. Team's work is measured just after it's finished, when project products are delivered. Quality of those products, time in which they were delivered, and resources used in relation the operational objective give the measure of operational performance (Trocki, 2012). The second one is the real influence of the team on how well strategic, basic, and operational objectives fit to each other. Both basic

performance and strategic performance are somehow biased by how well the primary and organisation's needs were translated into objectives. In this paper, it's assumed that entities other than project team formulate those goals. As a result, perfect project products, delivered by perfect teams, can lead to imperfect project results and, as an effect, to poor project impact. Therefore, in this paper, the project team performance is considered as the one fully dependent on the team's effort, without any bias imposed by the goals` formulation, which is equal to the project operational performance.

Putting the performance of the project team on a par with the operational performance of the project means that also the components of both measures must be the same. Given that performance is a measure of the degree to which the objective is achieved, and the project objective, according to the project triangle concept, is defined by: quality, time and cost (Project Management Institute, 2017), the operational objective of the project must also be defined in these three categories. As a result, team performance also consists of quality, time and cost.

But the cost criterion refers rather to the measure of efficiency, than performance (Głuchowski, 2001). This means that team performance combines features of two measures: efficiency and performance. This combination, however, seems natural in the context of project team's work. If the team could generate any cost, it would always achieve the desired quality in the expected time. But the task of a team, as a separate organisational unit, is to achieve a goal defined in business terms. Hence, an inherent component of its evaluation is the use of available resources.

2.2. Project success

Project success is a concept related to performance, but not identical. Its definition is constantly evolving and is perceived in many ways (Baccarini, 1999). In the initial definitions, project success was described as a successful implementation of a project or a project, which desired results were achieved. However, such definitions based on the so-called golden triangle (Haffer, 2009) were insufficient, due to the complex nature of projects and the wide range of actors involved in their implementation (Beleiu et al., 2015). Currently, project success is mainly considered on two levels: first-order success (basic), second-order success (Trocki, 2012).

First-order success is the degree of achievement of the project objective, defined according to quality, time and cost. It stems from the concept of the so-called golden triangle of the project. Success so defined is operational in nature and is equivalent to the operational performance of the project. Second-order success is extended by factors related to the satisfaction of customer needs, customer acceptance (Kerzner, 2004). This level corresponds to the basic performance of the project.

With the popularisation of project-based activities, further levels have been included in the definition of project success. Satisfaction of the project stakeholders' needs are considered the most important (Westerveld, 2003). The group of project stakeholders, however, is very diverse. It consists of: project champions, project participants, the community of project participants, parasites (Tuman, 2006). Project champions are the entities that define the overall objective of the project, representing the need for which the project is initiated. Representatives of this group are different types of customers. Project participants are primarily members of the project team and other entities directly related to the implementation of the project. Their goal is to ensure high operational performance. The community of participants includes the social, environmental, and political groups that constitute the project environment. From their point of view, the measure of a project's success is its impact, i.e. strategic performance. The parasite group is not directly associated with the project and seeks only to prey on its success or failure. Measuring performance is not applicable to this type of stakeholder (Tuman, 2006).

A logical model that considers both levels of project success evaluation is Atkinson's Square Route of project success criteria, according to which, when evaluating project success, the following should be considered: golden triangle, project result, benefits for the organisation, benefits for the stakeholders (Atkinson, 1999).

Table 1.
Evaluation elements in the Square Route model of project success criteria

Golden triangle	**Project result**	**Benefits (organisational)**	**Benefits for the stakeholders**
Quality Time Cost	Compliance with requirements Reliability Validity Information Appropriate quality Use	Increase in perfomance Increase in efficiency Increase in revenue Achieving the strategic goal Organisational learning Reduction of losses	User satisfaction Impact on the environment Impact on the community Personal development Access to finance Project team satisfaction Economic impact on the environment

Note. (Atkinson, 1999).

The large diversity of the stakeholder group means that each stakeholder places emphasis on different components of project success evaluation. Koelmans (2004) proposes a model of disaggregating success factors into eight specific factors, which are selected according to the needs of the evaluating stakeholder. The dimensions of success in Koelmans (2004) model are: quality, schedule, budget, project team, tools and techniques, health, safety and environment, usability, customer satisfaction. Shenhar et al. (1997) point out that the selection of components and weights for project success evaluation depends not only on the stakeholder but also on the phase of the project life cycle being measured. The authors propose the following four dimensions of evaluation, the weights of which are variable depending on the stakeholder and time: project performance, customer impact, business and immediate success, and preparation for the future. The dimensions of success in the model are arranged according to relative importance, which changes in time counted from project completion. According to this

arrangement, project performance is the most significant criterion at the time of project completion. The later success is measured, the more significant are the other measures. In the long term, only criteria related to the impact on the parent organisation are significant (Shenhar et al., 1997). According to Munns and Bjeirmi (1996), the composition of the group of project's stakeholders changes over the course of the project. During the concept (definition and initiation) phase, the customer, the users of the project results and the environment are most associated with the project. During the planning phase, the project team becomes associated with the project, while the users cease to be a significant stakeholder. During project implementation, the group expands to include the manufacturer and remains in this composition until the end of the handover phase. Only the client and the environment are interested in the closing of the project. Gardiner and Stewart (2000) point out that it is the NPV calculation that should be the basis for assessing the success of a project as well as any changes made to it.

Project success, although seemingly obvious, can be defined in many ways. Its perception depends on how the evaluator's relation with the project, when the assessment is made and how it is affected by the project products and results. The above argumentation shows that there are many analogies between success and project performance on the one hand and several divergences on the other. For example, in the Atkinson's model, the project team, which in the operational performance assessment is the assessed one, also stands on the side of the evaluators as a stakeholder. This shows how complex and ambiguous is a process of project evaluation.

2.3. Project key success factors

Considering the close relation between project team performance and project success, a research analysis of key project success factors has been conducted. The research question was asked, if teams working with the support of key project success factors achieve better performance? To build a set of the project key success factors a chronological analysis of research on their subject was made. It shows a significant development of interest in this area among authors throughout last decades. The first empirical research on the subject was conducted in 1967 by Rubin & Seelig (1967). They showed that a project manager's previous experience had a minimal effect on project success, but that the size of the projects in which he or she worked influenced project success. More conclusions were provided by the theoretical research of Avots (1969). He showed that the main causes of project failures are: choosing the wrong project manager, unexpected project termination, insufficient support from high-level management entities. The main causes of project failure according to Hughes (1986) are: reward for inappropriate actions and lack of communication of objectives. A study of large, complex projects by Morris and Hough (1987) found that the causes of project success or failure can be captured within a seven-element model. This consists of: project objectives, technical uncertainty, politics, community involvement, schedule, legal issues regarding contracts, and implementation problems. One of the first attempts to systematise the issue of project success was made by Schultz et al. (1987). Their systematics is based on the division of project

success factors into strategic and tactical. To the group of strategic factors they included: project mission, support of the top management, scheduling. Whereas among the tactical factors were: client consultation, staff selection and training. The model of two groups of project success factors was developed during two empirical studies conducted by the teams of Pinto and Slevin (1989) and Pinto and Prescott (1988). They resulted in the identification of the relationship between the strength of impact of factors on the project and the phase of the project life cycle.

Table 2.
Chronological listing of project success factors

1967	**1969**	**1971**	**1976**	**1983**	**1983**
Rubin and Seelig (1967)	**Avots (1969)**	**Sayles and Chandler (1971)**	**Martin (1976)**	**Baker et al. (1983)**	**Cleland and King (1983)**
The performance of a project manager depends on the size of the projects in which he/she has accumulated experience.	Project manager selection Project completion on time Support from top management	Project manager competences Scheduling Control and accountability system Monitoring and feedback Continued commitment to the project	Defined objectives Selected philosophy of project Organisation Support from top management Organising and delegating authority Selection of the project team Allocation of sufficient resources Information and control mechanisms Planning and revision of the plan	Clearly defined objectives Commitment of the team to the project objectives "Stationary" project manager Sufficient funding Sufficient team competence Accurate cost estimation Minimal difficulties at the start of the project Planning and control techniques Task-orientation vs. people-orientation No bureaucracy	Project summary Operational concept Support from top management Financial support Logistical requirements Technical facilities Economic intelligence Project schedule Development and training of managers Human capital and organisation Sourcing (?) Information and communication channels Project overview

Cont. table 2.

1984	1986	1987	1989	1996
Lock (1984)	**Hughes (1986)**	**Morris and Hough (1987)**	**Pinto and Slevin (1989)**	**Belassi and Tukel (1996)**
Public awareness of obligations to the project Authority for the project granted at a high level of the organisation Project manager competences Defined procedures and means of communication Defined control mechanisms Project meetings to inform about progress	Rewarding the right action Communication of objectives	Project objectives Technical uncertainty Politics Community involvement Schedule Legal issues concerning contracts Implementation problems	Support from top management Consultation with the customer Recruitment of Staff Technical tasks Customer acceptance Monitoring and feedback Communication Dealing with problems Characteristics of a project leader Power and politics Events in the environment Urgency	Project-related factors The size and value of the project, Uniqueness of project activities, Density of the project, Project life cycle, Urgency of the project. Factors relating to the project manager Ability to delegate authority, Ability to compromise, Ability to coordinate, Perception of one's role and responsibility, Competence, Commitment. Factors relating to the project team Technical preparation, Communication skills, Dealing with problems, Commitment. Factors relating to the organisation Support from the top management, Organisational structure Support from functional managers Project champion Factors related to the environment Political environment, Economic environment, Social environment Technical environment, Natural environment, Customer, Competitors, Subcontractors.

Note. Based on (Belassi and Tukel, 1996).

Particularly noteworthy is the comprehensive model developed by Belassi and Tukel (1996), which divides project success factors into four groups: project-related factors, project manager and team-related factors, organization-related factors, and environment-related factors. The group of project-related factors includes: project size and value, uniqueness of project activities, project density, project life cycle, project urgency. The size and value of a project translate directly into its scope, but the direction of the relationship between scope and project success cannot be clearly defined. Undoubtedly, the more unique the project activities, the fewer proven working patterns can be used, thus increasing the risk of implementation failure. The higher the project density, the more difficult it becomes to allocate resources and increases the risk of project failure. The urgency of the project is also a factor that significantly affects success. Projects implemented in the "fastest possible way" are at risk of not meeting

quality and cost expectations, as well as insufficient customer satisfaction. Among the factors related to the organisation, Belassi and Tukel (1996) mention: support of the top management, organisational structure, support of functional managers, project champion. The factors of this group refer primarily to the availability of resources available to the project manager. Cooperation with the top management and the champion, which plays the role of a project patron, is important from the point of view of negotiating for resources from selected organisational divisions. The group of environmental factors includes: political environment, economic environment, social environment, technical environment, natural environment, customer, competitors, subcontractors. Due to the lack of control over the environmental factors, their impact on the project may change unexpectedly during the project. A way to partially control this influence is to identify risks related to the project environment and prepare for their occurrence. Factors directly attributed to the manager include: ability to delegate, ability to compromise, ability to coordinate, perception of one's role and responsibility, competence, commitment. Factors directly related to the team are: technical preparation, communication skills, dealing with problems, commitment. Empirical research conducted by Belassi and Tukel (1996) indicates that this group of factors is the most important for project success. A previously conducted study by Tukel and Rom (1998) showed the greatest importance of a group of factors related to the organisation, especially access to resources and support from the top management.

A set built by Belassi and Tukel (1996), comprehensively covering both the project and its relationship with the environment, shows that there are many factors influencing the success of a project. Other interesting attempt to group them was made by Haffer (2009) in an empirical study carried out in enterprises in Poland. The author of the study used a modified set of success factors from Belassi and Tukel, in which she divided a group of environment factors into a group of general environment factors and a group of sector environment factors. The highest average ratings were given by the survey's respondents to the group of factors related to the project manager and the group of factors related to the project team. The groups of factors related directly to the project and the organisation received lower average ratings. The influence of external factors was rated the lowest. Table 3. presents a set of factors, which received an average score of 4/5 or higher. As none of the external factors received an average score of 4/5 or higher, this group was excluded from the summary.

Table 3.
Key success factors ordered by decreasing influence on the project

Factors related to the project manager	Factors related to the project team	Factors related to the project	Factors related to the parent organisation
Commitment	Commitment	Clearly defined project objectives	Atmosphere of cooperation
Sense of responsibility	Sense of responsibility	Systematic control of the implementation of the project plan	
Ability to respond to change	Professional/work competence	Free access to relevant resources needed for project implementation	
Communication skills	Communication skills	Realistic project plan	
Leadership skills	Appropriate team composition	Detailed and transparent structure of the project work division	
Formal and informal authority	Atmosphere that triggers creativity	Permission for active customer participation in project work / customer involvement	
Ability to coordinate activities and work	Acceptance and good relations between project team members		
Speed of decision-making	Transparency of the responsibilities assigned		
Previous experience in a similar position	Motivation		
Knowledge and skills in project management			
Ability to delegate			
Ability to compromise			
Motivation of the project manager			

Note. (Haffer, 2009).

Researchers studying the subject of the project key success factors try to build comprehensive sets of factors, which cover both the parent organisation and the environment in which projects are conducted. This seems to be an advantage, but also creates interpretation problems in at least two fields.

The first interpretive problem concerns the relationship between the project life cycle and measures of project success. As Shenhar et al. (1997) showed, as a project moves through the phases of its life cycle, the importance of the dimensions of its success changes. Meanwhile, most of the empirical research focuses on success as a conglomerate.

The second dilemma concerns the actors who evaluate project success factors. As Munns and Bjeirmi (1996) showed, the composition of project stakeholders with an interest in project success is variable over time. Therefore, results of empirical research depend on the relation between the respondents and the evaluated projects.

3. Method

The aim of the empirical research was to analyse the relationship between project team performance and the occurrence of key project success factors. The starting points for the study were: 1. the adopted definition of project team performance and 2. a summary of key intra-organizational success factors identified by Haffer (2009).

The research tool was an electronic questionnaire distributed to a purposively selected group of project managers with the support of polish branches of the International Project Management Association and the Project Management Institute. Respondents to the survey assessed the components of operational performance and the level of occurrence of key success factors on a scale from 1 to 5 in a project of their choice. The components of operational performance were: time, quality, costs. Each of the components was evaluated in relation to the value planned in the project: achievement by the project team of the planned value of the component gave a value of 3; deviation by no more than +/- 25% gave a score of 2 or 4; deviation by more than +/- 25% gave a score of 1 or 5. A set of key project success factors highlighted in the study by Haffer (2009) was used. The three most important project success factors from each of the four groups of intra-organisational factors, namely: project manager factors, project team factors, project factors, parent organisation factors, were adopted for the study. Since, according to the summary presented in Table 3, only one factor related to the parent organisation would have made it to the comparison, this group was expanded to include its two additional factors: organisational culture, project management autonomy. This selection ensured comparable representation in the study of each group of success factors.

4. Results

The empirical survey was addressed to members of SPMP and PMI associations. The survey covered 146 respondents, of whom 80 correctly completed the questionnaire. The IP address from which the electronic questionnaire was completed was controlled. No duplicates were found.

A linear Pearson's correlation analysis of project team performance components with key project success factors was conducted. Table 4 presents the correlation values between:

- the degree of occurrence of the key success factor and the components of operational performance, and
- the degree of occurrence of the key success factor and the weighted (overall) operational performance (with weights equal to ⅓).

Boxes without a value indicate a relationship with a significance lower than the assumed threshold of 0.05.

Table 4.
Relationship between key project success factors and operational performance

Key success factors	Weighted (overall) performance	Time	Quality	Costs
(A.1) Commitment of the project manager	0.35	0.24	0.23	0.26
(A.2) Manager's sense of responsibility for the project	0.31		0.22	0.24
(A.3) Manager's ability to respond to change	0.30			0.31
(B.1) Commitment of team members in the project	0.34	0.32	0.24	
(B.2) Team members' sense of responsibility for project results			0.22	
(B.3) Expertise of team members in relation to project tasks	0.30		0.30	
(C.1) Clearly defined project objectives	0.46	0.31	0.16	0.46
(C.2) Systematic monitoring of implementation	0.40	0.30	0.21	0.32
(C.3) Access to the required resources	0.31	0.30		0.30
(D.1) Atmosphere of cooperation	0.46	0.38	0.23	0.35
(D.2) Organisational culture	0.28			0.25
(D.3) Project management autonomy	0.33	0.24		0.26

The study found significant correlations between the key project success factors and the project team performance. The results presented in Table 4 show that:

- clearly defined project objectives and an atmosphere of cooperation are strongly correlated to the overall project team performance,
- an atmosphere of cooperation is most strongly correlated to project time,
- professional competence of team members in relation to project tasks is strongly correlated to quality,
- clearly defined project goals are strongly correlated to costs.

Within the group of factors related to the project manager (A), the strongest correlation to performance is shown by the project manager's commitment. The project manager's sense of responsibility for the project and his/her ability to respond to change have a slightly weaker correlation to performance. The correlation of factors from group A to overall performance is stronger than to its individual components.

The group of factors related to the project team (B) shows the strongest correlation to project quality among all the studied groups of key project success factors. The study found that the professional competence of the project team members is the factor most strongly correlated to project quality. None of the three key success factors from group B is significantly related to project cost. Only the commitment of the project team members to the project shows a correlation to project execution time.

The strongest correlation to the overall performance is found in the group of project-related factors (C). As many as two factors from this group have a correlation with overall performance equal to or stronger than 0.4. Clear project objectives are the factor with the strongest correlation to both overall performance and project costs. A systematic control of project implementation and access to resources have a slightly weaker correlation to costs. The factors

from group C also show strong correlations with implementation time, but almost no correlation to project quality.

The atmosphere of cooperation, included in the group of factors concerning the project's parent organisation (D), is most strongly correlated to the time of project implementation. It also shows a strong correlation to cost and overall performance. Project management autonomy shows a strong correlation to overall performance. The results of this group are very interesting as they do not deviate from the other groups of factors in correlation to operational performance. Meanwhile, in Haffer's (2009) study they were much less significant. This indicates that they are strongly correlated to the activities of the project team in relation to the achievement of the operational objective.

All the examined project success factors, apart from the team's sense of responsibility, are significantly related to overall performance. This largely confirms the findings of Haffer (2009) and upholds the validity of Belassi and Tukel's (1996) model. On the other hand, in the study group, factors from the groups C and D were most strongly correlated to project overall performance, which diverges from the cited research of Haffer (2009).

It is worth paying attention to the relationships between the individual success factors. The study showed significant relationships between the factors within groups and between groups, which is important for drawing conclusions about the relationship of single factors with project effectiveness. Table 5 shows the correlations between the success factors. Boxes without a value indicate a relationship with a significance lower than the assumed threshold of 0.05.

Table 1.
Correlations between key project success factors

	A.1	**A.2**	**A.3**	**B.1**	**B.2**	**B.3**	**C.1**	**C.2**	**C.3**	**D.1**	**D.2**	**D.3**
A.1	X	0.7211	0.6184			0.2596	0.3779	0.5726	0.2367	0.5128	0.2768	
A.2	0.7211	X	0.5606			0.2803	0.3328	0.5239	0.2248	0.3583		0.2316
A.3	0.6184	0.5606	X	0.2928	0.2685	0.4240	0.3354	0.3231	0.2405	0.3358		0.2999
B.1			0.2928	X	0.7067	0.4201	0.2789			0.4920	0.3009	0.4873
B.2			0.2685	0.7067	X	0.2385	0.2207			0.3627		0.3780
B.3	0.2596	0.2803	0.4240	0.4201	0.2385	X	0.2862		0.2785	0.2632		0.4275
C.1	0.3779	0.3328	0.3354	0.2789	0.2207	0.2862	X	0.3676	0.5314	0.3994	0.2304	0.4550
C.2	0.5726	0.5239	0.3231				0.3676	X	0.3074	0.3008	0.2872	0.2593
C.3	0.2367	0.2248	0.2405			0.2785	0.5314	0.3074	X	0.4018	0.2618	0.4476
D.1	0.5128	0.3583	0.3358	0.4920	0.3627	0.2632	0.3994	0.3008	0.4018	X	0.5325	0.4878
D.2	0.2768			0.3009			0.2304	0.2872	0.2618	0.5325	X	0.5400
D.3		0.2316	0.2999	0.4873	0.3780	0.4275	0.4550	0.2593	0.4476	0.4878	0.5400	X

The factors of each of the four studied groups of success factors are correlated intragroup. The strongest relationships are in the group of project manager-related factors, and the weakest in the group of project-related factors. The most significant intergroup relationships occur: between the group of factors related to the project manager (A) and the group of factors related to the project (C) and between the group of factors related to the project (C) and the group of factors related to the organization (D).

The group of factors related to the project manager (A) and the group of factors related to the project team (B) are poorly correlated, which proves their mutual independence.

A very strong positive correlation connects the manager's sense of responsibility for the project and his commitment to the implementation of the project. There is a slightly weaker relationship with the project manager's ability to respond to change. It is worth noting that the manager's commitment positively correlates with the systematic control of the project and the atmosphere of cooperation. The sense of responsibility also shows a positive relationship with the control of design work.

In the group of project-related factors, it is worth paying attention to the relationship between clearly defined project objectives and the team's free access to the necessary resources. Both variables are related to each other and, moreover, to the autonomy of project management in the organization. This means that the higher the level of project management autonomy, the better the conditions for project teams to work.

As in the group of factors related to the project manager, also in the project team there is a strong positive relationship between commitment and a sense of responsibility. Significant and relatively strong correlations exist between: the atmosphere of cooperation in the organization, the autonomy of project management and the involvement of the project team. Each of the relationships in this "triangle" of dependence is characterized by a correlation value not lower than 0.48. Therefore, it can be concluded that the more autonomy the project management has and the better the atmosphere of cooperation, the higher the team's involvement in the project implementation. It is worth emphasizing that the group of factors related to manager and project shows a very weak relationship with factors related to the team. This means that the team is primarily influenced by organizational conditions, which are very closely related to each other!

Considering the large number of correlations between the project success factors, it is certainly not possible to conclude about their individual direct impact on the project performance. It is worth noting, however, that from the point of view of an organization as a system, knowledge about the coexistence of factors and their collective importance for performance is very valuable.

5. Discussion

Results of the research allow to give a positive answer to the question, if project teams which are supported by key success factors achieve better performance. The choice of the key success factors was additionally justified in a post-hoc analysis of the most recent research about the project key success factors. According to Fossum et al. (2019) a universal key success factor for the global projects is a proper selection and training of team members. This confirms

group's B impact on the project success. Specifically emphasizes the B.3 factor – Expertise of team members in relation to project tasks. Also results from the research on the building construction projects (Mathar et al., 2020) stress out the importance of competencies and capability of the key personnel in different disciplines. Other important key success factors revealed by this research are: project manager competency, authority and involvement, clear communication channels between the project owner, project manager, designer and contractor, as well as commitment of all project participants to the established schedule and budget. This supports the importance of groups A, B, and the factor D.1 – The atmosphere of cooperation. The recent research on critical success factors of the project management in relation to Industry 4.0 for sustainability of projects also indicate that leadership and experiences – Group A – and employees and flexibility – Group B – are the most important ones (Vrchota et al., 2020). A bigger variety of project's key success factors is present in the results of the research on R&D projects in Indonesia (Hermawati, 2020). Among the most important ones are: lead and team researchers – Group B, laboratory or workshop and space – C.3, work, organizational culture – D.2, communication and support from decision makers – Group D. The mentioned research confirms the importance of key success factors considered in the empirical research presented in this paper.

What is important for project management practitioners, results show which key success factors affect specific performance components. This can be a valuable hint for project managers, who seek means for performance improvement, as well as for team members who would like to understand their current working conditions and propose improvements. Thanks to the structure adopted from Belassi and Tukel (1996) and analysis of the separate performance components, project managers, project team members and stakeholders responsible for project management can profit from the knowledge of a set of twelve key success factors with a confirmed impact on team's performance.

Yet, the correlations between key success factors shows, that they don't occur individually, but rather as groups. According to the results, especially factors from the group A, seem to form a package of a project manger's traits. This would suggest that if a project manager is committed to the project's goal, she or he would also feel the responsibility for results and be able to respond to the changes in the project. Considering these strong intra-group correlations, it's worth noting that group C, which consists of factors related to the project, has the strongest impact on the overall performance. This is very interesting, because all three factors from this group are to some extent results of the project manager's activity. This would suggest that personal features of the manager are less important than the results of her/his work, which impact the working conditions of project team. What is more, two out of three factors with highest correlation values (C.2 and D.1) with the overall performance are strongly correlated with the project manager's features: commitment and sense of responsibility for the project. Based on this, one can argue, that a good project manager focuses on creating the atmosphere of cooperation (D.1) and systematic monitoring of implementation (C.2). An interesting

conclusion can be drawn from the analysis of factors which correlate with the expertise of team members in relation to project tasks. Despite its obvious relation with the commitment of team members to the project, which allows to conclude that good employees` allocation supports their commitment, a strong relation was observed with the autonomy of project management and project manager's ability to respond to change. This would suggest, that with enough autonomy, a good manager can influence project's quality with the right staff allocation throughout the project's lifetime (emphasis on ability to respond to change). All the conclusions above, which are drawn from the intra-group correlations, point to the fact, that the real project manager's impact on team's performance is stronger, than suggested by the factors from group A.

As presented in Table 4, a set of key success factors and their relationship with the team's performance consider only operational performance level. A recommendation for the further research would be to use an analogous method to study basic and strategic levels of project's success. This would require implementing an additional dimension – stakeholder – as depending on stakeholder, a different point of view and success assessment should be considered.

6. Conclusions

The study made it possible to determine how strongly the individual success factors are correlated to the project performance components. The analysis of the results showed that the each of the performance components is related to other group of success factors: the time of implementation with the atmosphere of cooperation (parent organisation-related factors), the quality of the project with the professional competence of the project team members (team-related factors), the cost of implementation with clearly defined objectives (project-related factors). The results of the study show some similarities with the ranking created by Beleiu et al. (2015), according to which the five most important success factors in order are: clearly defined project objective, competent project team, clearly defined roles and responsibilities, communication and consultation with stakeholders, compliance with budget, schedule, and performance criteria. The study showed that from the project team's point of view the most important key success factors are those directly related to the project and organisation, i.e.: clearly defined project goals and the atmosphere of cooperation. However, the intra-group correlation analysis revealed the potentially stronger impact of project manager on team's performance, than the analysis of factors related him/her suggest. This impact, however, is made rather by the actions of the manager, than by the personal features, which were considered as key success factors.

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MANAGEMENT OF WASTE IN THE OPINION OF THE RESIDENTS OF THE PILCHOWICE COMMUNE

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Introduction/background: The increasing amount of waste, associated with socio-economic development, is a significant problem these days. In order to solve this problem, emphasis must be placed on the satisfaction of residents, who are the producers of waste. Their satisfaction positively influences their involvement in the process. Therefore, all studies and improvements regarding waste management should be made at the local level.
Aim of the paper: The aim of this paper is to use the Customer Satisfaction Index and Servqual methods to examine consumer satisfaction with services. The study examines the satisfaction level of the Pilchowice responders.
Materials and methods: The paper uses surveys and CSI and Servqual methods to analyse the survey results. The article was created on the basis of the diploma thesis.
Results and conclusions: The study showed that for the Pilchowice responders, punctuality and flexibility of services are most important. The attitude of the service staff was rated best. Flexibility, recycling level and access to information need improvement. Possible improvements were suggested in the areas that need to be improved.

Keywords: waste management, urban logistics, Customer Satisfaction Index, Servqual.

1. Introduction

Socio-economic development is inextricably linked to increased consumption and, as a result, also generates an increasing amount of municipal waste. According to World Bank projections, solid waste generation will increase from 2 billion to 3.4 billion tonnes per year over the next 30 years (Kaza et al., 2018). Due to the harmful effects of this waste on public health and the environment, including the potential for soil and water pollution, municipal waste management has become an important area of development for society (Sienkiewicz-Małyjurek, Niczyporuk, 2010; Ilic, Nikolic, 2016; Janmaimool, 2017).

Municipal waste accounts for approximately 7-10% by weight of all waste generated in the European Union, while being one of the most diversified waste streams (EU Parliament and Council Directive 2018/851 of 30 May 2018). Municipal waste management is therefore a challenge and its quality is indicative of the level of socio-economic development, as it requires an effective system for collecting, sorting and tracking waste streams, as well as citizen involvement in the process. However, municipal waste management is not easy, as it requires the cooperation of many actors, the implementation of modern solutions and, above all, the participation of local communities (Sienkiewicz-Małyjurek, 2015; De Melo Ferreira, De Vasconcelos Barros, Soviar, 2017; Singh et al., 2020). Indeed, further municipal waste management processes depend on these communities and their sustainable approach to municipal waste generation and collection. Therefore, the level of service to residents is an important issue, as it results in the level of involvement of local communities in the municipal waste management process. Taking into account that all public matters of local importance, including municipal waste management, are carried out at the local level (Act of 8 March 1990 on Municipal Local Government; Act of 5 June 1998 on Poviat Local Government), the level of public service and its involvement are also of local nature. This state of affairs makes it necessary that research on municipal waste management should also be conducted at the local level. In this paper, research was conducted on the example of the Pilchowice commune, and its aim was to identify the level of service provided to the residents of the Pilchowice commune in the field of municipal waste management and to suggest possible improvements in this respect. The article was created on the basis of the diploma thesis.

2. Introduction to the research problem

Municipal waste is "waste generated in households (...). as well as waste not containing hazardous waste from other generators, which due to its nature or composition is similar to waste generated in households" (Law of 14 December 2012 on waste). Due to their increasing quantity, it is necessary to manage them properly, which is one of the priorities of the pro-environmental activities of the European Union and the Polish environmental policy (Grygorczuk-Petersons, Talaj, 2007; Kaza et al., 2018; Czaplicka-Kolarz, Kruczek, 2018).

The EU Parliament and Council Directive 2018/851 of 30 May 2018 emphasises that waste management should be transformed into "sustainable materials management". The document stresses that the most effective way to reduce the negative impact of waste on the environment is through prevention. European Union Member States should therefore raise awareness among the population. promote the reuse of waste, and set up reuse networks, deposit return and refill systems (Directive EU Parliament and Council 2018/851 of 30 May 2018).

In Poland, the source of municipal waste management regulations is the Waste Act of 14 December 2012. It states that the most important assumption of this mechanism is to carry out management in a way that does not endanger human health and life and the environment, does not pose any threat to soil, water, air, plants and animals, does not cause any nuisance (e.g. smell, noise) and does not cause negative effects for rural areas and areas of particular natural and cultural significance (Act of 14 December 2012 on waste). The basic activities in the field of municipal waste management is to prevent their formation at source, and thus – to minimise the amount of waste arising, to manage it as much as possible and to reduce the amount of waste deposited in landfills. Therefore, the generation of waste should be primarily prevented, further returned to the production cycle and used in the economy, and only in the last place should it be landfilled (Bendkowski, Wengierek, 2002; Kubiak, 2019; Hryb, Ceglarz, 2021). Meeting the above requirements is possible by building public awareness of the risks associated with the generation of municipal waste, ways to reduce its number, as well as methods for its collection and storage. It also requires cooperation and a high level of service to local communities.

One of the aspects building the quality of waste management services is a systemic approach to the process. Only by knowing the standards and procedures at each level of the organisation, i.e. from direct contact with the inhabitants, it is possible to precisely determine the number of containers, vehicles, bins needed, as well as the frequency of municipal waste collection (Frąś, Scholz, Olsztyńska, 2015). Therefore, it is necessary to maintain systematic relations with local communities in order to find out their opinions on the level of service quality in municipal waste management.

3. Research methodology

Two methods were used to identify the level of service of the inhabitants of the Pilchowice commune in the field of municipal waste management: Customer Satisfaction Index – CSI (Woźniak, Zimon, 2016; Kramarz, 2016) and Servqual (Wolniak, Skotnicka-Zasadzień, 2009; Kadłubek, 2011). CSI and Servqual are the most comprehensive methods of measuring service quality that leads to meeting consumer expectations. Comparing the results from both methods may indicate key areas for improvement. Therefore, they are useful methods for examining residents' opinions on waste management.

The data necessary for the analyses were obtained on the basis of surveys carried out in December 2021 in the municipality of Pilchowice. A total of 82 people were surveyed, including 45 women (55%) and 37 men (45%). All respondents were of legal age – 28% aged between 26 and 40, over 25% aged between 41 and 60, just under 26% aged between 18 and 25, and almost 21% aged 61 or over. The majority of people surveyed lived in households consisting of 3-4 household members (45%), 29% lived in 1- or 2-person households,

and the rest (26%) lived in households with 5 people or more. Over 52% of respondents had higher education, 23% had secondary education, 16% had vocational education, while almost 9% had primary education. Research results concern this group of people.

Then, based on the test results obtained, appropriate indicators were calculated to identify the process dimensions requiring improvement. The results of the research refer to the responders' opinions and may be helpful in conducting research in other communes.

4. Results of studies carried out

4.1. Assessment of the quality of municipal waste management based on the CSI

The analysis of the obtained results indicates that the CSI for the municipal waste management process in the Pilchowice commune amounts to 3.568, while the percentage result – 71.35%. This means that the level of service in the municipality can be described as "average" – it is in the upper limit of the range (up to 75%). Responders therefore feel that there are areas that need improvement as they are not meeting their needs or are meeting them inadequately. Detailed results are shown in Table 1.

Table 1.
Calculation of the Customer Satisfaction Index

Satisfaction factors	Assessment of the factor	Factor weight	CSI	CSI max	CSI [%]
Timeliness – waste collection on time, according to the schedule	3.8	0.15	**0.555**	0.730	**76%**
The right time – the service provider collects waste at convenient times	3.8	0.08	**0.312**	0.410	**76%**
Adequate infrastructure – equipping consumers with bags, waste bins, appropriate equipment	3.8	0.10	**0.388**	0.510	**76%**
Proper condition - the way in which the service was performed (e.g. condition of the service site after its completion, collection of all the containers or bags put out according to the regulations)	4.0	0.10	**0.392**	0.490	**80%**
Flexibility – easy access to the service, possibility to deposit waste at a convenient time other than on the schedule, e.g. at a USCMW	3.0	0.12	**0.363**	0.605	**60%**
Comprehensiveness – rate of recovery of selectively collected waste	3.3	0.11	**0.356**	0.540	**66%**
Service price/service quality ratio	3.1	0.09	**0.295**	0.475	**62%**
Easy access to comprehensive information about the service	3.3	0.09	**0.287**	0.435	**66%**
Ability to react to irregularities, consumer problems and expectations, factual knowledge of employees	3.7	0.09	**0.337**	0.455	**74%**
Service attitude – behaviour and appearance of the waste collection crew	4.0	0.07	**0.284**	0.355	**80%**
				CSI	**3.568**
				CSI %	**71.35%**

The survey indicated that the dimensions of municipal waste management best rated by responders are: attitude of service (80%), proper condition of service (80%), timeliness (76%), proper infrastructure (76%), proper time (76%) and ability to respond to irregularities (74%). All these factors are above 75% or oscillate around this figure, which means that the level of satisfaction in the areas mentioned can be described as "good". The attitude of the service, i.e. the behaviour and appearance of the waste collection crew was rated at 4.0, but the weight of this dimension reaches only 0.07. The correct way of performing the service achieved a similar result – a rating of 4.0 and a weight of 0.1. This means that no further investment is required.

Timeliness is an important factor for responders - it is characterised by a weight of 0.15 and a score of 3.8. The results obtained can be considered satisfactory for the responders, and the level of timeliness of the service should be maintained or cases in which the service was not provided on time should be looked into, and it should be determined whether the irregularities were a result of random situations or negligence of the service provider. Adequate infrastructure was rated similarly high as timeliness. Residents of the municipality are provided with adequate infrastructure (waste bags and containers, service provider's fleet), but if a consumer needs an additional bag or container, they must go to the service provider's office in the municipality's neighbouring town, Knurów. The score of 3.8 may therefore be due to difficult access to additional resources. The actual waste collection time achieved a score of 3.8 for a weight of 0.08.

The lowest scores were for flexibility (60%), price/service quality ratio (62%), comprehensiveness (66%) and easy access to comprehensive services (66%). Flexibility scored the lowest with a score of 3.0 for a weight of 0.12. Access to services is important to responders, which means that improvements should be made in this area first. Many responders reported a need for a Unit of Selective Collection of Municipal Waste – such an investment could have a positive impact on the rating of satisfaction with the flexibility of services. Another low-rated dimension is the price/quality ratio of the service. which received a score of 3.1 for a weight of 0.09. It is therefore worth looking into solutions which could lower the price of the service (particularly in the area of transport) and to educate the public about what constitutes the price of waste collection. The degree of waste recovery reached a score of 3.3 for a weight of 0.11 – it therefore needs improvement in the short term, as does flexibility. Responders report that they are not informed about recycling rates or are not satisfied with current recovery and preparation for re-use rates. Many are of the opinion that since it is imposed on them to collect waste separately, the service provider should also care about higher recycling levels. Some respondents thought that the waste after collection by the truck is put into one compartment and mixed with each other, so the selective collection is lost immediately after collection by the service provider. The public should be educated on how residents can contribute to providing good raw material and respond to such concerns to motivate them to separate waste. This task lies with the municipality. The last factor rated low is easy access to

information with a score of 3.3 and a weight of 0.09. The factor is among those that require improvement in the long term. Responders believe that it is difficult to find information on waste and the website of the municipality is unintuitive. It is worth considering the introduction of an application or regular supply of brochures that could dispel residents' doubts on an ongoing basis, e.g. regarding waste that is not easy to allocate to particular fractions.

4.2. Servqual quality assessment of municipal waste management

Analysis of the survey results using the Servqual method allowed to identify differences between expected and perceived quality in the process of municipal waste management in the Pilchowice commune (Table 2). In order to obtain more precise results, the weights for each dimension of the applied method were also determined and amounted to: tangibility (0.19), reliability (0.19), responsiveness (0.17), assurance (0.15), empathy (0.30).

Table 2.
Servqual survey results

Theorem	Quality expected	Perceived quality	Difference
The service provider has a modern transport infrastructure suitably adapted to the municipal waste collection process.	5.4	4.8	**-0.6**
The infrastructure is properly adapted to the waste collection process – vehicles, buckets, waste bags.	5.7	4.9	**-0.8**
Unit of Selective Collection of Municipal Waste is suitably equipped and has easy access for the collection of municipal waste.	5.2	3.9	**-1.3**
Information material on waste collection and disposal is readily available to residents of the municipality and allows them to easily obtain the information they need.	5.7	4.4	**-1.3**
The service provider shall collect all waste bags or bins placed in front of the property.	5.9	4.8	**-1.1**
The service provider collects municipal waste according to a fixed schedule.	5.9	5.0	**-0.9**
The service provider shall leave the place of performance clean.	5.8	5.1	**-0.7**
The service provider collects waste at convenient times.	5.1	5.0	**-0.1**
The service provider and the municipality shall inform the consumer comprehensively about the service provided.	5.6	4.5	**-1.1**
Municipal staff show respect towards consumers, is polite and willing to help in case of difficulties.	5.8	5.4	**-0.4**
Staff is available to provide expert assistance if problems or difficulties arise in relation to the collection of municipal waste.	5.6	5.3	**-0.3**
Municipal employees immediately try to identify errors (e.g. in the forms) in order to avoid further irregularities, and if they occur, they refer them to the relevant department.	5.6	5.4	**-0.2**
The staff of the municipality and the service provider strive to understand the needs of the consumer and treat customer expectations individually.	5.2	4.9	**-0.3**
Municipal staff is knowledgeable about the waste management process and is able to answer consumer questions in a comprehensive manner.	5.5	5.2	**-0.3**

Cont. table 2

Municipal employees answer questions in detail so that the consumer does not have to ask for details.	5.6	5.2	**-0.4**
The behaviour of employees collecting waste is characterised by high culture.	5.3	5.1	**-0.2**
The appearance of employees collecting municipal waste is neat.	4.9	5.1	**0.2**
The service provider shall provide an appropriate number of containers and bags for the collection of municipal waste.	5.8	4.9	**-0.9**
The service provider collects waste at the times stated in the schedule	5.5	4.8	**-0.7**
The service provider shall collect municipal waste in accordance with its offer - it shall collect the types of waste listed in the offer.	6.0	5.3	**-0.7**
The service provider meets the required levels of recycling and preparation for re-use.	5.5	4.3	**-1.2**
The service provider shall provide a Unit of Selective Collection of Municipal Waste in the municipality.	4.9	2.6	**-2.3**

The results of the research indicate that the highest difference (-2.3) is in the sub-item concerning the Unit if Selective Collection of Municipal Waste. Responders are not satisfied with the lack of a waste collection point in the municipality. The statement regarding equipment and access to a USCMW achieved the second lowest score (-1.3). Currently, the nearest USCMW is located in a town neighbouring the commune – Knurów. Surveys conducted show that this causes dissatisfaction among responders. The same result (-1.3) was achieved by the availability of information materials. According to the respondents, access to information is difficult – the reason may be a non-intuitive website that does not contain all information or a schedule sent only by traditional mail once a year. Another low score (-1.2) is the level of recycling assessed by the respondents. Many responders are not sufficiently informed about the levels achieved and base their judgements on popular but false opinions. Responders are convinced that the existing obligation to separate municipal waste should result in much higher levels of recycling, recovery and preparation for reuse. The score of -1.1 was achieved by two statements: collection of all waste bags or bins placed in front of the property and comprehensive information from the Pilchowice Municipal Office. The second statement may be related to the low rating of the office website. The collection of all waste from the property is also a sensitive issue. Not all responders are aware that if the employees collecting waste notice waste in a given fraction that should not be there, they are not obliged to collect it. For the resident, this can be a reason for dissatisfaction, even though the fault lies with him. It is worth creating the possibility to explain such cases in order to be able to find out whether the situation was caused by the inadequate segregation by the resident or by the negligence of the service provider.

The points concerning collection of waste according to the agreed schedule (-0.9) and provision of an appropriate number of containers by the service provider (-0.9) were characterized by a smaller difference. Thus, there are situations where the service provider will not manage to collect waste of a given fraction on time. This situation is acceptable if weather conditions or road conditions make it very difficult or even impossible for vehicles to get to certain streets. This obviously causes dissatisfaction among responders, but does not have a large impact on the assessment of the level of satisfaction with timeliness. Many respondents understand that random factors beyond the service provider's control can hinder the municipal waste collection process. In the case of infrastructure provided by the service provider, dissatisfaction may arise due to difficult access to additional resources. If residents want additional bags or containers, they have to go to a neighbouring municipality. Providing a point within the municipality where additional bags or containers could be collected could significantly improve residents' satisfaction.

The highest scores in the survey oscillated around -0.5. Among these were: assessment of modernity and adequate adaptation of infrastructure (-0.6), respect shown by municipal office staff (-0.4), detailed manner in which officials answer questions (-0.4), professional help from officials (-0.3), attempt to understand residents and their problems (-0.3), adequate knowledge of municipal office staff (-0.3), immediate catching of errors (-0.2), attitude of waste collection staff (-0.2) and convenient time for waste collection (-0.1).

Surveys conducted among responders of the Pilchowice commune also allowed for the calculation of a weighted and unweighted Servqual average. The unweighted average is -0.69, while the weighted average is -0.77. The process itself therefore requires improvement, especially in those areas that drastically underestimate the satisfaction of responders and have been described above.

In summary, the Customer Satisfaction Index and Servqual methods yielded similar results. Both methods showed that low recycling rates and lack of access to the Unit of Selective Collection of Municipal Waste were the dimensions rated lowest by responders in the process under study. The results of both analyses also highlight residents' dissatisfaction with impaired access to information on municipal waste management, but this dimension was rated as less important in the CSI study. Nevertheless, impaired access to information and ineffective public education may be the cause of many problems arising further down the waste management process.

5. Suggestions for improvement

The process of municipal waste management in Pilchowice requires continuous improvement in order to achieve maximum consumer satisfaction. It is particularly valuable to make the public aware of the growing problem of municipal waste and how valuable a raw material it can be.

A holistic approach is necessary to improve the waste management process in the Pilchowice commune. Beginning with education, the residents can be made aware of how to prevent, collect and segregate municipal waste in order to provide the best quality raw materials for recycling. Large-scale education and encouragement of citizens by the local authorities to adopt solutions such as setting up home composting facilities can also significantly affect recycling levels or reduce landfill levels and can be a big step towards closing the waste management cycle.

The Pilchowice's municipality should also bear in mind that collection of waste should not only take place at source. A system of delivering waste to a collection point set up in the municipality would enable residents to dispose of some waste without having to wait for it to be collected according to the schedule. This would have a significant impact on the level of residents' satisfaction. especially in the case of bulky waste. The establishment of a Unit of Selective Collection of Municipal Waste in the Pilchowice commune would be an investment that would positively affect the level of residents' satisfaction. Such a point could also provide an opportunity to collect bags or containers for waste of various fractions, which would solve the problem of access to proper infrastructure.

It is also worth considering the range of available green solutions that could be implemented to increase recycling and preparing for re-use levels. Encouraging residents to compost bio-waste and economic incentives could reduce the level of biodegradable waste going to landfill. Glass and PET bottles are also a fraction that offers great recycling opportunities. Creating a deposit system in the municipality is a simple solution that could significantly reduce the amount of this type of waste.

Difficult access to information is also a dimension in need of improvement. On the website of the Pilchowice Commune Office it is difficult to find a tab for municipal waste or the schedule of its disposal. Many respondents indicated the need to provide information on municipal waste management by e-mail. Such a form of communication and information about events or changes taking place in the municipality would enable the creation of a well- informed community and, consequently, fewer mistakes, irregularities and misunderstandings not only in the field of waste management but also in other areas of social life. However, one should also bear in mind the older generation, for whom the rapidly progressing digitalisation of processes can be a problem. Almost the same number of respondents were interested in the possibility to obtain information through leaflets or brochures that arrive in the mailboxes of residents.

The low-rated price/quality ratio is also a dimension that needs to be looked at. The cost of the municipal waste collection and disposal service consists of 70% of the transport cost. There are solutions – not yet implemented in the Pilchowice commune – which could lower the price paid by residents. Solutions such as an integrated system, involving split-truck rubbish collection, which makes it possible to collect waste of several fractions, would reduce the number of vehicles required and the frequency of waste collection. Instead of each fraction being collected separately several times a month, it would be possible to collect several fractions at once. Also, the introduction of a two-stage system with a transfer station, which could be established in the vicinity of the new Unit of Selective Collection of Municipal Waste, would reduce the number of vehicles used, road congestion and the environmental footprint. In addition to organisational and technical methods of reducing the price of waste collection, there should also be an open dialogue with residents on what makes up the price of the service and how the introduction of elements such as the Unit of Selective Collection of Municipal Waste increases the price. Municipal waste management is an area where not only the attitude of the organisation managing the process or the service provider is important. Cooperation between residents who produce waste and local authorities may be the key to success in achieving a smoothly functioning closed loop economy.

Summary

Municipal waste management is an area where waste should be prevented from being generated in the first place and only when the waste is generated, it should be recovered or prepared for reuse. Viewing waste as a resource creates many opportunities to reduce landfill levels.

An important element in the waste management process is the attitude of the public. especially as regards sustainable consumption and prevention of municipal waste. It is also important to be aware of the importance of creating uniform waste streams, the producers of which are the inhabitants. It is they who decide at the entrance (at the time of waste collection) what quality streams enter the whole process.

The results of the conducted research indicate that for the residents of the Pilchowice commune the most important factors in the process of municipal waste management are those related to service reliability – among others timeliness and flexibility of services. The residents of the commune assess best the service in the commune office and the attitude of the staff collecting waste. This means that the level of these dimensions should be maintained in order to positively influence community satisfaction. The following dimensions need improvement: flexibility of services, achieved recycling levels and access to comprehensive information. Responders are also not satisfied with recycling levels. Therefore, it is worth considering

solutions such as a deposit system for glass packaging and PET bottles, as well as economic incentives for setting up home composters for biodegradable waste to increase recycling or reduce the amount of landfilled waste of this fraction. Other important solutions include the creation of the Unit of Selective Collection of Municipal Waste, the introduction of split-trucks collecting waste and a two-stage waste collection system. It is important to take a holistic approach to waste management, starting with education of the public, through cooperation between residents, local government and service providers, to continuous implementation of modern organisational and technical solutions.

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IMPROVEMENTS IN THE MUNICIPAL WASTE MANAGEMENT PROCESS: THE CASE OF WODZISŁAW ŚLĄSKI

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Introduction/background: The problem of municipal waste management is an increasingly popular topic. The overproduction of waste is dangerous for human health, but also for the whole environment. For this reason, the coordination of the municipal waste management process is important for the general public, but at the same time it is not an easy process and involves many organisational and social challenges.
Aim of the paper: The aim of the paper is to identify problems occurring in the process of municipal waste management together with a proposal for improvement measures.
Materials and methods: The paper was prepared on the basis of a critical review of the literature and an interview conducted with 9 employees of the Town Office in Wodzisław Śląski. The article was created on the basis of the diploma thesis.
Results and conclusions: As a result, the issues of municipal waste management were described, the process of municipal waste management in the municipality of Wodzisław Śląski was characterised, disturbances in the process were detected and improvements correcting the occurring errors were proposed.

Keywords: city logistics, municipal waste, municipal waste management, waste management system, Ishikawa diagram.

1. Introduction

Waste management is a major challenge in the modern world (Elsaid and Aghezzaf, 2015; Sukholthaman and Shirahada, 2015). The increasing amount of waste generated is a nuisance and sometimes dangerous to the environment as well as human health and life. Indeed, poorly managed wastes have a significant impact on the environment, directly threatening the soil, surface and groundwater, and air (Matczak, 2000; Sienkiewicz-Małyjurek and Niczyporuk, 2010). They constitute a socio-ecological problem. Moreover, despite the development of technologies related to the management and use of waste, which has been noticeable in recent

years, or the increase in social awareness, problems in this area still arise (Bautista and Pereira, 2006). Every human activity is associated with the generation of waste (Zdonek, 2021; Jonek-Kowalska and Kaźmierczak, 2020).

According to the Waste Act, the main entity responsible for the waste management process is the municipal government. Therefore, it is recommended that initiatives in this area be context-specific and implemented first at the local level. Furthermore, the socio-ecological importance of the waste management process and the problems involved make it a research area that requires deep and intensive exploration (Chodyński, 2021; Ryszko, 2020; Baran et al., 2017). These premises were the reason for undertaking research on waste management, which was carried out in one of the municipalities of the Silesian Voivodeship – Wodzisław Śląski. The main objective was to identify problems in the process of municipal waste management and to propose actions to improve it. The article was created on the basis of the diploma thesis.

2. Theoretical basis of municipal waste management

Municipal waste management is defined as "the collection, transport and treatment of waste, including the supervision of such activities, as well as the subsequent handling of waste disposal sites and activities performed as a waste dealer or broker". It is an organisationally complex process due to the participation of the municipality, residents and the company responsible for waste management (Bautista and Pereira, 2006; Elsaid and Aghezzaf, 2015). The tasks related to the waste management process are regulated, among others, in the European Union Treaties (Rosik-Dulewska, 2016), the Law of 14 December 2012 on waste and the Law of 13 September 1996 on maintaining cleanliness and order in municipalities.

The bodies responsible for waste management in the territory of each commune are communal offices. It is the responsibility of each commune council to set the principles of maintaining cleanliness and order in the territory of the commune by way of a resolution, while the tasks of the commune office include signing contracts with the company responsible for waste management, selected pursuant to the Public Procurement Act, collecting fees for waste management, which may vary with respect to the method of their calculation for each commune and organisation of the entire process of municipal waste management. The principles of operation of the system in the territory of a given commune are described in the regulations created by the commune council. The company, on the other hand, collects, transports and manages municipal waste under the contract signed with the commune office.

The phases of the waste management process can be divided as follows: prevention of new waste generation, collection, preparation for reuse, recycling, other recovery processes, and neutralisation (Law of 14 December 2012 on waste). The waste collection takes place before its transport to treatment sites. It includes pre-sorting that does not substantially change

the nature and composition of the waste and does not reclassify it and its temporary storage (Law of 14 December 2012 on waste – 3.34). Collection and preparation of waste for transport is the property owner's responsibility. The task is usually fully or partially taken over by the commune as part of the municipal waste collection service. In the next phase, there are two ways of collecting waste from the place where it is generated: collection "at the curb" (mainly used in dispersed multi-family housing), collection directly from the collecting place (e.g. from the property or dumpster). The selected company responsible for waste management in the commune is responsible for the transport of waste from the place of its collection to the place of its processing. The frequency of transport depends, among others, on the population density of the area and the activities carried out there. Recycling and other forms of recovery are forms of waste management that should be considered first. As a result of the recovery, wastes replace other materials. Primary and secondary segregation are processes that help obtain secondary raw materials for recovery. If wastes cannot be recovered for technological or organisational reasons, they are stored. Recycling is a recovery in which waste is reprocessed into products, materials or substances used for their original purpose or other purposes. Recycling waste means reusing it as a raw material to create new items or energy. On the other hand, neutralisation means reducing or eliminating the harmfulness of wastes to the environment through its transformation into biological, physical or chemical processes. The methods of management and neutralisation are divided into mechanical and biological processing applicable to organic waste (e.g. composting of waste, anaerobic digestion) and thermal processing (e.g. incineration, gasification, pyrolysis, fuel production) (Czyżyk, 2012). Generally, in the process of waste management, priority is given to the prevention of waste generation, followed by reuse, recycling, or other methods of recovery and disposal. The last and least desirable way to deal with waste is to landfill it (Rosik-Dulewska, 2016).

The basis for organising municipal waste management is selective collection, which is mainly the task of waste generators. Segregated waste is subjected, among others, to recycling, neutralisation and storage (Wota and Woźniak, 2006; Merkisz-Guranowska, 2010). The aim is to manage as much waste as possible, in line with the concept of a circular economy (Baran et al., 2017; Czaplicka-Kolarz and Kruczek, 2018).

3. Research methodology

In order to identify the problems occurring in the process of waste management in Wodzisław Śląski and possible improvements, all employees of the Municipal Waste Management Department of the Municipal Office in Wodzisław Śląski were interviewed in July 2021. The respondents were persons occupying the positions of inspector, sub-inspector or manager of the desk. The age range of employees is from 20 to 60 years. Their average work

experience in the field of waste management is 8.35 years – the lowest was 5 months and the highest 30 years. In addition, two persons holding inspector positions in the Tax Department, who are directly responsible for finances related to municipal waste management, were interviewed. Finally, nine interviews were conducted focusing on the following issues:

- level of waste management in the city of Wodzisław Śląski,
- problems in the waste management process by source,
- potential and planned improvements of the waste management process in the city of Wodzisław Śląski,
- barriers to the implementation of improvement actions.

The interview took the form of a conversation from which appropriate notes were taken. In order to be better prepared, the respondents were given the questions that were asked during the survey in advance.

4. Results of research carried out

4.1. Analysis of municipal waste management in Wodzisław Śląski

The process of waste management in Wodzisław Śląski begins at the Town Hall, where the list of properties covered by the municipal waste management system is updated on an ongoing basis. The list is subject to change in two cases. First of them is a situation when a property owner reports that there is no inhabitant on the property or municipal waste is not produced there (only in case of entrepreneurs). The second case concerns new properties. The staff of the office will pass this data on to the company responsible for waste collection.

The Department of Municipal Waste Management, which is part of the Department of Municipal Economy of the Town Hall of Wodzisław Śląski, controls the whole process of waste management in the town. It is responsible for signing contracts with companies responsible for collection, transport and storage of waste. The appropriate company is selected on the basis of a tender. The City Council collects a waste management fee from households and property owners where waste is produced and transfers part of the collected funds to the company responsible for waste management. The amount of the fee depends on the number of inhabitants (residential properties) or on the volume of waste produced (non-residential properties).

In Wodzisław Śląski waste is divided into mixed waste and selectively collected waste, which are divided into: packaging waste and secondary raw materials, biodegradable waste, bulky waste and dangerous waste. Waste is collected from properties according to the schedule, and additionally each resident of Wodzisław Śląski can deliver waste collected selectively directly to the Unit of Selective Collecting of Municipal Waste (USCMW). In the city, only USCMW has appropriate permits and infrastructure to manage hazardous waste.

Before starting the waste collection process, the company logs into the Database of Products and Packaging and Waste Management (DPP). This is an IT system as well as a waste database. DPP makes it possible, first of all, to verify the path of waste from its production to its final management and to collect current information about it – for example, about its transport. After logging in the Municipal Waste Transfer Card is generated together with its individual number assigned by the system. This card is, among other things, an authorisation for the driver to start transporting municipal waste and will accompany the entire process. Once all the formal aspects have been completed, the vehicle sets off from the company to the designated locations. At each of the properties, the company's employees check whether the waste has been properly collected. If they notice any irregularities, their task is to document the irregularities with a photo and to record the reason for not collecting the waste in the system using a tablet. The most common reason for irregularities is improper waste collection – mixing fractions or the presence of plastic bags in the bio waste bin. When no irregularities are found, waste is loaded into the vehicle. However, before this can happen, the employee must manually count the number of bags and containers collected, together with their capacity. The data collected is written down in a protocol.

Additionally, in the case of selectively collected waste, households receive waste bags, the number of which equals the number of bags collected. After the waste is loaded, the vehicle is driven to the municipal installation located in one of the five cities – Zabrze, Racibórz, Rybnik, Jastrzębie-Zdrój and Żory.

In a municipal installation, the vehicle must first be driven onto the overrun scales to be weighed. A computer system records the gross weight of the vehicle, which is then unloaded at a designated location. The next step is to weigh the vehicle again in order to calculate the net weight of the collected waste. After this process, a weighing slip is automatically generated and sent to the Municipal Office at the end of the month. The number of collected waste recorded on the receipt must match the number of collected waste on the Municipal Waste Transfer Card.

Next, mixed waste is sent to a landfill. In the case of waste collected from Wodzisław Śląski municipality, waste goes to one of six landfills located in Rybnik, Jastrzębie-Zdrój, Racibórz, Bytom, Lipie Śląskie and Kielcza. On the other hand, selectively collected waste goes to a sorting plant, where it is transferred to a conveyor belt. It separates sieve and subscreen fractions. The next stage is the baling of waste and delivering appropriate fractions to a recycler for reuse. In the final stage of the process, as in the case of mixed waste, the Waste Circulation Card together with weight receipts are handed over to the Municipal Office (Wodzisław Śląski Municipal Office, 2021). The framework process of municipal waste management in Wodzisław Śląski is illustrated in Figure 1.

The presented framework course of the waste management process has been designed for Wodzisław Śląski, however, due to the fact that it is based on legal acts in force throughout Poland, it may be an exemplary picture presenting the waste management system in every municipality and district in the country.

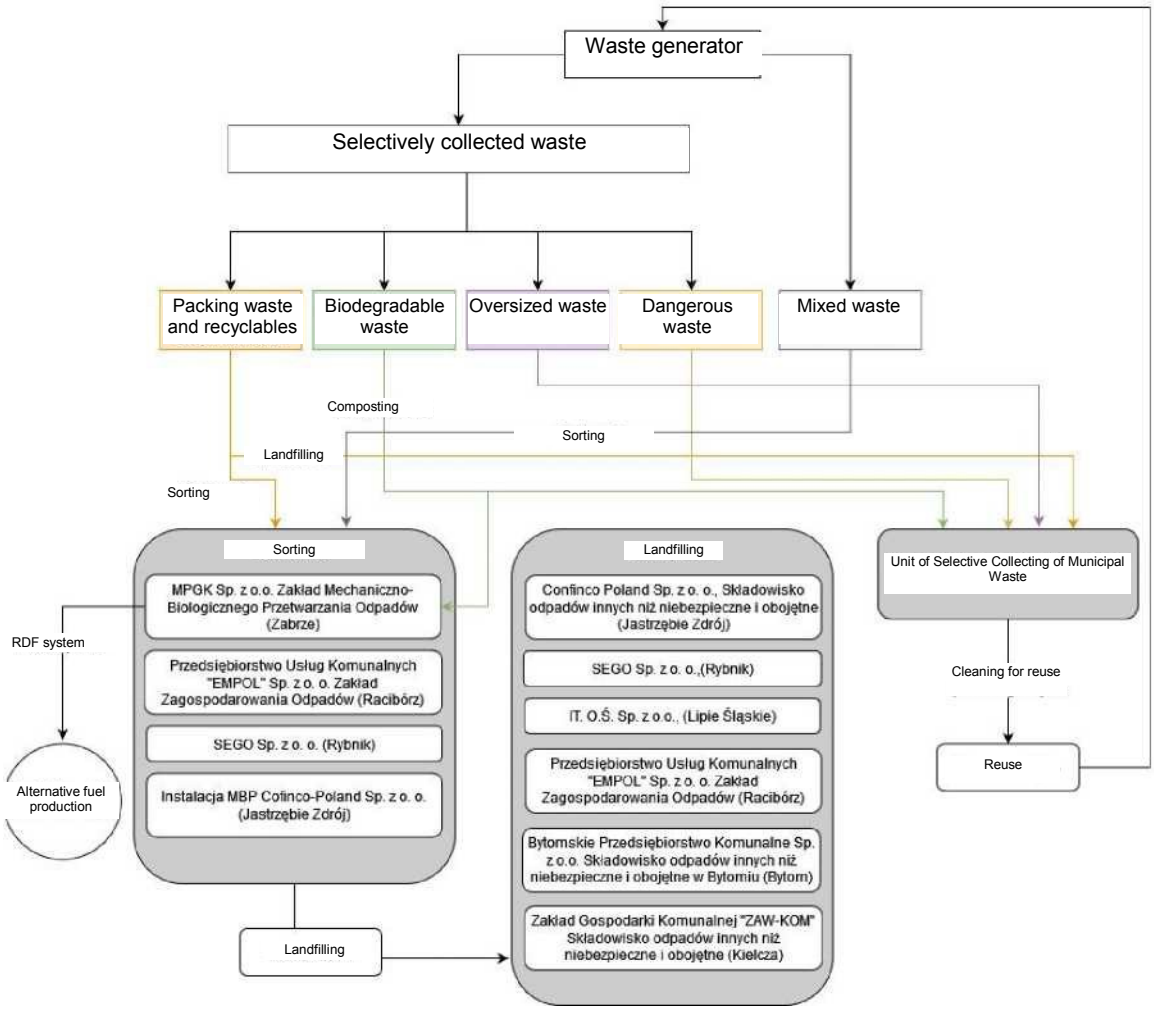

Figure 1. Framework of the waste management process in Wodzisław Śląski. Own work based on Szołtysek, J., Twarog, S. (2017) *Logistyka zwrotna. Teoria I praktyka.* Polskie Wydawnictwo Ekonomiczne, Warsaw;15. Wodzisław Śląski South Gate of Poland. Available online https://Wodzislaw-slaski.pl/miejsce-zagospodarowania-odpadow

4.2. Identification of problems in the municipal waste management process in Wodzisław Śląski

Interviews conducted with persons directly supervising the correctness of the municipal waste management process allowed to identify problems and bottlenecks in this area. Most of those respondents (88%) believe that the level of the municipal waste management process in Wodzisław Śląski is good and one person even considers it very good. Only one person is of an opposite opinion and claims that the level is insufficient. Respondents indicated also positive actions (e.g. introduction of biodegradable bags, special containers for caps from pet bottles) and mistakes (e.g. poor flow of information between the Office and the inhabitants, lack of control over wild dumps and public bins) in the process of municipal waste management. The Head of the Municipal Waste Management Department also added that any changes in the process are difficult to implement due to the legislative process. All municipal management issues must comply with the provisions of the Act of 13 September 1996 on Maintaining Cleanliness and Order in Municipalities.

Problems that originate from residents

The main problem directly attributable to city residents is poor waste segregation. It is stressed that this is mainly due to their ignorance about selective collection of municipal waste and laziness. Additionally, it has been pointed out that the inhabitants of the municipality do not observe the Rules for keeping cleanliness and order. Most of the deficiencies in the case of single-family housing concern such problems as:

- overloading of municipal waste containers,
- throwing waste into inappropriate separation bins,
- failure to close the lid of the container protecting the waste against rainwater,
- disposal of bio-waste in bags,
- lack of the required descriptions on containers and bags to identify the property from which they came.

On the other hand, in multi-apartment properties, where communal waste is collected in hubs, many irregularities are also observed. Due to the lack of possibility to identify the exact dwelling from which the waste comes, the principles of proper segregation are commonly ignored. Residents do not take care of tidiness in the hubs, leave waste in front of the hubs (e.g. when they forget the key to the shed) or leave it on the ground instead of throwing it into the container.

In addition, property owners very often fail to meet the obligation to resubmit the declaration when the number of people living on the property changes. Another negative aspect related to the declarations is the concealment of the number of people actually living on the property – underdeclaration in order to reduce the waste management fee. There are also many problems with payments, which are often made late or not made at all.

In the case of unoccupied properties where waste is generated, more bags/containers are continually put out for collection than previously declared. This is mainly due to the fact that it is impossible for entrepreneurs to estimate how much waste they actually produce.

Additionally, this number may change every month and declarations would have to be changed every month for this reason. The owners of such properties most frequently specify in the declaration the minimum number which is one 110 l container (PLN 17.46) for mixed waste and one 120 l bag (PLN 54.56) for fractions collected selectively. Moreover, entrepreneurs, as part of the fee for municipal waste management, collect non-commune waste (e.g. cardboard boxes belonging to packaging waste), which they should hand over to completely different entities on the basis of a previously signed agreement.

Problems caused by the municipal waste collection company

Another important entity involved in the waste management process is the company directly responsible for the collection, transport and management of municipal waste. The most frequent problems in the process of waste management, which are directly caused by this entity, include first of all: frequent failure to inform the Municipal Office about the inhabitants' failure

to comply with the segregation obligation or about the bad condition of waste storage containers and related problems. This constitutes a breach of the contract signed with the municipality. It is more profitable for the company to collect non-segregated waste, as the repeated arrival at the premises to collect the same (already segregated waste) is connected with repeated costs of transport, administration and depreciation charges.

In addition, the persons directly responsible for waste collection also do not comply with the rules laid down in the contract. Often there are situations when, in order to facilitate the company's employees, they enter the property from which waste is collected and because of that there are cases of damaging the property of the property owner, e.g. denting the fence or damaging the gate. Complaints are then made to the City Council in this regard. In addition, frequent complaints are received about damage to waste collection containers and employees leaving the collection area untidy.

There are also cases of incorrectly attributing the quantity of waste collected to a given property. There are also mistakes in the location of collection points due to a lack of knowledge of the area, which often results in a failure to collect waste from a given property.

Problems with the City Hall of Wodzisław Śląski

The problem in the process of municipal waste management is, above all, the frequency of mixed waste collection in the months from October to March, for which the Municipal Office is responsible for scheduling. In this period, waste for single-family properties is collected only once a month, i.e. half less frequently than in the rest of the year. This is too infrequent, especially in comparison to the collection from hubs for multi-family properties, for which collection is carried out twice a week. In addition, the weight limit for construction waste is an obstacle for residents. The owner of each property can only hand over 800kg of such waste to the USCMW for a period of three years. For new properties, the problem may arise at the very beginning. After filing a declaration with the Municipal Office, they do not receive bags for waste collected in a selective manner. These bags will be given to them only at the next collection, which may take place even a month after submitting the declaration. This is problematic as the waste is already produced and this forces the owners to provide them themselves.

It should also be noted that not enough time and resources are devoted to educational activities concerning proper waste segregation. Moreover, the respondents believe that the opinions and tasks of rank-and-file employees are not taken into consideration while making decisions related to the waste management system in Wodzisław Śląski. As an example they mention, among others, creating a model declaration, which for an average resident is impossible to fill in without the help of an employee of the office. There is also a prolonged flow of information concerning submitted complaints. When an irregularity occurs, residents must report it to the City Hall, which then contacts the company responsible for collecting municipal waste and forwards the information about the error. Once the complaint has been resolved, the information is returned through the same channels.

The results of the research also indicate that the problems in the process of municipal waste management are due to a deficit in human resources. In addition, there is a lack of a database combining the data of people making declarations, those registered and those receiving benefits, which also gives the number of people living in the property.

Holistic approach to municipal waste management in Wodzisław Śląski

In order to have a holistic view of the waste management process in Wodzisław Śląski, on the basis of conducted interviews, an Ishikawa diagram was developed. It is presented in the figure 2.

The diagram presented in Figure 2 shows that the greatest number of problems in the process of municipal waste management in Wodzisław Śląski municipality occurs in the areas of Material and Method. These problems are mainly organisational but also of social character. Therefore, they indicate the need for an integrated approach to waste management, affecting the problems related to the organisation of this process, ensuring the best available technologies, and building social responsibility. It is a difficult task because the municipal waste management process is dynamic. Its functionality is influenced by many internal and external factors, such as costs, technical requirements and constraints, and the dynamics of waste generation (Bautista and Pereira, 2006; Karbownik et al., 2012). One of such factors is the inclusion of residents in the municipal waste management process. Inhabitants are both producers of waste and the first link in this process. Their conscious and responsible approach to municipal waste management can reduce the amount of waste, resulting in better segregation and increasing the level of adaptability of the entire system thanks to bottom-up initiatives.

It is also worth noting that in many cases, sub-causes are interlinked in different spheres. This means, for example, that ignorance on the part of residents has an impact on inadequately sorted waste, but also on incorrect declarations or overproduction of waste. Deceitful declarations have an impact on the inappropriate method of calculating the fee, entrepreneurs issuing too much waste and overproduction of waste. In addition, they overburden the Municipal Office staff as the consequences of irregularities are evident in the lack of proper supervision, incorrect registers and the delay in sending information by the Municipal Office. The existence of dependencies between causes in the categories, as well as in the whole system, means that when the common sub-causes are minimised or completely eliminated the effects will be visible in the different categories and the solutions that make this possible will be much simpler. This will make it possible to reduce the number of mistakes made throughout the waste management process.

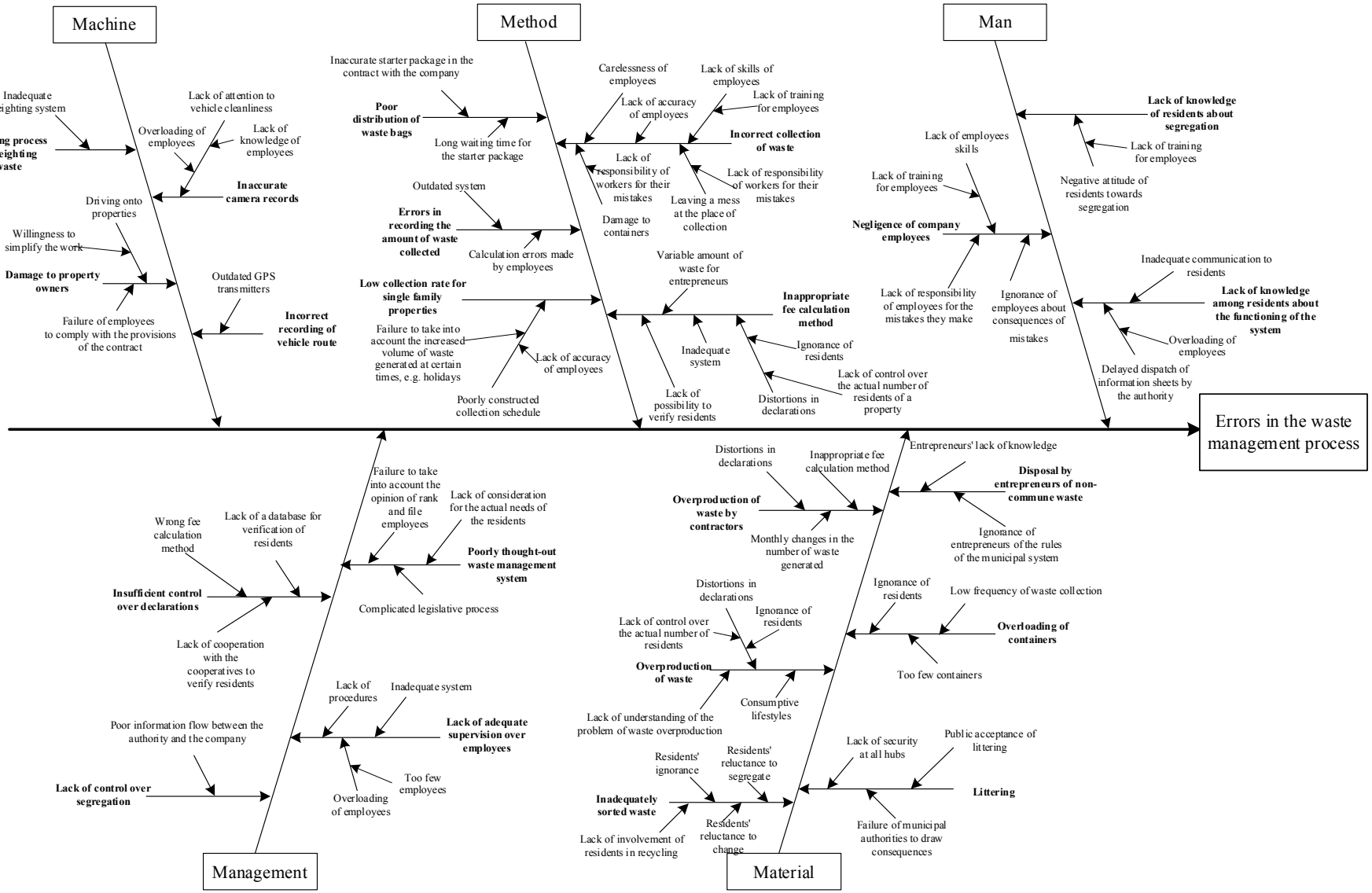

Figure 2. Ishikawa diagram for the municipal waste management process in the commune of Wodzisław Śl. Own work.

5. Suggestions for improvements in the process of municipal waste management in Wodzisław Śląski

Getting to know the waste management process through the people who are at the centre of its supervision has facilitated the knowledge of the problems occurring in it. Despite the fact that the process has been operating for years and all sub-processes included in it have been implemented in accordance with legal regulations, various problems occur. According to the interviews, the problems are mainly due to ignorance of the participants in the process and failure to comply with the rules in force. This particularly concerns property owners – the producers of municipal waste. The system requires continuous improvement and assumption of actual responsibility for municipal waste by all participants of the municipal waste management system in the city of Wodzisław Śląski. There are many possibilities in this respect. During the interviews, the respondents suggested many actions to improve the functioning of the municipal waste management process in Wodzisław Śląski. The most frequently indicated are:

- waste identification – waste attributed individually to the producer by creating a system of "chip" containers/bags,
- increased monitoring of illegal dumping sites and control of the dumping of household waste in municipal bins,
- monitoring of hubs where municipal waste is deposited in multi-apartment buildings,
- introducing reductions in payments for municipal waste management, e.g. for those who do not return ash,
- a change in the method of calculating the municipal waste management fee due to numerous misrepresentations in the declarations,
- the use of hubs for single-family properties, where possible,
- more frequent collection of waste from single-family dwellings,
- blocking of waste collection for properties which are in arrears for many years,
- blocking the possibility of depositing municipal waste at the USCMW in the case of properties that are in arrears with their waste management fees,
- the possibility to choose the frequency of waste collection for non-residential properties,
- creation of a uniform database to facilitate the control of properties in terms of the actual number of inhabitants,
- introducing more educational activities for city residents,
- introduction of higher charges for non-segregation,
- more frequent inspections of the process of waste collection and delivery to recycling by entrepreneurs (currently verification is done once a year),

- control of contracts concluded between waste collection companies and traders who have left the municipal waste management system (currently there is no control and a trader who leaves the system only makes a declaration about it),
- equipping public places such as parks, sidewals, etc. with bins for selective waste separation.

The research carried out allowed to identify areas which first require improvements to improve the functioning of the entire municipal waste management system in Wodzisław Śląski. Suggested improvements concern:

- switching from a bag to a container system,
- automatic identification of real estate,
- changes to the calculation of the municipal waste management fee,
- expand educational activities for city residents.

Switching from a bag to a container system would involve equipping all single-family residential properties with three 240 l containers, one per colour:

- blue – for paper,
- green – for glass,
- yellow – for metals, plastics and multi-material packaging waste.

Each container could have a sticker stating what waste should be kept in it, what waste should not be put in it, and a special barcode to identify it on collection. This solution would reduce the use of disposable bags in favour of reusable containers. It is a more environmentally friendly way of collecting waste, which additionally increases the protection of waste from rainwater, facilitates the collection of selectively collected waste and enables automatic identification of waste. Thanks to information placed on containers, residents would have no doubts as to what waste should go in particular containers, which would eliminate errors resulting from inappropriate sorting of municipal waste.

It is proposed to introduce an optical system for the automatic identification of properties by means of codes and scanners in order to eliminate errors caused by incorrectly assigned amounts of waste collected per property. It is recommended to use Code-39, which would encode information on the area, property address, type of waste contained in the container and its capacity. Each single-family property could be equipped with a unique barcode signed with the property address and type of waste. However, the code below would contain encrypted information:

- R – district number (I-XII) to which the property belongs,
- U – street marking according to predetermined numbering,
- NR – a specific property number,
- 1-6 – type of waste (1 – mixed, 2 – ash, 3 – plastic, 4 – glass, 5 – paper, 6 – BIO),
- P – container capacity.

This implies the need to equip waste pick-up staff with wireless scanners to scan the code and tablets to record the data.

Another proposed improvement is a change in the method of calculating the municipal waste management fee. The current method is based on declarations, in which there are often misrepresentations. Due to the impossibility of checking all properties, it is an inappropriate method of calculating the waste management fee. In order to eliminate this problem it is proposed to consider changing the method to a fee based on the amount of water consumed at a given property.

In the new method, the rate would be calculated on the basis of reports containing monthly water consumption in each property. The fee would depend on the number of cubic metres. For this purpose, the appropriate rate per one cubic metre of water used would be calculated on the basis of the average monthly water consumption in Wodzisław Śląski. Additionally, the calculations should take into account the cost incurred by the Town Hall for waste management in the previous year.

The proposed method of calculating charges for municipal waste management would make it possible to abandon declarations, the updating of which is the responsibility of residents. In addition, this method would take into account seasonal fluctuations in waste generation.

The last proposed improvement is to extend educational activities with basic information on the functioning of the city's waste management system and the correct segregation of municipal waste. It is proposed to organise a series of meetings with environmental education experts in all schools in the city. The classes should be tailored to the age group of the students and their aim would be to familiarise school students with the topics of proper recycling, circular economy, the problem of overproduction of waste and the functioning of the waste management system. Inculcating values at an early age will help avoid mistakes made in the future.

6. Summary

The research carried out allowed to identify many problems in the process of municipal waste management in Wodzisław Śląski. It was found that the main ones are of organisational and social nature. These problems have a negative impact on the environment and the health of residents, and limit the municipality's efforts to manage waste in a closed cycle. For this reason, on the basis of the interviews conducted, four improvements have been proposed to improve the functioning of the municipal waste management process in the municipality of Wodzisław Śląski, which include: changing the system from a bag-based to a container-based one, automatic identification of properties, changing the way of calculating the fee and expanding educational activities. These are basic undertakings whose implementation will enable the

introduction of advanced actions aimed at managing the greatest amount of waste. Although those measures have been identified in the context of the study carried out in Wodzisław Śląski, they seem to be universal and the premises for their application indicate that their introduction may also be beneficial in other cities.

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THE COST OF CAPITAL AS THE KEY TO THE VALUE OF THE COMPANY

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Introduction/background: The issue of company valuation is undoubtedly one of the very complex, poorly recognizable and controversial. Theories of estimating the cost of capital are characterized by high dynamics of development resulting from new experiences and challenges arising from the practice of valuation. It should be noted, however, that the application of the cost of capital in the practice of economic activity still leaves much to be desired.
Aim of the paper: This work focuses on the theoretical aspects of the cost of capital and practical issues in terms of how it is determined in developed capital markets.
Materials and methods: A company capital structure essentially – its blend of equity and debt financing – is a significant factor in valuing the business. In this research we demonstrated that the WACC method, generally reflects the return that hypothetical investors require. This work is conducted to bridge several methods: type of investment decisions, purpose of the capital, management plans.
Results and conclusions: A company's capital structure fluctuates over time as the effect of change in equity securities and its debts. We believe it is appropriate to use optimal capital structure if the business environment activity temporarily has veered off of actual capital structure.

Keywords: the value of the enterprise, the cost of capital, the structure of capital.

1. Introduction

To The concept of the cost of capital of an enterprise is one of the key issues of the theory of financial management or estimating the value of an enterprise. Decisions made as part of the management of a company are shaped by factors that are determinants of shareholder value. One of the pioneering views relating to the principle of business management may be the view of Aristotle. Its division can be made into three parts (Gnap, 2017):

1. onikonomikos, as a science of management, including the ability to earn from additional sources,
2. chermatistics, that is, the ability to obtain and accumulate money,
3. the last part refers to the science of money. This is a continuation of Xenophon's thought on how to compare the value of different goods with money.

The main link between the assessment of the effects of long-term decisions with the expected profits by investors is the cost of capital and its structure in financing business activity (Kowalik, 2010). The cost of capital could be defined in different ways:

1. this is the limit rate of return that a company should generate from its assets in order to maintain the value of the enterprise (Petty, Keown, Scott, Martin, 1993),
2. it is also defined as the minimum risk-adjusted rate of return that a company must achieve from its assets and investments in order for these projects to be accepted by the owners (Kufel, 1992),
3. it is the limit rate of return on the capital employed necessary to preserve the value of the entity for its owners (Czekała, Grześkowiak, 2007),
4. it shall be defined as the amount of the expected average rate of return on alternative ventures in assets with the same level of investment risk (Szczepanowski, 2007),
5. it is referred to as the cost of lost profits or the opportunity cost of capital employed (Zarzecki, 1999),
6. the expected rate of return required by the market in connection with a specific investment (Pratt, 2008).

In economic practice, the cost of capital is used basically in four situations (Włoszczowski, 2002):

a) a discount rate reducing the projected future cash flows achievable from the enterprise, its ventures, to their current values,
b) as a cut-off rate, necessary from the achievement of new ventures,
c) as the rate of payment of capital in the calculation of the value of economic profit,
d) when valuing the value of the company using an income and comparative approach.

According to the efficient market hypothesis, the prices of securities fully reflect all available information about them (Grossman, Stiglitz, 1980). The market refers, therefore, to investors who are rational candidates providing funds for a specific investment. In other words: "Since the cost of anything can be defined as the price that must be paid to achieve certain effects, the cost of capital is also the return that a company must promise to raise capital from the market, debt or equity" (Kaufman, 1999). In this context, the term "capital" means a component of the capital of an enterprise. The basic elements of the capital structure include (Brealey, Myers, Allen, 2014):

a) long-term debt,
b) preferred capital (shares in companies with preference characteristics),
c) ordinary capital (shares or divisions at the lowest or residual level).

Mentioned categories, may be more than one subcategory of capital. There may also be related to forms of capital, such as warrants or options. According to the authors, each of the components of the capital structure has its own unique cost, which depends primarily on the type of risk associated with the conducted business activity.

In a very simple and convincing way, the cost of capital is perceived by A. Damodaran (Damodaran, 2000): "The cost of capital is the rate that investors need from capital investment in a company." Recognizing that the cost of capital applies to both debt and equity investments, it is very accurate to say: "Both creditors and shareholders expect compensation from the investment made in one particular business instead of in another with the same level of risk" (Copeland, Koller, Murrin, 2000).

As Ibbotson put it (Ibbotson, 1999): "The cost of capital is a function of an investment, not an investor". R.A. Brealey and S.C. Meyers confirm this concept (Brealey, Meyers, 2014): "The true cost of capital depends on the purpose of the capital". It would be a mistake to judge a potential investment on the basis of the total cost of capital of the company if this investment is characterized by a more or less risky level of expected cash flows than the previous activity of the company. Each project should therefore be evaluated according to its own cost of capital (Rappaport, 1998).

The cost of capital reflects, therefore, the expectations of investors, which we can aggregate into three elements (Pratt, 2008):

a) the actual rate of return – this is the amount that a given investor receives in exchange for "allowing" the other party to use their money without incurring risk,
b) expected inflation – the expected depreciation of cash in a situation where it is not effectively allocated,
c) risk – uncertainty as to how much and in what time a given investment will bring a return.

Although these expectations may vary depending on the specific investor. According to the authors, the market has a kind of tendency to form consensus with respect to specific investments. This consensus determines the cost of capital for investments with different levels of risk. Therefore, the cost of capital should be understood as the market value of the asset and not its book value. To give a deeper view of the meaning of the above statement, the authors used the example of treasury bonds. The value should be measured on the basis of the rate of return at the time of redemption, i.e. the market price of the bond as at the closing date of the transaction and not its nominal value.

Another important issue in the context of the correct definition of the cost of equity is to determine the difference between the discount rate and the capitalization rate. The discount rate is understood as the annual cumulative rate of return, according to which the increase in cash flows is discounted to the present value. The sum of the discounted present value of the cash flows of each period equals the present value of the investment and thus reflects the expected amounts of return over the entire life of the investment (Lerch, 1990). According to the authors,

in the literature on the subject, but also in economic practice, the terms "discount rate", "cost of capital", "required rate of return" are often used interchangeably. On the other hand, in the context of the cost of capital conclusions, there is a fundamental difference between the discount and the capitalization rate. The capitalization rate is merely a kind of divisor applied to one of the elements of the cost of capital to estimate its present value. The only time the discount rate is equal to the capitalization is if each subsequent year is with the same increase in expected return (Kaltman, 1995).

2. Cost of capital – interpretation

If we assume that the subject of the analysis is a company that generates a constant amount of cash flows in each subsequent year until infinity, the shares of that company have a certain market value K, while the current debt is equal to Z, the market value of the entire company V, is (Arditti, 1973):

$$V = K + Z \tag{1}$$

Including the divider r, for cash flows CF, V we can derive according to the following formula:

$$V = \frac{CF}{R} \tag{2}$$

From this equality arise four important economic interpretations for *r:*

a) referring to the formula for the discounted value of the perpetual period, the rate r we can define as a discount rate equal to the capitalization rate,
b) can be defined as the average expected global rate of return on a company's assets, because we sum up the income from all implemented investment projects and then it is divided by the sum of the funds involved,
c) this is the minimum rate of return demanded by the shareholders of the company and its creditors,
d) due to the fact that r is the expected rate of return by all parties financing the business activity of a given company, that is, by definition, the average rate of return.

By entering additional parameters P_t, q_t, Z_t and V_t, which denote respectively the price of the share, the number the shares issued, the amount of debt and the total market value of the company's debt and equity. During the period $t = 0$ we get:

$$V_0 = Z_0 + q_0 Mrs_0 \tag{3}$$

If we assume that during the period $t = 1$ the company carries out changes in the financing structure, its total value will be:

$$V_1 = Z_1 + q_1 P_1 \tag{4}$$

Regardless of whether the company changes equity to debt or vice versa, the following must be maintained:

$$(Z_1 - Z_0) + (q_1 - q_0)P_1 = 0 \quad (5)$$

This means that if the undertaking incurs a debt $(Z_1 - Z_0)$ it will use it to buy back shares $(q_1 - q_0)$ at a price P_1. If we reverse the situation and assume that the newly issued shares are the funds obtained, which were intended to repay the debt, we will get the formula:

$$V_1 - V_0 = q_0 (P_1 - P_0) \quad (6)$$

When looking for an optimal capital structure, we should focus on the average cost *r*, and then reach a level of the foreign capital/total capital ratio that it will be *r* minimized.

Another concept is the marginal cost of capital, which, unlike to the average cost of capital, is used to make investment decisions.

Because the change *V* may result from changes in both the level of debt and the price of stock quotations, from new issues of shares or debt, we can derive the following formula (Janusz, 1997):

$$DV = Dk + Dz + \mathrm{dI} \quad (7)$$

where dI – means the minimum rate of return on investment.

By entering a condition $Dk = 0$, the equation takes the form:

$$DV = Dz + \mathrm{dI} \quad (8)$$

The assumption that the risk of non-payment of the current debt to creditors is unchanged seems justified, it can be assumed that $Dz = 0$, which leads to the equation:

$$DV = \mathrm{dI} \quad (9)$$

The marginal cost of capital is, therefore, such a return on investment that meets the condition:

$$\frac{dV}{dI} = 1 \quad (10)$$

With regard to the basic valuation formula, $V = CF/y$, we can find such a rate of return *dCF/dI,* which satisfies the condition $dV/dI = 1$. By differential of an expression $V = CF/y$ relative to the amount of money invested *dI* we get:

$$\frac{dV}{dI} = \frac{1}{r}\frac{dCF}{dI} - \frac{CF}{r2}\frac{dr}{dI} \quad (11)$$

If condition (10) is met, then:

$$\frac{dCF}{dI} = r + \frac{CF}{r}\frac{dr}{dI} \quad (12)$$

The average cost of capital can be written as a differential function of business risk "c" with the distribution of cash flows that are generated by the company's assets (so-called business risk), and the financial risk associated with the use of leverage "z", the cost of capital in the form of *r* we can present as:

$r = f(c, z)$ (13)

They differentiate (13) from the new investment, we get (Arditti, 1973):

$$\frac{\mathrm{dr}}{dI} = \frac{\partial f}{\partial c}\frac{dc}{cI} + \frac{\partial f}{\partial z}\frac{dz}{dI} \tag{14}$$

If we then assume that the new investment does not cause a change in the total risk of the business (this assumption is most often accepted in the literature of finance), i.e. that $dc/dI = 0$, this $dr/dI = 0$, then the formula (12) for the marginal cost of capital is reduced to:

$$\frac{dCF}{dI} = r \tag{15}$$

The above can be interpreted as if the new investment is characterized by the same level and type of risk as the whole business, then the marginal cost of capital is equal to the average cost of capital.

Expected return on assets r, may also be expressed as a weighted average expected rate of return on gross external capital b and equity k. If the starting point is a relationship $r = CF/V$, then it should be added and subtracted dZ from CF, to obtain the following equation (Haeley, Schall, 1983):

$$r = \frac{CF - bZ}{V} + b\frac{Z}{V} \tag{16}$$

Multiplying the first expression on the right by K/K, we will receive:

$$r = \left(\frac{CF - bZ}{K}\right)\left(\frac{K}{V}\right) + b\left(\frac{Z}{V}\right) \tag{17}$$

If we define k as follows:

$$k = \frac{CF - bZ}{K} \tag{18}$$

and then we substitute into the formula (16) then we get the expected rate of return on equity, which we can express through the equation:

$$r = k\left(\frac{K}{V}\right) + b\left(\frac{Z}{V}\right) \tag{19}$$

With a tax rate equal to ∂, the expected value of net cash flows takes the following form (Henderson, 1979):

$$CFN = CF - \partial(CF - bZ) = CF(1 - \partial) + \partial Bz \tag{20}$$

At a certain level of the market value of the enterprise, the average cost of equity after tax, r_T can be defined by analogy as a pre-tax cost:

$$V = \frac{CFN}{r_T} \tag{21}$$

or:

$$r_T = \frac{CFN}{V} \tag{22}$$

or:

$$r_T = \frac{CF(1-\partial)+\partial bZ-bZ(1-\partial)+bZ(1-\partial)}{V} = \frac{(CF-bZ)(1-\partial)+bZ}{V} = k(1-\partial)\left(\frac{K}{V}\right)+\left(\frac{bZ}{V}\right) \quad (23)$$

From the above equation, the following conclusions can be drawn: r_T can be written as the weighted average cost of equity after tax, denoted k_T, and the interest rate on the debt. Going further, if we define k_T for an enterprise with a specific life cycle n years, this equation will take the form:

$$V = \sum_{i=1}^{n} \frac{CFN}{(1+r_T)^t} \quad (24)$$

The expression (24) is different from the expression (21), but it can be proved that r_T from equation (21) is identical to r_T from equation (24):

$$V = \frac{(CF-bZ)(1-\partial)+\partial A+bZ}{(1+r_T)} + \frac{V_1}{(1+r_T)} \quad (25)$$

where:

A – depreciation of the company's assets involved in operating activities,

V_1 – goodwill in the period t = 1.

Value V_1 is defined as follows:

$$V_1 = \sum_{i=2}^{n} \frac{CFN}{(1+r_T)^{t-1}} \quad (26)$$

Analogous equality can be attributed to *K*:

K=((CF-bZ)(1-∂)+∂A-(λK_0-λK_1))/((1+k_T))+K_1/((1+k_T))(27)

where:

λ – the relation of foreign capital to equity in the company (assumption about the stability of the relationship over time),

$(\lambda K_0-\lambda K_1)$ – the amount of debt that has been withdrawn during the period *t = 1* in order to adjust the constant debt-to-equity ratio,

K_1 – the expected value of the company's equity in the period *t = 1*, which can be defined:

$$K_1 = \sum_{i=2}^{n} \frac{(CF-bZ)(1-\partial)+\partial A-(\lambda K_{t-1}-\lambda K_1)}{(1+k_T)^{t-1}} \quad (28)$$

Substituting the expression solution (25) for $(CF-bZ)(1-\partial)+\partial A$ to the formula (27) we will get:

$$K(1+k_T)=V(1+r_T)-V_1-bZ+K_1-\lambda K_0+\lambda K_1 \quad (29)$$

Accordingly, there are some equalities:

$$V_1 - K_1 = Z_1 \quad (30)$$

$$Z_1 = \lambda K_1 \quad (31)$$

$$Z_0 = \lambda K \quad (32)$$

As a result, we get a transformed expression (29) in the form:

$$K(1+k_T)=V(1+r_T)-Z(1+b) \tag{33}$$

which, simplifying, takes the form of:

$$r_T = k_T\left(\frac{K}{V}\right) + b\left(\frac{Z}{V}\right) \tag{34}$$

From the above, it can be concluded that if the firm undertakes investment projects that do not change its risk. *c* and the sources of financing are at an unchanged level of the relationship, then the average and marginal cost of capital are equal.

3. Conclusions

Summarizing the theoretical considerations in the estimation of the cost of capital, we can conclude that it is a key connector to transform the stream of expected cash flows into an estimated present value. It has several key features:

a) it is driven by the market, that is, it is expressed by the expected rate of return that the investor requires to engage capital in the investment;
b) is a function of the investment and not of the investor;
c) the basis for measuring the cost of capital is its market value and not its accounting value;
d) it should be measured in nominal values;
e) it is a "bridge" between the value of expected cash flows and the current value of investments at a given date.

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IMPACT OF THE COMMUNICATION SYSTEM ON THE MANAGEMENT PROCESS IN A SELECTED POVIAT HOSPITAL

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Introduction/background: This article is based on a master thesis carried out by Aleksandra Pędowska under the scientific supervision of the author (Management stationary II degree: "Impact of the communication system on the management process in a selected poviat hospital"). Communication, as an element of management, is an essential function of all activities that are undertaken in organisations. A high level of communication leads to effective and efficient functioning and management of the organisation. Any cooperation that occurs between employees within an organisation is geared towards communicating with each other in such a way that the organisation can function well. The communication process also shapes interpersonal relationships. Communication in organisations, as in everyday life, is a difficult and complex process, which requires constant improvement and change. Clear and reliable communication contributes to the professional success of the organisation, to job satisfaction and effectively influences the organisation's management; it also warms up the organisation's image, increases the satisfaction of customers or patients as well as the employees who work for the organisation.

Aim of the paper: The main aim of the research was to find out how the communication between the employees of the respective organisational units looks like and to collect as much information and data as possible on how the communication system influences the management process in the selected poviat hospital.

Materials and methods: Literature analysis, analysis of source materials (internal), survey method – technique: indirect survey, tool: survey questionnaire.

Results and conclusions: The important areas that comprise the effective management of a public organisation are dependent on the functioning of a proper communication system. The effectiveness of communication in the studied organisation in relation to management, in the opinion of the employees, is at a good or very good level. The occurrence of communication within the organisation contributes to the functioning of the organisation in an effective and efficient manner, despite the moderate current level of communication, which may be caused, for example, by the lack of training at the workplace. Communication contributes to the better functioning and management of the poviat hospital and furthermore warms the image of the organisation among patients and correctly influences the fulfilment of assigned duties or tasks by employees when communication is an efficient and clear process. Communication influences the management process in an organisation. Employees form the foundation of the organisation's functioning through communication within the organisation. In the researched organisation, the management orders and the electronic form (e-mail) are important areas in the process of information transfer, which works and is effective. It can be

concluded that a good communication system in the organisation means motivated to work and informed employees. The foundation for building an effective management process in the organisation is a coherent and clear communication system. Therefore, it can be concluded that communication in the selected organisation, which is Zespół Opieki Zdrowotnej Spółka z.o.o., (Health Care Centre LTD.) is correct both in the area of functioning of the entire organisation and between individual employees.

Keywords: Human Resources Management, quality, communication, management in the health care.

1. Introduction

Communication, as an element of management, is an essential function of all activities that are undertaken in organisations. A high level of communication leads to effective and efficient functioning and management of the organisation. Any cooperation that occurs between employees within an organisation is geared towards communicating with each other in such a way that the organisation can function well. The communication process also shapes interpersonal relationships.

Communication in organisations, as in everyday life, is a difficult and complex process, which requires constant improvement and change. Clear and reliable communication contributes to the professional success of the organisation, to job satisfaction and to the effective management of the organisation, as well as enhancing its image, customer or patient satisfaction and the satisfaction of the employees who work for the organisation.

This master's thesis is devoted to the issue of communication, with particular emphasis on the influence of the communication system on the management process in a selected poviat hospital located in the city of Świętochłowice.

The research conducted aimed to find out how communication is important in an organisation in order to manage it properly and effectively. A survey questionnaire was used to conduct the research. The data presented in the thesis is an analysis of the answers obtained from employees working in management/leadership units in Health Care Centre Świętochłowice.

The thesis consists of five chapters preceded by an introduction and conclusion and is divided into theoretical and practical parts. The first chapter defines key management concepts in terms of general management, public management and management in the health care system. The positions of different authors on how the term "management" is defined, what approaches exist in public management and what management in the health system looks like are briefly presented. The entire second chapter was devoted to communication from a theoretical perspective: the first part of this chapter discussed how important communication is in relation to human resource management in an organisation. Then, the basic elements of communication were presented, i.e. its objectives, functions, its types, as well as the

juxtaposition of the concept of communication by different authors. Particularly noteworthy is the analysis of the process of communication, which was divided and specified into given elements and the characteristics of these elements were made. The last two subchapters present the existing barriers to effective communication, as well as the principles of correct communication, which have been listed and described in detail. The third chapter deals with the general specification of the functioning of the health care sector in the country. The history of reforms in Poland concerning the health care system was presented. This chapter presents the basic issues of the health care sector, its functioning, participants and the whole structure of the system that is based on it. Moreover, the principles, which function in the Polish health care system, as well as its financing have been specified. This chapter also includes the characteristics of the models that existed in health care at that time and describes the model of the health care system currently existing in Poland. The fourth chapter contains methodological assumptions which are the basis of the study. It sets out the specific objectives including the main objective of the master's thesis, the problem area and research hypotheses, as well as a description of methods and research tool, which was used for own research in the study. At the end of the fourth chapter there is a brief characterisation of the organisation with a description of the course of research on the communication system on the management process. Detailed results of own research are presented in the last chapter. It includes the results of the questionnaire filled in by the employees. The whole research was thoroughly analysed on the level of general communication evaluation in the selected organisation as well as the communication system evaluation. An important element of the research was the aspect of how the employees of the selected organisation evaluate the communication process in the organisation where they work.

In the conclusion, final conclusions are formulated concerning the topic of the work and resulting from the analyses of the literature sources used to write the paper, as well as the research that was conducted for the purposes of the paper. The effects of the verification of the research hypotheses and the summary of the whole paper are also presented.

2. Characteristics of the studied facility

Zespół Opieki Zdrowotnej w Świętochłowicach Sp. z o.o. is an independent municipal organisational unit with legal personality. The founding body of the Company is the Municipal Council in Świętochłowice. The Company's seat and area of operation is the city of Świętochłowice. The Independent Public Health Care Unit was transformed into a capital company under the name: Zespół Opieki Zdrowotnej w Świętochłowicach Spółka z ograniczoną odpowiedzialnością (Healt Care Complex in Świętochłowice LTD.) by the act of transformation of 4 June 2012.

The Health Care Complex in Świętochłowice functions on the basis of:

- Act of 15 April 2011 on medical activity,
- the applicable Articles of institution,
- other provisions concerning independent public health care institutions and municipal organisational units,
- of the Act of 23 April 1964 – Civil Code.

Based on the Resolution of the City Council of 25th June 1997, the Health Care Complex became an Independent Public Health Care Institution. In order to secure the health needs of the city's residents, the Świętochłowice Municipality concluded a contract with the Independent Public Health Care Institution for the provision of comprehensive health care services. The establishment provides health services that serve to preserve, save, restore and improve health, as well as other medical activities resulting from the treatment process or separate provisions that regulate the principles of their performance and health promotion.

According to the Statutes of the entity characterised, the hospital provides health services in the field of:

- primary health care,
- outpatient specialised healthcare,
- inpatient specialised healthcare,
- a care and treatment facility,
- occupational medicine,
- sports medicine,
- diagnostic tests,
- outpatient emergency care,
- disease prevention and health promotion,
- long-term home care team – long-term nursing care,
- management of blood and blood products for the Hospital,
- services provided by the N. neonatology outreach team.

Currently, the following hospital wards operate in Zespół Opieki Zdrowotnej w Świętochłowicach Sp. z o.o.:

- Neurology Ward,
- Neonatology Ward,
- Paediatric Ward,
- Otolaryngology Ward,
- Rehabilitation Ward,
- Anaesthesiology Ward,
- Psychiatric Ward,
- Internal Medicine Ward,
- General and Short-Term Surgery Ward,

- Gynaecology and Obstetrics Ward,
- Alcohol Addiction Treatment Ward.

Health services are provided under a contract signed by the National Health Fund or under commercial services according to the price list established by Zespół Opieki Zdrowotnej w Świętochłowicach Sp. z o.o.

3. Research methodology

The subject of the undertaken research was broadly understood communication in relation to management on the example of a public organisation in management/management units.

The main objective of the research was to find out how the communication between the employees of the organisational units concerned looks like, and to collect as much information and data as possible on how the communication system influences the management process in the selected poviat hospital. Specific objectives were then set:

- characterise/examine the formal communication system in the Poviat Hospital in Świętochłowice on the basis of available documents,
- characterise/research the system of informal communication in the Poviat Hospital in Świętochłowice on the basis of conducted research in the form of a questionnaire and an interview,
- check whether an internal organisational structure is being built up at the Poviat Hospital in Świętochłowice through communication,
- find out whether communication can be part of the professional competence of health professionals,
- check the importance of communication for employees at the Poviat Hospital in Świętochłowice.

On this basis, the following research hypotheses were adopted:

- H1: A proper internal communication system of the organisation influences management.
- H2: The quality of communication affects management.
- H3: Proper communication in the organisation contributes to effective management.

The research concerned the influence of communication on the management process and was conducted among employees working in management/management units at the Health Care Centre in Świętochłowice.

A survey method was used to collect the most necessary information and data. The research tool that was used for the research method was a survey questionnaire that was developed by the author of the thesis. The questionnaire that was created for the author's own research,

which was about how communication influences management in management/leadership cells, provided a close-up look at how communication works in specific organisational cells at the poviat hospital. The research was conducted on the basis of a questionnaire that was sent to the respondents electronically via the Internet. The survey questionnaire had open-ended questions, which consisted of an independent answer, and closed questions, where each respondent had to mark one or a maximum of two answers in the question; the survey questionnaire also included Likert scale questions. The survey consisted of twenty-three questions. Each respondent independently answered the questions, which were divided into three groups: questions 6, 8, 9, 10, 11, 14, 15, 16 and 23 refer to the assessment of the importance of communication in general in the organisation, the second group of questions (7, 12, 13, 18 and 22) is the overall assessment of the communication system in the organisation, while questions 17, 19, 20 and 21 refer to internal communication among employees in the organisation.

4. Course of research

The course of the research and collection of materials for presentation was as follows: the realization of the research took place during a month-long student internship, which lasted from 1.02.2021 to 5.03.2021 on the area of the selected poviat hospital.

The mode of implementation of the research was such that the first stage of collecting materials for analysis was to send employees working in management/leadership cells in the public organisation a survey questionnaire in electronic form via the Internet. By using the research tool, it was possible to obtain a sufficient amount of data and research information. As a result, from the collected materials it was possible to proceed to their analysis and interpretation, and then to formulate and draw final conclusions.

Due to the prevailing situation in the country, caused by the COVID-19 pandemic, the study included ten employees working in the management/management cells at Health Care Centre Świętochłowice, most of whom were women, who accounted for 70% of all the surveyed employees of Health care Centre Świętochłowice; men accounted for 30%.

The second demographic characteristic of the respondents was their age. The following age structure was adopted in the research: group one - up to 25 years, group two: 25-35 years, group three: 36-45 years, group four – over 45 years. The most numerous age group is group three (36-45 years old), which constitutes 40% of all employees surveyed. The second group (25-36 years old) and the fourth group (over 45 years old) are equally numerous, accounting for 30% each. There are no members of the first group (under 25 years) among the employees surveyed.

Another characteristic of the employees surveyed is their level of education. All respondents indicated that they have a university degree, which is 100% of the votes.

With regard to seniority in the organisation, it can be noted that there is no dominant number of years worked. It can be concluded that each of the surveyed employees has different length of service, with 70% of the surveyed employees having shorter service in the organisation (from 1 to 5 years) than employees with longer service in the organisation and working over 13 years. Three employees with longer seniority represent 30% of the surveyed employees in Health Care Centre Świętochłowice.

5. Verification of research hypotheses

The research hypotheses made in the study were verified on the basis of the obtained results of the quantitative research, which was carried out on the basis of a questionnaire survey among the employees of the management/leadership units in the poviat hospital. In the studied organization, opinions were obtained from employees who work at managerial level in the following organizational cells: Administrative, Administration and Operations Section, Management, Secretariat, Wards and Hospital Departments. The selection of employees for the study was non-random, purposeful, as it was desired to present the communication system in the poviat hospital from the managerial level. On this basis, the adopted research hypotheses were verified.

H1: "A proper internal communication system of an organisation influences management". In the light of the research results obtained, the truth of the hypothesis can be confirmed. Based on the analysis of the questions concerning H1, the following conclusions were made:

- every employee of Health Care Centre Świętochłowice communicates with other employees so that there is communication between them, which allows for better management of the organisation regardless of what information needs to be communicated or matters need to be settled;
- in order to manage the organisation effectively by communicating the most important information within the organisation, the employees of Health Care Centre Świętochłowice practice two forms: management orders and electronic form (e-mail). Both forms are the most effective in transferring information as they are fast, formal and are delivered to all employees immediately/at the same time;
- feedback enables effective and correct communication between employees, which significantly influences the course of communication in an organisation;
- employees at Health Care Centre Świętochłowice felt that communication within the organisation has a significant impact in the workplace and on the management of the organisation as a whole;

- the communication system within the organisation has a strong influence on: the management of the public organisation, the image of the organisation among patients, the quality of the tasks and responsibilities performed by the employees, and the loyalty of the employees;
- the existing communication system at Health Care Centre Świętochłowice does not cause serious communication problems within the organisation.

H2: "The quality of communication influences management". In the light of the research results obtained, the truth of the hypothesis can be confirmed. Based on the analysis of the questions on H2, the following conclusions were made:

- the most effective tool in communication is formal communication;
- formal communication fulfils the function of giving orders and is the main and fluent source of information transfer in Health Care Centre Świętochłowice; there is also informal communication in the surveyed organisation, which is complementary to formal communication and fulfils the function of relaxing the atmosphere in the workplace;
- vast majority of the employees surveyed responded that formal communication is the more appropriate form of communication in management/leadership units, which is effective in influencing the quality of communication and management of the organisation as a whole, as it maintains the business path in the workplace, is more precise, more effective and more complete, which influences the quality of communication in the workplace as a whole;
- the surveyed employees unanimously answered that the quality of communication in the organisation is at a good/average level, which can be classified that the overall quality of communication is at a neutral, good level;
- quality of the communication system within the organisation also influences: the management of the public organisation, the image of the organisation among patients, the quality of the tasks and responsibilities carried out by the employees, and the loyalty of the employees;

H3: "Proper communication in the organisation contributes to effective management". In light of the research results obtained, the truth of the hypothesis can be confirmed. Based on the analysis of the questions on H2, the following conclusions were made:

- the communication system has a great impact on the management process in an organisation as it determines the quality and effectiveness of the organisation's management and the level of performance of tasks and responsibilities;
- the current communication system in the organisation is efficient and fulfils its role/function well to manage the organisation effectively;

- the current system of communication in the organisation towards the surveyed employees of Health Care Centre Świętochłowice needs to be improved in order to manage the organisation effectively;
- up-to-date communication system facilitates the transfer of the most relevant and up-to-date information to employees in order for them to function properly, and is efficient and clear and influences the management process in the organisation;
- communication in the organisation is acceptable, minor changes would suffice.

In conclusion, the analyses of the research findings confirmed that the communication system influences the management process in an organisation.

6. Conclusions and recommendations

The intention of the research in this research was to gain as much information and opinions as possible on how important communication is in the functioning of an organisation and to show to what extent the communication system influences management in a selected public organisation.

The main objective of the thesis, which was "to present the existing communication system and its influence on management at the Poviat Hospital in Świętochłowice", was achieved by using a research tool, i.e. a questionnaire survey. As a result, responses were received from employees working in management/management units at the Świętochłowice Poviat Hospital.

The important areas that comprise the effective management of a public organisation are dependent on the functioning of a proper communication system. The effectiveness of communication in the studied organisation in relation to management, in the opinion of the employees, is at a good or very good level. The occurrence of communication within the organisation contributes to the functioning of the organisation in an effective and efficient manner, despite the moderate current level of communication, which may be caused, for example, by the lack of training at the workplace.

Based on the quantitative research conducted using a questionnaire survey at Health Care Centre Świętochłowice, the employees stated that communication contributes to the better functioning and management of the poviat hospital and, moreover, warms the image of the organisation among patients and correctly influences the fulfilment of the duties or tasks assigned to the employees when communication is an efficient and clear process.

In the light of the research analysis, the results on communication condition that it influences the management process in the organisation. Employees form the foundation of the organisation's functioning through communication within the organisation. In the researched organisation, management orders and electronic form (e-mail) are important areas in the process of information transfer, which works and is effective. It can be concluded that a good communication system in the organisation means motivated to work and informed employees.

The foundation for building an effective management process in the organisation is a coherent and clear communication system. Therefore, it can be concluded that communication in the selected organisation, which is Zespół Opieki Zdrowotnej Spółka z o.o., is correct both in the area of functioning of the entire organisation and between individual employees.

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