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CONTENTS

PRO-INNOVATIVE PERCEPTION OF ENVIRONMENT IN FAMILY BUSINESSES

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Introduction/background: Family businesses play a very important role in modern economic processes around the world in both developed and developing countries. Family companies are currently experiencing higher and more complicated requirements, which are directed to them from the environment. The increase in the above requirements is a derivative of the increasing variability of this environment, but also of the fact that the set of people, entities, and often social groups interested in the activities of a given business that has been expanded.
Aim of the paper: The aim of this paper is to characterize the process of perception of the environment of companies and to identify pro-innovation perception of the environment in family firms on the basis of Oslo Manual 2018 guidelines.
Materials and methods: This research is a part of a project carried out in the Department of Entrepreneurship and Competitiveness of family and non-family businesses – a comparative analysis in selected areas. Stage II. Innovation: family and non-family businesses in Poland based on methodological assumptions of Oslo Manual. The survey was conducted from June to August 2020 by the Center for Research and Knowledge Transfer of the University of Economics in Katowice.
Results and conclusions: The presented results of empirical research indicate selected areas of perception of the environment in innovation processes from the perspective of family firms. Based on the presented results, it can be observed that family firms should pay special attention to monitoring the environment of the market on which they operate.

Keywords: family businesses, innovation, perception of environment.

1. Introduction

Family businesses play a very important role in modern economic processes around the world in both developed and developing countries. Family companies are currently experiencing higher and more complicated requirements, which are directed to them from the environment. The increase in the above requirements is a derivative of the increasing variability

of this environment, but also of the fact that the set of people, entities, and often social groups interested in the activities of a given business that has been expanded (Sadkowska, 2015, p. 10). The business development strategy and its management structure are strongly determined by the nature of the environment and the dynamics of its changes. The possibility of survival and development of an enterprise in the long term is determined by its ability to adapt to the constantly changing environment (Popczyk, 2013, p. 13). For this purpose, family businesses should take into account the signals coming from the market about the intensity of competition and adapt the undertaken competitive strategies to the market realities (Leszczewska, 2014, p. 271). In turn, issues related to the search for sources of innovation in the environment and perception of the environment in terms of emerging opportunities become particularly important. The purpose of this paper is to characterize the process of perception of the environment of companies and to identify pro-innovation perception of the environment in family firms on the basis of Oslo Manual 2018 guidelines.

2. Characteristics of family businesses

Based on the analysis of the literature on the subject, it is possible to put forward a thesis that these companies cope with crises and changes, are able to survive in difficult times. They contribute to generating growth and economic development. Family companies are entities with a significant economic potential, playing an important social role. They are clearly becoming valuable links in the economy, so it is worth getting to know the specifics of their functioning, goals and values that they are guided by in order to be able to use not only economic, but also social potential inherent in them (Hunger, Hunger, 2017, p. 15). In Poland, the issue of family businesses is mainly related to the sector of small and medium-sized enterprises, as they generate a significant share in various sectors of the economy.

The growing importance of family businesses in Poland requires conducting in-depth empirical research in various aspects of their functioning (Dźwigoł-Barosz, 2018, p. 42). Defining the concept of family businesses is usually based on two criteria: ownership and management. In the case of the criterion of ownership, a company is considered as family-owned if it has more than 50% of shares (stocks) or the dominant (largest) owner is a family. With respect to the management criterion, there are soft criteria (i.e. family influence on company management, significant participation of the older generation in management, major decisions made by the family, family control in management, at least two generations of control over the company) and hard criteria (i.e. a family member is the president of the company, more than one member of the board of directors comes from the family, the majority of the board of directors are family members), which determine whether a company is family-owned or not (Mandl, 2008, pp. 17-18).

The way of definition based on the management factor was adopted by R. Donelley, according to whom a family business is such a business in which "at least two generations of the family can be identified and when this connection (between generations) affects the policies of the company and the interests of the whole family (Donelley, 1964, pp. 93-105). On the other hand, R. Donckels and E. Fröhlich, adopting the ownership criterion, consider as a family business such a business in which family members own at least 60% of the capital (Donckels, Fröhlich, 1991, pp. 99-105). Gallo and Sven supplemented this definition with the thesis that family businesses in the world function according to the same logic and are basically similar in terms of their components, processes occurring in them and existing barriers and problems. Thus, the most important features of such companies are ownership, family succession and family involvement in running the business (Gallo, Sven, 1991, pp. 1-8). On the other hand, Ł. Sułkowski defines a family company as an entity with a family structure, in which the strategic control is exercised by this family, its members participate in management, and more than one generation is involved in the functioning of the company (Sułkowski, 2005, p. 13).

3. Perception of the business environment

The environment of the organization affects the functioning of the company with great force, so the perception of its elements is very important. The essence of the organization's environment is emphasized in the literature, defining opportunities as "all events and processes in the environment that create a favorable situation for the company" (Penc-Pietrzak, 2010, pp. 69). Thus, the success of an organization can be seen in its ability to smoothly adjust its strategy and dynamically changing environment (Budzik, Zachorowska, 2016, p. 92). Perception of the environment is an individual process of selecting given features of the environment that are relevant to a given organization. It enables the observation and study of the environment and then directing the strategy of the enterprise (Bednarczyk, 1996, p. 68). The behavior of the environment determines the behavior of enterprises, at the same time enterprises affect the formation of the environment. To be able to monitor the environment is important to know it in an orderly way, and scanning the environment should be carried out according to strictly defined categories (Wach, 2008, p. 57).

Generally, the environment of an organization can be defined as a set of elements that do not belong to it, but are in some interactions with it (Bielski, 1997, p. 126). In literature there is also a definition that defines environment as "a set of conditions created by various demographic, social, cultural, economic, legal, organizational, technical and environmental factors" (Penc-Pietrzyk, 2002, p. 31). Thus, the company functions in an environment in which its various elements affect the possibilities of its development. Due to the nature of the relationship between the organization and the environment, we can cite the basic division of

the environment, commonly considered in the literature, which distinguishes (Budzik, Zachorowska, 2016, p. 91):

- macro-environment, otherwise known as the further environment – it includes individuals and organizations, as well as factors that affect the functioning of the company and its results, but not in a direct way, but creating the conditions for the functioning of the company. In this area special attention is required to identify opportunities for the company resulting from changes in trends and unmet needs (Wolanski, 2013, p. 49). The influence of the macro environment on the organization can be observed in five segments: macroeconomic, technological, political-legal, sociocultural and ecological (Bednarczyk, 1996, p. 47);
- micro-environment - competitive, task-oriented, direct - these are the units and elements located outside the organization, which can influence its functioning and which are influenced by the organization itself. There are direct interactions between the micro environment and the organization. The most significant elements of this area include customers, suppliers, competitors (Budzik, Zachorowska, 2016, p. 91).

M. Bednarczyk in his publication, in addition to the above categories of environment, distinguishes additionally meso-environment, which is an intermediate layer between macro- and micro-environment. It includes field units and entities supporting the functioning of enterprises (Bednarczyk, 1996, pp. 46-47).

In the literature, defining the environment is imprecise, so there are, in addition to the categories indicated, many characteristics by which the organization's environment can be described. Within the framework of strategic management, the perception of enterprise environment has been proposed due to four perspectives: adaptive, resource, cognitive and ecological. The most often cited adaptive perspective indicates that the environment affects the activities of organizations, which actively adapt to the evolution occurring in it. It should be noted that within this perspective, it is the characteristics of the environment that largely determine the need to look for new ways to operate the organization (Zakrzewska-Bielawa, 2017, p. 176). Based on another characteristic of the environment proposed in the publication of M. Bednarczyk, its features were distinguished according to the following categories (Bednarczyk, 1996, pp. 42-45): differentiation, which considers the multiplicity of types and species present in the environment (homogeneous, heterogonic), the dynamics of the environment considers the changes in the properties of the environment over time (stable, turbulent), uncertainty, which considers the differentiation and dynamics of the environment considered in the context of the decision-making process (determined, risky), the pressure of the environment reflects the strength of the impact of the environment (high pressure, liberalization), the mode of impact considers the presence of tools of influence of the environment on the organization (direct, indirect).

P.F. Drucker, based on his study of environmental variability, indicated that the environment is a source of innovation opportunities for companies. He signed out factors outside the organization that generate innovation opportunities, i.e.: demographics, changes in perceptions, meanings, values, and new knowledge within and outside of science. However, in order to be able to identify opportunities for the enterprise, it is necessary to constantly observe the environment, as well as to include entrepreneurial management instruments in management (Bednarczyk, 1996, pp. 15-16). The process of observing the organization's environment should be carried out systematically and methodically. It takes into account the following consecutive, orderly stages (Kafel, 2000, p. 39):

- identification of the key environment of the enterprise,
- monitoring of typical trends in the environment,
- prediction of future trends of changes in the environment,
- measurement and evaluation of future changes in the states of the environment.

Conducted study of the environment according to the process approximated above gives a chance to improve the organization.

In the context of determining the orientation of the company in relation to its environment, it becomes important to properly recognize the potential of the external environment, its assessment, as well as its use. This skill of the management consequently can create favorable conditions for the organization to persist and develop (Matejun, 2017, p. 22). It is important that the environment also determines the necessity of using different management methods. It is not possible to apply a universal approach to management in different situations (Kawczynska, 2020, p. 40). The aspect of the organization's environment and its importance is referred to in modern management concepts and methods, including benchmarking, outsourcing, corporate social responsibility (Mateja, 2017, p. 22).

In order to adapt effective management techniques and strategies to the environment, methods of strategic analysis are used. Among the most frequently mentioned in the literature, the analysis of the environment includes PEST analysis (Babatunde, Adebisi, 2012, pp. 27-28), SWOT analysis (Fleisher, Bensoussan, 2015, pp. 105-122), Porter's 5 forces (Bednarczyk, 1996, p. 50), map of strategic groups (Flak, Hunger, 2012, p. 130). Thanks to the indicated methods, it is possible to identify pro-development factors that build market advantage of the organization (Wyrwicka, Jaźwińska, 2014, pp. 261-263). The effectiveness of the strategic orientation and the innovativeness of the company depends on environmental factors, so managers must appropriately adjust the strategy to the environmental conditions, because the external environment can moderate the relationship between strategy and company performance.

In the context of enterprise development opportunities, the literature indicates that the dynamic environment of an organization that is characterized by a constant rate of change opens up market opportunities. In such an environment, firms will pursue change and innovation to achieve competitive advantage. In contrast, a competitive or hostile environment poses a high

degree of threat to the organization. Companies operating in this type of environment tend to pay more attention to resource protection in defining strategy (Prajogo, 2016, pp. 242-243).

Business organizations are in constant interaction with their environment. Changes in the environment can cause changes in inputs, in processes, in firm performance, and these in turn can cause further changes in the organization's environment. The internal and external environment should be viewed as interrelated and interdependent rather than as separate entities. Various external factors affecting business organizations are also often interrelated. Examples include government decisions that can affect the level of demand, which can lead to changes in the general economic climate and have a significant impact on business. The combined effect of these factors can create a turbulent environment that will present challenges or opportunities for the organization. Such changes in the organization's environment can determine an increase in the health of the company or a significant decrease in its potential (Worthington, Britton, 2009, pp. 12-13).

4. Methodology of conducted empirical research

This research is a part of a project carried out in the Department of Entrepreneurship and Competitiveness of family and non-family businesses - a comparative analysis in selected areas. Stage II. Innovation: family and non-family businesses in Poland based on methodological assumptions of Oslo Manual. The survey was conducted from June to August 2020 by the Center for Research and Knowledge Transfer of the University of Economics in Katowice.

A total of 203 family businesses participated in the survey. The research sample was characterized in terms of the period of conducted business activity, the size of employed people and the dominant business profile.

According to the criterion of the period of business activity, companies that have been in business for up to 5 years accounted for 12.81% (26 companies). On the other hand, companies that have been in business for 6 to 10 years accounted for 23.15% of the research sample (47 companies), while companies that have been in business for 11 to 15 years accounted for 13.179% (28 companies). Companies with seniority in business were the most represented, as their share was 50.25% (103 companies).

Analyzing the research sample in terms of the number of people employed, it can be concluded that the largest share in the research sample were companies with 10 to 49 employees – 39.90% (81 companies). Quite numerous were companies employing up to 9 people – 31.53% (64 companies). Companies employing between 50 and 100 workers constituted 18.23% (37 companies), and those employing between 101 and 249 workers – 6.90% (14 companies). The least numerous group are companies with more than 250 employees – 3.45% (7 companies).

In the surveyed companies the dominant profile of activity was service – 52.71% (107 companies), while other types of activity are represented by companies of a commercial character – 16.26% (33 companies), production – 15.27% (31 companies) and mixed – 13.30% (27 companies). Additionally, companies with a dominant profile of construction were distinguished – 2.46% (5 companies).

The survey questionnaire was designed based on the Oslo Manual 2018 (Guidelines for Collecting, reporting and using data on innovation. 4th Edition, OECD/EU). In this study, the responses to questions regarding family firms' perceptions of the environment were analyzed. This element of the survey research was related to the respondents' evaluation of the following statements:

1) The firm's products/services can be easily substituted by competitors' offerings.
2) The entry of new competitors poses a serious threat to the firm's market position.
3) The company has strong competition in the markets in which it operates.
4) Price increases on the firm's products/services usually lead to immediate loss of customers.
5) The firm's main competitors are micro, small and medium-sized firms.
6) The buyers of the company's products/services are public sector entities.
7) The sector in which the company operates has become more complex in recent years.

The evaluation of the statements was done on a 5-point scale, where 1 means a strongly disagree answer and 5 means a strongly agree answer.

5. Analysis of empirical findings

First of all, a general statistical analysis of the answers given in the analyzed scope was performed (Table 1). The results indicate the existence of strong competition on the markets on which the surveyed family businesses operate. The competitors are companies from the SME sector. At the same time it is worth noticing that these companies do not rather cooperate with public sector entities, although in case of this statement there is the biggest standard deviation in the assessments made.

Table 1.
Evaluation of the features of pro-innovation perception of the environment in the studied family firms

Evaluated statements	**Average**	**Standard devation**
The company's products/services can easily be substituted for the competitors' offerings.	3,48	1,09
The entry of new competitors poses a serious threat to a company's market position.	3,36	1,13
The company has strong competition in the markets in which it operates.	3,78	1,02

Cont. table 1.

Price increases on a company's products/services usually lead to an immediate loss of customers.	3,36	1,16
The company's main competitors are micro, small and medium-sized companies.	3,70	1,17
The buyers of the company's products/services are public sector entities.	2,50	1,30
The sector in which the company operates has become more complex in recent years.	3,31	1,21

Source: own elaboration based on the analysis of conducted empirical research.

The analysis of the research results using the criterion of the period of operation of the surveyed family businesses (Table 2) shows that the tendency to perceive the sector in which the company operates as more complex decreases with the increasing period of operation. The youngest companies are characterized by the fear of their products/services being replaced by the offer of the competition, which is least intense in the case of the oldest companies. Similar regularities concern the issue of perception of threat from the entry of new competitors. However, the youngest companies assess the strength of competition in the market the lowest, which may indicate good positioning of the company in the period of planning the market entry.

Table 2.
Evaluation of the features of pro-innovative perception of the environment in the studied family firms according to the criterion of the period of their functioning

	Period of operation of the company			
Evaluated statements	**up to 5 years**	**6-10 yeras**	**11-15 years**	**over 15 years**
The company's products/services can easily be substituted for the competitors' offerings.	3,27	3,36	3,18	3,68
The entry of new competitors poses a serious threat to a company's market position.	3,12	3,21	3,75	3,39
The company has strong competition in the markets in which it operates.	3,50	3,83	3,71	3,85
Price increases on a company's products/services usually lead to an immediate loss of customers.	3,38	3,30	3,43	3,37
The company's main competitors are micro, small and medium-sized companies.	4,23	3,62	3,57	3,65
The buyers of the company's products/services are public sector entities.	2,62	2,32	2,96	2,42
The sector in which the company operates has become more complex in recent years.	3,54	3,57	3,11	3,19

Source: own elaboration based on the analysis of conducted empirical research.

Next, the analysis was made using the criterion of the number of employed people in the studied family firms (Table 3). First of all, there is a noticeable tendency that firms have direct competitors among firms with similar employment size, which may also indicate a lack of inclination to operate in small and profitable market niches. In addition, the results indicate that

family firms both with a small number of employees and those with a large number of employees tend not to have many buyers of products/services among public sector entities. This may indicate that family firms are primarily associated with the small and medium enterprise sector, and entities belonging to the public sector may prefer large enterprises.

Table 3.
Evaluation of the features of pro-innovative perception of the environment in the studied family firms according to the criterion of the number of persons employed

Evaluated statements	Number of persons employed				
	up to 9 people	10-49 people	50-100 people	101-249 people	over 250 people
The company's products/services can easily be substituted for the competitors' offerings.	3,34	3,57	3,21	3,21	4,00
The entry of new competitors poses a serious threat to a company's market position.	3,34	3,47	3,27	2,93	3,71
The company has strong competition in the markets in which it operates.	3,75	3,75	3,86	4,00	3,57
Price increases on a company's products/services usually lead to an immediate loss of customers.	3,30	3,49	3,32	3,00	3,43
The company's main competitors are micro, small and medium-sized companies.	4,00	3,95	3,22	2,79	2,57
The buyers of the company's products/services are public sector entities.	2,58	2,16	2,95	2,79	2,71
The sector in which the company operates has become more complex in recent years.	3,39	3,01	3,59	3,86	3,43

Source: own elaboration based on the analysis of conducted empirical research.

The analysis using the criterion of the dominant business profile of the surveyed family firms (Table 4) indicates that trading firms are most threatened by easy substitution of their offer by competitors. Construction companies are least threatened by the entry of new competitors and price increases leading to the loss of existing customers. The highest assessment of the complexity of the sector in which the companies operate is given by companies with a dominant service profile.

Table 4.
Evaluation of the features of pro-innovative perception of the environment in the studied family firms according to the criterion of the dominant business profile

Evaluated statements	Dominant business profile				
	construction	commercial	mixed	production	services
The company's products/services can easily be substituted for the competitors' offerings.	3,80	4,06	3,22	3,58	3,33
The entry of new competitors poses a serious threat to a company's market position.	2,60	3,79	3,30	3,19	3,34
The company has strong competition in the markets in which it operates.	3,40	4,00	3,48	3,94	3,77
Price increases on a company's products/services usually lead to an immediate loss of customers.	2,40	3,45	3,33	3,42	3,37

Cont. table 4.

The company's main competitors are micro, small and medium-sized companies.	3,00	3,48	3,63	3,65	3,84
The buyers of the company's products/services are public sector entities.	2,00	2,36	2,37	2,42	2,62
The sector in which the company operates has become more complex in recent years.	3,00	3,15	3,30	3,23	3,40

Source: own elaboration based on the analysis of conducted empirical research.

6. Conclusions

The perception of ongoing changes depends on many factors, but the most important seems to be in the entrepreneur's awareness of the need to monitor ongoing changes in the environment and the internal environment of the company and the ability to respond by taking action aimed at anticipatory adaptation of the company to the new situation (Marjański, pp. 154-155). The presented results of empirical research indicate selected areas of perception of the environment in innovation processes from the perspective of family firms. Based on the presented results, it can be observed that family firms should pay special attention to monitoring the environment of the market on which they operate. In addition, the products/services of family companies, which are easily replaced by competitors, are a strongly threatened area. In this context, family companies should undertake activities aimed at forecasting changes in the indicated areas. The effect of undertaken activity by companies may be a chance for their development and introduction of changes and innovations.

In the future, research in the presented area could be connected with the analysis of the influence of environment perception processes on the effects achieved by family companies.

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THE ROLE OF ORGANIZATIONAL CULTURE IN THE PERFORMANCE OF CHOSEN COMPANIES

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Introduction/background: Organizational culture is a relatively new issue. This concept has started to take on a great importance in modern organizations based on knowledge and innovation. The researchers and managers were faced with the problem of how to introduce values into the organization, how to implement the company's mission and vision, how to "manage" employees' creativity, how to motivate and assign tasks to employees. Another important issue concerns measuring the impact of these soft factors on solid results. Is there a relationship between organizational culture and organizational performance and how to verify it?

Aim of the paper: The work deals with the topic of organizational culture in theoretical and practical terms. The aim of the work was to define the influence of organizational culture on the management performance.

Materials and methods: The work is based on literature studies, the results of literary studies from empirical research and own research of the author. Index methods were used to assess the condition of enterprises based on publicly available financial statements. The research supplements the opinions of employees of these companies.

Results and conclusions: In the surveyed organizations, values, relationships and cooperation are put in the first place. Employees work primarily in teams. The aim of this style of work is to improve internal communication, mutual learning and information exchange, as well as stimulating creativity. Regarding the ratio analysis, the good condition of both organizations should be noted: the financial analysis indicators did not deteriorate. It should be stated that organizational performance is influenced by both the dependent variable and the independent variable. They can be analyzed as soft factors and solid factors. The analysis of the impact of these factors can be done using financial measures. The complementary value is constituted by the relations in the organization and the values which make it possible to more effectively implement the company's strategy, mission and vision of the business.

Keywords: organizational culture, performance, management, ratio analysis.

1. Introduction

The considerations on the issue of organizational culture began in the 1920s, when this concept began to be analyzed within the framework of cultural anthropology (Frost, Moore, Louis, Lundberg, and Martin, 1985). The further progress of research was influenced by the belief that the organizational culture has a significant influence on the behaviour of individuals (e.g. employees), groups and entire organizations, including those of an economic nature (Avlesson, 2002).

Contemporary research on organizational culture raises new questions for scientists, e.g. What should be understood as culture in economic organizations? Can culture be deliberately managed? Does culture have to be studied with the tools of a phenomenologist or ethnographer? What are the measurable effects of adhering to the rules of organizational culture in economic organizations and how can it be tested, etc.? (Sułkowski, 2008; Gorzelany, 2020).

Organizational culture issues are widely discussed in the literature. Analyzes of this problem in terms of management processes, apart from Schein (2004) and Hofstede (1998), were also performed by Frost, Moore, Louis, Lundberg and Martin (1985), Ouchi and Wilkins (1985), Cameron and Quinn (2003), Schneider, Ehrhart, Macey (2013), Alvesson (2002), Penc (2010), Serafin (2015), Perechuda (2000), Sikorski (2002), Łucewicz (1999), Klincewicz (2016) and many others.

In the literature, there can be find various contexts and approaches describing organizational culture, corporate culture, corporate culture or organizational culture (Klincewicz, 2016). The differences in its perception are mainly due to the fact that it is the subject of research by scientists from many fields of science, including anthropology, sociology, social psychology, management, and economics (Ouchi, and Wilkins, 1985). The way of perceiving this topic will therefore depend on the subject of interest of the researcher and the purpose of the research. In most of these sciences, the initial definition is organizational culture as a certain process of building the identity of an organization (Hofstede, 1998; Sikorski, 2002). However, the approach to individual components of organizational culture will be different, i.a. due to the need to take into account the context and surroundings (Schneider, Ehrhart, and Macey, 2013).

The components of organizational culture were described by Schein (2004) in his well-known model. Some of the presented elements determine the level of awareness among members of a given organization, and some refer to the perception of these elements by an external observer (Schein, 2004; Ouchi, and Wilkins, 1985). Schein (2004) divided these elements into three levels: values, implicit assumptions, and artifacts. An extremely important component of Schein's model are values that concern the understanding and unity of goals of the members of a given organization. The values apply to the overall conduct of members of the organization, not only in the workplace. Artifacts adopted in a given company are

an important component, as well as hidden assumptions that result from the character traits or predispositions of the members of the organization.

Schein's model, on which the analysis of the issue of organizational culture is often based, contains components that are difficult to measure. Hence, it is extremely complicated to analyze the impact of these factors on the effects of enterprise management (Cameron, and Quinn, 2003). Most often, a selection of factors is made, from among many, that allow to some extent to "measure" or evaluate the impact of these activities on the performance of the organization. Therefore, the strategic plan of the organization, company policy, mission and vision of the company can be taken into account (Serafin, 2015). Moreover, the management styles presented by managers, predispositions and their use in management should be included in the analysis, an attempt should be made to define the method of gaining authority and power and the principles of its criticism, and the application of methods and tools for employee motivation should be analyzed (Perechuda, 2000). Other important elements that make up the organizational culture are: the way of making decisions in the company (at its various levels), the possibilities of developing human resources in the organization, methods of group management and methods of solving conflicts in the group (Aniszewska, 2007). The following are also important in the company: a common conceptual framework and language, development and compliance with a code of business ethics, proper cooperation between departments in the company, the course of recruitment and employee recruitment processes, management of employees' creativity, as well as the effectiveness of internal and external communication processes (Sierpińska, and Jachna, 2004).

2. Methods

The considerations and conclusions contained in this article are based on literature studies, the results of literary studies from empirical research and own research, including the case study method. The aim of the research was to determine the spectrum of issues and problems faced by researchers and managers who analyze the impact of organizational culture on company performance.

The research was carried out in two ways. The first part of the research was related to the financial performance analysis for two economic organizations: the FAKRO Group and the Capgemini organization in 2015 and 2019. The study used commonly available data on the above-mentioned two companies, including financial data provided from financial reports. In order to examine the economic situation of enterprises, the method of ratio analysis can be used and the current indicators can be compared with the previous years (Łucewicz, 1999; Stańczyk, 2012). Selected measures were used in the study to perform an illustrative assessment of the condition of the organization, they were: *Cash Ratio*, *Quick Ratio*, *Current Ratio*, *Return*

on Assets, *Return on Fixed Assets*, *Debt Ratio* and *Debt to Equity Ratio* (Ejsmont, and Ostrowska, 2011; Wojtowicz, 2009).

Then the work was supplemented with the opinions of employees obtained in the online survey. These studies were not representative, but only served as a supplementary opinion to the case study. The survey was conducted on a group of 86 employees, including 40 FAKRO employees and 46 employees of the Capgemini organization. Employees of middle and lower management were asked to participate in the research. The questions concerned the comparison of selected management factors and methods in 2019 in relation to 2015. The article presents partial results of wider research conducted by the author in the field of analyzing and disseminating organizational culture.

3. Results

3.1. Case study: values and relationships in an organization

The FAKRO company[1] is a leader in the production of windows in Poland and one of the leading manufacturers in this industry in the world. Since 2003, it has also been operating on the American and Chinese markets. The company was founded in 1991 in the south of Poland. The company's mission is to ensure living comfort all over the world through the production of safe, energy-saving and environmentally friendly windows. When it comes to building an organizational culture, the following values are important for the company: responsibility, credibility, employees development, environmental protection. In its activities, the company places particular emphasis on the development, quality and safety of products, as well as on environmentally friendly solutions, increasing the trust and satisfaction of customers. The company implements the assumptions of CSR understood as a certain comprehensive method of management. Additionally, a code of ethics was developed, defining consistent values, attitudes and rules of conduct. The code sets uniform standards for all employees that reflect the company's policy, mission and values. The implementation of these assumptions is to contribute to the achievement of strategic goals and making optimal decisions at each management level. Currently, the company employs over 4,000. people, including over 100 engineers, responsible for designing new solutions.

The second analyzed company is a multicultural Capgemini organization[2], employing over 270,000 people in 50 countries. Since 1996, it has also been operating in Poland. Capgemini deals with consulting and technological and engineering services, including digital

[1] Data on the FAKRO company was obtained from publicly available sources: www.fakto.pl, www.SprawozdaniaFinansowe.pl, www.rejestr.io.pl.

[2] Data on the Capgemini organization was obtained from publicly available sources: www.capgemini.com, www.investors.capgemini.com.

technologies. The organizational structure of the Capgemini group is highly developed. It includes, among others Board of Directors, CEO, shareholders and stockholders. In 2019, the group recorded worldwide revenues of EUR 17 billion. The organization has a developed vision and mission. They define the values that guide all members of the organization (*people metters, results count*). The organization is focused on people who create new technologies. Cooperation, which means joining the forces of experts, employees and customers, is also an important value. This approach has been called *Collaborative Business Experience.* The organization has a developed the Code of Business Ethics that discusses the issues of business integrity, and defines the role of people, describes the correct nature of business relationships and CSR activities. The Code also specifies ways to build relationships with customers, shareholders, employees, partners and suppliers, as well as with the local community.

In the surveyed organizations, almost all surveyed employees (96%) knew the mission and vision of the company in which they worked. Over 60% of the respondents from both organizations considered cooperation and mutual respect for the most important values. Every third respondent indicated equality as the most important value. Other values, such as own development (career development opportunities), sustainable development or CSR, were indicated by 9% of respondents. Summing up, it can be concluded that the opinions obtained were dominated by those recognizing trust, loyalty and cooperation as the highest values in the company. More than two-thirds of the respondents indicated teamwork as a preferred and used model in the enterprise.

All respondents agreed that streamlining communication processes in the workplace results in increased work efficiency. The respondents assessed the effectiveness of internal communication as well as communication with the environment as good. Every fourth respondent indicated a further need for minor improvements in communication processes in the near future, especially when it comes to the development of organizational knowledge. Another important factor in building organizational culture is the relationship in the organization, which all respondents considered to be the key factor. Informal meetings, joint trips, good atmosphere at work, mentoring, training or empowerment are other examples of activities leading to building organizational culture.

3.2. An attempt to assess the situation of the surveyed enterprises

The economic model of organizational performance contains components that can be measured and give an objective picture of a company in the industry. According to Abu-Jarad, Yusof and Nikbin (2010), these components can be divided into three groups: 1) “Characteristic of the industry in which the organization competed, 2) The organization`s position relative to its competitors, 3) The quality of the firm`s resources”. Quantitative data and financial measures can be used to assess these three areas and obtain measurable results (Abu-Jarad, Yusof, and Nikbin, 2010). Financial indicators provide an objective picture of the company's condition,

being a measurable reflection of the effectiveness and efficiency of the organization's strategy implementation (Nassim, and Penman, 2001). Table 1 presents the results of the ratio analysis with the use of selected measures - for FAKRO and Capgemini in 2015 and 2019.

Table 1.
The results of the ratio analysis for the surveyed enterprises – selected indicators

Ratio indicator	Enterprise/Organization			
	FAKRO		Capgemini	
	2015	2019	2015	2019
Cash Ratio	0,11	0,14	0,18	0,19
Quick Ratio	1,02	1,09	1,32	1,26
Current Ratio	1,86	1,83	1,78	1,81
Return on Assets (RoA)	2,15	2,21	3,17	4,16
Return on Fixed Assets (RoFA)	3,13	3,20	4,92	6,52
Debt Ratio	0,62	0,73	0,71	0,54
Debt to Equity Ratio	0,92	0,87	0,88	0,69

Source: own elaboration based on financial statements.

The ratio analysis for the surveyed companies in 2015 and 2019 shows that they have not changed significantly. Both companies did not record a deficit of cash on their account, which means that they maintained proper financial liquidity (*Cash Ratio*). A similar conclusion can be drawn when it comes to the *Quick Ratio* indicator. The level of this indicator is correlated with investments carried out in the company. The value of the *Quick Ratio* index obtained for the FAKRO company indicates ongoing development investments. Based on the analysis of profitability ratios (*ROA, RoFA*), it can be concluded that the surveyed organizations managed their assets effectively. The values of the ratios describing the financial liquidity of the organization in the surveyed companies did not change significantly in 2019 compared to 2015, which indicates their stable situation in the business industry. More differentiated values were achieved by the profitability ratios, the growth of which is favorable for the enterprise. This was the situation in the Capgemini organization. The debt ratios taken into account (*Debt Ratio, Debt to Equity Ratio*) illustrate the sustained level of debt due to ongoing development investments, especially in FAKRO.

The results of the analysis indicate that in 2019 the financial situation improved in both organizations compared to 2015. While the financial liquidity ratios remained at a similar level, there was an increase in the values of the ratios determining the company's profitability and a visible improvement in the ratios describing the debt level.

To obtain a more complete picture of the relationship between organizational culture and organizational performance, the model of nonfinancial measures from both objective and perceptual sources should be included (Abu-Jarad, Yusof, and Nikbin, 2010). These measures include i.e. human relations, organizational culture, job satisfaction, organizational commitment, employee turnover, empowerment, etc. Chien (2004) determined five factors influencing organizational performance: “1) Leadership styles and environment, 2) Organizational culture, 3) Job design, 4) Model of motive, 5) Human resource policies”.

Figure 1 presents the most important factors influencing organizational performance and their relationships.

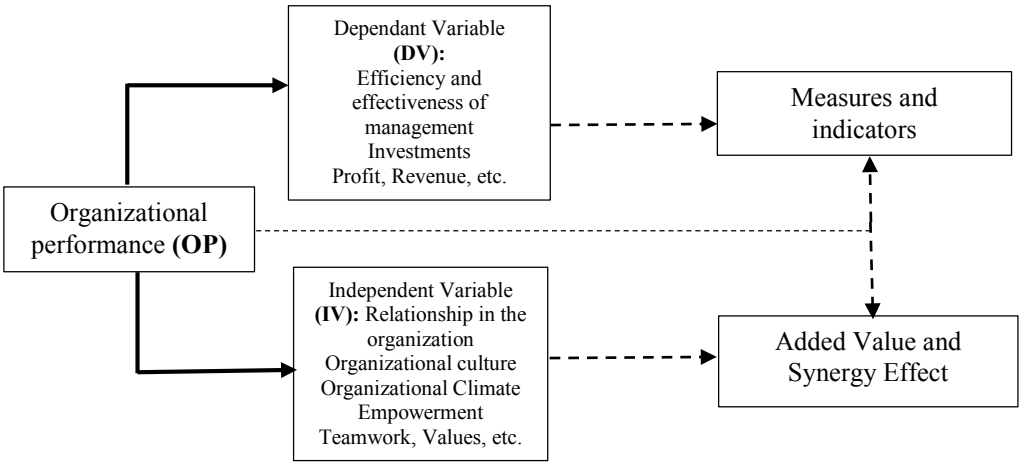

Figure 1. An example of a relationship between factors influencing organizational performance. On the base of "Diagnosing Organizational Cultures: Validating a Model and Method; Denison Consulting Group" by Denison, D.R.; Janovics, J.; Young, J.; Cho, H.J.: Carlisle, PA, USA, 2006 and "The Relationship Between Organizational Culture, Risk Management and Organizational Performance" *Cross Cultural Management Journal*, *Vol. XXI, Iss. 1,* pp. 13-20 by Abuzarqua R.

As shown in Figure 1, organizational performance is influenced by both dependant variable and independant variable. They can be analyzed as soft factors and solid factors. The analysis of the impact of these factors can be done using financial measures. The complementary value is constituted by the relations in the organization and the values which make it possible to more effectively implement the company's strategy, mission and vision. Thanks to teamwork and appropriate knowledge management processes, a synergy effect is achieved, which affects the effectiveness and efficiency of management. Goals and tasks can then be achieved faster and conflicts can be avoided (or resolved effectively). Building relationships with employees and verifying their predispositions also allow managers to better choose the management style and use the capabilities of employees.

4. Discussion

Investigating the influence of organizational culture on the effectiveness and efficiency of management is extremely difficult. The issue of organizational culture falls in soft terms in the management science (Łukasik, 2018). Organizational culture is based on values, and values are separated from profit, budget, efficiency (Kamińska, 2012). Despite this, researchers try to determine the impact of organizational culture on the measurable effects of activities, primarily by looking for a method, model or methods of measurement (Wojtowicz, 2009).

The first step in such research is data collection. Questionnaire methods are most often used to obtain data on organizational culture. The questions included in such a survey must relate to the adopted set of people and team management practices used in a given organization. Łucewicz (1999) in her works uses the methods of statistical analysis, including grouping method based on cluster analysis. In turn, Stańczyk (2012) points to the significant importance of the triangulation method in the study of organizational culture. Its purpose is to make cultural research reality and to give it a more "measurable" dimension. Wojtowicz (2009) refers to various diagnostic methods applicable both to an external researcher and to a manager who wants to analyze an enterprise for decision-making purposes. For an outside researcher, these include analysis of available documentation, visit to an organization, observation of meetings, conducting standardized surveys, supplementing information with in-depth interviews, etc. (Wojtowicz, 2009).

Modeling methods are also used to study the structures of organizational culture and its impact on other areas of the organization. Marcoulides and Heck (1993) propose the LISREL model. This method allows you to test a model concerning how an organization's culture affects organizational performance. However, studying the relationship between organizational culture and the effectiveness of management and obtaining measurable benefits is extremely difficult. As Lim (1995) points out, *despite the assumptions about the existence of a relationship between these two phenomena, it still remains unclear and difficult to measure. There is a further need to improve these diagnostic concepts and methods. It is proposed to consider methodological issues in future research, as well as the influence of moderating variables on this phenomenon*.

The results of research conducted in this area in Poland with the use of various cognitive methods indicate that the level of organizational culture in Polish enterprises is still too low. According to Szcześniak (2006), Polish employers assign employees too little role in the company's operations and success. The reason for this is still too low level of awareness of entrepreneurs. Greater activities are necessary to popularize knowledge about the role of organizational culture in running a business, including the popularization of organizational values and business ethics (Zbiegień-Maciąg, 2013; Czerska, 2003).

Based on the conducted own research and literature studies, it can be concluded that there is a positive relationship between the organizational culture and economic results achieved by the enterprise. A friendly atmosphere in the organization, empowerment, employee development and good relations between them certainly contribute to achieving a competitive advantage. It is extremely important to indicate to what extent the organizational culture contributes to the achievement of financial benefits. Developing a universal tool is difficult due to the soft nature of these issues. Nevertheless, according to Abu-Jarad, Yusof and Nikbin (2010), *it has been very important for managers to know which factors influence and organization`s performance in order to take appropriate steps to initiate them.*

5. Summary

The article discusses selected factors that may contribute to building an organizational culture, based on the example of two companies. Most of these factors are based on communication and relationships within the organization, hence the transformation of these factors into measurable values causes a lot of trouble for scientists and managers.

The conducted research and analysis of the literature allow to draw the thesis that organizational culture is not the only key to financial success, however, it constitutes the basis for building good relations in the organization and creates the organizational climate. This, in turn, affects the implementation of tasks and goals set in the company's strategy. However, studying these dependencies and their impact on each other is extremely difficult. The problem is much more complex, as the analysis of management effectiveness requires taking into account many different factors, both solid and soft. No single measure of performance may fully explain all aspects of the term. Therefore, it is important for managers to familiarize with these measurement methods and tools, as well as to realize the need for a holistic view of the company.

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CONCEPT OF DISTRIBUTION NETWORK CONFIGURATION IN THE CONDITIONS OF CENTRALISED FORECASTING

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Introduction/background: The article presents a literature analysis related to the concept of distribution network configuration. The main determinants of network configuration and their impact on key solutions used in networks are also indicated. As a key solution related to the correct management of demand, including forecasting, the author considered centralisation in networks. The article also presents the results of research carried out on 5 distribution networks, in which the correlations between the elements of their configuration and the results of forecasts made using the tool previously created by the author are examined.
Aim of the paper: The purpose of the article is to present the concept of distribution network configuration in the conditions of centralised demand forecasts, with the central unit at the level of logistics operator. In addition, the article will consider the hypothesis regarding whether the configuration of the distribution network affects the accuracy of forecasts.
Materials and methods: The purpose of the article and verification of the hypothesis was carried out with the help of literature studies, results of the conducted case study, and on the basis of the results of forecasts obtained using the prognostic tool created by the author in the R environment.
Results and conclusions: The article demonstrates the basic ability of a logistics operator, working in MDP in the distribution network, to make forecasts and analyse the distribution network. In addition to that, the article presents results indicating that a properly selected configuration of the distribution network has a positive effect on the accuracy of forecasts contained in it.

Keywords: distribution network, forecasting, logistics operator, network configuration.

1. Introduction

The concept of configuration is used in many disciplines of science; however, for each specific one it must take the appropriate dimension (Frefercik et al., 2018). It is often referred to as the arrangement of individual parts that create a whole in an inseparable form, or an arrangement of elements that can change in different ways under the influence of certain circumstances (Kawa, 2011). Undoubtedly, it is a definition that focuses on the spatial positioning of nodes in the distribution network. Another definition, to which the author of this

article is more inclined, regards configuration as a creation of connections, not only related to geographical positioning, but also to the appropriate level of relationships and flows occurring in the network. According to this approach, configuration is defined as: common clusters of attributes or relationships that are internally consistent (Miler, and Mintzberg, 1984). The configuration focuses on where to place individual activities in the enterprise value chain (Porter, 2001). It belongs to one of the main tasks of managing supply chains and distribution networks (Chandra, and Grabis, 2007), and the configuration problem itself is considered a strategic level problem in enterprises (Truong, and Azadivar, 2003; Tsiakis and Papageorgiou, 2008). In relation to the distribution network, the following configuration dimensions shall be indicated, which should take into account: network structure, network flows, and relationships and characteristics of services provided in the network. A configuration that incorporates many different aspects is called multi-configuration by some authors (Shishebori, and Babadi, 2018). It can be stated that network configuration is a strategic decision with a long-term nature and period of impact on enterprises (Kot et al., 2009). Among the goals of distribution network configuration, one can indicate, among others: minimising significant logistics costs, maximising customer service level, maximising profits generated by logistics (Bendkowski et al., 2010), as well as increasing network flexibility (Wasiak et al., 2019) and adapting the network to changing demand (Melacini, and Tappia, 2018).

By analysing the literature, the author identified 6 main determinants of distribution network configuration, and also indicated 4 main configuration solutions as a response to the needs of network configuration (Figure 1).

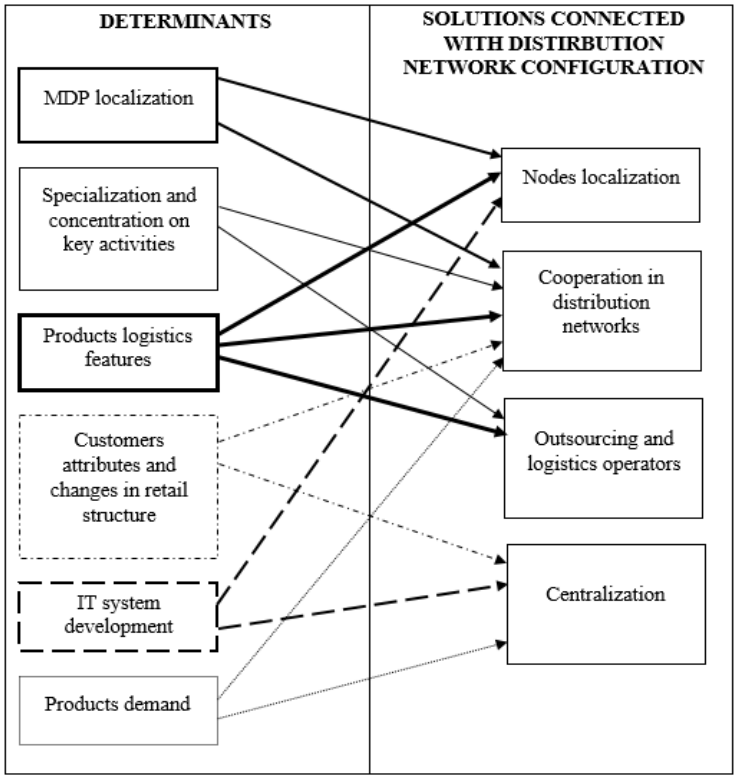

Figure 1. Distribution network configuration determinants and their influence on solutions connected with configuration.

The location of the MDP (Material Decoupling Point) determines the appropriate location of nodes in material flows and, in a way, enforces the use of certain forms of cooperation that are designed to enable actions specific to the appropriate forms and locations of the MDP (e.g. postponing the production of finished products or quick response to market demand in the MTO environment). The specialisation of enterprises and the focus on key activities affect the use of outsourcing services by enterprises in the network, and the presence of logistics operators in networks (Faur, and Bungau, 2019; Kramarz, M., and Kramarz, W., 2019). This determinant also results in new forms of cooperation that should be concluded between enterprises and their partners in the field of providing services. Product logistics characteristics determine the location of nodes in the network. Product features associated with, for example, its low transport or storage compliance may force a closeness between individual enterprises. The specific features of the products additionally enforce improved cooperation in the network to provide them to customers. Dealing with product flows with specific characteristics may also imply the need to use the services of specialised enterprises. Customer attributes and changes in the structure of retail trade, in particular the growing requirements and development of online commerce, make it necessary to change the strategy of cooperation in the network. This determinant also results in activities related to the decision to centralise or decentralise network activities. The development of IT systems results in changes in the requirements concerning the geographical location of nodes, where problems related to spatial distance are beginning to lose their significance. In addition, system development affects networking, which, supported by appropriate data exchange software, can evolve to a high level and bring great network benefits. IT systems and ways of collecting and transferring data also affect solutions related to centralisation (e.g. collecting data in a central link and sending data using EDI). Demand for products translates into the need to develop appropriate cooperation methods, in particular for products with irregular demand, so as to ensure them at the right time on the market, as well as to improve the effectiveness of forecasts for the implementation of centralisation solutions.

The author considers centralisation to be one of the most important configuration solutions. Centralisation is, from the author's point of view, a more appropriate concept in relation to forecasting in distribution networks. Centralisation is often only associated with the geographical positioning of warehouses (Schmit et al., 2015) and the associated stock management (Stevic et al., 2018). The opinion of the author is that this is not the right approach. Centralisation, in the opinion of the author, should be considered as a concentration of activities in one, separate and formalised cell (Droge et al., 1989), or as a consolidation of decisions made (Jonsson, and Mattsson, 2009). The main prerequisites for centralisation include (Szozda, and Świerczek, 2016): the diverse nature of individual activities, which are typical for many different organisational units operating in subsequent stages of product flow, the lack of separate units responsible for coordinating processes related to managing demand for products from other processes, as well as the vertical nature of organisational structures, which

intensifies the phenomenon of independent decisions regarding demand management in individual entities. Actors operating in centralised distribution networks are divided into (Kawa, 2011): central enterprises, as well as suppliers, recipients, selected or collaborating competitors and other entities. The central link is one of the most important elements in distribution networks. Its occurrence is one of the basic forms of their coordination (Kramarz, 2018). The central entity in the literature has many names. There are terms such as integrator (Brzóska, 2007; Czakon, 2010; Schweizer, 2005) or leader (Ciesielski, 2009). Central enterprises are also known as orchestrators or hub companies (Czakon, 2015), or as flagship units, coordinators, creators or conductors (Barczak, and Walas-Trębacz, 2011). However, one of the common concepts is to combine the concept of the central link of the network with the concept of the flagship enterprise. According to some authors, due to the broad decision-making role of such an enterprise, it can be additionally treated as a network leader (Kramarz, M., and Kramarz, W., 2015), and the very shape of the network centre depends on the shape of the flagship enterprise and the characteristics of the MDP. The flagship enterprise is usually a large enterprise that deliberately creates a network in its environment to achieve its own goals and easily acquires a qualified workforce (Anokhin et al., 2019). It does not necessarily have to be related to logistics; its core activity can be directed to another industry. A flagship enterprise that implements processes related to logistics can be defined as a logistics node, which is responsible for the synchronisation of material flows and the coordination of tasks ordered to partners in the network (Kramarz, M., and Kramarz, W., 2015). It is characterised by its reputation (Xiaotong, 2019), and also by its market size (Bakhtiyari, 2015). Such an entity takes responsibility for the quality of the product delivery process to the customer (Kramarz, 2016).

Centralisation in demand management in the distribution network, including forecasting, should match stocks forming in and between individual links in the network, in order to meet the final demand of customers, and thus prevent a situation of shortage of stocks or their increased level. It also helps to create and adapt the forecast by accessing current information on demand and stock levels in individual links. The main driving force of centralisation is the transparency of activities (Ekinci, and Baykasoglu, 2016). Retailers and suppliers use demand information to create their own stock plans. A characteristic feature of centralisation is the consolidation of activities related to product demand management and their grouping into a separate functional area. The degree of centralisation indicates at what level decisions are made, who has power and the ability to influence others, and who has the right decision-making powers (Szozda, and Świerczek, 2016). Centralisation actions are also justified in ecommerce impact nowadays (Yang et al., 2020).

2. Methods

The chosen research methods included a literature analysis and a case study based on 5 distribution networks, in which functioned a logistics operator located at the MDP, as well as results from the built-in forecasting tool and results of the questionnaire (Table 1).

Table 1.
Research methods used in the paper

Research method	Brief description
Literature review	Analysis of the literature on elements of distribution network configuration, but also the characteristics of enterprises that are able to reconfigure the network.
Case study	Case study in 5 distribution networks, in which the logistics operator provides outsourcing services to manufacturers located at the MDP.
Results from the forecasting tool (developed in the R environment)	The results of forecasts placed automatically using the script created by the author in the adaptive R programming environment. In the script, the author used 16 different forecasting algorithms, of which the one with the highest degree of matching was chosen for individual time series.

The logistics operator in the distribution networks under consideration provides logistics services, on an outsourcing basis, for production enterprises that produce finished products in accordance with the push strategy for distribution centres of large retail networks and wholesalers, as well as directly to points of sale (POS). Logistics services provided by the operator are adequate to the attributes of 3PL operators since this operator functions as a separate link in the network. They mainly concern the implementation of warehouse processes related to the receipt, manipulation in the warehouse, storage and release of products, processes related to co-packing and co-manufacturing, as well as physical distribution of products, including transport planning and transportation of products to destinations. Information on the demand for products flows directly to the manufacturer from the network link, which is the next recipient of the product after the link constituted by the logistics operator. This information is a peculiar forecast related to the expected demand of subsequent links in the distribution network. In order to meet the demand and meet the requirements of its customers, the manufacturer forecasts production volumes based on historical data related to the sale of individual SKUs (Stock Keeping Units). The forecast made this way is usually based on distorted information about demand, which is distorted by subsequent links in the network and does not include activities related to its artificial creation by various links. The logistics operator gets information on the quantity of products that it has to take from the manufacturer, and then about the quantities it has to issue to individual points. In some situations the operator in the warehouse also performs additional functions that are required by customers in the network. These are functions related to co-packing, which involve changing the logistic unit in cartons and creating sets from various products, which is related, among others, to the creation of

promotional sets, as well as functions related to co-manufacturing, where the operator takes over from the manufacturer the simple production tasks that they carry out on the created production lines in the warehouse.

3. Results

The overall structure of the network is presented in Table 2. The structure includes the SKU (Stock Keeping Units) in individual networks, as well as shares in assortment releases to individual network nodes.

Table 2.
Research methods used in the paper

No.	Quantity of SKU in network	Quantity of assortment groups	Assortment characteristic (main activity)	Number of nodes			Percentage of release directly from operator [%]		
				Distribution centres	Wholesalers	POS	Distribution centres	Wholesalers	POS
1	1,362	19	Chemicals and cosmetics.	322	0	14,695	78.39	0	21.61
2	1,152	15	Beverages and sweets.	132	231	17,343	25.15	19.08	55.78
3	415	12	Construction supply industry.	111	8	2,110	2.68	0.14	97.18
4	60	5	Sweets.	25	0	15	98.95	0	1.65
5	272	9	Chemicals.	180	0	8,180	100.00	0	0

The best results in terms of forecasting demand in the distribution network were obtained by distribution network No. 5, with an estimated MAPE of 13.58%. Subsequently, according to the verifiability of the forecasts, distribution network No. 2 – 17.52%, distribution network No. 4 – 17.58%, distribution network No. 1 – 17.76% and distribution network No. 3 – 37.43%. Forecast results are mostly similar. The following analysis is intended to show the reasons for discrepancies in forecasts in networks 5 and 3. The abovementioned relationships between the elements of the network structure and the verifiability of forecasts were tested using Pearson's r coefficient (r).

In the first step, the correlation between the impact of the share of products from the AX group (compared to the total number of products from the A group), as well as products from the AX and AY groups (also compared to the total products from A), and the prognostic errors of individual networks were found. The analysis showed a medium level correlation. The impact of the AX group on forecast errors was $|r| = 0.44$, and the impact of products from the AX and AY groups on the verifiability of forecasts was $|r| = 0.41$. Such a low result is caused

by the fact that the forecasts for the least important products from the C group are highly verifiable. Attention should be paid to the operator's ability to forecast the most important products for the network from group A. The analysis also showed no relationship between the size and range of the assortment and the verifiability of the forecasts (correlations respectively: $|r| = 0.14$ and $|r| = 0.09$). This is mainly due to the individual approach when making forecasts for each product. Regardless of the number of SKUs, the proposed script puts individual forecasts for all available time series.

Elements that, in the author's opinion, additionally significantly affect the quality of forecasts, are also forms of cooperation between the production enterprise and the operator, as well as forms of relationships occurring in the network. These factors specify the elements that have the greatest impact on them. These elements received adequate weights and then were rated on a scale of 0 to 3 (where: 0 – needs immediate improvement, 1 – needs improvement, 2 – medium level, 3 – relatively satisfactory level). The results are presented in Table 3 and Table 4.

Table 3.
Examination of networks – cooperation between the manufacturer and the operator

The evaluated element of cooperation between the manufacturer and the operator	**weight**	**Distribution Network No.**				
		1	**2**	**3**	**4**	**5**
Exchange of information on changes in the designation of production and warehouse references	0.2	1	2	1	2	2
Exchange of information on sales picks	0.2	1	1	1	2	2
Sending aggregate forecasts	0.1	3	2	0	2	3
Frequent direct contact	0.1	2	3	1	3	3
Rare stock exchanges	0.15	1	1	2	3	3
Inclusion of an operator in the flow of information	0.25	1	1	0	2	3
Final evaluation		**1.3**	**1.5**	**0.8**	**2.25**	**2.6**

Table 4.
Examination of networks – relationship level

The evaluated element of cooperation between the manufacturer and the operator	**weight**	**Distribution Network No.**				
		1	**2**	**3**	**4**	**5**
Exchange of information on changes in the designation of production and warehouse references	0.2	1	2	1	2	2
Exchange of information on sales picks	0.2	1	1	1	2	2
Sending aggregate forecasts	0.1	3	2	0	2	3
Frequent direct contact	0.1	2	3	1	3	3
Rare stock exchanges	0.15	1	1	2	3	3
Inclusion of an operator in the flow of information	0.25	1	1	0	2	3
Final evaluation		**1.3**	**1.5**	**0.8**	**2.25**	**2.6**

Based on the results of the assessment of individual factors, as well as the obtained results of forecasts, individual networks were assessed (from 1 to 5) depending on the assessment and the result of the forecast (1 – the lowest result, 5 – the highest result) – Table 5.

Table 5.
Examination of networks – summary

Distribution Network No.	Number of points		
	Forecast verifiability	Level of operator and manufacturer cooperation	Network relationship
1	**2**	2	2
2	**4**	3	4
3	**1**	1	1
4	**3**	4	3
5	**5**	5	5

The considerations show that some of the elements of the distribution network configuration affect the results of the forecasts. Such elements are, primarily, the forms of relationships occurring in the network, as well as cooperation models adopted by individual links of the network and the manufacturer themselves. These elements also include distribution strategies adopted in the network and the percentage shares of the distributed assortment relative to individual links, as well as the fact of considerations on direct distribution, and as one of the most important elements – the way of flow and collecting information on demand.

4. Discussion

The analysis also showed a strong relationship ($|r| = 0.99$) between the MAPE level and the share of POS directly supported by the operator. This correlation is statistically significant. Statistical significance is demonstrated by a result of $p < 0.05$. In a given case, the significance was at $p = 0.001992$. This correlation means that the greater the share in the network of endpoints directly served by the operator, the more difficult it is to make a correct forecast. These results were also confirmed when checking the correlation between the MAPE level for individual networks and their participation in releases to distribution centres and wholesalers, as well as participation in releases to POS. Correlation analysis demonstrated a strong relationship between these factors. It can be concluded that the greater the share of physical distribution of products directly to centres and wholesalers, the smaller the forecast errors ($|r| = 0.87$), and the greater the share of product distribution from the logistics operator directly to POS, the greater the forecast errors ($|r| = 0.87$). This is due to difficulties in direct contacts with POS. Information on demand is very disrupted in these cases, and the information provided is heterogeneously chaotic. Additionally, there is no logistics operator feedback for direct distribution to POS. Relationships with the distribution centres look different. These centres usually collect aggregate information on demand at individual sales points and forward it in a pre-processed form to the manufacturing enterprise. Wholesalers act in a similar way in estimating the volume of demand for their customers. Thus, it can be concluded that the verifiability of forecasts is influenced by such elements as the degree of centralisation in the

network, where networks have a lower degree of centralisation (i.e. more dispersed and chaotic information flows) and adopted models of interaction and cooperation in networks.

In the current configuration of the distribution network, the forecasts made are not satisfactory in the perspective of forecasting the demand for the entire network. In the current form, the forecasts at the presented level can be used mainly to improve operational and decision-making processes undertaken only at the level of the 3PL operator. However, taking into account the hypothesis confirmed by the author about the impact of network configuration on the verifiability of forecasts, as well as the fact of confirming the operator's basic ability to generate forecasts, the author considers it correct to introduce a solution into the network based on centralisation of forecasting. Such considerations should mainly concern checking the legitimacy of recognising the 3PL operator as the central unit, and by verifying the attributes of market enterprises forecasting demand and comparing them with the attributes of the operator.

5. Summary

The article showed the concept of network configuration and its centralisation as one of the most important solutions that are determined by changes in the network. The article achieved its purpose, which was to demonstrate the concept of central forecasting in distribution networks with a logistics operator as a unit acting as the central link. The article also confirmed the hypothesis regarding the impact of network configuration on the accuracy of forecasts.

The results in the presented form, as well as the use of the forecasting tool created by the author in current network configurations, can lead to improvement of the operator's working activity. In order to implement it in the network, it would be necessary to reconfigure the network related to, among others, the centralisation of information flows on real demand volumes and additional information that may affect its volume. The need for centralisation was demonstrated during the analysis of the distribution network.

In the opinion of the author, the article is an interesting area for deepening research in the field of network configuration and network centralisation. At a later stage, the author intends to analyse the attributes of 3PL operators operating in MDP and compare them with central enterprises and those that, within their activities, forecast demand in the distribution network. This will outline the overall picture of network configuration for the needs of centralised forecasting.

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SUCCESS FACTORS IN MANAGING REMOTE WORK: A GLOBAL PERSPECTIVE

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Introduction/background: This paper identifies and analyzes key considerations in managing online, work-from-home business operations. The literature review summarizes research done both previous to and during Covid-19 shutdowns. An original, international survey, conducted in August 2020, polled managers and professional leaders in multiple industries.
Aim of the paper: The best use of our survey is to learn about characteristics of remote work, and possible success factors in managing it, which tend to prevail across industry sectors and geographies. Further, our review of the literature is offered as a concise and practical summary of previous research. Altogether, we hope this paper will serve as a step toward building a wide-ranging, well-rounded body of knowledge on the management of remote work, which will be useful to practitioners and scholars alike.
Materials and methods: In August 2020 the authors conducted an international, cross-sector survey that drew responses from 158 individuals.
The LimeSurvey consisted of 26 questions exploring organizational responses to the pandemic and how people had been managing the transition to remote work. Along with the structured questions—which typically asked respondents to check one answer from a list of possible replies—there were spaces for open-ended comments.
Results and conclusions: Analysis and commentary on survey results has largely been done in the sections above. We would conclude, first, by repeating and summarizing a few key points. Providing technologies and tech support for remote work is necessary, but giving remote workers access to the information they need, when they need it, is mission-critical and may be more of a challenge.

Keywords: remote work, managing remote work, managing online, work-from-home, managing work-from-home, online productivity, online morale, management, pandemic management.

1. Introduction

What are the key factors that make work-from-home arrangements go effectively? The question came to the forefront after the Covid-19 pandemic drove most business operations to move online, but it was an important question before that and will remain so, as remote work predated the pandemic and will continue.

It is important for several reasons. One is to inform management of how best to manage remote work. Another is deciding whether to keep operations online, or choosing *which* operations (or which staff members) would be more effective online. The paper presented here is only a small part of a growing body of research in these areas. We have aimed to make it useful by providing two elements not frequently matched by others: a very concise review of the literature, and results of a distinctive survey we conducted in August of 2020. The survey polled managers and professional leaders in a range of industries on several continents, asking about their experiences with remote work during the pandemic. While no definitive conclusions should be drawn from either element of this paper, they combine to point out many key challenges, opportunities, and topics that deserve management attention.

2. Review of the Literature

To begin by stating the obvious: the most salient feature of remote work is physical isolation. Each person is in his/her own home or location of choice, separated from co-workers. It then follows that one way of optimizing remote work would be to leverage the potential advantages of isolation.

A number of research studies have found that enabling “autonomy” or “self-efficacy”, in any work environment, is associated with improved performance and well-being.

A definition and explanation of self-efficacy, from the American Psychological Association: *Self-efficacy refers to an individual's belief in his or her capacity to execute behaviors necessary to produce specific performance attainments (Bandura, 1977, 1986, 1997). Self-efficacy reflects confidence in the ability to exert control over one's own motivation, behavior, and social environment. These cognitive self-evaluations influence all manner of human experience, including the goals for which people strive, the amount of energy expended toward goal achievement, and likelihood of attaining particular levels of behavioral performance* (Carey, and Forsyth, 2009).

In an early study of remote work, Staples et al (1999) found that “it may be possible to enhance employees' work performance through management efforts to improve employees' remote work self-efficacy”. In a study of “fly-in, fly-out” workers—i.e., those flown in

temporarily to remote job sites—researchers found that "day-level autonomy predicted day-level engagement" with the work (Albrecht, and Anglim, 2018).

Further: *Independence at work is commonly considered a job resource which fosters motivation and employee well-being. Somewhat paradoxically, it is embedded in a relationship, and employees' independence also hinges on their leaders' willingness to grant it* (Gatti et al., 2019).

One question then becomes how managers can be not only willing to grant autonomy, but can actively support and encourage it. In a study of nursing assistants during Covid-19, the researchers emphasized creating "empowered environments that optimize work output by ensuring that employees have access to important information, resources, and support … and provide opportunities for growth and development" (Travers et al., 2020). Others have highlighted the value of a "transformational leadership" style, which one research team described as leaders who "act as inspirational role models, consider their employees individually, and support their employees' development. Furthermore, they motivate their employees through an effective communication of a positive vision for the future" (Bark et al., 2016).

Along with autonomy, there is a need to stay connected to one's company while working remotely. In a global survey done in April 2020, shortly after the pandemic forced many companies to move their operations online, employees listed "frequent" and "high quality communication" from management as a primary factor that helped them make the transition to working at home (Sull et al., 2020). The respondents valued "total transparency" on matters such as the reasoning behind management decisions, and how the physical shutdowns were impacting their companies' business. They also found value in multimodal, interactive forms of communication, including live video sessions combined with email updates, and mechanisms that allowed them to ask questions and give feedback (Sull et al., 2020).

Some companies have even tried to re-create, online, the kinds of informal interactions that can lead to serendipitous exchange of useful ideas and information. After the pandemic began, one venture capital firm scheduled biweekly "watercooler meetings" on Zoom. The sole purpose of these meetings was to share news and thoughts related to the investment portfolio, and the firm reported that the meetings were "highly effective" for "staying on top of changing needs" (Manes, 2020).

There appear to be cases in which online interactions can actually work better than face-to-face meetings. For example, certain healthcare workers, who would normally attend professional conferences in person, found that social-media platforms were more than adequate substitutes during the pandemic: "Whether to exchange information, increase productivity or enhance interpersonal communications with colleagues, these platforms provide a vehicle for the rapid dissemination of knowledge" (Mulrennan, and Colt, 2020).

It is also important to address the potential downsides of remote work. One company, finding that motivation declined for many newly remote employees after the first few weeks of Covid-19 shutdown, initiated online "check-in meetings" once per week, so that people could voice their personal concerns and support each other (Couch et al., 2020) Other organizations have tried incorporating social aspects into virtual meetings, such as games and family time (Hope, 2020; Pavlik, 2020).

Although family members in the home can be a distraction for remote workers (see for example Craig, and Churchill, 2020), their occasional presence online can sometimes produce positive effects. According to a previously cited research team, when coworkers get to see one another's "domestic and professional spheres colliding", it helps them to recognize their colleagues as "whole people" (Couch et al., 2020). Similarly, psychiatrists in a practice group noted that seeing their patients by means of virtual "home visits" allowed them to meet "family members who were previously difficult to access" (Crowley, 2020).

2.1. Equipment, Training, and Focus

Multiple sources point out that remote workers can only be effective when they are adequately equipped and trained for working virtually. A broad-ranging study in Poland during the pandemic found that "For many, information and communication technologies (ICTs) turned out to be a blessing, allowing them to work from home or to participate in the remote education system … [But] some could not take advantage of this opportunity due to the lack of digital skills, equipment deficiency or insufficient infrastructure" (Kuc-Czarnecka, 2020). During the same time period, an in-depth analysis of six U.S. companies found some adjusting to remote work much better than others. One success factor appeared to be scoring at level 3 or better on the 5-level CMMI (Capability Maturity Model Integration) scale, which could be seen as a general proxy for sophistication in IT management (Conger, 2020). Still, the author noted that *... most non-IT users in all of the companies had to learn VPNs and the on-line communications software used in their company, such as Zoom, MS Teams, or Skype. Successful remote technology use requires not only the ability to implement basic connective functionalities, such as joining a Zoom meeting, but the mastery of new etiquette for signaling you want a turn, signaling when you are done, chatting on the side, whether or not you show your face and the implications, recording meetings, and so on* (Conger, 2020).

Other findings suggest that training people in advance for remote work can be valuable, because when the transition is forced suddenly upon people—as it was at the start of the pandemic—in-person coaching sessions may no longer be possible, and training becomes more difficult. A researcher in the U.S. wrote: *There are many Web-based tools and tutorials available from vendors and through online sites such as YouTube, but ... these tutorials may not suit everyone, nor will they always be able to provide the answers desired. Some organizations may consider hiring on a temporary or contract basis persons to conduct specific organizationally-focused training. Regardless, organizations that forego or place minimal*

emphasis on training could find that employees may become frustrated which could easily affect how a person does his/her job (Mykytyn, 2020).

Further, simply knowing how to use remote technologies may not be enough. Managers and employees alike are advised to learn methods for dealing with the unique stresses and fatigue that can come from working virtually. For example, one research team observed that "videoconferences force us to focus differently, and more intently, than we do in comparable co-located interactions". This is because participants must struggle to maintain personal connection without getting the subtle feedback cues that "reward" such attention in face-to-face meetings, and the result can be "Zoom fatigue" accompanied by distraction and loss of effectiveness (Ebner, and Greenberg, 2020).

One possible solution is suggested by researchers in online education, who reported that "shorter, more frequent sessions" work better than long sessions requiring extended focus (Thistlethwaite et al., 2020). Similarly, "building in downtime between videoconferences" and taking occasional short breaks away from the screen can help (Ebner, and Greenberg, 2020). However, sustaining focus during online meetings is not the only issue that may arise. People working from home may feel they can never really step away from their jobs; they experience "work intensification and a greater inability to switch off" (Felstead, and Henske, 2017).

2.2. General Conclusions from the Literature Review

Ultimately, it would seem that a line should be drawn between what managers can do to make remote work go well, and what the individuals must do for themselves. According to one research team, persons involved in highly demanding "creative" work tend to do best when they practice "proactive vitality management", using the methods that suit them for "managing physical and mental energy to promote optimal functioning" (Op den Kamp et al., 2020).

Key responsibilities of management—to summarize the various sources cited in this review—would include: providing the necessary equipment and training for remote work. Giving remote workers access to the information they need for their jobs, along with "transparent" information on the company's progress and management decisions. Providing mechanisms for questions, suggestions, and feedback. Being mindful of remote workers' emotional issues and needs, and devising ways to address them. Finding the right balance between autonomy and oversight, and last but not least, designing online interactions with an eye to the particular issues raised by virtual media.

3. Research Design: An Original Survey

In August 2020, the authors conducted an international, cross-sector survey exploring impacts and management responses across a broad range of organizations during the pandemic, with an emphasis on the adoption of remote work. The August timing made it possible to capture several month's experience with remote work, along with the initial period of adaptation.

The survey consisted of 26 questions. Along with the structured questions—which typically asked respondents to check one answer from a list of possible replies—there were spaces for open-ended comments. These were organized as follows:

- 5 *identifying* questions on topics including the organization's type of business (a choice of 12 broad categories, such as manufacturing, retail, education, etc.); the respondent's position; and the extent to which operations were either in-person or online before the pandemic.
- 21 questions about *impacts* of the pandemic and shutdowns, and management *responses and results*. The more general topics included overall impacts on revenue and staffing levels, observed changes in productivity and morale, and lessons learned. There were also specific questions on topics ranging from the challenges of particular kinds of remote work, to customer interaction and managerial workload.

The survey was emailed to a non-random but diverse list of people. They were drawn mainly from these sources: former graduate business students of the authors, who had finished their studies and were now working; and contact information provided by private- and public-sector associates of the authors. Given that one author is based in the United States and the other in Poland, we were able to survey people throughout North America and Europe, as well as some in South America and the nation of South Africa.

Approximately 400 persons received the survey and 158 responded. Results are summarized and discussed in the sections below (*Percentages are rounded to whole numbers*: e.g., 25% instead of 24.8 or 25.13).

4. Profile of Survey Respondents and their Organizations

Responses came from a wide range of industries and sectors: all 12 categories in the "Type of business" checklist were checked by multiple respondents. Only 10 of the 158 (6%) reported working in manufacturing or related businesses, perhaps since the authors and many of their contacts live in highly developed regions that are not centers of contract manufacturing.

Dominant categories included retail and consumer services (37% and 28% respectively), education (16%), and software/IT and transportation/logistics (each slightly over 10%).

Of the persons who responded, 10% identified as C-level executives or founder/owners. The majority identified as either managers or professionals with leadership responsibilities (each 27%). A surprising 17% checked "Other", and we could not determine what this meant. Given the economic impact of the pandemic, perhaps some respondents were currently out of work or forced into jobs below the professional level. However, it is also possible that our list of choices for "position" was not broad enough or worded clearly enough.

Prior to the pandemic, most of the respondents' organizations—70%—were operating on a physical/in person basis "with minor or no online/O2O (online-to-offline)" components to their business. The remaining 30% had either "significant" online components or operated "entirely/almost entirely" online or O2O.

5. Survey Findings on General Impacts of the Pandemic

Most respondents were in organizations that have moved some or all activity from an in-person basis to remote work since the pandemic began. A minority, 11%, reported that their particular work units were operating "pretty much as before, with physical protective measures". The latter tended be doing so-called essential work (For example, in the open-ended comments, one person explained that his unit operates an electric power plant and must be at the work site constantly).

As for general business impact of the pandemic, responses ranged between two extremes.

- 30% reported a "Large or total drop in volume of business",
- 42% reported "Major cuts to staff".

And conversely:

- 17% reported an "Increase in demand and revenues".
- 22% reported "Adding staff".

As expected, there was considerable overlap between the pairs in each group—i.e., organizations with big drops in business also cut staff, while gainers tended to add staff. All other respondents reported only minor changes in business volume and staffing, or said that these level were "about the same" as pre-pandemic. In a section to come, we will correlate these patterns of response with responses to other parts of the survey.

6. Problem Areas and Success Factors in Remote Work

Delving now into details, we wish to call attention first to an important distinction.

- The vast majority of respondents (80%) said their organizations provided the *technologies* needed for remote work, to most people if not to all. Only 11.6% declared technology access "a problem with no good solution in sight".
- Access to *information and reference materials* needed for remote work was a different matter, however. Nearly half (49%) identified these as problem areas, with 28% seeing "no good solution" ahead.

We believe this is a significant finding. It paints a picture of IT for remote work in which many people have the "T", the technology, but lack the "I"—the very information that the technology is supposed to help them acquire and process. One can see how this might happen. Computing devices and online technologies are fairly standardized and widely applicable, whereas the information needed for particular jobs can vary greatly and may also change as new needs arise. Indeed, we received open-ended comments that appear to support this explanation.

On the technology issue, one respondent wrote: "Video conferencing and file sharing have become so convenient that we are satisfied with the telecommunication technologies". On information and communication, however, there were complaints, such as "More internal communications for planning [are needed]". And, "Email response from some employees is very slow". Whatever the case, the implication seems clear: *Communication and access to information are critical areas for management to address when using remote work.*

In another set of findings that seem significant, but not surprising, most respondents judged the results of remote work and interaction to be inferior to in-person interaction.

- 44% said *meetings and group sessions* went "not nearly as well" remotely, and 19% answered "not quite as well".
- 38% said *interaction with customers* went "not nearly as well", and 28% answered "not quite as well".

In trying to analyze the responses by industry sector, we found these problems turning up most consistently in *education*. A bit of confusion arises here, as it was not always clear whether teachers and professors in the survey considered online classes to be "group sessions" or "interactions with customers". However, virtually all reported difficulties with one or the other. In open-ended comments, educators gave varying insights into the nature of the difficulties. Some reported that students had trouble with the online systems that were set up by their schools, or did not have—and were not provided with—the digital equipment and network service needed in their homes. Some noted that students could easily view remote classes as an excuse for shirking their studies, e.g.: "Most students' expectation is good grades, no work". Meanwhile, other educators found the difficulties piling up at their own end. "It was a difficult

time for a teacher: answer a lot of personal emails", wrote one person, while another voiced a need for "more staff to support full-time instructors." And one instructor, noting that many colleagues have struggled with moving their courses online, even made this suggestion: "Have IT department design the classes".

Problems and solutions in remote education have been very intensively studied. We do not think our survey can contribute much to the body of knowledge within that sector. However, we hope that managers in other industries might glean some value from the survey results—and we would advise them that there is hope for success when moving interactions online.

- 15% of survey respondents said working remotely had *improved* meetings and group sessions.
- 21% said customer interaction was improved.

Judging from open-ended comments, one key to successful online meetings is to see that they move briskly and stay on purpose, with little wasted time. Similarly, customer interaction can be improved when remote customers are able to have rapid, complete access to the information and ordering capabilities that they need, whether it is through a web portal or a person. None of this may seem to be news. We would, however, point out the common thread—which is *leveraging the advantages of the online realm*. Remote interactions of any kind have the potential to be convenient and fast: People do not need to travel or commute, and if information access is set up properly, they can rapidly find what they need.

Looking further into management issues, survey results indicate that some aspects of remote work are tougher to manage than others. When survey participants were asked what is most challenging to manage and accomplish remotely:

- 31% said "Keeping people on task" is the greatest challenge,
- 28% said "Dealing with crises or urgencies" is the toughest,
- 26% chose "Making and implementing new plans" as the number one challenge,
- "Small-team collaboration" and "Inter-unit collaboration" were only rarely cited, by 8% and 6%, respectively.

One possible conclusion is that remote workers can be expected to work together reasonably well, as long as no significant new needs emerge—but that when they do, such as in emergencies or in times of planning and change, managers should devote extra effort to assuring the job gets done.

As for the "Keeping people on task" issue: Survey results suggest that in some respects, this may be largely an individual issue which varies from one person to the next. For example, 33% of survey participants reported that "duties and distractions in the home" interfered significantly with their own work or that of their close colleagues—while the rest found it to be only an occasional problem, or no problem at all.

6.1. Morale, Motivation, and Productivity

The findings on employee morale and motivation appeared to send a relatively clear message. 42% of survey subjects reported that morale and motivation have become "more of an issue" with remote work. And here, we can trace some possible contributing factors.

- Most notably, out of those 42%, the great majority (75%) were in organizations that had little or no online elements to their business before the pandemic-related shutdowns. They were filled mainly with people who had been *forced* to work remotely, without having much prior experience in it, within companies that did not have much experience in managing it.
- Furthermore, out of the 42% with morale and motivation issues, 32% were in organizations that had experienced substantial drops in business. This could well be another factor, as it would seem difficult to maintain a high-morale, highly-motivated workforce in a company where people are struggling to adapt to a new mode of work amid worries about lost revenue and fears of resulting job loss (Two typical comments: "We service only one-fourth [as many] customers now". And "I'm worried about my job").
- The above point may also be reinforced by an opposite finding. Out of *all* survey subjects, 15% reported that morale and motivation had improved. And half of these were in companies where demand and revenue were increasing.

One obvious conclusion might be that remote workers are more likely to be happy and motivated when their companies are doing well. However, this doesn't tell us much that is useful for managing remote work. For nearly all managers, helping to maintain or grow revenues is a core part of the job to begin with. We believe the most significant takeaway from this analysis can be found in the first bullet-point: When remote work is instituted in companies or work units that have little to no prior experience with online operation, managers should be prepared to deal with morale issues.

Two other points are worth considering here. First, we must acknowledge the effects of the pandemic itself. Our August 2020 survey was done at a time when it had been going on for several months. People were growing weary of both the health concerns and the restrictions on activity, while initial hopes for a quick recovery and return to normal were fading. In response to a specific question on the topic, 39% of survey subjects reported increased overall levels of anxiety or depression, while 29% chose the response saying they felt "Fine now, but concerned about the future".

The second point, a positive one, is that quite a few people in fact prefer remote work. Among survey subjects who reported that morale was either improved (15%) or holding constant in their organizations (11% saw no change), positive comments were numerous and in some cases vividly descriptive: "Love working alone". "Honestly, I prefer working from home". "My pets, being able to cook food and get sunshine outside really improved my well

being". One response even turned the morale question on its head: "In the office, morale is an issue. From home, I could make my happy place".

Next, we turn to the issue of productivity. Survey responses on this topic closely tracked the responses on morale and motivation. 38% said productivity in their group was "Not nearly as high" as before the shift to remote work, while another 30% said productivity was "Not quite as high".

Although the numbers look daunting, we think they should be weighed in light of considerations just mentioned: (a) many organizations and people were forced into remote work rather than choosing to do so, and (b) the survey was taken amidst unusual and trying times. This viewpoint is informed, in part, by the many positive responses that came in. 33% reported that productivity had either improved (18%) or stayed about the same (15%).

6.2. Analysis by Industry Sectors

A pertinent question can be raised about all of the survey results covered thus far, on topics from collaboration and interaction to morale, motivation, and productivity. Namely: How did these results vary across industry sectors? As noted earlier, survey respondents in the education sector reported near-universal problems working remotely with groups of students. But we hesitate to draw conclusions about patterns in other industries. Aside from education, we find it difficult to tell how (and whether) the type of business conducted by the organization makes a difference. It would probably be misleading for us to even present such an analysis.

One reason is that the industry categories listed in our survey were broad and general. It is possible that within the software and IT category, or within "retail" or "consumer services", there are sub-sectors that lend themselves well to remote work while others do not. Products, business models, customer bases, and competitive environments within all of these industries vary much more than they do in education. For example, a software firm focused on mobile apps or gaming is fundamentally different from an ERP or CRM company; and retailers in clothing are very different from grocery chains.

Also, it is possible that the culture or structure of an organization is a crucial factor in managing remote work. Future research of a more targeted nature is needed to yield useful industry-specific insights. The purpose of our survey was to cast a wide net, looking for patterns that might be prevalent across industries and types of organizations. We included identifying questions about the general industry sector, size, and form of the organization (i.e., whether for-profit, nonprofit, etc.) in order to determine whether a wide sampling was in fact obtained, which it was.

6.3. Management Workloads and Lessons Learned

This section concludes our report of survey results. When we asked all respondents how their workloads as managers or leaders had been affected by the movement to remote work, a striking polarity emerged.

- 34% chose the reply "I must do much more to adjust and accommodate," with another 14% needing to do "somewhat more".
- 38% reported the opposite: "My work as a manager/leader is made easier".

Only a small minority answered in between. We did not expect this pattern of responses. And, while it would obviously be helpful to learn how the managing of remote work can be made easier, this is another case where factors not captured by our survey seem to play a part. We included no follow-up questions (such as "In what ways, exactly, was your workload reduced?"), nor could we find correlations to other survey responses that might explain this sharply polarized result. We do, however, offer our raw data as a starting point to anyone interested in further research.

Finally, a question near the end of the survey asked about key lessons learned in the shift to remote work. The two most common replies chosen, by far:

- 33% said "Seeing who, among the staff, responded well and who did not".
- 30% said "Seeing weaknesses or failure points in the organization".

Here too, the pattern surprised us—and we find it enlightening. It indicates that many survey respondents found *diagnostic value* in moving to remote work amid the pressures of a pandemic. The process helped to reveal who the top performers were, and where the organization as a whole could stand to be improved.

One survey subject elaborated on the first point, as follows: *There are many employees who are taking extra initiative to prove themselves to the organization in these testing times. There are others who have shunned responsibilities. We are recognizing that the people who are rising to the occasion could possibly be promoted in the near future or the company could extend certain benefits for them*.

7. Survey Summary and Concluding Remarks

Analysis and commentary on survey results has largely been done in the sections above. To repeat and summarize major findings that can be useful to managers, with some further commentary added:

- Providing technologies and tech support for remote work is necessary, but giving remote workers the information they need, when they need it, is mission-critical and may be more of a challenge.
- Collaboration and interaction often become more difficult and less fruitful with remote work—but, there are opportunities to actually improve in these areas, as many survey subjects have reported. One potential key is to leverage the benefits of the online/virtual realm (convenience, time savings, rapid access to information and people) as much as possible.

- In general, it appears that small teams tend to interact and collaborate well remotely. However, managers should devote particular attention to managing change—as when crises or urgencies come up, or when new plans are being made and implemented.
- Morale and motivation often become issues among remote workers, *especially* in cases where remote work is introduced to a group that has little or no prior experience with online operation. As to what can support morale and motivation, useful indicators may be found in our literature review. Research by others has shown, for instance, that granting autonomy to remote workers can help, as can taking steps to inquire after and support their emotional well-being.
- The education sector faces numerous issues in moving to remote work. This fact was well known before our survey. What may be helpful to managers in other industries, however, is to study the problems that arise in education, along with best practices used by educators to address the problems.
- Results in all aspects of remote work may depend, to a large degree, on the individuals involved. Individuals may vary significantly in their ability to stay on task, in their tendency to be distracted (or not) by what is happening at home, and in how well they respond to unusual pressures and demands. All of these findings suggest that there is no one-size-fits-all approach to managing remote work.
- A sizable number of individuals prefer and eagerly embrace working from home. Are there ways in which these people can serve as co-leaders in the movement to remote work?
- Finally: Putting employees on a remote-work basis is a learning experience, which managers can use for broader diagnostic purposes. The experience can help to identify promising performers and reveal organizational weaknesses that need to be bolstered.

7.1. Limitations and Best Uses of This Research; Areas for Future Research

Perhaps the greatest limitation of our survey is that it was conducted during extraordinary times, when the pandemic and shutdowns had massively disrupted business as usual. This has likely colored many of the responses that we received, and should be taken into account by anyone consulting our research for possible guidance on future management of remote work—when macroeconomic conditions may (we hope) be otherwise.

The survey had geographic limitations, too. Although we reached out to people and organizations across North America, Europe, and some other parts of the world, we were not aware of having any significant coverage in Asia—a massively populated region, and a pivotal one in the ongoing development of today's global economy. Also, due to a technical issue plus measures to preserve anonymity, we were not able to trace the locations of those who responded to the survey. This means we do not know if world regions were represented in proportion to their share of global population or GDP, and it means we could not attempt any analysis of survey responses by location.

The best use of our survey is to learn about characteristics of remote work, and possible success factors in managing it, which tend to prevail across industry sectors and geographies. Further, our review of the literature is offered as a concise and practical summary of previous research. Altogether, we hope this paper will serve as a step toward building a wide-ranging, well-rounded body of knowledge on the management of remote work, which will be useful to practitioners and scholars alike.

We also hope it will point to promising areas for future research. As noted throughout the paper, these areas include: industry-specific studies, studies of difficulties versus "make-easy" factors in managing remote workers, and studies of remote work in rapidly emerging economic regions such as Asia.

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OUTSOURCING EFFECTS AND COMPANY SIZE – A COMPARATIVE ANALYSIS BETWEEN THE MANUFACTURING AND THE SERVICES SECTOR IN POLAND

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Introduction/background: The popularity of outsourcing as a management tool among Polish enterprises is increasing. Growing competition forces companies to look for new solutions for company management. Outsourcing is defined as a management tool to reduce costs in an enterprise.
Aim of the paper: The aim of the study was to check whether there is a relationship between outsourcing and the size of the company. In the study, I list large companies and SMEs. Compares the relationships between the manufacturing and services sectors.
Materials and methods: In this category, data from 250 companies from the Notoria database were used. In the first part of article, it compares the value of outsourcing across sectors using the Student T-test. In the next part of article, I examine the relationship between outsourcing and the size of companies. I compare the results between the vectors. Pearson's correlation test was used. It then compares the use of outsourcing between small and large companies. The student's T-test for independent programs was used.
Results and conclusions: The results say there are differences in the use of outsourcing between the manufacturing and service sectors. I noticed that industrial companies use much more solutions provided by external suppliers. Moreover, I can see that outsourcing has a greater impact in manufacturing than in the service industry. As the company grows, the use of outsourcing increases. It also shows that large companies use outsourcing to a greater extent than smaller companies.

Keywords: outsourcing, manufacturing, services, SME, companies.

1. Introduction

Outsourcing as a management tool is becoming more and more popular among Polish enterprises. The growing competition forces companies to look for new solutions. Outsourcing is defined as a management tool to reduce costs in an enterprise (Aalders, 2001). It is often referred to as an agreement with a third party to carry out a certain activity (Lysons, & Gillinham, 2003). As shown by the data, outsourcing is often used both in the US and Europe (Kakabadse, 2003). Outsourcing is also a key and important strategic solution in the operations

of companies. It is used in global supply chains. It is said to be the current business trend introduced by companies (Kweku et al., 2018).

There are many benefits of outsourcing. The literature is about reducing costs, improving profitability and management efficiency. Many more can be mentioned. Companies often use outsourcing to gain new knowledge or learn about new products appearing on the market (Dolgui, and Proth, 2013). Often researchers say that outsourcing improves the productivity of companies. This makes it a great tool to improve business performance. Recent studies on outsourcing, however, vary.

G. Lee et al in their study show that according to employees the impact of outsourcing on organisational performance is small. The authors also show the relationship between outsourcing and performance through the impact on job satisfaction (Lee et al., 2019). This study provides results for a market other than Poland.

In turn, the latest studies appear for Polish conditions. According to A. Maziarczyk, the use of outsourcing increased the profitability of industrial enterprises after the global economic crisis (2007-2009). This confirms the importance of using outsourcing in management in Poland (Maziarczyk, 2020). In addition, research on the performance of enterprises in Poland also confirms that it is a useful tool in the development of companies. The author notices the increase in the efficiency of companies after the introduction of outsourcing (Maziarczyk, 2020).

An examination of the existing literature shows that it is useful to supplement it with research on the comparison of outsourcing between sectors. This will enable the definition of outsourcing to be completed, which will be important for current business strategies.

This study has five parts. Part one shows the problem of considering the impact of company size on the use of outsourcing in foreign companies. In the next, I described the research trial. It also gives the characteristics of the sample. The next part describes in detail the methodology of this research. I also provide an explanation of the possibility of using statistical tests. The next part describes the results obtained in this study. In the last section, I draw and present conclusions for Polish enterprises.

2. Outsourcing, company development and company size – literature review

As we already know, outsourcing has become a popular management tool. More and more companies notice the benefits it brings. This prompts researchers to conduct research on outsourcing. Much research investigates the extent to which outsourcing affects the profitability of companies. It turns out that in most foreign studies one can see such a relationship. The authors also try to see important aspects in terms of the size of the companies.

S. Munjal et al. analysed the impact of various management tools on the improvement of the financial performance of companies in India. In the study, they distinguish between small, medium and large companies. As it turned out, outsourcing fared very favorably compared to other tools. The results confirm that outsourcing has a positive effect mainly in small companies (Munjal, 2019).

C. Sheehan and B.K. Cooper tested the impact of company size and human resources management on the use of outsourcing. Moreover, they checked the extent to which outsourcing influences an organisation's performance. The research was conducted on a sample of 441 observations from Australian companies collected through the survey. The results do not confirm that outsourcing in smaller organisations is used more often than in large companies. However, there is a link between the use of outsourcing and the improved performance of Australian companies (Sheehan, and Cooper, 2011). S. Bakhtiari sheds light on the decisions to introduce outsourcing in Australia. The author examines various forms that reduce the amount of overhead. The results show that outsourcing is a good management tool for companies changing from SME (Small and Medium Enterprises) to large companies. This demonstrates the impact of outsourcing on the size of the company (Bakhtiari, 2011).

On the other hand, A. Arbore et al. Studied the relationship of outsourcing and its determinants in SME. Based on the research, they conclude that the size of the company is very important in the use of outsourcing. Ultimately, they focus on SME companies. They show that the size of the company is also very important in this case. They conclude that outsourcing decisions alleviate the disadvantages related to the size of the company and its location (Arbore, 2006).

A similar study was conducted by M. Mohiuddin and Z. Su. They provide results on the impact of outsourcing on SME productivity in Canada. In the study, the authors say that companies that use outsourcing build a competitive advantage. The results show that not only large international companies but also SMEs that have implemented outsourcing achieve success and improve financial results (Mohiuddin, and Su, 2013).

J.I. Agburu and all conducted a survey of companies in the SME sector in Nigeria. The results of the study show that the introduction of outsourcing has a positive effect on the profitability and improvement of SME efficiency. The authors recommend that SMEs make greater use of outsourcing strategies to benefit from cost savings. SMEs should also make sure that the costs of managing the outsourcing process are not greater than the profits (Agburu, 2017).

Research results are not always unequivocal. Isaksson and Lantz (2015) analysed the outsourcing strategy of SMEs in Sweden. They investigated the relationship between outsourcing and return on equity (ROE) and return on investment. The authors conclude that outsourcing does not affect the profitability of SMEs (Isaksson, and Lantz, 2015).

A preliminary analysis of research conducted on outsourcing companies around the world does not give unequivocal results. The literature offers a range of studies on the impact of outsourcing on profitability. You can also find a detailed study for SMEs. The results, however, turn out to be contradictory. This means that it is worth carrying out further research and learning more about this management tool. However, I do not find a study of such a topic for Polish conditions. Therefore, I present the following research hypotheses:

H1) there are significant differences in outsourcing between manufacturing and services,

H2) there is a relationship between company size and outsourcing,

H3) large companies outsource significantly more than SMEs.

3. Sample

The listed companies participated in this study. The target sample included over 250 companies. The companies considered operate on the Polish market. The study includes a panel sample of 1000 observations. The research sample is divided into two groups: SMEs and large companies.

In the study, we use data from the Notoria database. The financial data included in this database cover the period 2010-2019. The sample was selected as follows. At the beginning, all the necessary data for calculations was downloaded from the database. The gaps that appeared were filled using the variable interpolation method. This method assumes the completion of the sample mean. This minimizes the error obtained in the results, and the total number of the tested samples remains unchanged. Data mining is then undertaken. All companies are categorised according to size and are placed into in one of two groups of companies, one for SMEs and another for large enterprises. Companies are distiguished according to the total assets held. Companies with over 43 million euro in toal assets[1] are classified as large. All the assets whose average value of assets for the analysed period is less than 43 million euro are classified as SMEs. In this way, the database with annual data was created. All calculations were made independently.

4. Method

Initially, the data was explored. All calculations for the assessment and verification of the hypotheses were made using the statistical module. Research was begun by checking whether

[1] Experts recognise this value for Polish conditions as a division into medium and large companies.

there are significant differences in the amount of outsourcing between manufacturing and services sectors. Based on world literature, I check the hypotheses this time with respect to the Polish market. The variables used in the first part of the study are presented in the table 1.

Table 1.
All variables used in this study

Variable	Description
Company size	Natural logarithm of firm's assets
Outsourcing	costs of external services divided by total costs (natural logarithm)

Source: author's own elaboration.

In this study, one decides to determine the size of the enterprise based on the value of the property. Based on other studies, it can be observed that this measure is often used. This variable is a logarithmic value. I do this to avoid possible inconsistencies in the values between sectors and between individual variables.

In this study, I define the value of outsourcing as the share of external service costs in the total costs. It should be noted that there is a certain limitation in the obtained results. The costs of external services may include costs that may not always be outsourced. Regardless of this, I take into account all the costs of external services, assuming that the deviations for the entire sample are so small that they do not need to be specified, such as the variable 'company size', the variable 'outsourcing' is a logarithmic value. The logarithm of the values brings the distribution of the variables closer to the normal distribution.

Taking into account the use of outsourcing as a method of company management by Polish companies, we can assume that there are differences in its use by the respective sectors. It is related to the specificity of the conducted activity. I ascertain whether there are significant differences in the use of outsourcing between sectors.

In this part of the study, two independent groups are compared. The variable 'outsourcing' is distributed close to the normal distribution. Therefore, the main assumptions for the application of the T-student test for independent samples were met (Cypryańska, and Bedyńska, 2012). The results are described in the next part of the study

Then I was looking for a relationship between company size and outsourcing. I check if there is such a relationship in the manufacturing and services sector. As it is assumed that there are differences between sectors in the use of outsourcing in management, I want to check how these differences are distributed among sectors. This will help determine how much the size of the company affects the implementation of outsourcing. It seems that the bigger companies are, the more they should use outsourcing for certain activities. Does such a relationship really exist in manufacturing and services? Or maybe the resulting dependencies are so small that small and medium or large companies should not pay much attention to outsourcing. I check if there is a relationship between the company's size and outsourcing.

In this part of the study, I examine the impact of company size on the implementation of outsourcing in the company and examine individual sectors for the strength of this relationship. I compare what these dependencies look like in manufacturing and services with use of the Pearson correlation (Scibor-Rylski, 2012). The assumptions for this test have been met. The variables are quantitative, the distribution is close to normal, and there are no outliers in the sample.

Then I did a regression analysis to determine the degree of influence of company size on the implementation of outsourcing in Poland. I also checked whether it is possible to predict the level of outsourcing based on the size of companies in a given sector.

Finally, I check whether large companies actually use outsourcing to a greater extent than do smaller companies. In this part of the study, I divide the sample into SME companies that are assigned a value of 0, and large companies that are assigned a value of 1. The analysis is broken down into sectors. I check whether large companies use outsourcing significantly more than SMEs.

This part of the study is a kind of summary. Large companies seem to rely more on external providers. In this way, they use management solutions and reduce employee service costs. Based on the literature analysis, it can be assumed that SMEs will show a greater impact. However, the question arises whether this fact is true for both manufacturing and services. I'm trying to check it out.

5. Results and their analysis

When examining the use of outsourcing as a management method by Polish companies, certain differences between sectors can be assumed. This is due to the specific nature of the company's activities. The research carried out on a sample of 250 companies in Poland led to the following preliminary results:

Table 2.
Descriptive statistics

Variable	**Manufacturing**				
	Mean	**Median**	**Minimum**	**Maximum**	**Std. dev**
Outsourcing	1,59	1,63	0,17	4,50	0,83
Companysize	12,95	12,71	9,15	17,98	1,65
	Services				
Outsourcing	1,12	1,05	0,06	5,60	0,97
Company size	12,44	12,32	9,73	16,67	1,46

Source: autor's own elaboration.

I start my research with the analysis of basic statistics. Manufacturing and service sectors are listed and analysed separately. Values after log transformation are discussed. There are significant differences between sectors.

At the beginning, taking into account outsourcing, it can be noticed that in manufacturing the mean is higher than in services (1.59 > 1.12). Moreover, that the mean and median for the variable 'outsourcing' in manufacturing and services are similar. This means that there are not many outliers in the sample that could distort the results. A greater maximum value of outsourcing was recorded in services. In both manufacturing and services, the results diverge from the average by less than 1.0. This is evidenced by the amount of the sample standard deviation. This means that on average, the results of outsourcing in manufacturing may reach values higher or lower by 0.83, and in services by 0.97. This is a large dispersion of values with respect to the mean value.

Looking at the average size of a company in manufacturing and services, it can be concluded that these values are similar. The manufacturing average is not much higher. Both in manufacturing and services the mean and median values are similar. This means that there are not many outliers in the sample. Thus, the results in further analyses will not be distorted. The standard error for 'company size' in manufacturing and services is small. This means that there is little dispersion of the variables in relation to the mean and there is little sample differentiation.

Based on the above statistics, it can be said that the sample of 250 Polish companies is diversified in terms of outsourcing. The nature of the business may have a significant impact on this. The next step is to verify the hypotheses.

5.1. Verification of hypothesis 1

In this part of the study, I check whether there are significant differences in the level of outsourcing between the manufacturing and services sectors. It is worth recalling that the assumptions for using the student's T-test have been met. This test was used because it compares two independent groups. The obtained results are presented in the table 3.

Table 3.
Results of the student's T-test for independent samples

Variable	Mean		t	df	p
	Manufacturing	Services			
Outsourcing	1,59	1,12	-4,10	248,00	**0,000**

* the results are statistically significant with $p < 0.05$.

Source: autor's own elaboration.

Based on the results obtained, it can be concluded that there are significant differences in outsourcing in manufacturing and in services. This is confirmed by the statistic value $p = 0.00$ ($p < 0.05$). Additionally, it can be seen that industrial companies use more outsourcing. The results of the student's T-test for independent samples are unambiguous and confirm that there are statistically significant differences between the sectors. The sectors differ significantly from each other in terms of the use of outsourcing. The average is higher in manufacturing than in services ($1.59 > 1.12$).

As there are differences in outsourcing, I am going to check whether the size of the company can affect the implementation of outsourcing. I check what it looks like in manufacturing and services.

5.2. Verification of the hypothesis 2

In this part of the study, I check whether there is a relationship between outsourcing and the size of companies in manufacturing and services. I check in which sector this relationship is stronger. I compare the results across sectors. The results of the Pearson correlation test are shown in the table 4.

Table 4.
Pearson's correlation results

Variable	**Company size**	
	Manufacturing	**Services**
Outsourcing	0,48 **p = 0,002**	0,23 **p = 0,025**

* the results are statistically significant with $p < 0.05$.

Source: autor's own elaboration.

Table 4 shows the results of the correlation test. It is worth recalling that the assumptions for the application of the Pearson test were met. The variables are close to normal, they are quantitative and there are not many outliers.

Based on the obtained results, it can be concluded that both in manufacturing and services there is a relationship between the use of outsourcing and the size of the company ($p < 0.05$). However, differences in the strength of this relationship between sectors can be noticed. In manufacturing there is a moderate positive relationship (0.48), while in services there is a weak positive relationship between outsourcing and company size. This means that the frequency of outsourcing implementation increases as the size of the company grows. Moreover, it is worth noting that union strength is higher in manufacturing than in the service sector. This also confirms the previous part of the study that industrial companies more often use outsourcing as a management practice.

5.3. Verification of the hypothesis 3

In this part of the research, I divide all companies into two groups: SMEs and big companies. Data of the student's T-test for independent samples are presented in the table 5.

Table 5.
Comparison of the use of outsourcing

Variable	Mean		t	df	p
	Big companies	SMEs			
Outsourcing	1,55	0,90	2,41	248	**0,021**

* the results are statistically significant with $p < 0.05$.

Source: autor's own elaboration.

Based on the obtained results, it can be concluded that there are significant differences in the level of introducing outsourcing as a management method in large companies and SMEs. This is confirmed by the value of the statistics $p = 0.021$ ($p < 0.05$). It can be seen that outsourcing is used more by large companies. The average is higher in manufacturing than in services ($1.45 > 0.90$). Large companies more often use outsourcing in enterprise management than SMEs.

6. Conclusions

The study examines the diversity of outsourcing in manufacturing and services depending on the size of companies. When analysing the differences between sectors, several conclusions can be drawn.

I note that there are significant differences in the use of outsourcing across sectors. This is due to the specific nature of the company. Industrial companies outsource many more services to external contractors than service companies. It is worth recalling that there is a certain limitation in the interpretation of the results, as not all external services have to be outsourced to external suppliers. The manufacturing shows significantly higher values of the use of outsourcing. Additionally, both in manufacturing and services, there is a relationship between outsourcing and the size of the company. It is therefore confirmed that as the size of the company grows, the use of outsourcing also increases. However, there are differences in the strength of the outsourcing link between industry and services. In the industrial industry, this relationship is much stronger.

In addition, a detailed list of SMEs and larger companies made it possible to compare the use of outsourcing depending not on the sector but on the size of the company. I notice that large companies use solutions from external suppliers much more often. The question arises

whether outsourcing is a good solution only for large companies and whether SMEs should be inclined to use other management tools.

T. here are new issues in this study that need to be exploredSince we know the relationship between outsourcing and the size of industrial and service companies, it is worth checking the determinants of outsourcing in small companies. Or do they use such a management tool? Another question that arises is whether outsourcing is a solution only for large and medium-sized companies in Poland? Other researchers can check it.

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SOURCES OF ISO 9001 QUALITY MANAGEMENT SYSTEM REQUIREMENTS IN MANAGEMENT SCIENCES

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Introduction/background: The success of ISO 9001 quality management system results from its inner integrity and complexity based on rich achievements of management sciences. Thus deeper understanding of particular components and requirements of the standard demands paying attention to their sources deriving from specific concepts and methods of management, which became an inspiration for the international standardization in the area of quality management in organization.
Aim of the paper: The aim of the paper is to identify and interpret the sources of current requirements of ISO 9001 quality management system in the legacy of management sciences.
Materials and methods: The study includes literature review aimed at capturing the substantive and historical connections between the developed concepts and methods of management and the contemporary shape of systemic solutions in the field of quality management expressed by means of ISO 9001 standard.
Results and conclusions: The requirements of ISO 9001 quality management system are characterized by a number of substantive links with the achievements of management sciences developed throughout the history, derived both from classical and modern concepts and methods of management. Originality of this work results from holistic and historical approach to identification and interpretation of sources for changing requirements of the quality management system. The value lies in formulating specific managerial conclusions to improve the evolution, implementation and application of ISO 9001 standard in the future.

Keywords: quality management, ISO 9001, quality management system requirements, management sciences.

1. Introduction

ISO 9001 quality management system is based on the seven principles, including strong focus on customers and their expectations and needs, as well as on top management motivation and involvement, process orientation and continuous improvement. Applying the principles of ISO 9001 facilitates provision of consistent, high-quality products and services to customers,

which in turn ensures numerous business benefits (Bravi, Murmura, and Santos, 2019; Shaikh, and Sohu, 2020).

Despite words of criticism towards certified systems, many production and service organizations still decide to implement such systems. These decisions result not only from customer requirements, but mainly due to the fact that working in standardized systems is an element of competitive advantage for the organization (Wilson, and Campbell, 2020; Tarí et al., 2020). The standards provide guidance and tools for companies and organizations that want to reassure customers that their products and services consistently meet both legal and customer requirements and that quality is constantly being improved. The popularity of the quality management system finds reflection in the number of certificates confirming that an organization operates according to the principles of quality management. Currently, about one million companies in almost 200 countries have the ISO 9001 certificate, out of which in 2019 11,460 were the organizations located in Poland (ISO, 2020). The largest number of implementations of ISO 9001 is carried out in the sector of small and medium-sized enterprises (SME) (Walaszczyk, 2018, p. 362).

The success of ISO 9001 quality management system results from its inner integrity and complexity based on rich and proven achievements of management sciences. Thus deeper understanding of particular components and requirements of the standard demands paying attention to their sources deriving from specific concepts and methods of management, which became an inspiration for the international standardization in the area of quality management in organization.

Taking the above into consideration, the aim of the article is to identify and interpret the sources of quality management system ISO 9001 in the legacy of management sciences. The study includes literature review aimed at capturing substantive and historical associations of the developing concepts and methods of management with the current shape of system solutions in the area of quality assurance. In the first part the evolution of ISO 9001 quality management system requirements is presented. After that the authors discuss the influence of management sciences achievements on the shape of modern requirements of quality management system in the area of: organization context, leadership, planning, support, operational activities, assessment of the activities effects and improvement. In “Conclusions” implications of the considerations for theory and practice of management sciences have been formulated. Limitations of the study are also identified.

2. Evolution of the requirements of the ISO 9001 quality management system

The origins of modern quality assurance go back to the industrial revolution initiated in the beginning of the 20th century. In the late 1950s quality began to be perceived systemically, which led to standardization in the field of management systems. The first quality standards were formulated in the USA, in the 1970s. Other countries (such as Canada, Australia and Great Britain) were elaborating their own national standards. The British standard published in 1979 became the benchmark for the creation of the first international quality standard ISO 8402 "Quality management and quality assurance" (Koskela, Tezel, and Patel, 2019). The evolution from perceiving quality only in terms of inspection-control process, through quality assurance, to the aspect of comprehensive quality management, has been reflected in standardized system requirements (Kiran, 2016). The above led, inter alia, to the publication in 1987 of ISO 9001, ISO 9002 and ISO 9003 standards describing three quality assurance models (Wolniak, 2018), which turned out to be the turning point in organization management (Hamrol, and Mantura, 2005, p. 175).

Organizations that were increasing the quality of their products and services thanks to the implementation of a quality management system were gaining recognition in the eyes of customers. The ISO 9001 standard "Quality management system. Requirements" was assumed to bring organizations closer to the concept of TQM, introducing them to a higher level of qualitative perception of their activities in all areas. This result was achieved by regarding the changing customer requirements as the overarching ones, with a strong emphasis put on the use of a process approach and on the involvement of top management. In later amendments to the 2008 standard, the provisions concerning some of the requirements were rearranged. Yet the changes to the standard's requirements were referred to as 'cosmetic' (Mnich, 2015, p. 84).

The latest amendment, introduced in 2015, includes among the requirements of the quality management system activities based on risk and opportunities, to a greater extent takes into account the organizational context and stakeholders of the organization, emphasizes the role of the organization's manager as the leader, and modifies the requirements for documentation of the management system. All these changes taking place over the years resulted from transformations in the social-economic environment, as well as took into account the increasing competitiveness and shifting expectations of the market.

The requirements of the quality management system are included in seven chapters of the ISO 9001 standard, and they cover the following areas: organizational context, leadership, planning, support, operational activities, assessment of performance and improvement. They have been formulated by the International Organization for the Standardization based on well-established and proven theoretical recommendations formulated by management sciences

and practical experiences gathered by organizations. All those who submit their comments and proposals as to the shape of requirements during the draft phase of the standard elaboration have the possibility to influence the shape of the standard. Representatives of enterprises, experts and scientists can thus influence the final shape of normative regulations by enriching them with the best organizational solutions and rules applied in management theory and practice. As a result the evolving output of management sciences plays important part in formation of the quality management system. The latest edition of the standard, ensuring to organizations more effective and efficient operation, is the result of this evolution (da Fonseca et al., 2019).

The relationships between the output of management sciences and standards are visible already at the level of conceptual foundations. Organizations working in quality management systems carry out activities based on the process management model, in accordance with the PDCA cycle, known as the Deming circle, loop or the continuous improvement cycle (Deming, 1986). The sources of the individual stages of the PDCA cycle can be found in the trend of scientific organization of labour, in particular in the concept of the organized action cycle by H. Le Chatelier (Pietrzak, and Paliszkiewicz, 2015; Trenkner, 2017). The specificity of individual requirements of the quality management system also derives from the achievements of management sciences. As a result, it is possible to indicate direct links between current requirements of the standard and specific concepts and methods developed throughout the process of management sciences development, which is presented further on in the article.

3. Influence of the achievements of management sciences on the shape of contemporary requirements of the quality management system

3.1. Organizational context

The requirement included in the ISO 9001:2015 standard (PN-EN ISO 9001:2015-10.P, 2016, p. 4.1) includes defining the organizational context by an organization. It is considered that in order to achieve its intended goals, an organization must counteract the influence of factors disrupting its functioning. This means constant striving to remain in a state of equilibrium in such a way that none of the factors interfering with its activity would disrupt the established course of action. Organizations should therefore identify these factors (positive and negative), as well as monitor and review them. The source of this approach is the principle of inertia/equilibrium (rule of defiance) promoted by a representative of the scientific organization of labour, H. Le Chatelier, which was transferred to the organization science by K. Adamiecki, calling it ‘the law of counteracting’ (Martyniak, 1993, p. 23). According to the rule if a system in the equilibrium state is subjected to a specific factor, the system will counteract in order to reduce this stimulus (Lachiewicz, and Matejun, 2020, p. 94).

According to the standard, the organizational context also includes the establishment of processes carried out in or on behalf of an organization. A process is defined here as a set of determined and planned, interrelated or interacting activities that use inputs to deliver an intended result. Thus understood process approach recommends holistic consideration of processes as interrelated activities, the identification of which allows for a better understanding of value creation.

The sources of process approach can be identified already in the administrative field of management sciences. Within its framework, the so-called 'Fayol's passerelle' (Isomura, 2020, p. 48) has been identified, which allows for direct contact of employees from various organizational divisions on operational matters, without the need for the superiors' interference each time. The concept of the process is also grounded in the concept of the value chain by M. Porter (1985), in which the implementation of individual activities increases the value of involvement in the creation or delivery of a product/service to the market. It is so because each subsequent action performed in the process adds to the value of the previous action effect.

This approach originates also from the ideas of process organization and process management (Wąchol, 2018). The development of these concepts entailed a shift from structural to process thinking, which created a new management philosophy (Bitkowska, 2009). Its essence lies in the organization's openness to changes and the departure from the linear view of the organization in favour of the correct flow of resources and competences, in order to ultimately receive a product or a service. The implementation of business process reengineering in organizations is an expression of the shift towards the process approach (Hamer, and Champy, 1993). The key features of this concept, such as the fundamental rethinking of the company's organizational system, radical redesigning of the organization in the operational area and a clear improvement in the results achieved by treating the process as the key dimension of the activities, bringing by itself an added value (Zimniewicz, 2014, pp. 101-102), are nowadays critical to the success of the organization in the implementation and application of the requirements of the ISO 9001 quality management system.

3.2. Leadership

Another requirement of the standard draws attention to leadership and commitment of the top management in activities for quality assurance. The activities include focusing on increasing the satisfaction of internal and external customers, establishment and dissemination of quality policy, as well as ensuring that the responsibilities and powers of the staff performing important roles are properly assigned, communicated and understood in the organization. This model assigns a leading role to the leadership, placing it in the centre of all activities and processes in the organization related to the quality assurance system (Walaszczyk, and Polak-Sopinska, 2019).

Leadership has always been a very important foundation for the development of management sciences. In this context, the leadership is defined as influencing the behaviour of other people by establishing new patterns of acting and providing information about their modification, thus playing the key role in implementing changes in organization (Hussain et al., 2018). An efficient leader is able to select effective employees and closest associates so that they support the leader in implementation of the vision and goals (Mnich, & Wiśniewski, 2019). At individual management levels the leaders that would be appointed should integrate and motivate their teams and resolve contentious issues that arise while performing activities (Mazur, & Gołaś, 2010, p. 49). Therefore, it was no accident in the evolution of the normative requirements of quality management systems that the requirement of responsibility was changed to that of leadership and commitment of the top management. The mere bearing of responsibility is not enough to effectively implement changes and improve organization.

The sources of this requirement are derived from the concept of changing role of managerial staff, already developed within the framework of scientific work organization. The representative of this period, F.W. Taylor, under the principles of scientific management, emphasized the role of close cooperation between the leaders and workers in the work process ensuring proper performance of tasks. He also proposed almost equal division of labour and responsibilities between leaders and workers in the work process, with leaders focusing on tasks for which they are better prepared than their personnel (Taylor, 2008, p. 27).

The importance of leadership was also emphasized in the domain of administration and in the theory of bureaucracy. H. Fayol (1972), when formulating 14 principles of management, drew attention to such dimensions of leadership as motivating and building staff commitment, as well as appropriate treatment of employees, characterized by a combination of goodwill and justice. It was also important for him to focus on the initiative of his subordinates, which means the freedom to propose new ideas and the possibility to implement them, as well as to focus on teamwork and harmony, building a sense of belonging and supporting staff involvement in teamwork.

As part of this trend, the direct ties between leadership and authority in the organization were also emphasized, an example of which is the concept of bureaucracy by M. Weber (1972). He distinguished charismatic authority, based on the subordinates' faith in the uniqueness of the leader, their unusual or model qualities, as well as on the legitimacy of the norms or order defined by that person. The motives of subordination are related here to idealism and most often have a moral dimension, which enables triggering strong commitment among employees and achieving above-average results.

The sources of this requirement can be also identified in the achievements in the field of interpersonal relations school. An example can be the Y theory of by D. McGregor (2006), in which he emphasized that active interaction between leaders and employees take place in organizations. The character of these relationships should be inspiring and supportive, so that all members believe that the goals of the organization and their implementation are of personal

importance to them. According to the assumptions, such an attitude triggered self-directivity, creativity and self-control of the staff, supported by searching for and taking responsibility for undertaken and implemented actions.

At a later time, the Full Range of Leadership Model (Kirkbride, 2006) was developed basing on these achievements. The model underlines the role of transactional and transformational leadership. Specific features of transformational leadership, such as: emphasizing the importance of internal motivation and positive development of employees, supporting high moral and ethical standards, promoting cooperation and harmony, and encouraging subordinates to act freely and to go beyond their own interests for the common benefit (Bass, and Riggio, 2006) are currently important as guidelines for implementation of ISO 9001 quality management system in organizations.

3.3. Planning

In the next chapter, the standard introduces the requirement of planning, which includes the analysis of risks and chances determining functioning of the organization, designating, communicating and monitoring the achievement of measurable quality management goals for relevant functions, levels and organizational processes, as well as the principles of introducing changes in the quality management system. The importance of this requirement stems from the role of planning in management sciences. Planning is treated as the first function of the management process, and it refers to formulating of the main goal, and then of specific objectives that the organization will pursue within the set time and with the use of specific resources (Szymańska, 2020, p. 167). The process of goals planning and determining the methods to achieve them is complex. One should take into account not only the identified goals of the social subsystem of the organization, but also the goals of entities from the immediate and further environment and then unify them so that they are consistent with each other (Hamrol, and Mantura, 2005, p. 72). Therefore the process of planning through setting goals and determining the methods of their implementation appears repeatedly in various trends in management.

The sources of this requirement are derived from the achievements of the field of scientific work organization, within which H. Emerson (2003, pp. 59-370) formulated the twelve principles of efficiency. The first of them, the principle of a clearly defined goal, indicates the need to set a specific course of action for the organization, which must be known to all members. The activities of the entire staff should be focused on its implementation. H. Emerson, as a consultant in the field of work efficiency improvement, had practical managerial experience. Under the principles developed by him, also the second guideline, i.e. the principle of common sense, is vital for planning. It indicates the possibility of taking actions useful and necessary for achieving the goal, while allowing for the elimination of possible obstacles. This principle relates directly to the activity dimension in the function of planning, which involves defining the ways and means by which organizational goals are to be achieved.

Planning is furthermore directly related to the principle of establishing the order of action, which consists not only in precise determination of the course of work, but also in documenting these activities, which will also support the achievement of the goals. The requirement is also derived from the achievements of the administrative field, including the managerial functions described by H. Fayol, which have become the foundation of the contemporary understanding of the process of managerial activities. The first of these functions was predicting, that incorporated identification of events that could occur in the future and developing appropriate action programs in response (Lachiewicz, and Matejun, 2020, p. 99).

The important role of goal setting and business planning was also emphasized in the system approach. H. Leavitt (1972) identified the subsystem of goals and values as one of the key elements of the diamond organizational model, paying attention to its direct, dynamic and multidirectional relationships with other subsystems: psychosocial, structural and technical, as well as with the organizational environment. Within the framework of the principles of the systemic direction (Piotrowski, 2010, pp. 697-699), goal-setting was preferred to defining detailed action programs in order to trigger creativity and independence of the organization members, at the same time leading to the formation of self-regulation and self-control mechanisms. Moreover, attention was drawn to the equifinality of the organization, expressing its ability to achieve the same goals (results) in different ways, starting from different initial states (Bielski, 2002, pp. 35-36).

The sources of this requirement are also derived from the rich achievements of strategic management, under which the emphasis is put on formulating main goals of an activity, continuous and dynamic monitoring of the environment and resources of the organization, as well as determining the methods and means necessary to achieve the set goals. As a result of these activities, the organization creates and implements a strategy, in other words, a program that defines the main goals of its activities and the methods of their implementation (Romanowska, 2009, p. 16). The planning nature of the strategy was emphasized by H. Mintzberg (1987), who treated it, inter alia, as a plan, i.e. a consciously intended and prepared direction of long-term action, a kind of signpost for the organization, setting the directions for its development and building its competitiveness in the future. As a result, an understanding of strategy and strategic planning that includes, among others:

- plan, template,
- the best way to use organization resources and competences,
- capability of identifying opportunities quickly and efficiently,
- ability to make choices under conditions of risk and uncertainty,

which are aimed at achieving the assigned goals (Zakrzewska-Bielawska, 2020, p. 190), is currently becoming an important requirement for the implementation of the ISO 9001 quality management system in organizations.

3.4. Support

Another requirement refers to the provision of support for quality management system in terms of resources, development of staff competences and awareness, assurance of communication and documented information. The foreground of these provisions is occupied by the identification and provision of human and infrastructural resources (both physical and intangible: information and knowledge), indispensable for establishment, implementation, maintenance and continuous improvement of the quality management system.

The origins of this requirement derive primarily from the resource-based view, marked with the importance of orchestrating tangible and intangible resources in order to generate exceptional value, translating into enhancing competitive advantage and achieving above-average market results (Sigismund Huff et al., 2011, pp. 45-47). In compliance with this approach, the resource potential of an organization is expressed not so much by the range of resources but, above all, by the degree of development of their strategic framework identified in VRIN framework, including: value, rareness, imperfect imitatiability and non-substitutability (Barney, 1991). Over the years, this model was being developed to the form of VRIO framework, additionally highlighting the need for a proper resource organization (Barney, and Hesterly, 2015).

The key resources, according to the resource-based view, include intangible resources, which is consistent with the requirement of the standard, in which the leading role is assigned to competences and human resources. From the beginning, human resources were among the key areas of interest for management sciences, starting from the trend of the scientific organization of work. Their appropriate selection, and then training and improvement, so that each employee could be assigned a job, in which their physical and mental qualifications would enable achieving maximum efficiency, were a valuable component of the work system according to F.W. Taylor (2008, p. 27). The discussed standard indicates similar requirements. They include:

- defining and assurance of proper selection and necessary competence of the personnel responsible for the effects of operation and efficiency of the quality management system,
- developing and consolidating the awareness of the staff in relation to significant quality objectives and personal contribution to the implementation of the strategic goals of the organization.

The above requirements indicate the necessity to maintain high motivation among employees involved and responsible for quality assurance in the organization. The standard also requires the maintenance of a social and physical work environment necessary for the functioning of processes and the achievement of compliance of products and services. In this aspect, special attention is paid to social and psychological factors, introduced into the requirements together with the amendment to the standard in 2015. These factors are based on

relations between employees, mutual support in the implementation of entrusted tasks and the sense of belonging to a team and awareness of working towards a common goal.

The sources of this requirement originate from the achievements of the behavioural school and the human relations field, whose representatives emphasized the dominant role of psychosocial factors, especially the so-called informal organization, appropriate work atmosphere, trust in the management-subordinate relations, proper communication between the organizational levels and the participation of personnel in the company's activities (Lachiewicz, and Matejun, 2020, p. 102). As an example of the classic concept of motivation, one can point out A. Maslow's (1943) hierarchy of needs, according to which a person is motivated to meet needs in a specific order, which at the same time constitutes the structure of individual motivators for each member of the organization. The important role of the work environment and social and psychological factors was confirmed, among others, by the results of the research by E. Mayo (1933). They show that the effects of work depend on feelings and mental states related to the work environment and atmosphere and on interpersonal relationships in groups, also in the informal ones.

The new recommendation of the analysed standard also applies to ensuring, maintaining and sharing the knowledge necessary for the functioning of processes and for achieving compliance of products and services. The source of this requirement is derived from the concept of knowledge management (Nonaka, 1991; Nonaka, and Takeuchi, 1995), aimed at achieving goals by locating, acquiring, developing, disseminating, using knowledge and preserving knowledge in an organization (Probst, Raub, and Romhardt, 2000). This concept assumes the dynamic nature of knowledge, while providing a framework for the conversion of tacit and explicit knowledge into organizational knowledge through socialization, externalization, combination, and internalization.

The discussed standard also introduces the requirement of efficient and effective internal and external communication regarding the quality management system. Communication is the process of providing information and disseminating knowledge, which aims to bring about understanding for decisions among the personnel and development of their loyalty and identification with the organization (Walecka, 2020, p. 457). The guidelines of the quality management system require documenting of the strategic goals and operational activities of the organization, adequately to their scope and specificity. Historically, the requirements for documenting activities derive from the achievements of the trend of scientific organization of labour. H. Emerson (2003, pp. 205-240), in his concept of twelve principles of efficiency, emphasized the importance of written communication and the need to conduct reporting and reports on the implementation of tasks, which should be reliable, immediate, accurate and up-to-date. This approach is fully consistent with the modern requirements of the timeliness, availability and integrity of the quality management system documentation.

3.5. Operational activities

In the next chapter, the standard introduces the requirements for manufacturing products and provision of services by organizations. They include processes related to the design and manufacturing of products and the provision of services, communication with customers and supervision over processes, products and services supplied from the outside.

In particular, the provisions introduce a requirement to establish, implement and maintain a design process, including planning, as well as the definition of input, output and supervisory activities. In addition, the organization should produce and provide services under supervised conditions. The source of these requirements are, above all, the rich achievements of the operations management concept, which was initiated as part of the trend of scientific organization of labour. One of the first examples of a synergistic connection between design and strict supervision over production processes is the system of work organization and management of a large industrial enterprise that was developed by H. Ford (Kurnal, 1970, p. 44). He proved that concentration on the design and control stage increases the chances of success in mass production, with simultaneous progressive cost reduction and product quality improvement. As part of the further development of the operations management concept, more and more attention was paid to production planning, design and management of production processes, facilities planning, management and maintenance, as well as to inventory management and control (Krajewski, Malhorta, and Ritzman, 2018), which is now reflected in the provisions of the quality management standard.

The sources of the requirements in the field of communication with customer derive from the rich legacy of marketing, in particular from the development of marketing communication (Wiktor, 2013) and relationship marketing (Otto, 2004). The concept of marketing communication assumes the use of specific sources and channels of communication in order to effectively transmit messages from senders to recipients. Its purpose is to stimulate attention and to evoke specific reactions of recipients to the signals and stimuli sent, as well as to acquire and process information and feedback in order to improve the offer and streamline the organization's operations. These features successfully meet the requirements of the standard, among others, in the field of communicating messages to customers and obtaining feedback on products and services from the customers. Relationship marketing, on the other hand, is focused on building specific, long-term relationships with customers that support customer satisfaction and loyalty. In this context, the relationship marketing is a source of knowledge about customers' expectations and needs, necessary to ensure that the requirements for products and services offered to customers are met under the quality management system.

In accordance with the provisions of the standard, as part of operational activities, organizations should also ensure compliance with the requirements of all processes, products and services provided by external suppliers, and necessary for proper functioning of the organization. For this purpose, it is necessary to establish and apply criteria for the qualification, selection and evaluation of suppliers, as well as procedures for monitoring and evaluation of deliveries of products and services. Originally, this requirement only covered the purchasing process of all necessary elements to produce a product or provide a service. In this situation, all external services necessary for the functioning of the organization were not supervised. Currently, the content of the requirement refers directly to the concept of outsourcing, which is defined as the supervision over activities transferred from the internal structure of the company to be implemented by external entities (Trocki, 2001, p. 13). Outsourcing enables the use of competences and skills of specialized external partners (service companies) to perform tasks (processes or functions) that are important for continuity of the economic activity (Matejun, 2011).

3.6. Assessment of the effects of action

Next, the standard introduces the requirement to monitor, measure, analyse and evaluate the effects of the quality management system operation, as well as the requirement of internal audit and management review. These activities consist in systematic examination of processes, products and services that are characterized by variability. Thanks to this, it is possible to identify all deviations from the standard and all non-conformities, and to take appropriate corrective actions (Łunarski, 2012, p. 217). In the first place, the organization should adopt an adequate form and scope of monitoring and measuring each process and its impact on manufacturing a product/provision of a service compliant with the requirements (Walaszczyk, and Błaszczyk, 2013, p. 90). Further on these data are a subject to analysis, with the purpose to assess the suitability and effectiveness of the quality management system, primarily taking into account customer satisfaction and compliance of the actions with the requirements (Łunarski, 2012, pp. 277-279).

The requirements of the standard in the field of monitoring, measurement and analysis derive from the achievements of the quantitative school in management sciences. Under this approach mathematical and statistical methods were applied to determine interactions and relationships between multiple factors. The changes in the values of these variables and to the analyses performed with the use of IT tools enabled quick determination of the effects of these changes, which accordingly provided the basis for taking managerial decisions (Lachiewicz, and Matejun, 2020, pp. 101-108).

Nowadays, monitoring, measurements, analyses and evaluation of the effects of conducted activities are performed mainly within the trend of performance management. This concept is a set of analytical and managerial processes and activities supported by technology, that enable organizations to define goals, measure their achievement, and then – based on the results of the assessment – make specific decisions ensuring the achievement of goals in an efficient and effective manner (Cardy, and Leonard, 2014). Both, the basic features of this concept, as well as the analytical tools used within it, including in particular key performance indicators (Parmenter, 2020) and balanced scorecard (Kaplan, and Norton, 1992), are currently important components of the ISO 9001 quality management system requirements in organizations.

Internal audit and management review are required to ensure the suitability, adequacy and effectiveness of the quality management system and its compliance with the strategic directions of the organization's activities. They are carried out in order to identify weak points in the functioning of the organization and to discover overlooked sources of potential for development (Mnich, 2016). Moreover, they bring added value in the form of diagnostic information about the course of processes in the organization and the directions of their improvement (Molenda, 2014, p. 21). The results of internal audits constitute the necessary input data for the management review, which includes a comparative analysis of the performance of individual processes.

The sources of this requirement are derived from the field of administrative management, within which H. Fayol drew attention to the function of control, by which he understood the analysis and assessment of compliance with the relevant regulations, orders and objectives (Kieżun, 1977, p. 75). The concept of benchmarking should be indicated as a source of comparative data assessment. The concept stands for comparing one's own solutions with the best, model solutions in a given field in order to improve the organization performance (Lachiewicz, and Matejun, 2020, p. 117). The requirements for audit and management review are primarily derived from internal process benchmarking (Adamik. 2015, p. 53-54), where comparison is made within the processes implemented in a given organization. In the auditing process, thanks to the measurement and analysis of the results of each of the implemented processes, it is possible to confirm the degree of compliance with the requirements, at the same time drawing conclusions for further improvement of the quality management system.

3.7. Improvement

The last chapter of the standard indicates the requirement to improve all activities of the organization in order to meet the requirements and increase customers' satisfaction, as well as to prepare the organization to meet their future needs and expectations. The improvement process is related to the company's ability to correct, prevent and reduce undesirable actions and effects and to prevent the products and services inconsistent with the assumed requirements from occurring (Łunarski, 2012, p. 277). In this way, the organization can continuously improve the suitability, adequacy and effectiveness of the quality management system.

The improvement element occurs in almost all classic management trends, referring both to the workplace (direction of scientific work organization), administrative solutions (administrative field) or relations between members of the organization (direction of interpersonal relations).

Still the interest in this issue increased predominantly together with the development of the research on organization learning curves (Cochran, 1968; Dutton, Thomas, and Butler, 1984). It was proven under the research that the increase of production experience provided the employee with an opportunity for incremental learning, which lead to expected cost reduction per a product unit in time. The improvement element was also highlighted in the concept of incremental process innovation. For example, W. Abernathy and P. Townsend (1975), while analysing the sources of acceleration of the innovation creation and dissemination, stress that process innovativeness is supported by 3 types of changes:

- rationalization of processes, which includes the development of predictability of production and introducing automation into production processes, aimed at the increase in the volume of production with standardized specifications. As a result, in production processes, automatics is intermingled with manual operations, whereas innovations increasingly result from the development of new technology;
- system-based technological development, ensuring stabilization of processes through joining together rationalization of processes and application of more and more advanced production technologies. Under the development, process engineering is placed in focus, including the issues of inventory control, process balance and optimal equipment selection. Also relations with suppliers, who have to perform process tasks that are either uncontrolled or difficult to automate, undergo transformation;
- process/product realignment, which is concentrated on further increase of productivity through: material inputs improvements, changed process technology and labour skills, larger process scale, and a tailoring of product characteristics. This change assures further possibilities of development with the assumption that production processes are being adjusted to the conditions of the external environment. Hence the additional requirement is to consider the pressure from the environment in the process of incremental improvement.

Still the sources of the standard requirements in the area of improvement derive mainly from the development of the concept of quality management. This challenge is noticed by W.E. Deming (1986) in his concept known as 14 Points of Attention for Managers (also: 14 Points for Management, the Deming Management Method). Already in point 1 he assigns the commitment for the organization to create constancy of purpose toward improvement of product and service, with the aim to become competitive, to stay in business and to provide jobs. In point 5 he indicates the necessity of constant and endless improvement of systems of production and service provision for the purpose of improvement of quality, productivity and cost reduction. It is also important to introduce modern methods of

professional development (point 6) and motivate the staff to continuous development through training and self-improvement (point 13). The final requirement is to engage all members of the organization in the processes of transformation and quality improvement (point 14).

In this approach commitment to quality comes from the top management, and continuous improvement in production processes should be followed by each and every member of the organization. Improvement is not a single effort but a continuous journey that businesses should follow to reduce waste and to improve quality. It is the role and responsibility of the management to keep an eye on constant improvement in design, product, process, training, supervising, maintenance, etc. (Agrawal, 2019, p. 1163).

Among specific tools for quality management aimed at organizational improvement one can enumerate: Quality Circles, Kaizen (Albayrak, and Kececi, 2020) or Kansei Engineering (Zuo and Wang, 2020). Constant improvement is also the key element of quality improvement methodologies, such as (Sokovic, Pavletic, and Pipan, 2010): PDCA cycle, EFQM Excellence Model, RADAR Matrix (Results, Approach, Deploy, Assess and Refine), DMAIC (Define, Measure, Analyse, Improve, and Control), or DFSS (Design for Six Sigma). In contemporary times this rich output of the concept of quality management in the area of continuous improvement is most fully expressed through the practice of implementation of quality management systems accordant with ISO 9001 standard.

4. Conclusions

The considerations presented in the article indicate that a number of substantive links with historically shaped legacy of management sciences can be found in all contemporary requirements of ISO 9001 quality management system. At the same time the sources of normative requirements derive both, from classic theories of management (among others the field of scientific organization of work, administrative, school of interpersonal relations) and modern management concepts and methods (among others strategic management, reengineering, benchmarking, outsourcing, relationship marketing). Identified linkages between following ISO 9001 requirements and concepts/methods of management are presented in Table 1.

Table 1.
Linkages between ISO 9001 requirements and concepts/methods of management

ISO 9001 requirements	Related concepts and methods of management	
	classic	**modern**
Organizational context	– scientific management (e.g. principle of inertia/equilibrium), – administrative management (e.g. Fayol's passerelle).	– value chain, – process organization and process management (e.g. business process reengineering).
Leadership	– principles of scientific management, – administrative management, – theory of bureaucracy, – interpersonal relations school.	– leadership (e.g. full range of leadership model, transactional leadership, transformational leadership).
Planning	– scientific management (e.g. twelve principles of efficiency), – administrative management (e.g. managerial functions concept), – system approach.	– strategic management (e.g. strategy, strategic planning).
Support	– scientific management (e.g. work system by F.W. Taylor), – behavioural school (e.g. motivation theories).	– resource-based view (e.g. VRIN, VRIO frameworks), – knowledge management.
Operational activities	– scientific management (e.g. work system by H. Ford).	– production management (e.g. production planning, production processes, maintenance, inventory and control management), – marketing (e.g. marketing communication, relationship marketing), – outsourcing.
Performance assessment	– quantitative school, – administrative management.	– performance management (e.g. key performance indicators, balanced scorecard), – benchmarking.
Improvement	– scientific management, – administrative management, – interpersonal relations school.	– organization learning curves, – incremental process innovation, – quality management (e.g. 14 Points of attention for managers, Quality Circles, Kaizen, PDCA cycle)

Source: prepared by authors on the basis of study results.

Knowledge of the aforementioned conceptual foundations and their associations with the requirements of the standard enables more comprehensive understanding of quality management philosophy and ISO standard by managers. The understanding is useful already at the stage of taking decision on implementation of a quality management system, facilitating the assessment of the accordance of the concepts and methods of management applied in a company with the requirements of the standard. The understanding plays vital role at the stage of implementation and maintenance of the system, enabling flexible adjustment of particular managerial solutions with simultaneous assurance of their efficiency and linkage to the system of managing the whole organization and its particular functions. A deeper understanding of the conceptual bases for the standard requirements also reduces the barriers faced by organizations during implementation and application of quality management systems, enabling achieving better outcomes resulting from their application.

The dynamics of the influence of management sciences on the character of current requirements also indicates the necessity for further changes in ISO 9001 quality management system together with the development of new concepts and methods of management. Yet the rate of introducing changes and developing updates responding to the dynamic development of management theory and practice poses a challenge. This point is highlighted, among others, by R.D. Reid (2020), who states that, taking into consideration the acceleration in the rate of changes, organizations may not be able to await the update of ISO standards, which lag current practices by at least three to five years due to the time required to get them to market. In his opinion, greater representation of new technologies and automation can be expected in management systems in the future. That applies in particular to solutions in robotics, and Internet of Things. The changes will be rather evolutionary than revolutionary in character, and they might evolve towards integrating the various applicable standards into one overall management system.

Still, a quantitative prognostic analysis carried out by M. Ikram, Q. Zhang and R. Sroufe (2020) for 6 selected countries in the period 2018-2026 indicates that the number of ISO certifications will continue to increase, although with a varied dynamics. The authors predict that China and India will become the leaders in the area of quality management systems implementation. They will be followed by Italy, Germany, Japan, and then the United Kingdom. On the other hand, the results of the research carried out by M. Ćwiklicki, K. Pilch and M. Żabiński (2019) on the sample of 2150 local government units indicate that only 37,9% of the units with the experience of the ISO 9001, were willing to continue using the solution. The reason for that situation has been the increase of interest in alternate management improvement solutions (mainly Common Assessment Framework – CAF and Planning Institutional Development – PRI), as well as introducing in 2009 the obligation to conduct management control. Thus the future of ISO 9001 quality management system remains uncertain. This future will depend mainly on the capabilities of introducing changes in normative guidelines that will keep up with the dynamic development of the theory and practice of management sciences with the benefit for organizations.

Considering the obtained results and formulated conclusions, the limitations of the study should be taken into account (Geletkanycz, and Tepper, 2012). They mainly derive from the subjective selection of the concept and method of management considered as conceptual foundations and sources of quality management system ISO 9001 development. Certainly, the study does not take into account all the concepts and methods of management, which became an inspiration for the international standardization in the area of quality management. However, a journey through the classical and modern history of management sciences allows in this case a deeper perception for the philosophy and practice of ISO 9001 quality management system by managers.

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SAFETY IN THE PUBLIC SERVICES SUPPLY CHAINS – THE CASE OF EMERGENCY MANAGEMENT

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Introduction/background: The concept of the public service supply chain has become increasingly popular in the science and practice of public governance. Complex supply chains are formed consisting of many organizations from different sectors. Coordination of such chains is not straightforward and deals with many organizational, social, relational, and situational challenges. This makes safety issues increasingly important.
Aim of the paper: This article aims to develop a framework of the public service supply chain safety management. The usefulness of this framework was presented on the example of emergency management.
Materials and methods: This article was prepared based on a critical literature review and a structured interview questionnaire conducted with 15 emergency management experts.
Results and conclusions: As a result, safety management issues in the public services supply chains were described, the emergency supply chain was characterized, and the framework of the public services supply chain safety management was developed.

Keywords: public service supply chain, safety management, emergency management operational risk, relational risk.

1. Introduction

The issues of configuration and coordination of the public services supply chains are nowadays a new and intensively developing research area. The possibilities of using the principles of operation of supply chains to deal with the complexity of activities in the public sector, as well as to improve the processes of public service provision, are increasingly recognized. Research on this topic concerns, among others, public procurement (Vecchi, Cusumano, and Boyer, 2020; Amann et al., 2014), public-private partnership (McCarter, and Fudge Kamal, 2013), smart technologies (Szymczak, 2015; Meijer, and Bolívar, 2016), or the use of lean management (Arlbjørn, Freytag, and de Haas, 2011). They are undertaken from the perspective of the functioning of various areas of public management, such as criminal justice (Seepma, de Blok, and Van Donk, 2020; Odlanicka-Poczobutt, 2016), healthcare

(Leksono, and Suparno, 2018; Esain et al., 2016; Twaróg, 2014), emergency management (Peterson, Young, and Gordon, 2016; Ficoń, 2011; Malindžák, and Olejarz, 2017), or humanitarian relief (Van Wassenhove, and Pedraza Martinez, 2012; Banomyong, Varadejsatitwong, and Oloruntoba, 2019).

However, the functioning of the public services supply chains is not free from the risk of external threats, inter-organizational misunderstandings, or problems connected with leading activities in collaborative networks. These problems refer to challenges associated with governing turbulences (Ansell, and Trondal 2018; Ansell et al., 2017). Issues contained improper customer service, waste of public money, long time cycles of activities, or poor inter-organizational communication may occur (Nkwanyana, and Agbenyegah, 2020; Mafini, 2016). However, research in this field is fragmentary. Although the theory of high-reliability organizations has been in use for a long time (Laporte, and Consolini, 1991; Roberts 1989), there is still an absence of analysis on resilience, resistance, and reliability in public service delivery (Berthod et al., 2017). The consequences of the Covid-19 pandemic highlighted the weaknesses, vulnerabilities, and lack of flexibility of public services supply chains (Lemke et al., 2020; Qin et al., 2021). For this reason, there is a need to reconsider and reconfigure these chains, taking into account the dynamics and turbulence of changes and safety issues. These are problems that create new research opportunities.

Emergency management is a particularly representative area in this respect, as it creates exemplary conditions for understanding the public services supply chains in particularly high-risk conditions (Gazley, 2013; Comfort, 2007). This is due to the complexity of the supply chains in emergency management. Each emergency is different: it occurs in various places and times, its scope and intensity are different in each case, and various people are at risk. Such various situational conditions make it necessary to configure the service supply chain differently in each case, even if it is the same type of threat. Besides, it is the area where the most advanced research on the functioning of supply chains is carried out, compared to other areas of public governance (Peterson, Young, and Gordon, 2016; Van Wassenhove, and Pedraza Martinez, 2012; Peck, 2006). The scientific achievements in the field of emergency supply chains could be valuable to research safety issues in public services supply chains in turbulences. On this basis, this article aims to develop a framework for public services supply chain safety management. The usefulness of this framework was presented on the example of emergency management.

2. Research method

This article has a conceptual nature and was prepared on the basis of three theories: public service delivery, service supply chain, and safety management.

A critical review of the literature was used to achieve the purpose of the article, which is to develop a framework for public services supply chain safety management (Grant, and Booth 2009). It was used to learn about the safety issues of the functioning of the public services supply chains. The Scopus and the Web of Science databases were used for the research. These are databases containing publications of high scientific value, reviewed by independent experts and ensuring high-quality results (Newbert, 2007). The search words were "supply chain", "public service delivery", "threat", and "safety". On this basis, the framework of safety management in public services supply chains was developed.

The usefulness of the developed framework was presented on the example of emergency management. For this purpose, the legal acts and regulations, and obligatory operating standards were taken into account. Empirical research was also carried out to verify the level of risk resulting from organizational and relational circumstances. A structured interview questionnaire conducted in January and February 2019 with 15 emergency management experts from blue-light organizations who had at least 10 years of practical professional experience. This study identified the level of operational and relational problems in the emergency supply chain.

In the course of the conducted analyses, public services and the process of their delivery were characterized. The public services supply chains and safety management in these chains were also described. The conducted research and analyses allowed both the systematization of knowledge in the field of the functioning of the public services supply chains and the development of a new, holistic approach to the study of supply chain safety management. These results were supplemented with empirical research conducted in the area of emergency management. On their basis, threats related to the leading joint activities in emergency management were identified, and the usefulness of the developed framework was presented.

3. Public service delivery

Public services are defined as specified goods, offered by the public sector, that are generally available for everybody. They have a value that is not decreased by subsequent users, regardless of the number of people using it. The classification of public services concerning the nature of tasks performed by public administration includes (Kożuch, and Kożuch, 2011, p. 41):

- Administrative services and e-services: issuing documents other than administrative decisions, permits, concessions; entering into databases; issuing permits and decisions under the code of administrative procedure; issuing permits and concessions related to the economic activity regulated by the state.
- Social services and e-services: healthcare, education, culture, recreation, social security and care, housing, public safety.
- Technical services: transport (services and infrastructure), water supply, removal of wastewater, waste management, maintenance of cemeteries, energy supply (electricity, gas, heating), maintenance of public greenery.

The public service delivery process is complex and not easy. It is defined as "a series of highly localized actions by agents in public agencies or private enterprises to provide needed goods and services to citizen beneficiaries in a way that meets their expectations" (Caceres et al., 2016, p. 1). Difficulties in the public services delivery result from their wide range and complexity of their implementation process. This process is shaped by legal regulations, political conditions, and the specificity of the functioning of public organizations responsible for its course. These organizations function at governmental (central) and local government levels. However, the issues of public management and public service delivery are primarily the domain of local governments. The proximity of local governments to society allows them for quick undertaking activities aimed at meeting local needs. The central level tasks are, in turn, legislative and regulatory activity, shaping public policies, periodic monitoring of the effects of undertaken activities at the local and regional state level, and launching State Reserves if necessary.

It is also worth noting that public organizations differ significantly from private organizations (Seepma, de Blok, and Van Donk, 2020; Boyne, 2002). The difference in their functioning results, first of all, from directing activities at providing high-quality public services, not generating incomes. Public investments are made thanks to taxes and fees collected from society and are carried out under legal regulations, on publicness, transparency, and economic basis. These investments do not generate revenues, but add value to public services.

However, public organizations cannot deliver public services to a society based only on their competencies and resources. The difficulties related to this process, the degree of its complexity, as well as the ever-changing social needs, make it necessary to include organizations from all sectors in the process of public service delivery (Bryson, Crosby, and Stone, 2006; Frączkiewicz-Wronka, 2009; Osborne, Radnor, and Nasi, 2012). For this purpose, many solutions are used, but the most common are public procurement and public-private partnership (Vecchi, Cusumano, and Boyer, 2020; Amann et al., 2014; McCarter, and Fudge Kamal, 2013). Public procurements are procedures for spending public funds on services, supplies, and construction works carried out on the basis of contracts between the authority and the performer from the private sector. In turn, public-private partnership is a form of

cooperation between entities from the public sector and entities from the private sector, in which tasks and risks related to the performance of a specific public service are divided. The effect of this partnership is the delivery of a specific public service, the implementation of the task by a public organization, and the profit for a private entity. Both public procurement and public-private partnership constitute legal mechanisms of involvement of private sector organizations in undertakings related to the delivery of public services and consequently affect the creation of the public services supply chains.

4. Characteristics of the public services supply chains

The public services supply chains can be understood as networks of organizations from different sectors using their resources for contributing to the creation of public value. Their task is to deliver high-quality public services based on the principles resulting from the general theory of the service supply chain. According to this theory, „the service supply chain is the network of suppliers, service providers, consumers and other supporting units that performs the functions of transaction of resources required to produce services; transformation of these resources into supporting and core services; and the delivery of these services to customers" (Baltacioglu et al., 2007, p. 112). Under this definition, the operations undertaken in the service supply chain are aimed at transforming the resources of individual organizations into core and supportive services, which together create value for the customer (Baltacioglu et al., 2007; Wang et al., 2015; Kauf, 2017). Concerning public services, this includes the provision of core services such as social assistance, healthcare, delivery of media, maintaining public transport, or organizing cultural events. This may also require to delivery of supportive services, e.g. maintenance of technical infrastructure, medical examinations, delivery of garbage bags, developing textbooks for schools, etc. The delivery of public services is generally not possible without taking into account the flows of tangible resources necessary for the implementation of core processes, e.g. equipment and work clothes of public service providers, tools for the maintenance of technical infrastructure, communication equipment, etc. (Wang et al., 2015; Baltacioglu et al., 2007). However, in most cases, flows in the public services supply chains are intangible. For this reason, their functioning differs significantly from traditional supply chains where the flows of tangible resources are mostly analyzed. Many other differences arise from the characteristics of the services and apart from intangibility their include (Arlbjørn, Freytag, and de Haas, 2011; Baltacioglu et al., 2007):

- Simultaneity, because customers must be present for the service to be provided.
- Heterogeneity, because services cannot be standardized and are perceived differently by the customer each time.

- Impermanence causing potential missed opportunities.
- Labor intensity resulting from the importance of involving human capital in the process of creating services.

The specificity of the public service supply chains is publicness and transparency of the processes carried out in them. As a result, their structure and relations are open, implemented based on applicable legal regulations, system solutions, and partnership agreements. The specificity of service supply chains and the activities undertaken in them are presented in the literature in the form of models. From among the existing service supply chain models, two have been selected that significantly affect the development of research in the area of public service delivery. Although they refer to services in the general sense, they can be successfully applied in the study of public service processes. Both are based on the Supply Chain Operations Reference Model (SCOR) (Baltacioglu et al., 2007; Ellram, Tate, and Billington, 2004). In the model developed by Ellram, Tate, and Billington (2004), the traditional focus on production is abandoned and the flow of information is a key process visible at all stages of supply chain management. As in production-focused supply chains (Lambert, and Enz, 2017), this model proposes functions necessary for effective supply chain management (Ellram, Tate, and Billington, 2004), which include: capacity management, demand management, customer relationships management, supplier relationship management, service delivery management, and cash flow management. The second model developed by Baltacioglu et al. (2007) takes into account the characteristics of services, as well as the inability to involve agents and dealers in the process of their delivery. Therefore, the customer and the end consumer are the same nodes in this model. The role of the supplier and sub-supplier was presented similarly. As a result, the model of Baltacioglu et al. (2007) is of a direct supply chain and comprises three nodes: supplier, service provider, and consumer. It is also worth noting that in this model not only the service provider but also the supplier can provide public services to the consumer, and both the service provider and the consumer are jointly involved in the process of creating the services. This model also considers the following management functions performed in specific phases of the supply chain: information flow and technology management, demand management, capacity and resources management, supplier relationship management, service performance management, order process management, and customer relationship management.

Both presented models are useful in the analysis of public service delivery processes, e.g. criminal justice (Seepma, de Blok, and Van Donk, 2020; Odlanicka-Poczobutt, 2016), healthcare (Leksono, and Suparno, 2018; Esain et al., 2016; Twaróg, 2014), or humanitarian relief (Van Wassenhove, and Pedraza Martinez, 2012; Banomyong, Varadejsatitwong, and Oloruntoba, 2019). They contribute to a better understanding of these processes and emphasize the impact of proper management on reducing operating costs, increasing the quality of services offered, as well as increasing customer satisfaction by implementing processes more effectively.

5. Safety management in the public services supply chains

Safety issues have long been researched in the literature on supply chain management (Wang et al., 2015; Hussain, Al-Aomar, and Melhem, 2019; Mollenkopf, Ozanne, and Stolze, 2020). Analyzes in this area are carried out concerning the strategies taken as well as operational processes, their vulnerability, protection, resilience, and preparedness (Essig et al., 2013; Marucheck et al., 2011). Although the scientific achievements in the field of supply chain safety management have been developed mainly concerning traditional supply chains, this issue is becoming more and more popular with service delivery (Baltacioglu et al., 2007; Ellram, Tate, and Billington, 2004; Choudhury et al., 2020), including public services (Arlbjørn, Freytag, and de Haas, 2011; Esain, et al., 2016). Research trends on this subject are illustrated in Figure 1.

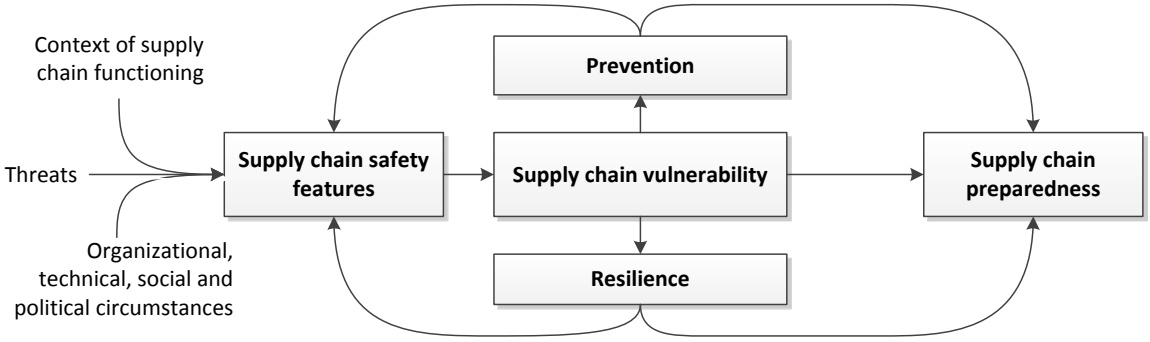

Figure 1. The issues of safety research in service supply chains. Developed based on Essig et al., 2013, p. 42.

According to Figure 1, the features of service supply chain management are influenced by the type of threat; external organizational, technical, social, and political conditions; the context in which a given chain functions. The features refer to the level of complexity of the service supply chain structure (including the number of nodes and links between them), processes implemented (the scope of flows depends on the type of public service), as well as the level of partnership and the scope of inter-organizational collaboration. These features shape the vulnerability level of the service supply chains. It determines the extent to which this chain may fail to meet the challenges resulting from the existing threats and emerging complexity (Haimes, 2011; Turner et al., 2003; Chodyński, 2014).

Activities aimed at reducing the level of vulnerability contain prevention and resilience building. Prevention focuses on identifying potential threats, preparing action plans, developing alternative activities, training employees, etc. Resilience, on the other hand, means the ability of the service supply chain to adapt to new operating conditions by resisting and introducing changes (Essig et al., 2013; Sienkiewicz-Małyjurek, 2015). Undertaken activities as a result of prevention and resilience strengthen the features of the public services supply chain and limit its vulnerability. The cyclical nature of these activities and the constant striving to reduce the

vulnerability of the service supply chain affect the level of preparation of this chain in case of threats. This is the goal of safety management in the public service supply chain. In this respect, both structural and behavioral components of management are taken into account (Lambert, and Enz, 2017; Rajani, and Heggde, 2020).

It is also important that the safety management in the public service supply chain is carried out on the basis of the following main stages (ISO 28001:2007): identification of the assessment scope, conduction of the assessment, development of the safety plan, execution of this plan, and continuous improvement. The first phase is to identify which part of the supply chain is being analyzed. Conduction of the assessment includes the identification of potential threats, risk analysis, and development of mitigation approaches. On this basis, the safety plan is prepared. It is used to monitor the level of implementation of the planned processes and introduce improvement actions. The activities planned and taken for implementation in the safety plan are individual in each case, as they depend on the type of threat and the context in which the public service supply chain operates. After an emergency occurs, safety plans are modified based on new experiences and knowledge.

Public services delivery takes place in various areas and contexts of operation, and the supply chains are configured individually in each case. Differences occur in the planning, organizing, coordinating, and verifying activities depend on the situational circumstances. Moreover, the type and scope of undertaken activities also determine the area of public governance, e.g. health care, public transport, waste management, water and sewage systems, or emergency management. Apart from different operating conditions, the configuration of the entities involved in the delivery of specific public services is different in each situation. The diversity and variability of the conditions of public services result in many threats, and a multi-dimensional approach to safety management in is essential (Fig. 2).

The framework of the supply chain safety management in emergencies presented in Figure 3 is based on the models of service supply chain of Ellram et al. (2004), Baltacioglu et al. (2007), and Caceres et al. (2016).

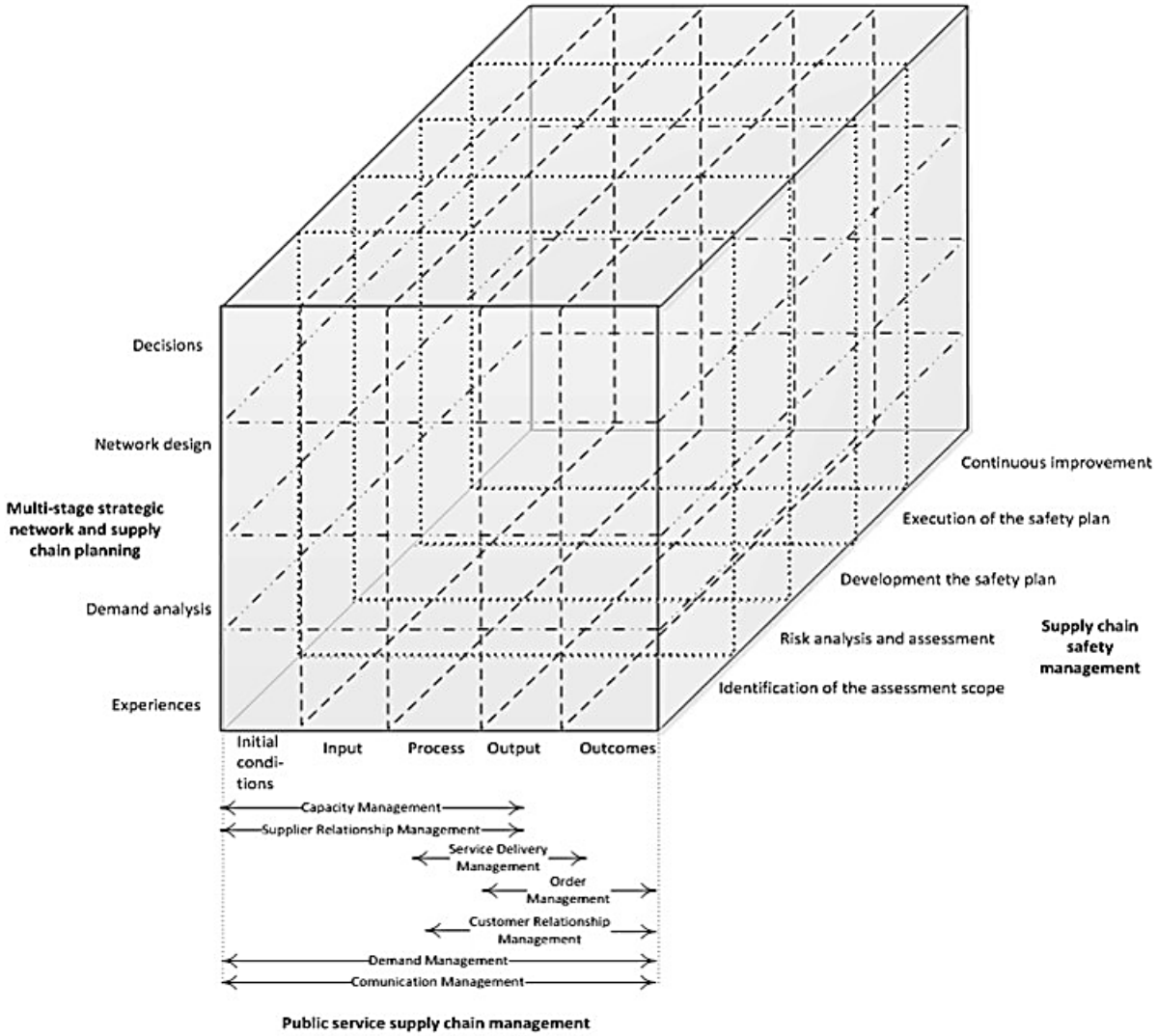

Figure 2. The framework of public services supply chain safety management. Own elaboration on the base of Ellram, Tate, and Billington, 2004; Baltacioglu et al., 2007; Essig et al., 2013; Sienkiewicz-Małyjurek, 2015; ISO 28001:2007; Timperio et al., 2016; Sienkiewicz-Małyjurek, 2019; Caceres et al., 2016.

The first dimension of the developed framework relates to the characteristics of service supply chain management. Initial conditions include the type and scale of the threat; social, political, and economic conditions; legal regulations; and resources. On this basis, activities are prepared and the supply chain is designed. The next two phases include the outputs of the performed activities and outcomes, which mean long-term consequences. The following functions occur in the various stages of service supply chain management (Ellram, Tate, and Billington, 2004; Baltacioglu et al., 2007): capacity management, supplier relationship management, service delivery management, order management, customer relationship management, demand management, and communication management. These functions are aimed at acquiring the resources necessary for the implementation of processes and ensuring the effectiveness of their flows in the supply chain.

The second dimension indicates that the public service supply chain is individually configured in each case depending on the type of threat and related needs. It is based on a multi-stage strategic network and supply chain planning (Timperio, 2016). In this regard, the following are important: previous experience in dealing with a specific threat; analysis of demand from a social, organizational, technological, and relational perspective; network design including all network nodes and links between them, as well as decisions on resource deployment and coordination of activities. This dimension allows the public service supply chain to be adapted to situational and social needs.

The individuality of each supply chain makes it difficult to predict what problems may arise during the implementation of operations. In addition to dealing with threats, the public service supply chain also strives for an efficient and safe course of processes. For this reason, the third dimension of the developed framework refers to supply chain safety management. It consists of the application of principles aimed at protecting the supply chain from threats, operational, and relational problems. In this respect, the analyzes consist of (Essig et al., 2013; Sienkiewicz-Małyjurek, 2015; ISO 28001:2007):

- determining to what extent or parts of the supply chain the safety management will apply;
- carrying out an analysis and assessment of the risk of threats, as well as preparation and implementation of the necessary preventive actions;
- developing and implementing a safety plan;
- continuous improvement of the safety plan, adequately to the emerging challenges and situational conditions.

The merger of the three dimensions of safety research in the public service supply chains allows for considering this issue from the operational and relational perspective. As a result, it is possible to identify various threats in individual phases and processes of public service delivery, as well as the links between them. This approach can contribute to a better understanding of the multidimensional nature of safety management in the public service supply chain.

6. Safety management in emergency supply chain

Emergency management is a deliberate act carried out by authorities at all levels of the state. It consists of preventing emergencies, preparing to take control over them through planned actions, reacting in the event of an emergency, and restoring the infrastructure (Waugh, and Straib, 2006; Sienkiewicz-Małyjurek, 2012). Activities in this area are taken in the case of such threats to human life and health, the environment, and property that occur on a large scale and require the implementation of coordinated actions of many organizations. These are,

for example, natural disasters, pandemics, technological threats, terrorist attacks, etc. Many entities participate in such activities: public administration, fire brigades, police, ambulance services, army, border guard, construction supervision, transport supervision, non-governmental organizations, private enterprises, local communities, and others. They form supply chains aimed at achieving a common goal - helping the injured, and saving the environment and property. Emergency supply chains are analyzed primarily from the perspective of their structure (Kumar, and Havey 2013; Afshar, and Haghani 2012), performance (Deng et al., 2016; Van Wassenhove, 2006), and relationships connecting individual nodes (Kovács et al., 2012; Dubey et al., 2020). The developed framework (Fig. 2) brings these perspectives together and analyzes them for potential risks.

Risks resulting from the situational conditions and vulnerability level are analyzed in emergency management plans in detail (C/2019/8929; PE/90/2018/REV/1). In Poland, public authorities focus on 19 types of threats, including (NCMP, p. 45-47): flood, epidemic, chemical contamination, disturbance in the energy and gas systems, heavy snowfall, hurricanes, large-scale fires, droughts, radiation contamination, etc. There are assigned the tasks and responsibilities of entities included in the emergency management structure in the form of a security matrix to each of these threats. On their basis, emergency response procedures, modes of activating the necessary forces and resources, and variants of plans are developed. However, risk analyzes related to inter-organizational relations are occasionally undertaken.

Organizations involved in emergency management have to face many challenges, such as the unpredictability of demand, time pressure, a wide range of requirements for the supply of services and resources for implementing them, as well as lack of resources (Timperio et al., 2016; Sienkiewicz-Małyjurek, 2019; Sienkiewicz-Małyjurek, 2012). Decisions are made in conditions of uncertainty and constant change. In such conditions, apart from emergencies, complex problems may arise related to the coordination of joint activities of many autonomous organizations.It is essential to ensure high quality of inter-organizational collaboration in an emergency supply chain, enabling efficient flow of resources and information. The results of empirical research on the risks associated with the collaborative issues in emergency supply chains are illustrated in Figure 3. The factors taken into account were assessed on a 5-point Likert scale.

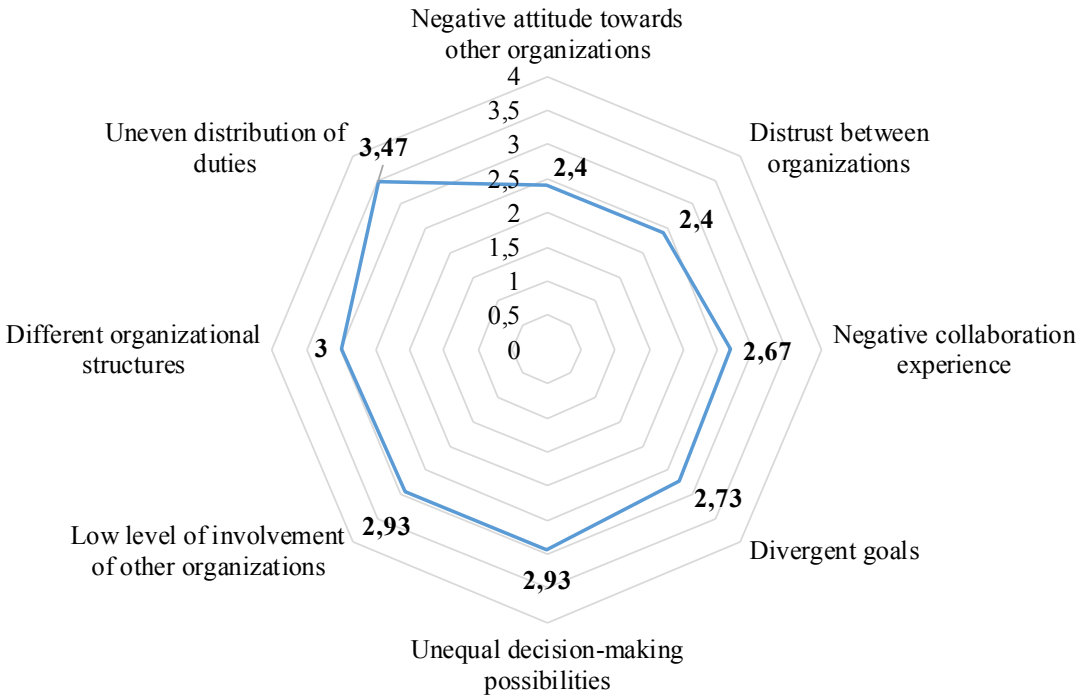

Figure 3. Risks associated with collaborative issues in emergency supply chains. Own elaboration.

The results presented in Figure 3 indicate that the threats related to the joint activities in the emergency supply chain are primarily operational. The uneven distribution of duties and different organizational structures are of fundamental importance. The first factor results from individual entities' statutory competences, and therefore it is difficult to eliminate. The help of other units in areas where they are not experts may create additional problems and threats resulting from the lack of appropriate skills. On the other hand, dissimilar organizational structures may limit integrating and synchronizing the emergency supply chain. Among the relational factors, the low level of engagement in the implementation of joint activities is dominant. In addition to the threats mentioned above, it may also be necessary to conduct projects in highly urbanized areas and conditions of damaged infrastructure. In such circumstances, a multi-dimensional approach to safety management in the emergency supply chain is essential. On this basis, the stages of safety management according to the developed framework (fig. 2) could be started from analysis of the context of threat (place, time, range of impact, consequences) and operations (number of participating organizations, differences between the resources needed and possessed). Secondly, the situational, operational and relational risks analysis is needed. On this basis the supply chain design and its management functions could be designed and customized to the context of activities. Simultaneously, it is necessary to develop of safety plans and their verification. These plans and supply chain design should be continuously improved based on experience and demand analysis.

7. Discussion and conclusions

The complexity and turbulence of contemporary situational conditions create the need for quick adaptation of public service delivery processes to social needs and coping with threats. Therefore, there is a need to continually reconfigure and increase the flexibility of public services supply chains. Besides, the context of the functioning of public services supply chains makes safety management increasingly important. The need for safety management implementation to public services supply chains is due to the growing uncertainty of the activities context.

The developed framework of the public services supply chain safety management (fig. 2) results from the growing complexity of providing public services processes and the need to involve many organizations, institutions, and individuals from all sectors in these processes. The application of this concept contributes to a better understanding of safety issues and more effective public service delivery. This framework includes contextual conditions and adjusting the service supply chain management functions to them, organizational requirements, and the prepared safety plans based on potential threats and the activities context.

The main finding of the research presented in this article is a multi-dimensional approach to safety management in public services supply chains. In this approach, it is not enough to take into account only direct threats that result from situational conditions and adapt actions to them. It is necessary to consider network design, formal and informal relationships between entities, possibilities of reconfiguration of the resource base, organizational interdependencies, and changes in demand.

In the case of emergency management, the activities are implemented under high uncertainty and risk. Such chains create high requirements in planning and preparing activities, adaptation to external conditions, ensuring quickness and synergy of actions, or coping with uncertainty. Considering the issues of safety management leads to monitoring the course of processes on an ongoing basis, reducing losses, and increasing joint actions.

The conducted empirical studies in emergency management indicate that operational threats may have a very significant impact on the course of activities. These threats include primarily: uneven distribution of duties and different organizational structures. Moreover, such relational threats as low level of involvement and negative collaboration experience may generate risks of failure of joint actions. For this reason, a multi-dimensional approach to safety management is needed. It could allow us to identify different types of threats, find links between them and develop appropriate safety plans.

However, this article has some limitations result from its conceptual character. The developed framework includes certain assumptions based on a merge of three theories: public service delivery, service supply chain, and safety management. Possibilities of using this framework have been outlined only on the example of emergency management in Poland.

For this reason, it is necessary to continue research on public services supply chain safety management both conceptually and empirically. However, despite these limitations, the conducted research has added value to the public governance theory. They can also be useful for policymakers responsible for public service delivery processes. Thanks to the understanding rules of functioning the public service supply chains, and the multi-dimensionality of safety issues, public managers can more easily identify threats in implemented processes. It is the basis for making appropriate decisions. As a result, the effectiveness of public services supply chains can be enhanced.

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PUBLIC SUPPORT FOR ESTABLISHMENT AND DEVELOPMENT OF SMES IN POLAND – RESEARCH PROCESS PREPARATION

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Introduction/background: The development of the small and medium enterprises sector is extremely important for economy from the point of view of many, very diverse criteria. Employment increase, market expansion, active involvement in internationalization processes and product portfolio expansion require many qualitative changes such as improvement of the management system, implementation of innovations, raising funds for investments, overcoming paradoxes and management shortcomings. Politics and public support instruments play an increasingly active role in those processes. Such public aid may include, for example, dedicated EU funds, support for business environment institutions as well as direct and indirect public influence exerted from the central, regional and district level.

Aim of the paper: The purpose of this paper is to present an outline of the approach to contemporary entrepreneurship of small companies and the related development requirements which SMEs sector entities need to face as well as to draw out the research approach adopted by the author for evaluation of the public aid provided to entrepreneurs.

Materials and methods: The research instruments have been independently developed by this paper's author. They are the effect of pilot surveys held by the author with small and medium entrepreneurs and representatives of entrepreneurs' self-government in which they indicated their feelings about and reflections on the opportunities for obtaining public support. The author has based his work also on the evaluation reports on the use of EU Structural Funds in the years 2007-2014.

Results and conclusions: The system of research proposed by the author of the paper creates a space for becoming familiar with how entrepreneurs and administrators of aid funds evaluate potential changes which may result in corrections, as part of public support after 2020, that is during the period of the new perspective of financing with EU funds and during the greatest economic crisis after World War II caused by the coronavirus pandemic.

Keywords: entrepreneurship, SMEs sector development, public support for SMEs.

1. Introduction

In a turbulent environment, especially in the case of hypercompetition resulting from intensified globalisation, having an optimised knowledge about the conditions of, and components which block or facilitate, the development of the small and medium enterprises (SMEs) sector activity, about increasing SMEs' market potential and the ability to create market advantage, is becoming increasingly important.

If we adopt the paradigm according to which small and medium enterprises play essential role in economic development, it is important to show the factors determining SMEs' market position and their importance to entrepreneurship processes in the context of market opportunities and hazards.

The sector of SMEs (micro-, small and medium enterprises) makes up an overwhelming majority of all enterprises in Poland – 99.8%. Microenterprises are the most numerous group (96.7%; 2.08 million). Small enterprises make up 2.4% (52.7 thousand) of all Polish companies, medium ones – 0.7% (15.2 thousand), whilst large enterprises – only 0.2% (3.7 thousand) (Polska Agencja Rozwoju Przedsiębiorczości, 2020).

The entrepreneurs operating the entities which belong to the category of SMEs are faced with a number of decision dilemmas and situation complications related to running a business activity. They are looking for answers to a number of questions relating both to how the business activity conditions conducive to efficient and effective management should be shaped, how to build company's competitiveness in the context of new business models increasingly oriented at innovativeness, as well as to how and where to look for key success factors within a specific competition sector. Absorbing questions refer also to human resources, i.e. whether entrepreneurs, employees and managers of organisational units of all levels improve their skills and formal qualifications and whether they use them skilfully to implement functional strategies, processes and tasks oriented at company's development.

Managing small entities differs significantly from managing large enterprises and is frequently much more complicated and more difficult than managing a large enterprise whose management board often has a number of advisers who support the decision-making process and applies newest management methods. Fluctuations in economic situation in the SMEs sector have an important impact on labour market, on the situation of households and on maintenance of intra-economic ties such as, for example, complex logistics chains. Support for the SMEs' activity is becoming an important factor which strengthens their development strategies and allows effective management of market niches in a highly globalised market with an increasingly stronger supremacy of international concerns. What is more, the scope of such support needs to be more and more directed and expanded whilst dedicated forms of support need to be more precisely specified. From the point of view of public entities such coordination is relatively difficult, however, as the experience of SMEs indicates, it is also currently

inevitable, be it just for the purpose of reinforcing the activity in the area of internationalisation which requires improved innovativeness of enterprises where the capability of simple forms of support, such as, for instance, exhibitions, to effectively enhance the business activity of micro, small and medium enterprises, has been exhausted (Wodarski, Krannich, 2020, pp. 109-113).

The system of research proposed by the author of the paper creates a space for becoming familiar with how entrepreneurs and administrators of aid funds evaluate potential changes which may result in corrections, as part of public support after 2020, that is during the period of the new perspective of financing with EU funds and during the greatest economic crisis after World War II caused by the coronavirus pandemic.

2. The role and importance of SMEs in economic relations and possibilities in the area of providing support to the SMEs sector

In global literature increased interest in managing small and medium enterprises could be noticed in the 70s of the 20th century. The so-called Bolton Report published in 1971 was the first work in which quantitative and quantitative standards that define entities which belong to the SMEs sector were formulated. In Poland the interest in such entities emerged along with the economic and political reforms after 1989. At that time the important, if not essential, role of SMEs in the process of changes in Poland's political system was emphasised, as well as the economic and social importance of the entities from that sector to the development of the new economic order.

It should be noted, however, that development of small enterprises in Poland has had a much longer tradition which comprises the entrepreneurship traditions of the Second Polish Republic as well as functioning of craftsmanship and agriculture at the time of the Polish People's Republic. The initial phase of the so-called "outburst of entrepreneurship" which took place in 1988-1993 was related to intense structural changes in Polish economy, privatisation of state companies, elimination of many unprofitable economic entities as well as increase in unemployment and in social exclusion, pauperisation of some households and increased inflation rate. System transformation and the then flexible legal regulations made many venturesome people decide to register independent businesses. The trend was so strong that the number of small and medium enterprises quadrupled – from approx. 570 thousand in 1988 to 2.1 million in 1993 (Lachiewicz, Matejun, 2012, pp. 13-45).

Therefore management in SMEs is a relatively young subdiscipline of the quality and management studies, distinguished based on the criterion of a specific type of organisation (Sudoł, 2007). Increasingly often, however, it is assumed that the aggregate of small and medium enterprises is internally very diverse which makes scientific comparisons complicated and also makes generalisation of trends identified in a given group of entities more difficult

(Dominiak, 2005). The sector of SMEs may be perceived as a relatively heterogeneous, and hard to unambiguously define, collection of entities whose legal shape, internal structure and nature of operation is determined by the methodology of the selected systematisation.

The sector of SMEs plays an important role in creation of economic prosperity, for example through (Lachiewicz, Załęczny, 2003, pp. 16-20):

- quantitative domination in the total number of business entities,
- significant share of the smallest enterprises in total employment (on the level of entire economy),
- significant contribution to generation of gross domestic product, both on the level of individual countries as well as the entire European Union,
- significant impact on the level of trade (especially exports), investment expenditures and creation and diffusion of innovations,
- ability to create changes in the industrial structure of the country, manifesting itself in particular in development of the services and trade sector,
- being conducive to deconcentration of assets and passing antitrust regulations, related among other things to establishment of spin-off companies and entities which rapidly react to market changes,
- significant participation in the development of economic infrastructure which serves both individual and institutional customers,
- impact on the changes in regulations which facilitate development of entrepreneurship,
- development of the markets which remain outside the interest of large companies which is related to creation of dynamic and flexible business entities operating in specific segments and niches of the market,
- influencing the budget revenue of the country and communes, shaped by direct and indirect tax revenues as well as revenues from the tax due on employees' pays,
- educating "staff for economy", related to mobility of contemporary human resources,
- disbursement of own funds and dormant capital reserves,
- active marketing of new products, services, also including elimination of market gaps,
- increasing the capital flow rate that leads to increased dynamics of trade and economic stimulation also in less developed regions,
- influence on the economic multiplier effect, which consists in the impact of establishment or bankruptcy of one enterprise on emergence or decline of other business entities.

Such elements of impact accompany the study of the issues of development, financing, support and ongoing functioning of the SMEs sector. They focus on a broad range of substantive areas, taking into account various features of enterprises from that sector. Diagnosis of changes in the environment of the SMEs sector and analysis of entrepreneurs' specific needs indicates the increasingly important groups of research problems that include, for example:

- organisational culture and corporate social responsibility,
- managing entrepreneurship and intellectual potential,
- managing innovation,
- strategies for creating competitive advantage,
- perspectives of cooperation between small and medium enterprises and the environment of those organisations,
- policy of financial and non-financial support for the entities from the SMEs sector.

It seems that the last item deserves a particularly careful examination due to the value added indicator included in the "2020 report on the condition of the SMEs sector". In 2018 value added made up as little as 24% of turnover and did not indicate any evident upward trend. The decrease (by 0.2%) with respect to 2017 was just a continuation of the previous tendencies. During this decade the value increased noticeably only in three years (2013, 2015 and 2017). This may mean that there have not been any significant triggers for innovative operation or for using highly processed knowledge for building a market position or creating a competitive advantage of SMEs. Competitiveness of an enterprise is evaluated on two levels (Bieliński, 2005, p. 16):

- the level of results – in the product market,
- the level of factors – the relationship between competitiveness and the factors and environment in which a company operates.

The elements which have a positive impact on competitive advantage of SMEs include, for example (Nogalski, Karpacz, 2004, p. 30):

- orientation on innovation (due to limited scale of production and individual approach to satisfying purchasers' needs),
- clarity and transparency of organisational structures (it is caused by a limited range of offered products and concentration of operation on geographically small markets),
- the fact that the business is dominated by entrepreneur's personality (it has an impact on both internal and external relations of the company and therefore direct contact of the entrepreneur with his or her employees may be of great importance).

The factors which weaken competitive advantage of small and medium enterprises include, for example (Nogalski, Karpacz, 2004, p. 35):

- limited resources,
- structural limitations and ways of managing the company,
- unspecified plans for company's operation.

Limited financial resources to a large extent determine the operation of SMEs and obtaining funds from lending institutions is frequently restricted due to the cost of capital and significant formal requirements related to obtaining such capital. Synthetically, all source impediments to obtaining financing from financial sector entities come down to (Gołębiowski, 2009):

- continuously high interest rates on loans to entrepreneurs,
- complicated, time-consuming and incomprehensible bank procedures,
- complex character of creditworthiness,
- expensive formal security measures, frequently many times higher than company's assets,
- high commissions charged by banks,
- lack of stable economic and legal conditions,
- relatively higher costs related to awarding and controlling loans which in the case of SMEs are fragmented and dispersed.

This frequently results in a very insufficient development potential of a company. In such a case financial capital has its source in own savings, family support or borrowings from friends. Limited resources may result in entrepreneur's unwillingness to wait for profits for a long time while, at the same time, requiring an increase in invested cash flows. Insufficient resources include not only the funds for financing ongoing operations or investments but also capital resources.

Support for the entities which are not large companies is a relatively young field of the country's economic policy. Economic policy deals with the actions of public authorities with respect to economy, and in particular with the process of specifying social preferences, preparing variants of selection of appropriate institutional solutions for effecting such preferences and with ongoing decisions of the country (Acocella, 2002, p. 20). In such a way the entirety of the impact of public authorities on economy, its structure, dynamics of transformations and long-term functioning, impact on economic relations in the country and economic relations abroad for the purpose of achievement of assumed goals is being defined (Owsiak, 2006, pp. 51-56). Such an impact is effected by means of such instruments as stimuli (such as: prices, costs of capital, money supply, income); regulations (monopolies, tax burdens) and direct involvement (public supply of specific goods, nationalisation) (Władyka, 2007, p. 191).

The instruments of state's impact are direct and indirect in nature. Indirect instruments are used for influencing attitudes and behaviour of aid administering entities (e.g. import duties). Direct instruments have a form of a command for specific behaviour (e.g. production limits) (Władyka, 2007, pp. 22-24).

Supporting SMEs is the object of interest of state's economic policy. Its conceptual foundations include identification of the most desirable forms, directions of promotion, responsible actors and instruments of such policy (Piasecki, 2001, p. 80). Development of such foundations means not only that institutional framework, i.e. goals and instruments for their achievement expressed in the form of strategies and programmes, are consistent, but also that such foundations are based on empirically verified theories.

Various entities operating on different levels, both commercial and public, including high risk funds, lease funds, banks and consulting companies are involved in stimulation of development of small and medium enterprises. Support for SMEs is also offered by governments of different countries, whilst on the European level by the European Union itself (through EU directives).

On the European level EU regulations and programmes have a significant impact on the development of enterprises. This is the case also in Poland. Together with sector and regional policy the support for small and medium enterprises is treated as one of the cores of the community's economic policy. Major objectives of such EU's approach to the policy towards SMEs include:

- increase of the production potential of an enterprise,
- creating the conditions conducive to development of market competition,
- helping to create market competition,
- making sure that small companies are able to operate and compete with other entities.

Due to the gradually increasing importance of entrepreneurship for Poland's economic development central administration offers an increasingly broad support programme both for establishment of enterprises and for development of the already existing ones. National governments use different tools of support – from tax relieves or lower social insurance premiums to financial aid and subsidies. Many operations in the area of support for enterprises from the SMEs sector are also implemented on the regional level by means of the programmes implemented by local government units. These operations have different dimensions which results from the fact that local governments are at the same time the participants of the market and the entities which to a certain extent influence market participants' operation. The tools which support development include, for example, the administrative and legal, infrastructural, advisory and research instruments that support implementation of innovations and, first of all, the economic and financial instruments. Regional support is frequently provided in the form of the institutions which directly cooperate with small and medium enterprises. The system of support for SMEs operates on many levels – supranational, national, as well as regional and local ones. It comprises many support entities and instruments of different nature. The most common areas of operation include finances, trainings, implementation of innovations, consultancy and access to market information.

3. Methodology of approach to the research in assessment of public support for SMEs

For the purpose of assessment of the approach to supporting SMEs two research tools have been developed. These tools allow to analyse the perception and effectiveness of public support for enterprises. The research instruments have been independently developed by this paper's author. They are the effect of pilot surveys held by the author with small and medium entrepreneurs and representatives of entrepreneurs' self-government in which they indicated, often in a very general way, their feelings about and reflections on the opportunities for obtaining public support. The author has based his work also on the evaluation reports on the use of EU Structural Funds in the years 2007-2014.

The first questionnaire refers to the evaluation of public support processes from the point of view of entrepreneurs. For that purpose from the SMEs sector 150 entrepreneurs were selected who take advantage of development support in the following specialist industries:

- services,
- commerce,
- construction,
- industrial manufacturing,
- transport.

These industries correspond to the market activity of the majority of entities from the SMEs sector. Detailed breakdown of the entrepreneurs selected for the research which form a cross-sectional and representative sample (Table 1), is the following:

Table 1.
Detailed breakdown of selected entrepreneurs

Category	Classification	Number of SMEs*	[%]	Number of entities to be analysed	including the entities which employ the disabled**
Services	Section I, J, K, M, N	933073	33.6%	50	2
Commerce	Group 45.1, 45.3, 45.4, Division 46, 47	796297	28.7%	43	1
Construction	Section F	493000	17.8%	27	1
Industrial manufacturing	Section C	337943	12.2%	18	1
Transport	Division 49, 50, 51	214176	7.7%	12	0
	Total	**2774489**	**100.0%**	**150**	**5**

*On the basis of the Central Statistical Office's REGON tables, as on 31.12.2019.

**According to the Economic Activity Survey (*Badanie Aktywności Ekonomicznej Ludności – BAEL*) the disabled make up approximately 3% of all employed people.

Source: own analysis – preparation of a research sample.

Detailed questions, in the questionnaire, include the following substantive modules:

- Reasons and motivations behind starting an independent business activity.
- Factors which discourage entrepreneurs from starting an independent business activity.
- Relations between the skills acquired in the course of education and the type of business run by entrepreneurs.
- Sources of company's financing at the moment of starting the business.
- Assessment of the usefulness of the support obtained by an entrepreneur.
- Current needs for support.
- Support in the form of the information on opportunities, places and types of public support for SMEs.
- Evaluation of the selected existing forms of support from the point of view of entrepreneur's needs.
- Characteristics of the industries in the SMEs sector which require special public support.
- Evaluation of enterprise's situation after obtaining support.
- Current directions of potential support.

At the moment field research is being conducted. The research conducted with the use of the said research tool is planned to be completed by the end of 2020.

The second survey initially had a form of a narrative interview with a series of open-ended questions to decision-makers – funds administrators in the public institutions which manage dedicated support programmes and development funds – with respect to the forms of support for SMEs (middle and senior management representatives). The research tool was distributed in such institutions as:

- Employment agencies.
- EU funds administrators, e.g. Śląskie Centrum Przedsiębiorczości.
- Local governments of voivodships.
- Local governments of communes.
- The National Centre for Research and Development (NCBiR) – e.g. with respect to providing support to start-ups (grants).
- Academic incubators of entrepreneurship.
- Technoparks.
- Innovation and Technology Transfer Centres – operating at universities or universities of technology.

However, due to the difficulties related to the pandemic a mixed survey was used – it was a combination of Likert scale questions and open-ended questions. The questionnaire included the following substantive modules:

- Types of institutions and nature of their operation.
- Types of offered forms of support.
- Factors which encourage entrepreneurs to start an independent business activity.

- Factors which discourage entrepreneurs from starting an independent business activity.
- Assessment of the currently used forms of support.
- Assessment of the method of verification of applications submitted by entrepreneurs.
- Assessment of the operations which promote entrepreneurs' access to selected forms of public support.
- Demands and suggestions submitted to institutions – administrators of support for entrepreneurs.
- The weakest and strongest elements of support programmes and procedures.
- Barriers which make it difficult for entrepreneurs to periodically use public support.
- Assessment of public support in crisis situations.
- Assessment of cooperation between support administration units.
- Areas of long-term changes in the operation of the institutions which offer public support for entrepreneurs.

Direct research with the use of the second survey questionnaire is currently conducted in the group of 50 decision-makers which administer public support for SMEs. The research process is planned to be completed by the end of 2020.

4. Summary

Characteristics of the impact of SMEs sector entities on the functioning of the market system is multidirectional. These entities, due to the fact that they are flexibly responding to signals from the market, quickly fill the gaps in supply and operate based on the pragmatics of experience and rational management, have the greatest impact on the size and structure of market offer. For that reason their activity stimulates competition, thus creating an entity structure of economy and leading to its deconcentration and contributes to the weakening of the monopolistic position of large corporations in certain sectors. As a result micro-, small and medium enterprises exert an impact on the pricing game in individual markets and the extent of generalised demand which finds its reflection in economic growth.

Also the labour market is a significant area of impact of market behaviour of the entities from the SMEs sector (Aidis, 2005, p. 305). The research which was and has been conducted in Europe shows that the entrepreneurship activated in the SMEs sector contributes, to a significant extent, to job creation and reduction of unemployment. The number of newly employed people depends on the sector to which they belong (European Commission, 2015).

An important consequence of an effective process of supporting micro-, small and medium enterprises may also be establishment and deepening of cooperation between entities from the SMEs sector. Companies may enter into cooperation with one another for example due to the

lack of sufficient capital, the vision of keeping the company in good condition in the future, of choosing one specialisation, improving quality, broadening of the scope and scale of operation and expansion of operation (Wiatrak, 2001, p. 33). Public support for creating a network of cooperation or for building clusters provides an opportunity for significant reinforcement of the competitive position of SMEs.

The factors which make it possible for SMEs to achieve an attractive market position very often include key skills which give a company a chance to satisfy consumers' new needs (Prahalad, 1990, pp. 79-91). This can be achieved through active pro-innovative approach consisting in building sets of key competences which public aid may effectively initiate in the case of micro-, small and medium enterprises. The concept of the extraordinary character of using one's own potential and currently held resources as an element which is more valuable than the structure of the sector or impact of the environment is characteristic for the definition of competitiveness in the resource-based approach to management (Obłój, 2007).

From the point of view of many countries' politics the SMEs sector is treated as one of the most important elements in the implementation of priorities of the economic and social progress. Therefore we are dealing with a dispersion of support policies with respect to that sector in nearly all fragmentary policies and public intervention programmes on the national and EU level. At the same time the share of expenditures for supporting entrepreneurship and individual SMEs in public spendings has been growing. Therefore the demand for developing a consistent concept of operation in this field, based on scientifically verified foundations, seems legitimate. Such an analytical concept based on verifying the usefulness, efficiency and effectiveness of the dedicated orientation of public support to the SMEs sector, evaluated by beneficiaries of such operations may be used, in the form of recommendations for future operation of the administrators and authors of public aid instruments, for example for the purpose of:

- modification of general and detailed principles of addressing public support,
- correction of support granting procedures,
- formulating more effective decisions with respect to operational evaluation of implementation of the given support programme during its operation,
- better cooperation and exchange of information between beneficiaries of support and public institutions and funds administrators,
- changing the principles of evaluating the reasonableness of granted aid,
- development of additional instruments of support for the entrepreneurs from the SMEs sector.

For the purpose of achievement of his research objectives and further analyses the author of this paper developed his own research instruments which are to help understand and analyse the use of public support obtained by different SMEs from different sources and from various

entities – public funds administrators. Field research is currently being implemented and will be carried out until the end of 2020.

The research conducted among entrepreneurs by this article's author are oriented at practical evaluation of public support for micro-, small and medium enterprises as perceived by such public funds' beneficiaries.

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SELECTED PROBLEMS OF CONSUMER ACCEPTANCE OF INNOVATIVE FOOD PRODUCTS

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Introduction/background: Consumer reluctance to try new, formerly unknown foods poses a serious obstacle for the development of innovations in the food market. Considerable attention has been given to the threats perceived by consumers related to eating selected innovative foods: genetically modified food (GMF), convenience food and functional food.
Aim of the paper: This paper is aimed at indicating factors that shape consumer acceptance of innovative food products. The research was focused on establishing the association between the attitude towards new food and the selected demographic (age, sex) as well as psychological traits (the speed of adopting innovation based on Rogers' Diffusion of Innovation Theory) of the respondents.
Materials and methods: The paper presents the results of the authors' own studies conducted among Polish consumers using the direct survey method. The research was carried out in 2019 and involved employing a purposive sampling technique (n = 240). The data were analysed utilising the following methods: analysis of the internal consistency of the attitude scale using Cronbach's alpha, k-means cluster analysis, contingency tables.
Results and conclusions: The 9-item Food Neophobia Scale (FNS) was reduced to three variables: enthusiasm, neutrality and reluctance. These variables were subjected to k-means cluster analysis, which resulted in identifying two homogenous groups with similar attitude towards new food. We have found a statistically significant association between belonging to a cluster-based on the approach to innovative food and the speed of accepting innovation using Rogers' model of diffusion of innovation – and the sex and age of the respondents.

Keywords: consumer attitudes, consumer acceptance of innovation, consumer perceived risk, food innovation.

1. Introduction

The food market undergoes dynamic development thanks to technological progress in agriculture and industry. Traditional as well as internet media, providing both information and advertising content, play an important role in the public discussion on nutrition. The Internet

represents a specific type of media that enables fast dissemination of information as well as direct information exchange among consumers. A wide-ranging discussion on food and nutrition has an impact on shaping consumers' attitudes and on consumers' purchasing decisions (McCluskey, Kalaitzandonakes, Swinnen, 2016, pp. 467-486). Consumers make more conscious dietary choices and confront food producers with increasingly difficult challenges. Currently the food market is shaped by various fads and trends that must be carefully observed by food producers, especially when it comes to developing new food products (Si, 2020, pp. 305-321). The purpose of this paper is to indicate factors affecting consumer acceptance of innovative food products. We have searched for the association between the attitude towards new food (positive/neutral/reluctant) and demographic traits, such as the age and sex of the respondents, and the speed of welcoming innovation according to the model of diffusion of innovation developed by Rogers.

2. Consumer resistance to innovation: perceived threats and food neophobia

Developing innovative products becomes a necessity for producers operating in the increasingly competitive food market (Makała, Olkiewicz, 2004, pp. 121-124). Given the constant growth in consumer expectations, the range of products delivered by food producers must constantly change and expand. The main trends in developing new food products emerge as a result of needs communicated by consumers and by the technological solutions available at a given time. According to the literature, innovative food is commonly subdivided into three categories: convenience food, GM food, and functional food (Gawęcki, 2002, pp. 5-15; Lähteenmäki, Grunert et al., 2002, pp. 523-533; Tuorila, 2001; Urala and Lähteenmäki, 2004, pp. 793-803). From the consumers' point of view, innovations in the food market are completely subjective and frequently constitute minor modifications of the product, e.g. connected with changing packaging design, finding innovative uses or new functionalities (Babicz-Zielińska, Dąbrowska, 2011, p. 40).

The innovations introduced by manufacturers do not always meet with favorable reception from consumers. Genetically-engineered foods represent a category that arouses a considerable concerns due to limited knowledge about genetic modifications, difficulties in providing an explicit definition of genetically modified organisms (GMO), general lack of widespread understanding for scientific achievements, ethical dilemmas, and religious beliefs as well as the inability to indicate the benefits GMO could deliver (Rzymski, Królczyk, 2016, p. 690). Convenience food that can be prepared quickly and easily, which represents an obvious advantage, is highly-processed and perceived by consumers as unhealthy and unnatural (Botonaki, Mattas, 2010, p. 630; Brunner, van der Horst, Siegrist, 2010, p. 499). As healthy

lifestyle trends continue to grow, one could expect that functional food should meet market demands. Unfortunately, due to lack of legal regulations, this type of food is not widely known and accepted among consumers (Annunziata, Vecchio, 2013, pp. 350-351; Krygier, Florowska, 2008, p. 2; Kudełka 2011, p. 291). Besides consumer perceptions of threats associated with the types of food discussed above, the innovation on the food market can be seriously hindered by reluctance to try unknown food products.

Trying innovative food is somehow tantamount to taking a risk. Fear of the unknown and selecting products that we are familiar with represent typical human reactions (Dolgopolova, Teuber, Bruschi, 2015). Negative attitude towards different food forms and nutrition is often associated with the lack of products knowledge (Babicz-Zielińska, 2006, p. 379). Fears and lack of trust in new technologies applied in food production are strongly correlated with reluctance to try novelties (Cox, Evans, 2008, p. 704; Royzman, Cusimano, Leeman, 2017, pp. 466-467). Consumer reluctance to eat new, unknown foods is defined as food neophobia (Tuorila, Hartmann, 2020, pp. 1-2). This eating trait is understood as an attitude towards food manifesting as avoidance of trying new products (Babicz-Zielińska, 2006, p. 380). The level of food neophobia depends, among others, on the following factors: age, sex, place of residence (town/village), income, education, psychological characteristics (attitude towards innovation), genetic factors, cultural traits, purchasing knowledge and experience, and sensory sensitivity (Kowalczuk, Fusiek, Nowocień, 2017, p. 76).

3. Research methodology

The results presented and analysed here were obtained in the course of the authors' own research conducted in 2019 among Polish consumers using direct survey as the research technique. Purposive sampling involved taking into account respondents' age (two categories) and sex (two categories). The analyses presented in this paper were carried out based on answers provided by 240 respondents. Questionnaire survey was used as a research tool. The questions in the questionnaire regarded consumers' attitudes towards innovative food products as well as their habits and behaviour connected with trying new foods that they have not sampled before.

With regard the questionnaire, two measuring scales were adopted based on available literature. The first used in the study was applied to assess food neophobia. Original Food Neophobia Scale (FNS) consists of 10 statements (10-item test) about trying novel foods (Pliner, Hobden, 1992, pp. 105-120). Our questionnaire included 9 statements taken from that scale[1]. The second scale was based on the model of diffusion of innovation devised by Rogers (Rogers' Diffusion of Innovation Theory). According to that model, it is natural that consumers

[1] The statement 'I like to try new ethnic restaurants' was omitted, as the research was focused on the consumers' attitude towards new food products selected during everyday grocery shopping.

differ with regard to accepting innovations. 'Innovators', who are the first to welcome innovations, usually constitute a small percentage of the population. 'Early adopters' are relatively less innovative. The following groups, comprising the majority of consumers, include the 'early majority', who hesitate to adopt novelties, and 'late majority', who are skeptical about innovation. The last group consists of laggards, who are conservative and do not like changes (Rogers, 1983, pp. 248-251). That question was aimed at identifying respondents' general attitude towards innovations on the food market.

4. Results

4.1. Consumer acceptance and distrust in new foods

In order to evaluate consumers' attitude towards new, formerly unknown food, the analysis of multi-item scale consisting of nine variables/statements taken from the original Food Neophobia Scale (Pliner, Hobden, 1992, p. 109) – was conducted. The items used are presented in Table 1. The respondents were asked to evaluate to what extent they agree with the statements using the 7-point Likert scale.

Table1.
Items of FNS used in the research

Item symbol	Scale item
FNS 1	I will eat almost anything.
FNS 2	I am constantly sampling new foods.
FNS 3	I like trying foods from different countries.
FNS 4	At parties, meetings, dinners, I am eager to try new foods.
FNS 5	I treat new foods without emotion.
FNS 6	If the food looks too exotic, I have doubts whether to eat it.
FNS 7	I am afraid to taste anything that I have never had before.
FNS 8	If I don't know what is in a food, I won't try it.
FNS 9	I like traditional dishes; I don't try new foods.

Source: own elaboration based on Food Neophobia Scale (Pliner, Hobden, 1992, p. 109)

It is worth pointing out that the table presented above can be divided into three sub-scales (as indicated by factor analysis). The first sub-scale consists of positions from FNS 1 to FNS 4 that are connected with a positive attitude towards trying new foods. The second one is neutral and includes a single item (variable FNS 5). Variables from FNS 6 to FNS 9 constitute a distrust scale. The first (enthusiasm) and third (distrust/reluctance) scale represent multi-item scales (4-item scales). The analysis of internal consistency of these scales, based on Cronbach's alpha (Cronbach, 1951, pp. 297-334) and average correlation, indicated that they are internally consistent. Cronbach's alpha for the enthusiasm scale amounted to 0,8719, while the average correlation amounted to 0,6546. With regard to the distrust scale, Cronbach's alpha reached the value of 0,8253, with the average correlation between the items amounting to 0,5503.

According to Nunnally (Nunnally, 1978, p. 245; DeVellis, 2012, pp. 109-110) the values for Cronbach's alpha obtained here are acceptable and are recommended for basic research. The results demonstrate that all four items in the analysed scales measure the same aspect of the studied phenomenon and constitute single dimensional scales. For that reason it was possible to use arithmetic mean as a variable representing each dimension and reducing four items to one synthetic variable. Thus, each sub-scale reflecting the attitude to new, unknown food was represented by one variable. Mean values obtained for particular dimensions and standard deviation are shown in Table 2.

Table 2.
Mean values and standard deviation for identified three sub-scales (all respondents)

Variable	Total	
	Mean	SD
Enthusiasm	4,36	1,5935
Neutrality	3,54	1,7425
Reluctance	3,26	1,4977

Source: own elaboration.

The next step involved identifying homogenous groups (clusters) in terms of attitudes towards new foods. K-means cluster analysis (Mooil, Sarstedt, 2011, p. 255) with the use of three variables representing acceptance scales (enthusiasm, neutrality, reluctance) was performed. Analysis of variance revealed that for two homogenous groups all three variables diversify clusters at the level p = 0,000000, as presented in Figure 1.

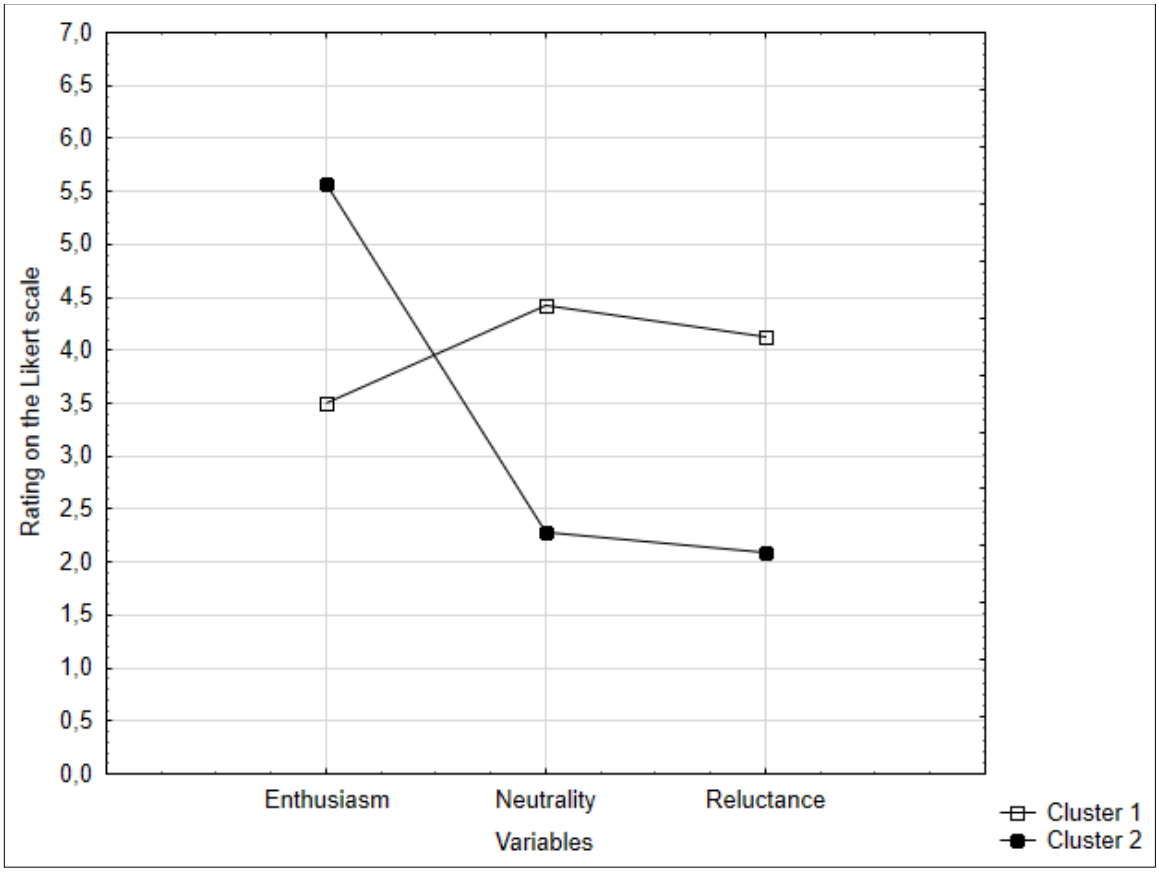

Figure 1. Graph of mean values calculated for each cluster. Source: own elaboration.

The first cluster, including 140 persons, was designated ‘reserved’. This group is rather reluctant to try new food products and treats them with high level of distrust. The second cluster includes ‘enthusiasts’. Mean values obtained for the neutral and distrust scale were very low, which indicates that respondents from that cluster were not afraid of novelties. Quite the opposite; they are eager to taste new foods, which is clearly seen from the high score on the enthusiasm scale. Standard deviation presented in the table indicates that answers delivered by respondents assigned to the second cluster were more diversified. Means for particular variables and corresponding standard deviation are shown in Table 3.

Table 3.
Mean values calculated for each cluster

Variable	Cluster 1 ‘Reserved’ N = 140		Cluster 2 ‘Enthusiasts’ N = 100	
	Mean	SD	Mean	SD
Enthusiasm	3,50	1,1208	5,58	1,2842
Neutrality	4,43	1,0759	2,29	1,5738
Reluctance	4,12	0,7683	2,09	1,3056

Source: own elaboration.

Subsequent stages of the analysis involved studying the relationship between belonging to a homogenous group and the respondents’ demographic characteristics, such as sex (two categories) and age (two categories). Men outnumbered (59%) women (41%) in the ‘reserved’ cluster. There were 22% more women in the cluster ‘enthusiasts’ as compared to the first cluster, while men constituted 37% of ‘enthusiasts’. The observed association is statistically significant ($p = 0,00066$), but weak (Phi coefficient amounts to 0,2197, while contingency coefficient to 0,2146). Men displayed reluctance towards innovative foods more often than women. The first cluster included more respondents aged between 35 and 64 (56%). The trend was opposite among enthusiasts. The majority of enthusiasts (59%) constituted young people, aged between 18 and 34. The association between the assignment to a given cluster and age was statistically significant, assuming $\alpha = 0,05$ ($p = 0,01844$). However, this relationship is very weak (Phi coefficient amounts to -0,1521, while contingency coefficient to 0,1504). Enthusiastic attitude towards innovative food weakens with age. Assignment to clusters considering age and sex is presented in Figures 2 and 3.

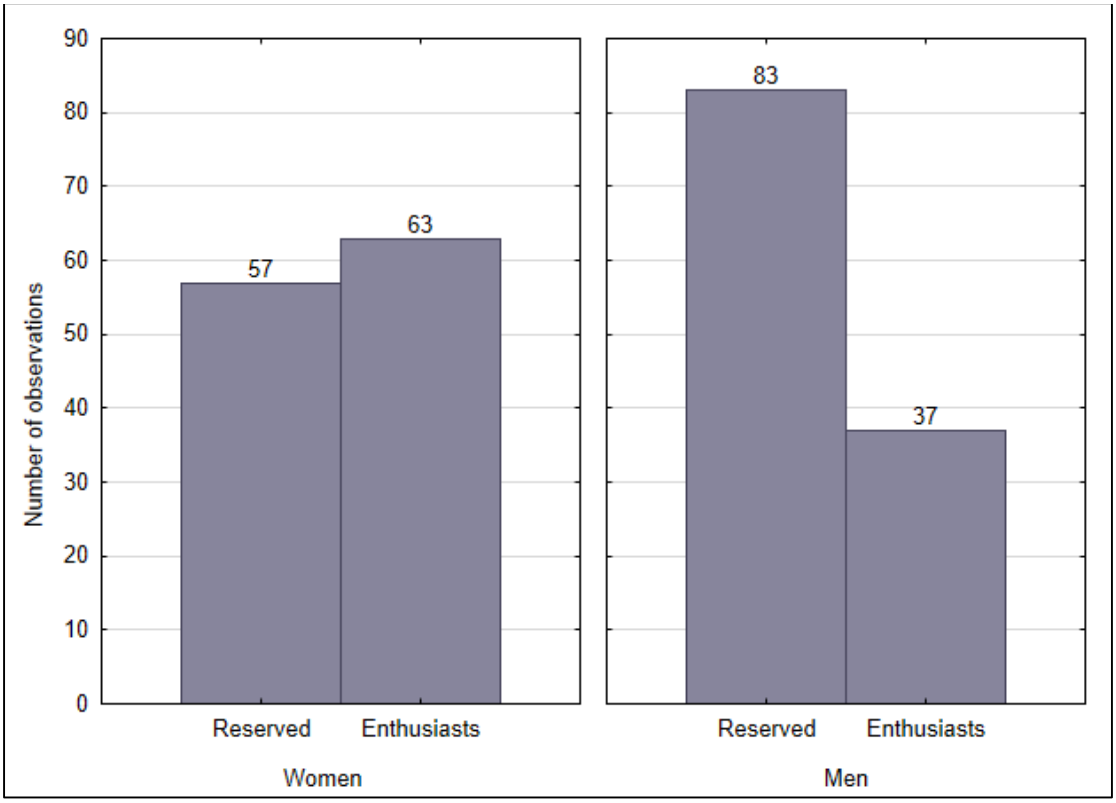

Figure 2. Revealed cluster versus sex. Source: own elaboration.

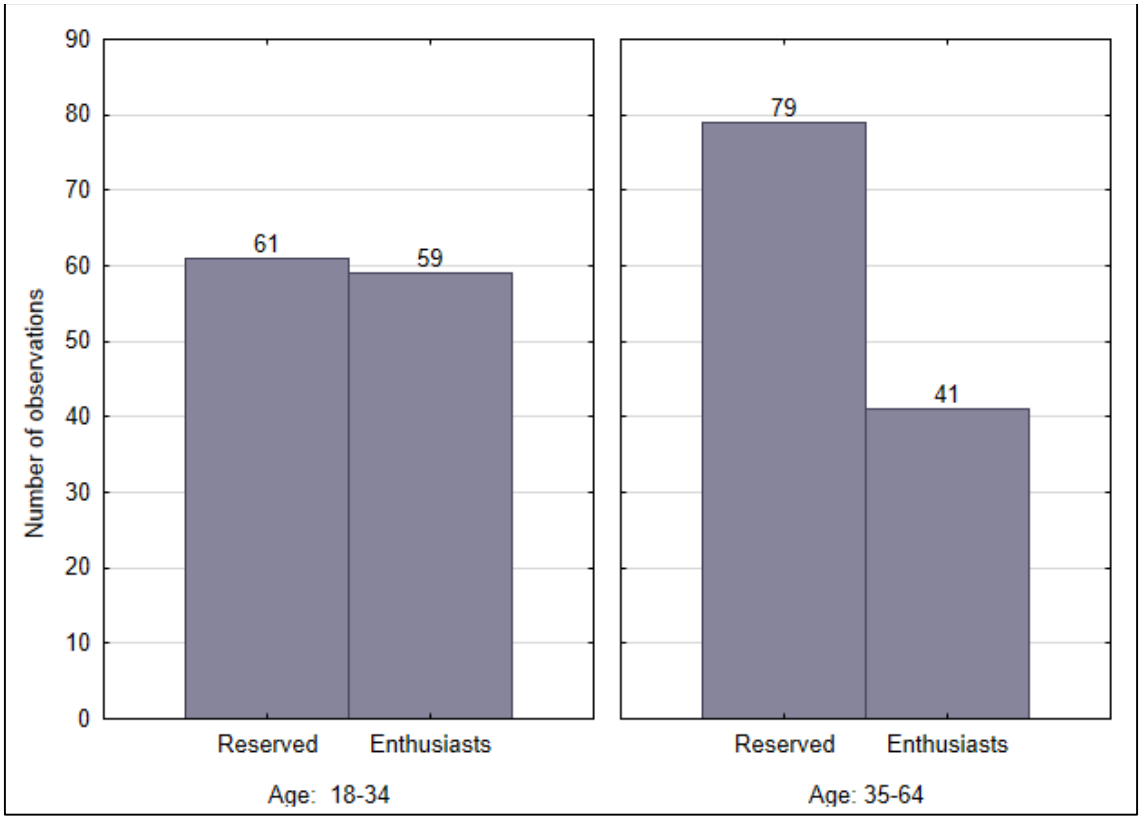

Figure 3. Revealed cluster versus age. Source: own elaboration.

4.2. Acceptance of innovative food versus the speed of acceptance of innovations based on Rogers' Diffusion of Innovation

The questionnaire included the following closed question: 'What is your attitude towards innovations appearing on the food market?' It was devised to assess the speed at which food innovation was adopted by the consumers. The respondents were allowed to select one of five statements derived from Rogers' Diffusion of Innovation Theory:

- I like to be the first to have it, when a new food product appears on the market;
- I buy relatively quickly, but after some thought;
- I buy when some friends have tried it already;
- I buy when most of my friends have already bought it and assessed it positively;
- I'm reluctant to buy.

Based on the reply determining respondents' attitude towards innovations (in terms of the speed of its adoption), they were assigned to appropriate groups. Detailed results are presented in Table 4. Innovators represented the least numerous group, consisting of as few as 2% of all survey participants. The next three groups (early adopters, early majority, late majority) comprised a similar number of respondents, those between 62 and 65. Laggards represented almost one fifth of all respondents.

Table 4.
The speed of adopting innovations in the food market based on Rogers' Theory

Group name	Number	Cumulative number	Percentage	Cumulative percentage
Innovators	5	5	2,08	2,08
Early Adopters	65	70	27,08	29,17
Early Majority	64	134	26,67	55,83
Late Majority	62	196	25,83	81,67
Laggards	44	240	18,33	100,00

Source: own elaboration.

Due to the low number of innovators in the studied sample, this group was merged with early adopters to carry out subsequent analyses. Then, the association between the speed of adopting innovation based on Rogers' model and assignment to a homogenous group in accordance with attitude towards innovative food was examined.

Table 5.
The speed of adopting innovations versus assignment to homogenous group

Group name	Assignment to cluster		Total
	Reserved	Enthusiasts	
Early Adopters	23	47	70
% from the column	16,43%	47,00%	
Early Majority	42	22	64
% from the column	30,00%	22,00%	
Late Majority	39	23	62
% from the column	27,86%	23,00%	

Cont. table 5.

Laggards	36	8	44
% from the column	25,71%	8,00%	
Total	140	100	240

Source: own elaboration.

The structure of both homogenous groups obtained, based on the attitude towards innovative foods (modified FNS scale), differs primarily with respect to the number of respondents assigned to extreme groups based on Rogers' Diffusion of Innovation Theory. Early adopters were fewest in numbers of the groups in the reserved cluster (16,4%), while the number cluster enthusiasts was the largest, constituting almost half of all cases. As regards laggards, the situation is the complete opposite: the reserved cluster numbers over three times more respondents (25,7%) than cluster enthusiasts (8,0%). Graphic representation of the analysed association is shown in Figure 4.

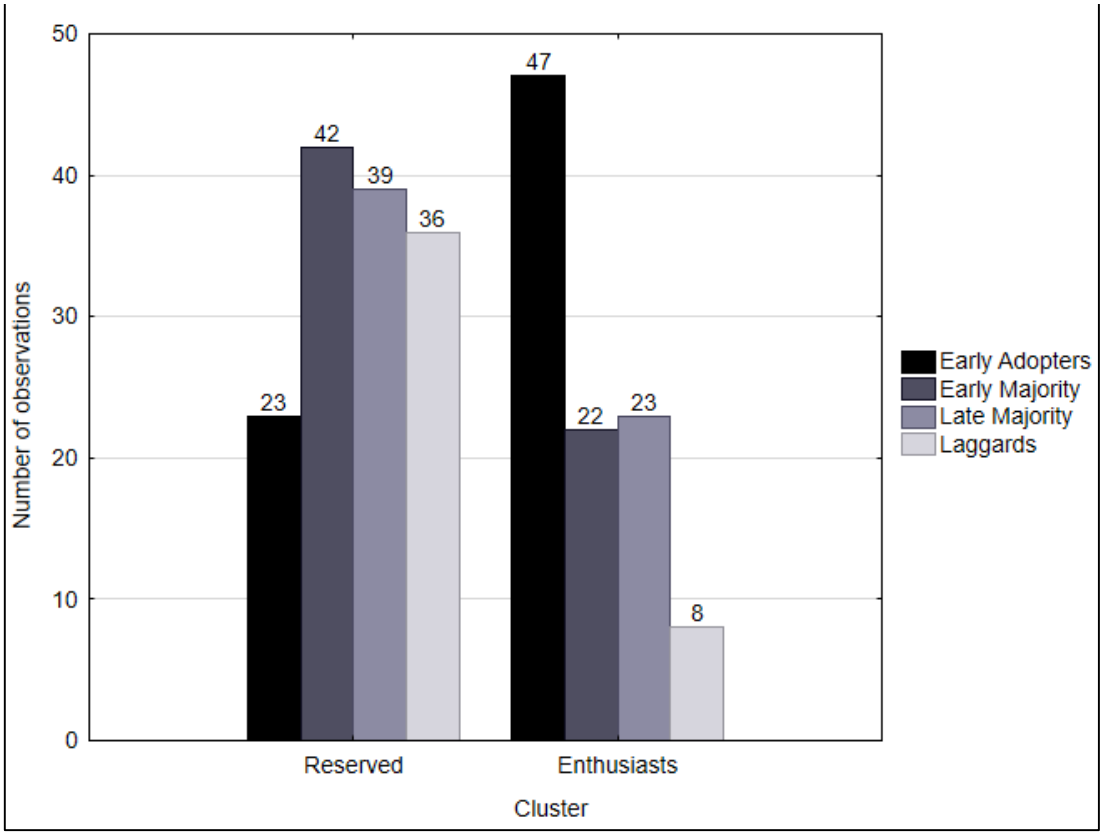

Figure 4. Cluster versus the speed of adopting innovation based on Rogers' model. Source: own elaboration.

The p-value (p = 0,00000) indicates the existence of association between belonging to a homogenous group and the speed of adopting innovations by consumers. This relationship is slightly stronger in the case of previous analyses, but still classified as weak (Cramer's V = 0,3571).

5. Conclusions

In the present study, we attempted to identify factors that have an impact on consumers' acceptance of innovative food products by applying two popular measuring scales: Food Neophobia Scale (10-item scale; 9 items were selected for the purpose of this research) and the model of diffusion of innovation (Rogers' Diffusion of Innovation Theory; 5-point scale). An initial factor analysis revealed that the first scale (FNS) can be reduced to three attributes designated: enthusiasm (four internally consistent items of the FNS scale), neutrality (one item in the FNS scale), and distrust (four internally consistent items). K-means cluster analysis for these three new variables resulted in creating two homogenous groups displaying a similar attitude towards innovative foods. The majority of respondents (58%) represented the 'reserved' cluster, as they expressed their lack of interest innovelty foods and their reluctance to try them. The cluster innovative-foods 'enthusiasts' comprised 42% of all study participants, which indicates that there is plenty of opportunity to expand this market. The research demonstrates that the attitude towards new, unknown food is associated with the consumer propensity generally to adopt innovations quickly (Rogers' Diffusion of Innovations Theory). As shown in this paper, women show more positive attitude towards innovative food than men, and that the reluctance to novelty foods is greater in the older age group. That being the case, the major difficulty involves reaching older citizens (including men). Currently, the easiest way to convey convincing information is to reach Internet users, which describes almost all young and middle-aged persons. Thus, in the future, launching new food products targeted at senior citizens will be easier.

Functional food with proven health effects, constituting one of the innovative food products discussed in the theoretical part of the paper, seems to be the most promising in terms of developing the market. Food producers who plan to design innovative foods boosting health are challenged with convincing reserved and distrustful consumers to make a purchase. Moreover, functional foods should be targeted mostly at older populations and the most difficult task in this respect is concerned with reaching senior consumers. As regards the scientific community, it should focus on advancing methodology to enable detailed time-trend analysis of this phenomenon. When it comes to FNS scale, it would be beneficial to introduce three additional items into the neutral sub-scale to obtain the same number of positions for all analysed variables. Additionally, more attention should be given to the psychographic characteristics of the respondents and to the application of qualitative methods to understand the basis of the reluctance of the older part of our society to avail themselves of scientific achievements in innovative foods, especially those intended for the improvement of health.

Acknowledgements

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TECHNICAL AND ORGANISATIONAL CONDITIONS IN THE MANAGEMENT OF RECOVERY AND RECYCLING PROCESSES OF WASTE BATTERIES AND ACCUMULATORS

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Introduction/background: Waste batteries and accumulators are hazardous waste and should not be sent to landfill sites. Their presence in the waste mixture causes the release of dangerous heavy metals into the natural environment.
Aim of the paper: The aim of the study is to review the processes currently used in the recycling of used batteries and accumulators, currently used in the world and in Poland, as well as installations and technologies, depending on the types, kinds and physicochemical properties of waste, and to draw attention to the ventures to prevent waste generation.
Materials and methods: The paper discusses the nature of waste, storage and transport conditions, organisation of collection, processes and processing technology. The article presents examples of waste management facilities dealing with recovery and recycling of batteries in Poland and Silesia. The research was based on an analysis of legal acts, statistical data, professional literature and company experiences. The second part is a case study. Selected environmental systems presented on descriptive models are based on the results of an environment (region) system analysis.
Results and conclusions: EU directives and national law force the reuse of raw materials used in their production. Therefore, one should strive to apply the most effective technologies of waste recovery and recycling. The most recommended and cost-effective is product salvage followed by material recovery, especially of scarce, rare and precious earth metals. Various processes and technologies (installations) for the recovery of raw materials from waste batteries and accumulators are used around the world. The best known are: Jogmec, Batrec, Recytec, Accurec, Everead, Inmetco, Sab-Nife, Snam-Savam, Citron, Batenus, TNO. Long battery life minimises the amount of waste, and thus reduces the burden on the environment. Therefore, in the process of producing batteries, it is important to improve the technology already at the production stage. An example is the Polish experience (Europower; Tuborg; Tuborg-Silver).

Keywords: hazardous waste, waste recovery and recycling, recycling efficiency, recycling technologies, waste battery and accumulator processing plants.

1. Introduction

Used batteries are a source of valuable raw materials. Recycling the metals they contain saves energy used to extract, process and separate metals from minerals. In addition, the use of recycling reduces the risk to the environment posed by the metals contained in waste batteries/accumulators. Collection of these wastes at landfill sites leads to decomposition and accumulation of toxic metals in landfill leachate (Grzybowska, 2009). The substances that make up batteries and accumulators become dangerous for the environment and human health after they are used up, as they contain: lead, mercury, cadmium, nickel, cobalt and their compounds and the hydroxides: potassium, sodium, lithium. The management of this waste is complex due to its basic composition, as well as the wide range of equipment used in many areas of life (Kawczyńska, 2014; Act of 27 April 2001; Act of 14 December 2012; Kłopotek, 2004; Grzesik, 2005). Recycling of batteries eliminates waste that poses a serious threat to the environment, while at the same time acquiring substances of high purity, useful for various industries.

The hazardous waste management system designed as part of the "Comprehensive hazardous waste management programme for the region of southern Poland" is based on an organised network of municipal collection points (GPZON), transhipment stations (SPON) and enterprises and recovery organisations that have their own network covering the entire country. In terms of the level of collection, recovery, recycling and disposal, as well as the number of units carrying out these processes, batteries rank third in the recycling system (Wengierek, 2017a, 2017b).

2. Nature of the waste

2.1. Battery types and substances contained therein

In accordance with the Regulation of the Minister of the Environment (Regulation of the Minister of the Environment of 27 September 2001; Regulation of the Minister of the Environment of 9 December 2014), waste batteries and accumulators were classified into group 16 (waste removed in other groups) and subgroup 16 06 (batteries and accumulators). In this subgroup, the following types of hazardous waste are listed (*):

16 06 Batteries and accumulators.

16 06 01* Lead batteries and accumulators.

16 06 02* Nickel-cadmium batteries and accumulators.

16 06 03* Batteries containing mercury.

16 06 04 Alkaline batteries (except 16 06 03).

16 06 05 Other batteries and accumulators.

16 06 06 06* Selectively collected electrolyte from batteries and accumulators.

The Act of 24 April 2009 defines a battery and accumulator as a source of electrical energy generated by the direct conversion of chemical energy, which consists of one or more:

- primary non-rechargeable battery cells,
- secondary rechargeable battery cells.

This Act defines different categories of batteries and accumulators (Act of 24 April 2009):

- industrial battery, industrial accumulator — intended exclusively for professional use — industrial use or for installation in electric vehicles,
- portable battery, portable accumulator — a battery and accumulator including button cells or sets that are tightly closed and capable of being carried in the hand and are not industrial or automotive batteries or accumulators,
- automotive battery, automotive accumulator — battery and accumulator used for starter, lighting or ignition initiation in vehicles.

The most popular cells, depending on the type of construction, are: AAA, AA, AA, R1, R14 (UM2, MN1400, HP11), R20 (MN1300, UM1) and PP3-PP9. There is also a division according to the chemical composition of the cells (Jaśnikowski, Marcinkowski, Marek, 2002).

Depending on the composition of the electrolyte and the design of the electrodes, the following battery types are distinguished:

a) Lead-acid batteries — where the electrolyte is a sulphuric acid solution, the electrode (-) is made of lead (with additives) in the form of a grid, and the electrode (+) is made of lead oxide (IV) PbO_2 immobilised on a lead frame – such batteries are used extensively in cars.
b) NiCd accumulators — also known as secondary alkaline batteries – in which the electrodes are made of nickel hydroxide and cadmium hydroxide, and the electrolyte is a semi-fluid or solid substance with a chemical composition varying according to the manufacturer but always having a strongly basic (or alkaline) reaction.
c) NiMH accumulators — an improved version of NiCd accumulators, in which one of the electrodes is made of nickel and the other of sintering rare earth elements (REE) in a hydrogen atmosphere. An electrolytic key is a spongy structure soaked in alkaline substances and a chemically complex catalyst.
d) Li-ion batteries, where one of the electrodes is made of porous carbon and the other of metal oxides, and the electrolyte is made up of chemically complex lithium salts dissolved in a mixture of organic solvents.
e) Lithium polymer batteries — a variety of Li-ion batteries in which the liquid electrolyte is replaced by a solid polymeric electrolyte made of, for example, a polyacrylonitrile-based sponge.

Depending on the charging cycle, a differentiation is made:

- Non-renewable batteries — these are batteries whose construction allows them to be discharged only once. They are made of materials used for the production of secondary batteries, but their construction and production stages are completely different. Therefore, it is not recommended to recharge the primary batteries. Batteries of this type are dominated by the following batteries:
  - Alkaline-manganese.
  - Zinc-carbon.
  - Zinc-air.
  - Lithium.
  - Silver.
  - Mercury.
- Renewable batteries work in the same way as primary batteries, but their chemical processes can be reversed by recharging. The battery is able to recover its original properties and can be used again. Typical secondary batteries are:
  - Nickel-cadmium.
  - Nickel-hydrogen.
  - Lead-acid.
  - Lithium-ion.
  - Alkaline-manganese.

Batteries and accumulators are used in means of transportation, for emergency or power supply in torches, measuring equipment, telephones, tablets, portable computers, cordless electrical appliances, household appliances, etc. Currently, 80% of the batteries used in Poland are disposable batteries. 90% of the amount of waste batteries is generated in transportation, both by business entities and individual users (www.rewolucjawsmieciach.pl/.....).

One tonne of used batteries contains on average the following ingredients: 270 kg manganese dioxide, 210 kg iron, 160 kg zinc, 60 kg graphite, 35 kg ammonium chloride, 20 kg copper, 10 kg potassium hydroxide, mercury (mercury oxide) 3 kg, a few kilograms of nickel and lithium (4 kg), 0.5 kg cadmium, 0.3 kg silver (silver oxide), small amounts of cobalt (Korkozowicz, 2010).

The table below presents an example of the material balance of the recycling process of used automotive accumulators, as well as nickel-cadmium, nickel-metal hydride and lithium batteries. The data is related to 1 tonne of waste (Orzeł Biały SA).

Table 1.
Material balance of the recycling process of waste batteries/accumulators

Waste types	Income (kg)	Outcome (kg)
Used automotive batteries	1,000	
Gypsum		140
Granulate		55
PVC		35
Lead		770
TOTAL	1,000	1,000
Used nickel-cadmium batteries	1,000	
Nickel		190
Cadmium		270
Iron		310
Cobalt		10
Other elements		220
TOTAL	1,000	1,000
Used nickel-metal hydride batteries	1,000	
Nickel		420
Iron		290
Lanthanum		110
Cobalt		10
Other elements		170
TOTAL	1,000	1,000
Used lithium batteries		
Lithium		10
Iron		100
Phosphate minerals		190
Copper		110
Aluminium		240
Graphite		130
Other elements		220
TOTAL	1,000	1,000

Source: Own work based on Orzeł Biały SA.

3. Collection, transport and storage of waste batteries and accumulators

Transport of batteries from collection points to specialised processing plants should be in compliance with applicable laws and regulations. In the case of waste batteries/accumulators, collection schemes are limited and mainly operated by recovery organisations or entities that fulfil the obligations of producers of batteries or accumulators. In the Silesian Voivodeship, these are, among others, the following companies: Elektrozłom Sp. z o.o. — Ślemień, Marco Ltd. Sp. z o.o. — Katowice, Baterpol Sp. z o.o. — Katowice, Przedsiębiorstwo Techniczno-Handlowe TECHNIKA Sp. z o.o. — Gliwice, Mariola Studnic Ekoland — Chałupki, Orzeł Biały SA — Bytom, Prolimit Sp. z o.o. — Katowice, Andrzej Kochel Śląskie Centrum Utylizacji SCU — Katowice, Amper Sp. z o.o. — Tarnowskie Gory, Adam Ben EKO-RORT — Bielsko-Biała, Wektor A. Chudak Sp. j. — Katowice, Włodzimierz Błachut — FPHU BŁACHUT — Sienna (Waste Management Plan ...; Voivodeship ...).

Used portable and small-size batteries are collected in most educational institutions, local government entities and chain stores selling such products.

A separate collection scheme is proposed for waste portable batteries and accumulators, as they are small and very dispersed, as well as to fulfil the obligation to meet the required collection levels.

Used batteries/accumulators as hazardous waste require special EU-approved containers and cars for collection and transport, hence processing plants equip their suppliers with acid-proof containers. Processors also have their own trucks adapted to transport this waste, but their delivery is also handled by specialised transport companies and companies collecting and buying recyclable materials.

The storage and treatment of used batteries should be carried out in places with a hardened, impermeable, weather-resistant surface or in suitable containers resistant to the substances contained therein. On the other hand, waste lead-acid batteries should be stored on impermeable surfaces connected to a closed-circuit sewage system, directing the sewage to special tanks or to an installation processing waste batteries. Used batteries should be stored for a maximum of one year in total.

The main sources of supply of used batteries are:

- companies with their own purchasing points,
- companies specialising in the purchase of scrap from various sources and in its transport to processing plants,
- manufacturers of batteries and accumulators,
- complementary import from abroad.

The level of battery collection in selected EU countries, Poland, including the Silesian Voivodeship, is as follows. Poland is ranked 6th after Belgium, Denmark, the Netherlands, Germany, Czechia (g/person collection rate). In terms of the number of collection points, the Silesian Voivodeship is ranked 2nd (3,003 collection points) after the Masovian Voivodeship (3,305 collection points). Other voivodeships are: Greater Poland, Lower Silesia, Lesser Poland, Łódź, Pomerania and Kuyavian-Pomeranian (www.reba.com.pl).

An important part of the EU directives and the Batteries and Accumulators Act is the minimum requirements for the recycling efficiency of waste batteries and accumulators. These standards depend on the type of waste treated (Directive...; Commission Regulation...).

On 27 September 2011, the minimum recycling efficiency levels came into force by means of technologies and installations for the treatment and recycling of specific types of waste batteries/accumulators (www.mos.gov.pl; Regulation of the Minister of the Environment of 3 December 2009):

- achieving a collection rate for used portable batteries/accumulators of at least 45% of the mass of introduced portable batteries/accumulators in 2016 and subsequent years,
- maintaining the level of recycling efficiency:
  - used lead-acid batteries/accumulators of at least 65%,
  - used nickel-cadmium batteries/accumulators of at least 75%,
  - other used batteries/accumulators of at least 50%.

In 2014, Poland achieved the required recycling efficiency levels for waste batteries and accumulators set out in Directive 2006/66/WE. This is (Report...):

- 77.3% for waste lead-acid batteries/accumulators,
- 85.5% for waste nickel-cadmium batteries/accumulators,
- 56.7% for other waste batteries.

According to the report of the Chief Inspectorate of Environmental Protection [GIOŚ] on the functioning of the system of management of batteries and accumulators and waste batteries and accumulators for 2014, all collected used batteries and accumulators were subjected to treatment, including recycling (in accordance with Article 12, paragraph 1 of Directive 2006/66/WE).

The collected waste has not been exported outside the EU. In 2014, over 1,402 Mg of waste with code 16 06 01* (in 2013, this was 1,917 Mg) was imported to Poland from Germany, Slovakia and Cyprus (rzseie.gios.gov.pl/...; www.mos.gov.pl).

The recycling rate of waste batteries and accumulators in 2015 amounted to 109.68%. In the previous years, the recycling rate achieved by Poland was lower. This was 80.43% in 2014, 91.23% in 2013 and 98.59% in 2012. The plants did not process all used batteries; surpluses were accumulated in warehouses and, depending on the volume and capacity of the installation, were gradually processed in 2015 (Report...).

For waste portable batteries/accumulators, 38.35% (assuming a 40% level) was collected in 2015 (Directive ...; Report ...).

In the Silesian Voivodeship in 2014, a total of approximately 2,300 Mg of waste batteries and accumulators were produced, including 2,200 Mg of hazardous waste. However, approximately 14,700 Mg was collected, including 14,400 Mg of hazardous waste. A total of almost 76,000 Mg of waste was recovered (six recovery and recycling plants). The dominant recovery process was process R4 (Recycling and recovery of metals and metal compounds) (Voivodeship...).

Due to the progressive development of technology, more and more batteries and accumulators are being used in various areas of life. Assuming an increase of 1-1.5% in the amount of collected waste batteries and accumulators per year, for 2030, this increase in relation to the base year 2013 will amount to about 20-25%, while maintaining the percentage level of collection set for 2016 (www.mos.gov.pl/pl/.....).

In the Silesian Voivodeship, the forecast of the volume of battery waste expected to be collected separately by 2030 is as follows: 2020 — 2,627 Mg/year, 2022 — 2,951 Mg/year, 2028 — 3,414 Mg/year, 2030 — 3,883 Mg/year (ietu.pl).

Such a small upward trend in the quantity of collected waste batteries will result from the improvement of their quality and the extension of their lifespan.

4. Recovery and recycling technologies of batteries and accumulators

All types of batteries/accumulators contain metals and their compounds and possible additives, e.g. graphite, polymers, etc. This makes it necessary to use different processing methods and technologies (ippc.mos.gov.pl/ippc/...).

Depending on the type of waste (cells of one type or a mixture of cells), three basic types of material recovery processes are used in the battery/accumulator recycling process (Pyssa, 2007; Kopczyk, 2005; Rogulski, 2005):

- Mechanical (separation).

  They are most often used for large batteries (industrial type) and as a preliminary operation in most of the processing technologies. They involve mechanical loosening of the structure (body) of the battery and separation of components with characteristic physical properties (density, size, magnetic properties). These activities are usually simpler and cheaper than other processes and should therefore be used to prepare the material stream for further chemical processing. Mechanical methods most often boil down to shredding and separating into individual fractions of used battery mass: ferromagnetics (steel, chromium, nickel), diamagnetics (paper, plastics, tar), paramagnetics (other impurities, non-ferrous metals, graphite) (Lower Silesia...). Technologies for recovery and disposal of batteries and accumulators were presented in detail on the example of the DKE Oława Sp. z o.o. battery recycling installation in Polkowice (Dolnośląska...; www.reba.pl).

- Thermal (pyrometallurgical).
  They are based on the recovery of materials by melting metals in special furnaces. Their advantage is the possibility to recycle various types of cells, including those containing organic electrolyte. On the other hand, the relatively low efficiency of such recycling and the possibility of creating secondary waste during the process significantly limits their use. There are industrial installations that process unsorted battery and accumulator scrap, such as CITRON (France). The technology applied there allows for the recovery of zinc, lead and cadmium after their evaporation in a rotary kiln at a temperature of 1,250°C. Other metals, such as iron, manganese, nickel, chromium, cobalt, copper and others, found in the reaction sludge, may undergo further processing. Pyrometallurgical technologies (Sab-Nife, Snam, INMETCO), based on the distillation of cadmium at 900°C are used in the processing of Ni-Cd batteries. Cadmium is recovered in the form of powder – cadmium oxide. The oxide obtained is used, among other things, for the production of accumulator masses and cadmium pigments, and any ferro-nickel-containing parts are used for the production of alloy steels. In these technologies, nickel and cadmium are not fully recovered. In addition, pyrometallurgical processes are energy-intensive and cause the emission of dust and gases into the atmosphere.
- Hydrometallurgical.
  They are based on acidic or alkaline leaching of properly prepared battery waste (after mechanical treatment processes). It is followed by a sequence of physicochemical operations that lead to the separation and concentration of valuable or burdensome components between the relevant phases, all the way to commercial products and semi-finished products for separate technological processes. The advantages of these methods are low energy inputs and the generation of small amounts of secondary waste. The overall process generally involves the following steps: dissolving the respective waste fractions, purifying and concentrating the resulting solution, separating pure chemicals. In industrial practice, the Batenus technology is most often used. This is a multi-stage hydrometallurgical process that has been in use since 1996. It allows for the recovery of more than 99.5% of components from used batteries and accumulators, and the recovered metals are directly reusable. The TNO process, which involves leaching in hydrochloric acid, is also often used, followed by cadmium extraction with tri-butyl phosphate. Finally, nickel and cadmium are recovered by electrolysis. Bertolozzi has developed a method based on selective leaching in sulphuric acid (VI) and metal recovery by ion exchange and solvent extraction of the sludge fraction of crumbled Ni-Cd batteries. The final product of this technology is nickel, cadmium and iron salts. Recovery of the useful components of Ni-MH batteries is possible thanks to a combination of two-stage leaching (HNO3, HCl), solvent extraction and precipitation techniques. As a result of these processes, 16% of used batteries and accumulators is recovered (Wengierek, 2018; Sobianowska-Turek, 2009).

4.1. Recycling of lead-acid batteries

A lead-acid battery consists of two sets of lead plates and a vessel with electrolyte. One plate set is a positive pole. These plates are coated with lead dioxide (PbO_2). In the second group of plates, which is a negative pole, the so-called spongy lead is used. Plates made in this way are placed in the electrolyte. The electrolyte in this type of batteries is a sulfuric acid solution.

In motor vehicles, lead-acid batteries are still the most frequently used source of static energy (Merkisz, 2011).

The process of recycling lead-acid batteries consists of the following stages (Bendkowski, Wengierek, 2004; Pyssa, 2006):

1. Separation of the battery into components. This technology involves dismantling the battery, then separating and filtering the components: metallic fraction, polypropylene from the battery casing, pastes (mainly lead sulphate and lead oxides), polyethylene, electrolyte.
2. Desulphurisation. As a result of this process, the sulphur content of lead paste drops from approximately 8% to maximum 1%.
3. Crystallisation of sodium sulphate. The filtered and chemically purified solution is directed to the crystallisation line. This process results in high-purity crystalline sodium sulphate.
4. Production of raw lead. The metallic fraction recovered in stage 1 and the lead paste desulphurised in stage 2 are melted down into crude lead in fully automated melting lines.
5. Production of refined lead and lead alloys. Raw lead is melted in refining boilers and subjected to refining processes, i.e. removal of foreign metal impurities.

The main product of battery recycling is refined lead of high purity and lead alloys intended mainly for battery manufacturers. Other products recovered in the process of battery scrap recycling include: polypropylene intended for manufacturers of plastic products and crystalline sodium sulphate used in the chemical, glass, paper and textile industries.

4.2. Recycling of large and small size nickel-cadmium batteries

The nickel-cadmium battery (Ni-Cd) is one of the most common types of battery, which is equipped with high quality electrodes made of basic nickel oxide and metallic cadmium. Ni-Cd batteries and accumulators can be divided into small and large size. While the former are mainly used in cordless and mobile phones, the latter, due to their large electrical capacity and durability (10-12 years), are used in mining, metallurgy, telecommunications and railways. The treatment of Ni-Cd batteries and accumulators includes recycling processes using various technologies. These include (Wolff, Ziaja, Stryjewski, 2006):

- Accurec technology.
  The first stage of processing is to remove the electrolyte and then to separate the casings, mainly made of plastics. The remaining material is vacuum distilled in a quartz tube furnace, in which a container of raw material is placed and inductively heated. The process is carried out in two stages at a pressure of about 10 mbar. First, the plastic parts are burned at a temperature that does not exceed 500ºC; the temperature is then raised to 850ºC, and cadmium is distilled. A single operation takes about 12 hours. Cadmium purity is 99.95% unless other batteries are mixed in the batch. The processing plant is located in Mülheim, Germany, with an annual capacity of 1,000 Mg.
- Everead technology.
  Another process developed for the recycling of nickel-cadmium batteries (Ni-Cd) is the Canadian Everead process. It was created for waste containing cadmium. It is a pyrometallurgical technology whose three basic operations are carried out in one furnace. The cycle begins with heating the material for about 1.5-2 hours at a temperature of 200-300ºC. Its purpose is to remove moisture. The temperature is then raised to 500-700ºC, and heating continues for another 2-2.5 hours. In this phase, organic material is fired. Ultimately, the temperature is raised to 900-1,100ºC, and cadmium is distilled. This stage lasts 2.5-3.5 hours and is carried out under inert gas conditions (argon) and after the charge surface has been covered with carbon material. Cadmium vapours are condensed in the adjacent chamber, where a temperature of 300-400ºC is maintained. The declared purity of cadmium produced in this way is 99.9998%.
- Inmetco technology.
  lnmetco is a process developed by the International Nickel Company (INCO). Originally, it was designed to process dust from electric furnaces, but it can also be used for other materials, e.g. nickel-cadmium batteries. Technological operations begin with placing dusts with carbon reducing agents in a rotary kiln, in a thin layer, and heating them up to 1,350ºC. Zinc and lead pass into the gaseous phase, while chromium and iron remain in the granular material. In the case of batteries, e.g. Ni-Cd, Ni-Fe, Ni-MH, Li-ion and Zn-Mn (excluding those containing mercury), cadmium is also transferred into the gaseous phase. The products of the process (volatile dust and firings) are processed separately. Pre-selection of batteries plays an essential role in the technology, preventing contamination of the product, removal of electrolyte and crushing of the larger ones. Currently, in the developed variant, the material from cadmium batteries, after preliminary preparation, is heated for 12-14 hours in a chamber furnace at 950ºC, in a non-oxidising atmosphere, in order to isolate cadmium. Only after this process is the material directed to the electric furnace. The purity of cadmium obtained in this way remains at a level of 99.95%.

- The Sab-Nife process.
  One of the first nickel-cadmium battery recycling processes developed in Sweden in the 1980s is Sab-Nife. At the beginning, electrolyte is removed, and the electrodes are cleaned and dried. The material (electrodes) then goes to the reactor, where three consecutive operations are performed. The first reactor is heated to 400-500ºC, and the organic matter is burned in a controlled atmosphere of a mixture of nitrogen and oxygen. This stage lasts approximately 24 hours, and the control of the process conditions (especially the oxygen potential) is related to the reduction of cadmium evaporation. Process gases are burned in a separate chamber. After the organic matter is burned (gasified), the reactor temperature is raised to approximately 900ºC, and cadmium is distilled. During this process, a reduction atmosphere (a mixture of nitrogen and hydrogen) is maintained. This stage lasts about 20 hours, and after its completion, the batch contains no more than 0.01% of cadmium. In the last part, the temperature is raised to about 1,300ºC to obtain an Fe-Ni alloy. The purity of cadmium obtained in this way is, as in the case of other processing technologies, 99.95%.
- Snam-Savam technology.
  The Snam-Savam process originates from work conducted by two companies in the 1980s: Société Nouvelle Dáffinage dês Métaux (Snam) and Société Aveyronnaise de Valorisation dês Métaux (Savam) in France. Currently, the process is used for Ni-Cd and Ni-MH batteries. First, the plastic containers are pre-treated, i.e. they are cut and separated. The recovered electrolyte is cleaned of cadmium and sold to battery manufacturers. The cathode and anode material, together with household batteries, is divided into three categories: containing cadmium, containing nickel but not cadmium, not containing any of these elements. In the cadmium material, the organic part is gasified, and the metallic cadmium is distilled. It is then melted together with components containing nickel, but without cadmium, into an Fe-Ni alloy.

4.3. Recycling of portable batteries/accumulators

In the case of recycling of portable batteries and accumulators, the recycling process is more standardised, despite the use of different treatment methods (Sobianowska-Turek, 2009).

The Ni-MH battery recycling process consists of the following steps:

- sorting,
- a discharge of residual energy from the battery,
- thermal decomposition of organic parts, mainly plastics,
- extraction metallurgy, i.e. melting and purification of metals,
- recovery of nickel and iron, for use in the production of stainless steel,
- return of metal hydride elements as slag (low value, used e.g. as road aggregate).

The recycling process of lithium, lithium-ion batteries consists of the following steps:

- sorting,
- a discharge of residual energy from the battery,
- cooling the battery to at least -160°C with liquid nitrogen,
- cutting and shredding of batteries,
- separation of shredded material (sorting),
- conversion of lithium to lithium carbonate or lithium oxide,
- neutralisation of electrolytes to the form of permanent compounds,
- recovery of cobalt from lithium-cobalt oxide ($LiCoCO_2$), if possible.

The existing recycling processes for the material recovery of lithium-ion and Ni-MH batteries and cell packs are based on a melting process in which batteries, cell packs and other output materials are loaded into a kiln without pre-treatment, which minimises the risk for operators (prevents the formation of carcinogenic hazardous substances, i.e. dioxins and furans).

Melting conditions are strictly controlled. In the process, we obtain pure slag (used in the construction industry as an aggregate for concrete). In the cobalt and nickel cleaning installation, alloys containing these two elements can be further processed to obtain pure cobalt and nickel. In a further process, the cobalt obtained is converted into final lithium-cobalt dioxide ($LiCoO_2$), which can be used in the production of new lithium-ion batteries.

The nickel-metal hydride battery recycling project was developed by Jogmec, supported by the Japanese government. It aims to increase metal recovery and to reuse and reduce the amount of hazardous waste. In addition, the company has developed a technology to increase the recovery of nickel, cobalt and cerium/rarity metal alloy (lanthanum and cerium) for reuse. Thermal recovery processes used for Ni-Cd cells are designed to recycle large industrial cells used in the railway industry, by power plants, the army and telecommunication companies, as back-up energy sources. Small Ni-Cd cells used in transmitter-receivers, portable tools and electrical devices, medical equipment and emergency lighting installations are also reprocessed.

The recovered cadmium is used to produce new Ni-Cd batteries. Nickel and iron are melted again into an alloy used for the production of stainless steel. Battery electrolyte can be used as a reagent in wastewater treatment plants (www.jogmec.go.jp).

Lithium-metal-hydride batteries provide even longer service life (much higher energy storage density). Currently, there is a lot of research going on into silicon, which is the best lithium absorbing material with the highest capacity of all known materials.

5. Recovery and recycling facilities for batteries and accumulators in Poland, including the Silesian Voivodeship

As of 31 December 2014, a total of 2,798 businesses were registered, including 2,774 businesses placing batteries or accumulators on the market (630 businesses placing only batteries and accumulators on the market and 2,144 businesses placing batteries or accumulators together with electrical and electronic equipment on the market) and 24 businesses operating waste battery or accumulator treatment plants. The number of entities introducing batteries/accumulators in the territory of the Silesian Voivodeship as of 11 October 2015 amounted to 339 (Voivodeship...).

Within the territory of Poland, there are two installations for processing waste nickel-cadmium batteries and accumulators with a capacity of over 2,000 Mg. Taking into account the mass of waste nickel-cadmium, large and small batteries and accumulators recycled in 2014 (504 Mg) and the mass of those batteries placed on the market in 2014 (939 Mg), it can be estimated that the capacity of the installations for the treatment of this waste group in Poland is sufficient.

The waste batteries and accumulators produced in the Silesian Voivodeship are estimated at about 7,000 Mg/year. These are mainly used lead-acid batteries with electrolyte produced in an amount of about 6,650 Mg/year, large-size Ni-Cd batteries – 300 Mg/year, small-size Ni-Cd batteries – 50 Mg/year and other small-size (including mercury) batteries – about 6 Mg/year. In the voivodeship, the recovery of Ni-Cd batteries is handled by MarCo Ltd. located in Rudniki near Częstochowa, which recovers iron-nickel plates, iron-cadmium plates and electrolyte. The electrolyte is neutralised, and the iron-cadmium plates are transferred for processing into cadmium oxide, which is collected by the Kadm-Oława company for the production of cadmium oxide. Nickel-iron plates are exported. An alkaline electrolyte is used to neutralise acidic solutions. The Kadm-Oława company (at "Oława" steelworks) [hutaolawa.pl] specialises in the processing of ferro-cadmium plates into cadmium oxide. It has technologies where in one cycle, cadmium oxide is directly obtained from ferro-cadmium electrodes. Oxide is used for the production of accumulator masses and cadmium pigments, and iron and nickel-containing parts are used for the production of alloy steels.

The co-owners of the company are "Oława" steelworks, MarCo Ltd. Sp. z o.o. and Permedia S.A. [listed company]. Another plant is located in Polkowice and belongs to Ecoren DKE Sp. z o.o. [Ltd.]. The company has a crusher, a mill and a magnetic separator. Waste batteries are shredded and magnetically separated. The processing generates metal-bearing fractions and waste fraction (ferromagnetic, paramagnetic, diamagnetic) (batteries.eko.org.pl/...). The installation has a capacity of 1,500 Mg of portable batteries and accumulators per year.

There are only a few recycling facilities for portable batteries and accumulators in the country. One of the largest plants of this kind is located in Stanowice. The French company Recupyl, together with Zakład Utylizacji Odpadów Sp. z o.o. in Gorzów [Waste Treatment Plant in Gorzów Ltd.], built a plant for sorting and processing used batteries with a capacity of 2,000 Mg per year. In 2010, a technological line for battery recycling was launched and is the only one in this part of Europe. Today, the plant collects batteries from Sweden, Latvia, Lithuania, Germany and Finland. The plant recovers coal, alkaline, zinc-air and lithium batteries (gorzow.gazeta.pl/...).

The processing of lead-acid batteries is carried out by only two companies located in the Silesian Voivodeship: Orzeł Biały in Bytom – capacity of 120,000 Mg of scrap metal per year, and Baterpol in Świętochłowice — capacity of 70,000 Mg per year. These companies have a waste battery collection network.

The battery recycling process is mainly aimed at recovering lead and sulphuric acid. The demand for processing of lead batteries in Poland is estimated at approximately 80,000 Mg, and the processing capacity of these two plants significantly exceeds this.

In the case of zinc batteries in Poland, there are four large processing plants with a capacity of more than 14,000 Mg (eneris.pl).

5.1. Recycling of batteries at Baterpol S.A. [listed company]

Recycling of battery scrap in the company consists of several stages (baterpol.pl; ecogroup.info; ekogroup.info; wnp.pl/...):

1. Separation of the battery into components.
   The technology is based on dismantling the battery and then separating and filtering the components. After breaking the battery, the electrolyte is filtered and recovered. The remaining solids are subjected to flotation separation. The following are formed: metallic fraction (the so-called grid, battery terminal clamps, intersectional connections in the battery), polypropylene from the casing, paste (mainly lead sulphate and lead oxides), polyethylene. All products are repeatedly washed and deacidified.
2. Desulphurisation of paste.
   The recovered lead paste and electrolyte are directed to the line in the previous stage. The sulphur content of the paste drops from approximately 8% to maximum 0.5%. Chemical reactions in this process result in a solution of sodium sulphate.
3. Crystallisation of sodium sulphate.
   The filtered and chemically purified solution is directed to the crystallisation line. This process generates high purity crystalline sodium sulphate. Stages 1, 2 and 3 of the activities are carried out using the equipment of the Italian company Engitec Technologies S.p.A. [listed company].

4. Production of raw lead.
   The metallic fraction is melted into raw lead in the furnaces of the Lead Plant in Szopienice, and the desulphurised lead paste in stage 2 is melted into raw lead in the modern, automated melting line of the French company BJ Industries, which is located in Świętochłowice.
5. Production of refined lead and lead alloys.
   Raw lead from both plants is melted in refining boilers in Szopienice and subjected to refining processes, i.e. removal of foreign metal contamination.

The products obtained from the recycling process are refined lead and lead alloys, which are collected mainly by the producers of lead batteries.

Moreover, rolled and extruded products from lead and lead alloys, crystalline sodium sulphate used in the chemical industry, mainly for detergents, as well as polypropylene, used in the manufacture of plastics, are obtained.

Technological solutions in the company close the cycle of battery recycling and allow for economic use of more than 95% of the mass of battery scrap. The plant can process over 70,000 Mg of battery scrap by recovering 17,500 Mg of metallic lead, 28,500 Mg of lead paste, 3,500 Mg of polypropylene, 700 Mg of ferrous waste and 1,400 Mg of electrolyte.

The processing of battery scrap is executed in the modern technological lines of the ENGITEC TECHNOLOGIES company utilising the so-called CX Technology.

5.2. Recycling of batteries at Orzeł Biały S.A. [listed company]

The technological process of Orzeł Biały S.A. is characterised by the so-called closed production cycle, which means that waste is processed and managed or stored inside the company. The company's technological facilities are constantly being modernised, and its refinery is one of the most modern in Europe. The company has been cooperating with the Institute of Non-Ferrous Metals in Gliwice for many years. The entire technological process consists of several stages (orzel-bialy.com.pl; orzel-bialy.com.pl/pl...; bj-industries.net/...; gravitatechnomech.com): separation of electrolyte from used batteries, crushing of battery scrap at the Battery Scrap Processing Department (so-called breaker), smelting of lead-bearing materials at the Metallurgical Department, refining of crude lead at the Refinery Department (high quality lead alloys and refined lead, so-called soft lead).

The first stage of the production cycle is the separation of individual battery fractions, which include electrolyte, plastic fraction (polypropylene), PVC, lead-bearing paste and metallic fraction. The electrolyte is processed (neutralised) into gypsum, which is then stored and sold. Polypropylene is crushed, cleaned and converted into granules, which is also stored and sold. The separated polyvinyl chloride (PVC) is transported and stored in the Bytom Municipal Enterprise [Bytomskie Przedsiębiorstwo Komunalne]. The remaining fractions, i.e. lead-bearing paste and metallic fraction, are sent to the metallurgical division, where the process of their remelting takes place. For this purpose, a BJ Industries tilt and turn furnace is used.

The result of this stage is raw lead, which is sent to the refinery and then refined. As a result of refining, refined lead and high-quality lead alloys are produced. The final product is subjected to control tests in a laboratory to confirm the correct composition of lead, i.e. 99.97% to 99.99%. If the requirements are not met, the product is re-melted and re-refined. A product with appropriate properties goes to a warehouse, where it is stored in one room with batteries intended for recycling. Ultimately, the product is sold. In addition to soft lead, the following are also final products: low-processed alloys with a low content of other metals, antimony alloys with the addition of other metals and calcium alloys.

6. Summary and conclusions

Uncontrolled disposal of waste batteries and accumulators leads to contamination of the soil and groundwater with hazardous substances. The recovery and recycling of these wastes, especially the material recovery (acquisition of secondary raw materials) allows for a reduction in the demand for and extraction of valuable natural resources. On a global scale, it contributes to saving raw materials and energy, eliminating or reducing the quantity and toxicity of solid, liquid and gaseous waste and reducing the negative impact throughout the entire life cycle of the product. Prevention of waste batteries and accumulators is mainly based on the use of long-life batteries and accumulators, including the selection of energy-efficient appliances. As a matter of fact, benefits can also be achieved by restricting the use of disposable batteries in favour of reusable batteries. An example of extended-life batteries are those of the company Emu sp. z o.o., spk from Gdańsk – Europower and Tuborg batteries by AutoPart from Mielec (http://www.emu.com.pl…; http://www.prostowniki-akumulatory.pl/…).

Conclusions of the study

1. Depending on the types of waste (single cell, mixed cell), three basic types of processes are used to recycle batteries and accumulators. These are: mechanical, pyrometallurgical and hydrometallurgical.
2. Mechanical processes are used to prepare a given material for further chemical processing (mechanical and magnetic separation). An example is the recovery of nickel-containing alloys from waste nickel-hydrogen batteries and accumulators (Jogmec – Japan) (www.jogmec.go.jp).
3. Pyrometallurgical processes are used to recover materials by melting metals in special furnaces. They also allow for the recovery of metal oxides (iron, manganese, zinc). Some examples are processes of conversion of zinc-manganese batteries (Batrec — Switzerland (www.batrec.ch), Recytec — France (www.recytec.fr)) and conversion of nickel-cadmium batteries (Accurec — Germany (https://accurec.de), Everead — USA

(www.eveready.com), Inmetco — USA (www.inmetco.com), Sab-Nife — Sweden (saftbatteries.com), Snam-Savam — Sweden, France (www.snam.com)). The advantage of these processes is the possibility to recycle various types of cells, including those containing organic electrolyte.

4. Hydrometallurgical processes are based on acidic or alkaline leaching of battery waste pre-prepared in mechanical treatment processes. Batenus and TNO technologies for the recovery of nickel and cadmium from nickel-cadmium batteries and accumulators are most frequently used in industrial practice.
5. In Poland, the basic method of recycling cells is their mechanical shredding, capturing the resulting ferromagnetic fraction used in the iron and steel industry, converting the diamagnetic fraction (paper and plastic elements) into alternative and paramagnetic fuel (non-ferrous metals and graphite) constituting waste consisting of non-ferrous metals and residues of the ferromagnetic fraction used, among others, for pencils and paints.
6. Recycling of lead-acid batteries in Poland is carried out by only two companies (Orzeł Biały, Baterpol — the Silesian Voivodeship). The recycling process carried out in these companies is mainly aimed at the recovery of lead and sulphuric acid. Despite the unfavourable situation (low lead prices, overproduction of cheap lead in China), almost 100% of waste batteries is currently processed, and the capacity of these two plants significantly exceeds the demand for processing of lead batteries in Poland.
7. Collection of small size batteries and accumulators is very poor in the country. A positive example is Nokia's operations (forty service points, including six in Silesia).
8. At present, Poland lacks an effective system for collecting and processing small nickel-cadmium batteries (no plants with appropriate processing technologies). Export could be the solution — France, Sweden, Germany.
9. In the case of large-size batteries and accumulators, the processing is started periodically, only if an order is placed, due to the withdrawal of cadmium from use (Oława steelworks). Due to the lack of sales to CdO, it is necessary to change the technology of processing cadmium plates to metallic cadmium (does not harm the environment when stored). In the disposal of batteries, the nickel plates are mainly recovered (economically viable sales). The remaining disassembly products are removed by pouring the electrolyte into the sewage system or soil, while the iron-cadmium plates are transferred to steelworks as scrap.
10. Nickel-cadmium batteries and accumulators are gradually being replaced by other types of cells, e.g. nickel-metal hydride, lithium-ion or lithium-polymer. There is a technology of freezing lithium batteries in liquid nitrogen before they are crushed. The lithium is then dissolved in a special solution. The element recovered in this way can be used repeatedly. The main source of this element is to be the recycling of lithium-ion batteries (relatively low price and small fluctuations in price changes). The most cost-effective way to recycle is to recycle nickel-metal hydride batteries.

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