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IDENTIFICATION OF LEADING FACTORS SUPPORTING DECISIONS IN PREVENTIVE QUALITY MANAGEMENT

Agnieszka MISZTAL[1*], Milena DRZEWIECKA-DAHLKE[2], Roma MARCZEWSKA-KUŹMA[3], Józef GRUSZKA[4]

[1] Poznan University of Technology, Faculty of Engineering Management; agnieszka.misztal@put.poznan.pl, ORCID: 0000-0003-4439-4198
[2] Poznan University of Technology, Faculty of Engineering Management; milena.drzewiecka-dahlke@put.poznan.pl, ORCID: 0000-0002-3997-7631
[3] Poznan University of Technology, Faculty of Engineering Management; roma.marczewska-kuzma@put.poznan.pl, ORCID: 0000-0002-5473-4689
[4] Poznan University of Technology, Faculty of Engineering Management; jozef.gruszka@put.poznan.pl, ORCID: 0000-0003-1700-0931
* Correspondence author

Purpose: The main aim of the article is to present the results of research of entrepreneurs who maintain a certified quality management system in terms of leading factors supporting decisions of a preventive approach to management.
Design/methodology/approach: Interview method conducted in manufacturing companies with an implemented and certified quality management system using CATI technique
Findings: Research has shown that in large industrial enterprises the key stimulants of preventive actions are, above all, efficient information flow, technical and organizational order, as well as consistent pursuit of the goal. Smaller enterprises put the main emphasis on maintaining good relations with the environment, safety and ergonomics of work, as well as skillful selection of suppliers.
Research limitations/implications: The authors of the paper see the need to continue research in the field of in-depth analysis of selected factors in relation to the effectiveness of the actions taken and the possibility of supporting information.
Practical implications: Entrepreneurs with knowledge of key stimulants will make decisions more consciously and focused on a targeted analysis of data in order to search for relevant premises to prevent non-compliance.
Originality/value: This paper concerns key factors influencing a preventive approach that can support decision-making. For the purposes of multicriteria decision-making processes, it is valuable to know the key stimuli characteristic of effective preventive actions. An additional value of the article is the showing of the factors with a differentiation by company size. This enables a more relevant focus of the research results.

Keywords: decision making, prevention of non-conformities, quality management.

Category of the paper: Research paper.

1. Introduction

Increased competitiveness, cost reduction, and greater satisfaction of internal and external customers are just a few of significant benefits of implementing a quality management system in an enterprise. The need to survive in a very demanding market and to ensure operation in accordance with international standards prompts enterprises to obtain quality certificates. However, it is not enough just to obtain them. It is important to monitor internal and external changes taking place in the enterprise and assess their effects. In companies with quality management systems, the manufacturer should establish processes, specifying when and how to make corrections, corrective or preventive actions. It is the ability to eliminate the threats and implement control mechanisms that prevents potential problems and is essential for continued customer satisfaction and continued effective business practice. Making decisions on preventive actions is extremely difficult due to the unavailability of premises and the reliance on risk estimation (Schätter et al., 2019, p. 12; Ivanov, 2020). An additional difficulty is determining the areas of threat seeking, which are diverse and translate to a different level as a result of product non-compliance.

Preventive actions are important for the functioning of quality management systems, however, they are discussed in only a few studies in the literature, and those that are available usually refer to selected aspects of management (Selvik, Bansal, Abrahamsen, 2021; Shojaie, Kahedi, 2019, pp. 35-43). This the more surprising that knowledge about management has a large set of methods and tools to support decision making. Unfortunately, the level of their use is still low, despite the fact that entrepreneurs more and more often see the need for risk analysis and a predictive management style (Misztal, Belu, 2016). There can be many reasons and conditions for insufficient use of management methods. Hence, there has been a need to conduct research covering both barriers and incentives for a preventive approach in enterprises.

The cognitive aim of the research was to assess the level of awareness and preventive approach in the quality management of production companies. The utilitarian goal of the research was to identify good practices in the use of a preventive approach in manufacturing companies. The main aim of the article is to present the results of research of entrepreneurs who maintain a certified quality management system in terms of leading factors supporting decisions of a preventive approach to management.

2. Literature search for premises for possible prevention

Preventive quality management in manufacturing companies has been an issue promoted for years by quality promoters, but still insufficiently defined in the literature. Undoubtedly, preventive actions constitute the most rational form of organizational improvement. It is due to their proactive, and not reactive nature that they are the most profitable and justified economically (Szkoda, 2012, p. 62). These actions are aimed at eliminating potential nonconformities in order to prevent their occurrence. Potential problems can be identified by applying methods such as extrapolating corrective actions for current nonconformities to other applicable areas with similar actions, trend analysis or research into operational risks. The main tasks of nonconformity management include identifying possible causes of nonconformities and developing the necessary corrective actions to prevent them. The ISO 9001: 2015 standard gives an important place for corrective actions to eliminate identified nonconformities. As it is known, there is no section in the current version of the standard where detailed requirements for preventive actions are formulated. However, this does not mean that preventive action should be rejected. As noted in on the contrary, preventive actions become an integral part of the risk management system. They become part of 'risk-based thinking' where risk comes to the fore (Ivanov, 2020; Ezrahovich, Vladimirtsev, Livshitz, Lontsikh, Karaseva, 2017, pp. 506-51).

The PDCA cycle is the starting point for considering preventive research in quality management systems. It was W. Edwards Deming who in the 1960s recognized that an effective method for continuous improvement is to prevent the occurrence of controlled variability, which can be limited by appropriate preventive actions resulting from the theses he cited. Actually, each of the following steps he has a message for continuous improvement through prevention. Continuous improvement of previously obtained results allows to increase the efficiency and effectiveness of the company's operations.

What is more, Juran found that in addition to not taking into account the total cost of these efforts, companies have invested far more money in dealing with external failures than in preventing them. Interpretation of selected theses of Deming and Juran and an attempt to characterize their preventive character is presented in Table 1.

Table 1.
Selected theses of Deming along with their importance in preventing nonconformities and the connection with Juran's Principles

Deming's principle	Juran's principle	Importance
1. Creation and maintenance of company's orientation aimed at continuous product improvement, clearly defined management responsibility	**1.** Awareness of need and opportunities for quality improvement. **2.** Setting the goals of continuous improvement	Clearly defined direction of enterprise improvement related to a clear pattern of committed management – **prevention by motivating employees to act and strive for excellence**

Cont. table 1.

5. Detecting and solving problems, aimed at continuous improvement of all elements of the production system, including planning, design, purchasing, technology and staff training	**8.** Announcement of results **9.** Record of results	Awareness of the impact on the quality of all possible production factors, but also the human factor - prevention by the selection and improvement of employees - prevention by motivating employees - prevention by joint pursuit of a goal
6. Modern methods of vocational training in the workplace, both for management and workers, in order to acquire new skills to keep up with changes in materials, methods, product design, equipment, technology and service	**5.** Assignment of problem tasks	The importance of employees as a factor enabling flexible response to changes - **prevention by predicting controlled volatility, prevention by participatory management**
7. Pro-quality supervision over production - reacting to information about defects arising in the earlier stages of production, machine maintenance needs, bad tools, wrong instructions and other phenomena that cause poor quality	**6.** Informing about the course of work	Awareness of the importance of the quality of auxiliary processes and their impact on the quality of the final product - **preventing the consequences of detected non-compliance threats in the processes**
9. Team work integrating many units, greater efficiency through the occurrence of horizontal bonds	**6.** Informing about the course of work	The importance of internal communication as a factor enabling flexible response to changes - prevention through an efficient flow of information
11. Removal of labor norms and shortcomings as well as numerical productivity and piecework norms; standards lead to ineffectiveness and high costs and violate professional ethics - in their place, the introduction of support measures and methods supporting management	**7.** Incorporating authorizations into normally used systems and processes of the company, which maintains the enthusiasm of employees	Awareness of improving work efficiency through the use of selected methods and tools - **prevention with the use of proven management instruments**
12. Removing barriers that prevent you from doing work with pride, abolishing the job evaluation card, deviating from management by goals **14.** The rank of competences and commitment of the top management in the pro-quality transformation of the enterprise; appointment and maintenance of such a board that would be able to consistently implement thirteen theses	**3.** Establishing an organization that will help achieve these goals by appointing a quality council, identifying problems, selecting the right project, creating teams and selecting coordinators	The importance of job satisfaction in creating product quality - **prevention through corporate culture** The role of top management in conducting continuous improvement - **prevention through planning**
13. Continuous training and self-training program for employees and their retraining	**4.** Training of all employees	Awareness of the cyclical improvement of employees in conjunction with customer expectations - prevention through employee improvement

Source: own elaboration based on Bank, 1996, pp. 76-78

What is more, also John Oakland, professor of the University of Bradford behind Deming, Juran, Feigenbaum, Crosby equates quality management with prevention, with activities undertaken before the implementation of the process, not after its completion. The importance of prevention was in fact that the second stage of the development of quality management techniques is defined as ensuring a specific, intended level of quality (Oakland, 2004).

Preventive actions, like corrective actions, should be adjusted to the scale of problems or effects of potential problems diagnosed during monitoring, audit, management review or as a result of decisions, orders, recommendations, etc. Establishing a preventive action procedure is aimed at: defining responsibilities and powers of those involved, identifying potential nonconformities and their causes, correcting potential nonconformities, assessing the need for preventive action, establishing and implementing the necessary actions, recording the results achieved, reviewing the effectiveness of the preventive actions taken. Taking preventive action may involve investigating several causes.

It is useful to distinguish between corrective actions and preventive actions. Corrective actions are steps taken to remove the causes of an existing nonconformity or undesirable situation. The corrective action process is designed to prevent recurrence of nonconformities or undesirable situations. He tries to make sure that existing inconsistencies and situations do not recur. It tries to prevent relapses by eliminating the causes. Corrective actions are based on real problems. In contrast, preventive actions are steps taken to remove the causes of potential nonconformities or potential undesirable situations. The preventive action process aims to prevent nonconformities or situations that do not yet exist, it tries to prevent the occurrence by eliminating the causes (Tashi, Mbuya, 2016). ISO 9001 and TQM force organisations to adopt structured procedures in order to implement corrective and preventive actions (Zhang, Zheng, 2015).

A set of instruments that can be used to support decision-makers in taking appropriate preventive actions comes out against the evolving approaches of preventive quality management. Methods for detecting and removing possible non-conformities, the effects of which could become apparent later, during production or operation, are called **preventive methods.**

Literature proves that there are currently no studies defining the state of a preventive approach in enterprises (Kaganov, 2001; Shojaie, Kahedi, 2019, pp. 35-43; Majanoja, Linko, Leppänen, 2017, pp. 528-549; Păun, 2019).

However, few scientific reports suggest that preventive actions in organizations are marginalized (Macot, 2003, pp. 349-357; Hardoroudi et al., 2011, pp. 177-181; Klimczak, 2014, pp. 16-21; Kovalyova, Zhdanov, 2018, pp. 28-39; Banerjee, 2019, pp. 542-595; Fraser, 2010; Kim, Lim, 2020, pp. 423-430; Zupanets, 2020; Chittipaka, 2020). At the same time, there are examples of searching for effective preventive actions. Most often they relate to:

- relationship with the environment (Junquera, Del Brío, 2016, pp. 1-17; Salem et al., 2016, pp. 755-769; Olszewska, Piwoni-Krzeszowska, 2014, pp. 45-53; Figge, 2005, pp. 19-30; Solana-Ibáñez, Caravaca-Garratón, 2021; Walecka, 2018, pp. 25-41; Katsuki, Miriam, 2017, pp. 1080-1097),
- relationship with employees (Bjerke, 2020, pp. 1-20; Ladegaard, Skakon, Elrond, Netterstrøm, 2019, pp. 44-52; Biggs et al., 2016, pp. 2-12; Sahoo, Sahoo, 2019, pp. 783-799; Greguras, Diefendorff, 2010, pp. 539-560; Zhang et al., 2019, pp. 369-395; Beltrán et al., 2017, pp. 403-422; Thomas et al., 2010, pp. 275-300),
- information management (Chun, 2002; Czekaj, 2012; Nowduri, 2019, pp. 2-6; Nkosi, Sukdeo, Bakama, Molefe, 2020, p. 1028-1038; Lis, Tomski, Bajdor, 2014, pp. 55-60),
- innovation in data analysis (Chluski, Ziora, 2015, pp. 1006-1012; Edmunds, Morris, 2000, pp. 17-28; Lönnqvist, Pirttimäki, 2006, pp. 32-40; Mantura, 2012, pp. 7-30; Yeoh, Koronios, 2010, pp. 23-32; Wójcik, 2016, pp. 61-70),
- modern solutions in the field of maintenance (Lamptey, Labi, 2008, pp. 376-387; Palmarini et al., 2007, pp. 23-28; Vilcu et al., 2017, pp. 656-660; Franciosi, Lambiase, Miranda, 2017, pp. 13692-13697; Barbu, Andreica, Popescu, 2018, pp. 53-58; Shahin, Aminsabouri, Kianfar, 2018, pp. 1296-1315; Alvarez-Alvarado, Jayaweera, 2019; Zhang, Jia, Wu, Yin, Ding, 2020; Larbi Rebaiaia, Ait-kadi, 2020; Wakiru et al., 2020; Wang et al., 2020, p. 123365).

It is noteworthy to develop a simple and efficient tool to understand corrective/preventive action, facilitate follow-up and ensure the availability of appropriate documentation. By means of brainstorming, 5W method, Pareto principle, root cause analysis: it was possible to create such a tool. Essentially, it is a system that allows to get a clear vision of a situation and act on it in an effective way that produces important results. It is simple to explain, simple to use, and anyone involved in corrective action can benefit from it in no time (Macot, 2003; Seo, 2017). A modified quality function implementation technique is then used to evaluate and classify alternatives against three different parameters: benefits, costs and impact. A personalized and modified version of the QFD technique is proposed to perform the most important phase: the selection of solutions and the most appropriate corrective actions. This methodology allows to evaluate the possible outcomes of various alternatives to eliminate the root causes. Finally, a modified QFD can be developed to obtain quantitative results in the form of benefits and costs, not just qualitative results (Carmignani, 2009). Among the risk assessment methods, the example of the FMEA method is outstanding. The use of this method is aimed at identifying the causes of potential non-compliance and planning solutions that first limit their occurrence (Mohanty, 2020). The method can also be treated as an important element of the company's continuous improvement strategy. When applying the FMEA method, it should be assumed that the commitment of the management is necessary to ensure the effectiveness of the proposed improvement solutions (Askari, 2017).

The conducted literature search showed a clear gap in knowledge about the areas and methods of preventing non-compliance in enterprises. The need for a preventive approach is unquestionable, but there is no scientific basis for determining effective methods of their implementation. The established five areas of positive non-compliance prevention defined the basis for the development of the research questionnaire, where these areas were detailed. Thus, the need to examine the leading factors supporting the decisions of a preventive approach in the quality management of manufacturing enterprises was addressed.

3. Stages of the research process. Selection of the research sample

The diagnosis of the preventive approach in quality management in manufacturing companies was conducted in accordance with the typical research process presented in Figure 1. The main purpose of these activities was to assess the general state of the preventive approach level in the surveyed companies and to determine the key factors influencing it.

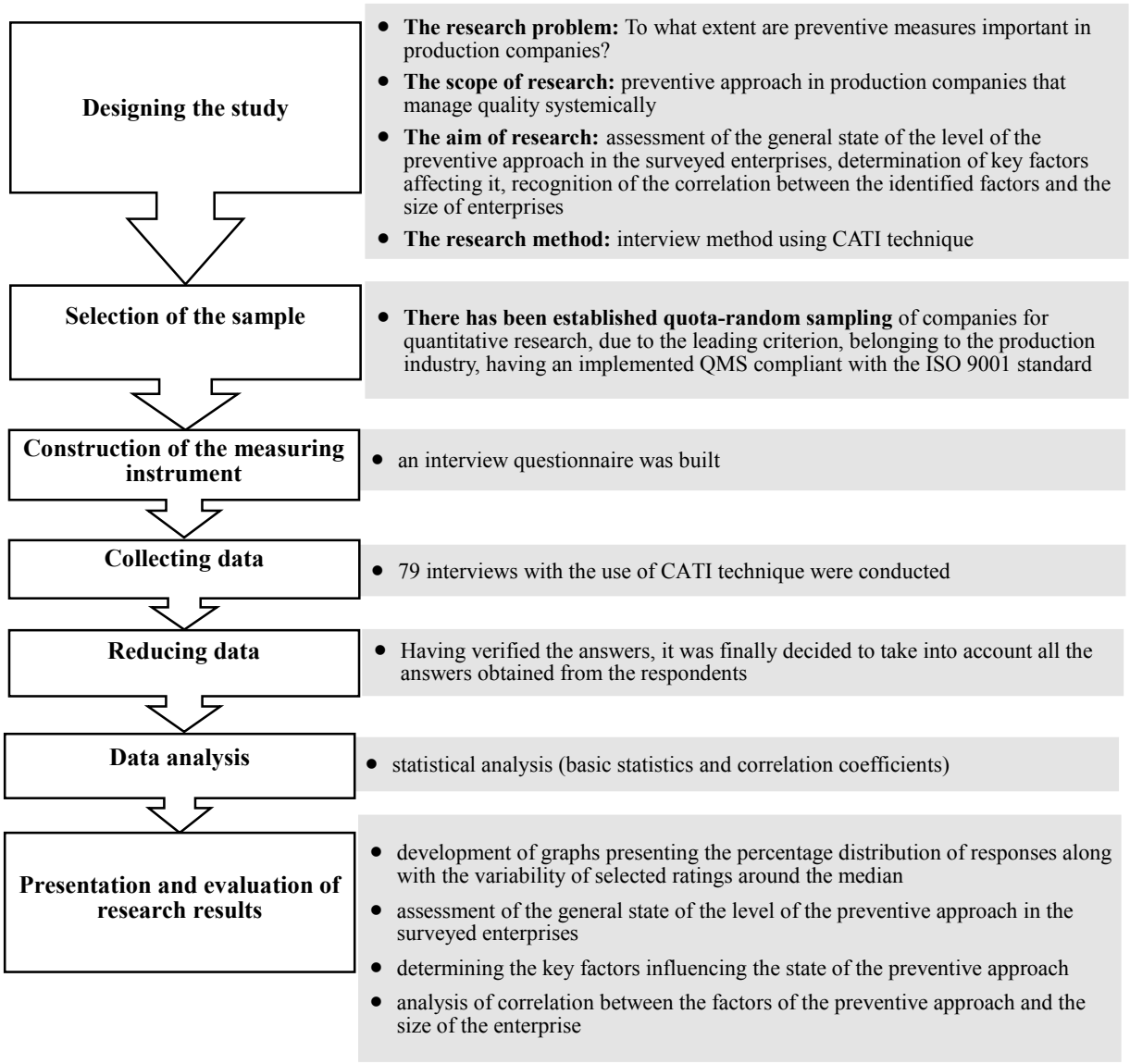


Figure 1. Stages of the research process carried out during quantitative research.

Source: own elaboration based on (Kaczmarczyk, 2003).

In order to implement the research program, the authors have conducted quantitative research using the interview method, with the use of the CATI technique (computer-assisted telephone interviews). The interviews were conducted in manufacturing companies with an implemented and certified quality management system compliant with the ISO 9001 standard. The questionnaire used in the study consists of:

- the record containing information provided by the respondent on: company name, size of the enterprise, number of years on the market, and the position held by the respondent,
- one question regarding the general assessment of the level of the preventive approach in quality management in the represented enterprise, specified by the respondent on a five-point scale, i.e. very unsatisfactory, poorly satisfactory, average, satisfactory, very satisfactory,

- 23 questions to which the respondent answered in two planes. First, it was assessed to what extent the prevention in various spheres of the company's operations is implemented in the company represented by the surveyed company. Then, the respondent assessed the extent to which prevention is important for the enterprise in terms of the assessed aspect. In answering these questions, a five-point scale was used, organized according to the so-called Likert scale,
- for the assessment of the importance of a factor in preventive quality management: 1 it does not matter at all, 2 it has a low impact, 3 it has an average effect, 4 it is quite important, 5 is of great importance,
- for the assessment of the degree of implementation of an aspect in the enterprise: 1 completely no, 2 no, 3 medium, 4 rather not, 5 completely not.

In order to obtain answers to the questions prepared by the authors, the services of a research company specializing in the provision of Business Process Outsourcing, call and contact center services were used.

The sample size was determined on the basis of the minimum (required) sample size criterion. When planning the research, we had data on the number of companies from Greater Poland that have ISO 9001 certificate, which in 2019 was 492. Thus the sample size was computed using the formula 1 (Oribhabor, Anyanwu, 2019):

$$n = [(N)\ (p)\ (1 - p)] / [(N - 1)\ (B/C)\ 2 + (p)\ (1 - p)] = 215{,}97 \quad (1)$$

where:
N is the population size (N = 492),
p is the proportion of population expected to choose (p = 0,5),
B is acceptable amount of sampling error (B = 0,05),
C is Z statistic associated with the confidence level which is 1.96 that corresponds to the 95% level.

The sample size was estimated at 216 companies. A randomized sample selection was used. The amounts are set according to the size of the enterprises (micro, small, medium and large). Due to the specificity of the industry and the small percentage of micro-enterprises in the pool of all production enterprises, this group was merged with small enterprises.

The structure of the population and the research sample are summarized in Table 2.

Table 2.
Structure of the population and research sample

		Percentage share in:		
		Population in general	**A computation trial**	**Samples study**
Enter-prises	**micro and small**	36,79	36,97	32,91
	average	47,97	47,97	49,37
	big	15,24	15,24	17,72
TOTAL		**100,00**	**100,00**	**100,00**

Source: own elaboration.

By selecting a group of enterprises belonging to the SME category (micro, small and medium-sized enterprises) from the research sample, it was determined that it constituted 82%. In the population of manufacturing companies from Greater Poland, the group of SMEs accounts for 85%. Thus, the pilot sample reflects the percentage structure of the population. The respondents were classified into four groups due to their position:

- quality representatives (36,7 %),
- employees in managerial positions (specialists) (27,8 %),
- owners / management representatives (22,8 %),
- administrative staff (12,7 %).

On the basis of the provisions of ISO 9001: 2015, the companies that would like to certify a quality management system no longer have to select the position of a quality management representative in their organizational structures. This function is often taken over by the management team that was represented in the research by 40 representatives.

4. Research results

4.1. General level of a preventive approach in quality management

Before starting the main part of the research, the respondents were asked a question concerning the assessment of the general level of the preventive approach in quality management in the represented enterprises (Fig. 2).

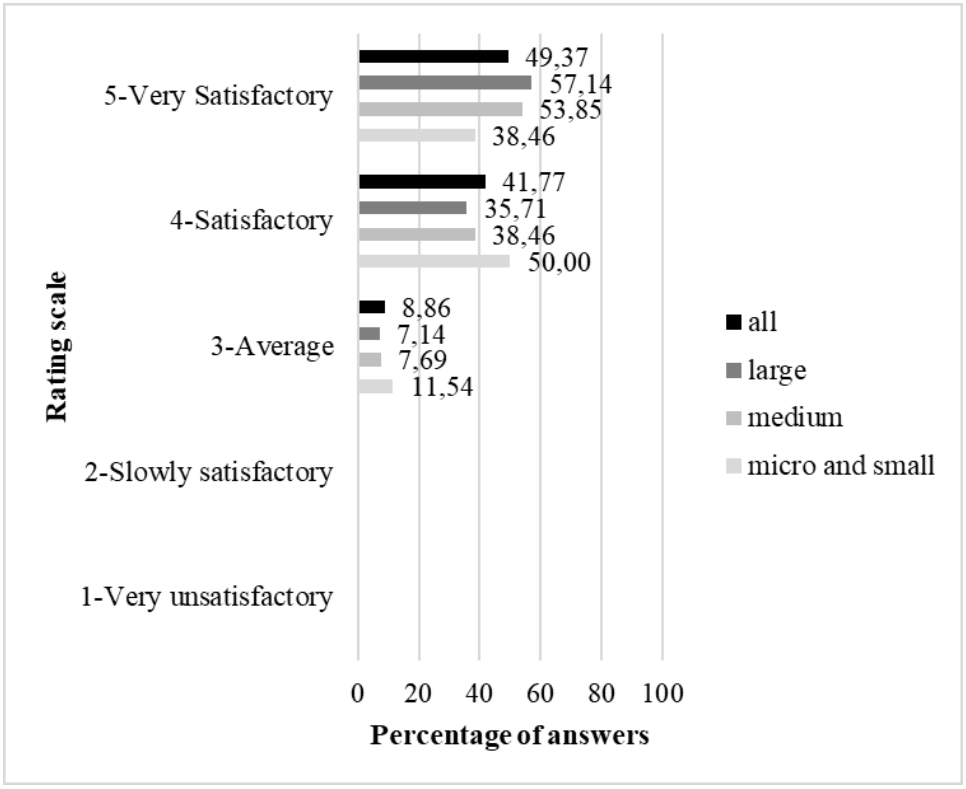


Figure 2. Percentage share of answers to the question regarding the assessment of the general level of the preventive approach in quality management in manufacturing enterprises.

Source: own elaboration.

Due to their function, the respondents should be aware of the issues raised in the research. According to Fig. 2, over 90% of the respondents noted that the level of a preventive approach to quality management in the production companies they represent can be considered very satisfactory or satisfactory, and only 8.86% were responses indicating an average rating.

By analyzing in detail the distribution of responses regarding the general assessment of the level of the preventive approach in quality management in individual groups of respondents, it can be initially concluded that the size of the enterprise does not have a significant impact on the responses obtained. This was confirmed by determining the value of Pearson's correlation, which was 0.14. Therefore, this level proves a weak degree of interdependence of the analyzed variables. Due to the positive value, it can be indicated that this tendency is directly proportional, i.e. the level of a preventive approach in quality management increases slightly with the growth of the company.

Table 3. summarizes the basic statistical data necessary to graphically present the variability of assessments of the level of implementation of the preventive approach in quality management in manufacturing companies (see Fig. 3).

Table 3.
Basic statistics for the assessment of the level of the preventive approach in quality management

Company / Statistics	Medium	Median	Minimum	Maximum	The lower quartile	The higher quartile	Standard deviation
Total	4,41	4,00	3,00	5,00	4,00	5,00	0,65
Micro and Small	4,27	4,00	3,00	5,00	4,00	5,00	0,67
Medium	4,46	5,00	3,00	5,00	4,00	5,00	0,64
Large	4,50	5,00	3,00	5,00	4,00	5,00	0,65

Source: Own elaboration.

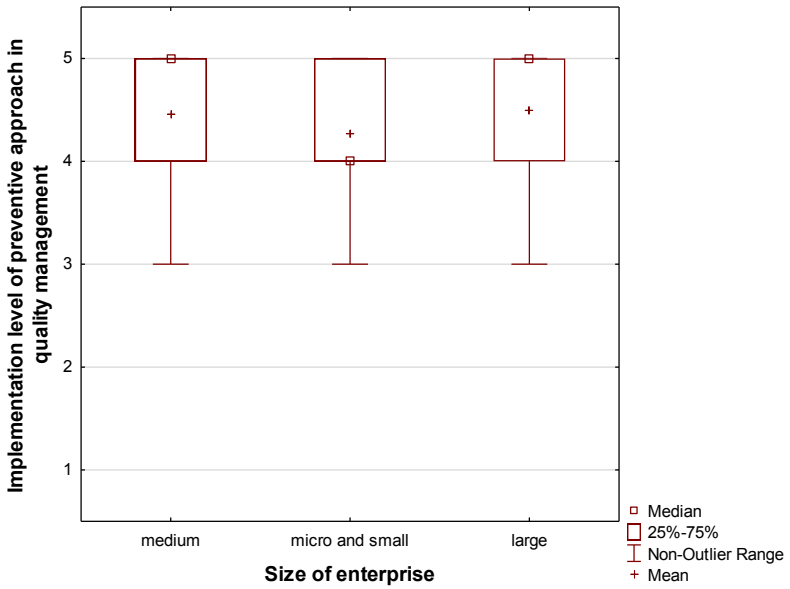


Figure 3. Variability of assessments in the level of the preventive approach implementation in quality management of manufacturing companies around the median.

Source: own elaboration using Statistica software.

In the data set from large and medium-sized enterprises, the median reached the highest value of 5, which means that 50% of respondents admitted that the level of implementation of the preventive approach in quality management is very satisfactory (Fig. 3). In small enterprises, the median decreased slightly and reaches the value of 4.0. The distribution of answers is the same in each group of organizations, both in small, medium and large enterprise. Ratings of 4 and 5 were most often given because they belong to the interquartile distribution. Among the companies which gave a rating of 3, there were 87% that had been operating on the market for over 20 years, and the remaining companies, i.e. 13%, belonged to the group existing for over 11 years. Average rating was given by management or quality representatives' respondents.

4.2. Analysis of factors influencing the level of a preventive approach in quality management

The main part of the research consisted of 23 questions concerning the degree of implementation and significance of the assessed factor, which influences the level of a preventive approach to quality management in manufacturing companies. These questions are summarized in Table 4.

Table 4.
List of the assessed factors

The determination of a factor	Factor
K1	Constant tracking of the requirements of the interested parties (customers, consumers, suppliers, industry groups)
K2	Maintaining good relations with the environment
K3	Skillful selection of suppliers and continuous evaluation of cooperation
K4	Consistent pursuit in implementation of the set goals
K5	Selection of employees based on their competences
K6	Participatory management (i.e. involving lower-level employees in decision-making processes)
K7	Raising the qualifications of employees and improving their skills
K8	Ensuring safety and ergonomics at work
K9	Leading employees (leaders giving direction)
K10	Shaping the corporate culture (creating an atmosphere conducive to achieving goals)
K11	Efficient flow of information (informing employees about the course of work)
K12	Improving data processing and analysis techniques (digitization of processes, documentation, communication, reporting, etc.)
K13	Rationalization of work time and its content (implementation plans based on resource availability)
K14	Use of proven methods and management tools (e.g. control sheets, volatility charts, diagrams such as Pareto, Ishikawa, FMEA method, QFD, 5Why)
K15	Technical and organizational order (creativity, accuracy of designers, diligence in workmanship and control, compliance with standards, the use of procedures, economy, care for the maintenance of machines, devices, instrumentation, care for tools, neatness and order)
K16	Standardizing of ways of treatment of technical problems
K17	Providing infrastructure appropriate to the assumed characteristics of processes and products
K18	Forecasting maintenance (use of risk analysis, preventive inspections, technical condition monitoring, participation of equipment and machine operators in maintenance, use of TPM and RCM, 5S methods and independent inspections)
K19	Improving quality control methods (e.g. improving accuracy, changing measuring instruments, measuring frequency, reporting method, etc.)
K20	Technological innovation
K21	Tracking and using the state of technology standardization
K22	Predicting controlled variability (recognizing disturbances and being able to monitor them)
K23	Knowledge exchange as part of economic cooperation (industry associations, chambers of commerce, capital groups, clusters, alliances, holdings, etc.)

Source: Own elaboration.

Searching for good practices in the preventive approach, the authors analyzed in detail the responses of the respondents, who generally assessed the level of implementation of the preventive approach in management in the represented enterprises as very satisfactory.

Due to the fact that two of the respondents representing medium-sized companies did not answer all the questions, the decision was taken to reduce the data and not include these interviews in further analysis. Figure 4 presents the percentage distribution of the answers given in the discussed topic, taking into account the size of the organization.

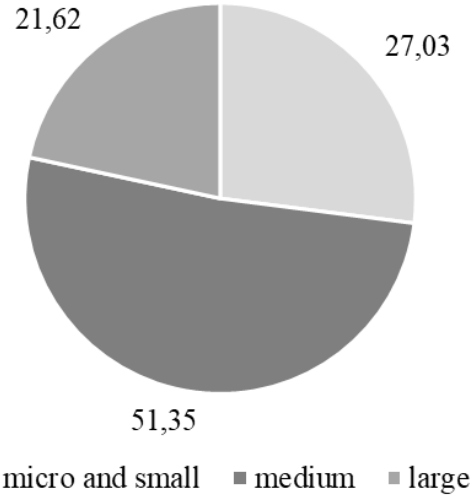


Figure 4. The percentage share in terms of the size of enterprises that assessed the level of implementation of the preventive approach in quality management as very satisfactory.

Source: own elaboration.

The respondents on a 5-point scale determined the importance of individual factors in a preventive approach to management. Basic statistics concerning the assessment of the importance of the factors listed in Table 4 are presented in Table 5.

Table 5.
Basic statistics of the importance of individual factors (decreasingly according to the mean)

Statistics / Factors	Mean	Standard deviation	Median	The higher quartile 75	The lower quartile 25
K2	4,973	0,162	5	5	5
K8	4,973	0,162	5	5	5
K11	4,919	0,273	5	5	5
K15	4,919	0,273	5	5	5
K5	4,892	0,311	5	5	5
K3	4,865	0,342	5	5	5
K4	4,865	0,342	5	5	5
K7	4,865	0,342	5	5	5
K1	4,838	0,436	5	5	5
K10	4,811	0,456	5	5	5
K19	4,811	0,392	5	5	5
K18	4,784	0,412	5	5	5
K13	4,73	0,444	5	5	4
K20	4,676	0,523	5	5	4
K9	4,676	0,523	5	5	4
K12	4,622	0,672	5	5	4
K14	4,595	0,715	5	5	4
K16	4,568	0,679	5	5	4

Cont. table 5.

K17	4,541	0,55	5	5	4
K21	4,46	0,641	5	5	4
K22	4,46	0,682	5	5	4
K23	4,162	0,916	4	5	4
K6	4,054	0,899	4	5	4

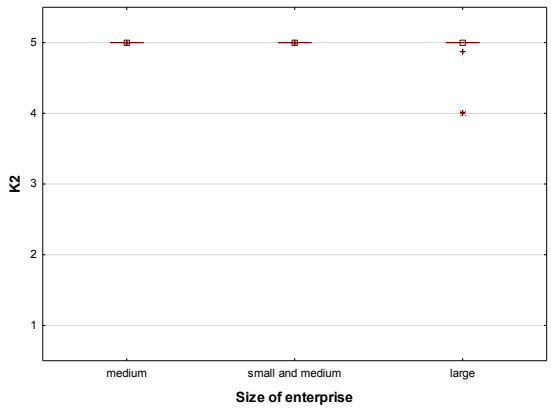
Source: own elaboration.

The highest mean results were obtained for the following eight factors:

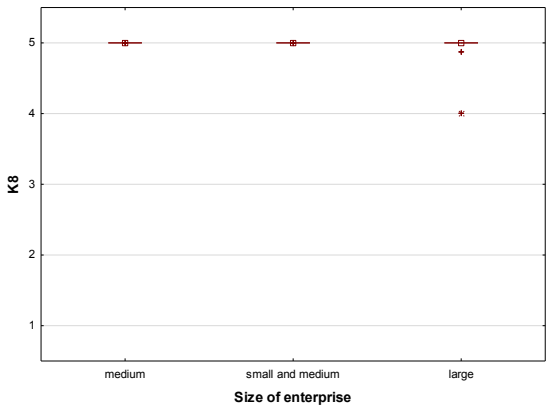
- K2 Maintaining good relations with the environment.
- K8 Ensuring safety and ergonomics at work.
- K11 Efficient flow of information.
- K15 Technical and organizational order.
- K5 Selection of employees based on their competences.
- K3 Skilful selection of suppliers and continuous evaluation of cooperation.
- K4 Consistent pursuit in implementation of the set goals.
- K7 Raising the qualifications of employees and improving their skills.

A detailed analysis of statistical data was carried out for these factors. Figure 5 graphically shows the variability of the importance ratings in the range of the eight highest rated factors around the median as the midpoint, taking into account the size of enterprises.

a) K2 Maintaining good relations with the environment



b) K8 Ensuring safety and ergonomics at work



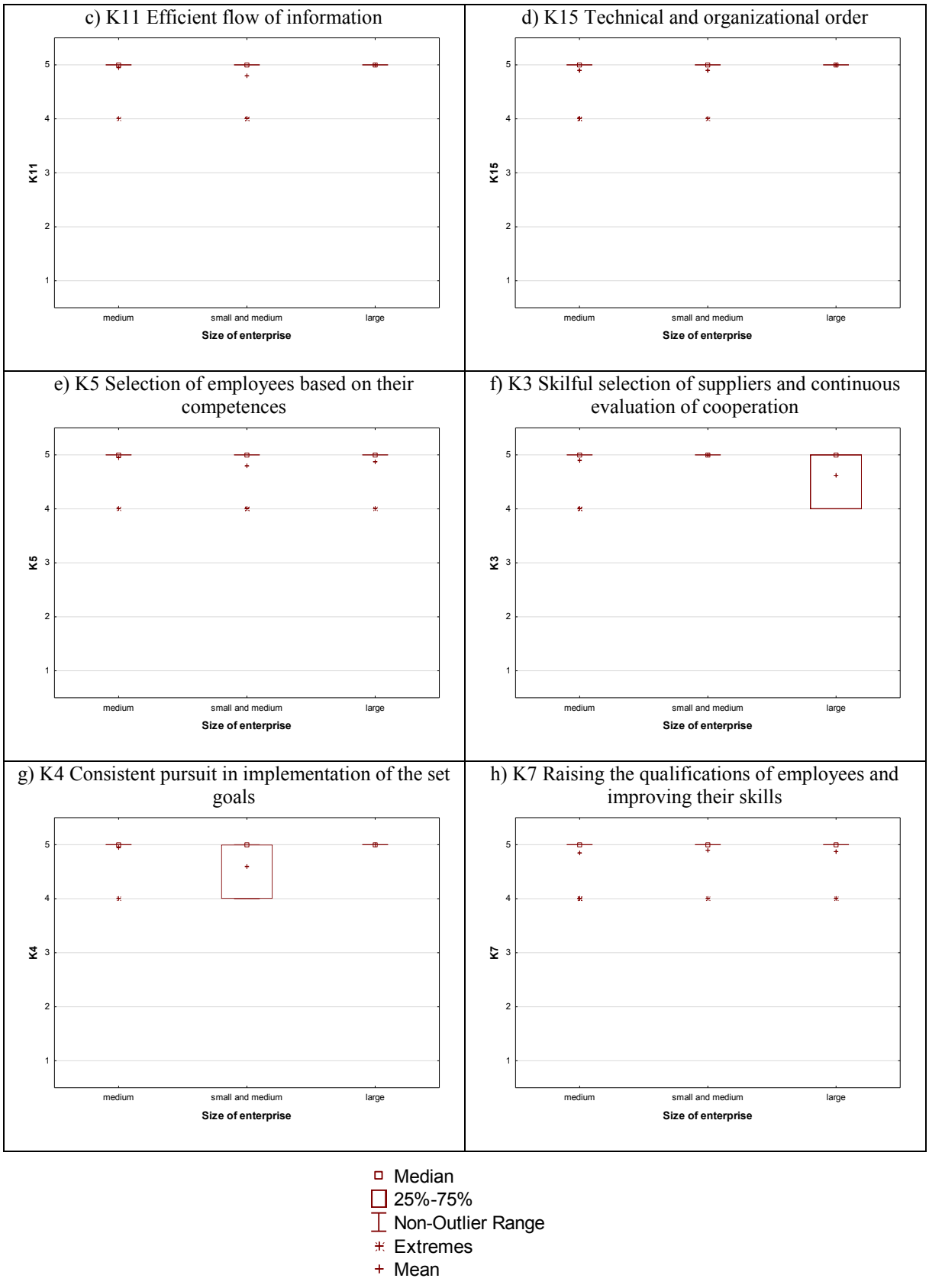


Figure 5. Variability of assessments of the importance of the most important preventive factors, taking into account the size of enterprises.

Source: own elaboration.

Based on the data analysis (Fig. 5a), it can be concluded that, among both small and micro-enterprises as well as medium-sized companies, the factor K2: Maintaining good relations with the environment was assessed by all respondents as having a huge impact on quality management in manufacturing companies. The fifth grade assessment was also most often assigned by representatives of large companies. In this group, the assessment graded 4 belongs to extreme assessments (it was only confirmed in 12.5%).

When analyzing the variability of the importance ratings assigned to the K8 factor: Ensuring safety and ergonomics at work (Fig. 5b), it can be concluded that this distribution was identical to the K2 factor assessment. Both among small, micro and medium-sized enterprises, it was assessed by all respondents as having a huge impact on quality management in manufacturing companies. The majority (87.5%) of representatives of large enterprises also assigned a grade at the fifth level. A grade four was rare.

Analyzing the responses to factor K11: Efficient flow of information in quality management (Fig. 5c), it can be concluded that they are similar for all enterprises. Enterprises rated this factor as being of great importance or quite important. The answer is of great importance, it was provided by 100% of large enterprises, 95% of medium-sized enterprises and 80% of small and micro enterprises.

Also factor K15: Technical and organizational order (Fig. 5d) was assessed as being of great importance or quite important in quality management. The answer is of great importance, it was provided by 100% of large enterprises, 89% of medium-sized enterprises and 90% of small and micro enterprises.

For factor K5: Selection of employees based on their competences (Fig. 5e), the distribution of responses also falls within two levels of the Likert scale, *i.e.* the factor is of great importance in quality management or is quite important. The answer is of great importance, from 78% of large enterprises, 95% of medium-sized enterprises and 80% of small and micro enterprises.

Among micro and small enterprises, the factor K3: Skilful selection of suppliers and continuous assessment of cooperation (Fig. 5f) was assessed by all respondents as having a huge impact on quality management in manufacturing enterprises. The fifth grade was also indicated by 89.5% of respondents representing medium-sized companies, and the fourth grade was indicated by 10.5%. In large enterprises, 62.5% of the respondents treated the assessed factor as very important.

Based on a detailed analysis of the data on the assessment of the K4 factor: Consistent pursuit of the set goals (Fig. 5g), it can be concluded that by micro and small enterprises this factor is treated as very important - 60% of responses or as quite important - 40% answers. By 95% of medium-sized enterprises, this factor is considered of great importance in quality management, and only for the rest as quite important. The K4 factor was rated as having huge impact by all respondents representing large companies.

When considering the distribution of responses in terms of factor K7: Upgrading employees' qualifications and improving their skills (Fig. 5h), it ought to be noted that 78% of large enterprises, 89% of medium-sized enterprises and 100% of small and micro-enterprises consider this factor to be of great importance in quality management. The remaining companies belonging to the research sample indicated the fourth grade on the Likert scale, i.e. quite important.

In the data set from large enterprises, only with regard to the K3 factor (skilful selection of suppliers) the interquartile range is between the answers 4 and 5, hence it is precisely for this factor that the average value reached the lowest value among all the analyzed factors. For factors K2, K8, K5 and K7, the answer at the level of 4 in this group of enterprises belonged to extreme values, i.e. it was assigned very rarely. The factors K11, K15 and K4 were rated the highest by representatives of large companies (an unequivocally assigned grade equal to 5).

By analyzing the box-and-whisker plot, it was shown that in the set of responses provided by representatives of medium-sized enterprises there is the smallest dispersion, as evidenced by the interquartile range for all the eight factors considered, equal to 5. For factors K2 and K8, the preventive awareness was the highest, for the remaining six factors there were answers with a level of 4 belonging to the extreme range.

On the other hand, in the group of micro and small companies, the factor K4 was rated the lowest, as evidenced by the largest interquartile range between 4 and 5. For this factor, the average value was at the lowest level. For factors K 11, K15, K5 and K 7, there were four responses (they were classified as extreme responses). In this group of respondents, the highest scores were obtained by factors K2, K8 and K3.

However, the differences in average ratings do not differ significantly in individual groups of enterprises, however, in order to deepen the analysis, it was decided to check the correlation coefficient in the discussed scope.

The lowest average value was obtained for the factor K6: Participatory management and it amounted to 4.054, which is not a low result, but in the ranking of initiating preventive actions it is the weakest factor. This means that all signalled areas are taken into account, there is no reason to reject any of them.

4.3. Analysis of the correlation of the importance of factors influencing the preventive approach depending on the size of the enterprise

In addition to identifying the key factors, it was also diagnosed whether the size of the enterprise had an impact on the assessment of individual aspects. Table 6 presents the results of correlation of the assessment of the importance of the eight analyzed factors with the size of the enterprise among those respondents who assessed the general level of the preventive approach as very satisfactory.

Table 6.
Correlation of the importance of factors K1- K23 with the size of the enterprise

Factor	Pearson's correlation coefficient between a given factor and the size of the enterprise
K2	-0,253
K8	-0,253
K11	0,262
K15	0,119
K5	0,098
K3	**-0,372**
K4	**0,424**
K7	-0,031

Source: own study based on the Statistica program.

Based on the data in Table 6., it can be concluded that for factor K3: Skilful selection of suppliers and continuous evaluation of cooperation and K4: Consistent pursuit of the goals set, the value of the correlation coefficient indicates a moderate strength of the relationship (the strength of the relationship is in the range (0, 31-050) and it is therefore possible to define the direction of the relationship. Due to the fact that the correlation is a symmetrical measure, for the K3 factor there is a relationship that the smaller the enterprise, the greater the essence of skilful selection of suppliers, and for K4: Consistent pursuit of the set goals is directly proportional, i.e. the larger the enterprise, the greater the score the importance of consistent pursuit of goals.

For the remaining factors, the correlation coefficient is in the range (0,00-0,30), which means that the correlation does not exist or is very weak. On this basis, it can be concluded that the size of the enterprise does not matter if the key factors supporting decisions regarding the preventive approach in quality management are selected.

4.4. Discussion

The conducted research on the preventive approach in quality management allowed for: assessment of the general state of the preventive approach level in the surveyed enterprises, identification of key factors influencing the preventive approach and recognition of the correlation between the identified factors and the size of enterprises.

Over 90% of respondents considered that the level of a preventive approach to quality management in the production companies they represent can be considered very satisfactory or satisfactory. This provided the basis for in-depth research with regard to identifying leading factors that drive decisions about taking preventive action.

Half of the respondents belonging to the group of large and medium-sized enterprises admitted that the level of implementation of the preventive approach in quality management was very satisfactory (the median reached the highest value of 5). In small enterprises, the median dropped slightly, reaching a value of 4.0. Among the companies that assessed the level of implementation of the preventive approach in quality management as average, there were 87% of companies operating on the market for over 20 years, and the remaining companies, i.e. 13%, belonged to the group existing for over 11 years. The authors suppose that

the long-term operation of enterprises on the market is associated with the inevitable development of technology and employee experience, which contributed to the standardization of basic processes. Long-term orientation of enterprises towards the purpose of their functioning may, therefore, result in undertaking unconscious actions for prevention - e.g. in the scope of the aforementioned standardization.

Based on the conducted research, the key factor influencing the preventive approach in quality management turned out to be maintaining good relations with the environment, which was confirmed both in the elections of SMEs and large enterprises. The authors see the basis of the research results in the commonly used approach of enterprises to taking into account both the needs of internal stakeholders and, above all, of external stakeholders. It is undoubtedly related to the current business approach, in which both the analysis of the needs of interested parties and the context of the company's functioning constitute the basis for effectively undertaken activities in all spheres of the company's operation. The second most important factor is ensuring safety and ergonomics at work. The distribution of answers can be justified by the legal regulations in force in Poland, according to which each entrepreneur is responsible for the life and health of his employee. The basic provisions in this matter can be found in the Constitution of the Republic of Poland, as well as in the Labor Code.

When assessing the following factors: efficient information flow, technical and organizational order, selection of employees based on their competences, and improvement of employees' qualifications and improvement of their skills, the respondents indicated that they are of great importance or are quite important in quality management (fifth or fourth level of the Likert scale). It should be emphasized that the size of the enterprise was not significant in the distribution of responses.

Based on the analysis of the box-and-whisker plot, it has been shown that in the group of large enterprises the following factors were assessed the best:

- K11 Efficient flow of information.
- K15 Technical and organizational order.
- K4 Consistent pursuit of the set goals.

In the group of respondents representing medium-sized enterprises, the highest scores were given to:

- K2 Maintaining good relations with the environment.
- K8 Ensuring safety and ergonomics at work.

In turn, among the micro and small, the highest scores were also given for factors K2 and K8, and also for K3 Skilful selection of suppliers and continuous evaluation of cooperation.

The essence of the above-mentioned factors can be justified by the specificity relating to the size of each of the separated groups of researched enterprises. In large enterprises, the essence is undoubtedly, among other things, to take care of the flow of information. Entrepreneurs unequivocally confirmed in these companies the highest level of awareness with regard to the free flow of information. Therefore, they have shown their weakness in this area

and at the same time know that the need for improvement should be critical in this area. In turn, in the group of enterprises with small and medium-sized enterprises, it is important to take care of, inter alia, relations with the environment (both external and internal stakeholders). In micro companies, the awareness of special care for relationships with suppliers is also growing.

Figure 6 presents the essence of the preventive approach in quality management, taking into account the identified key factors that act as stimulants in this regard.

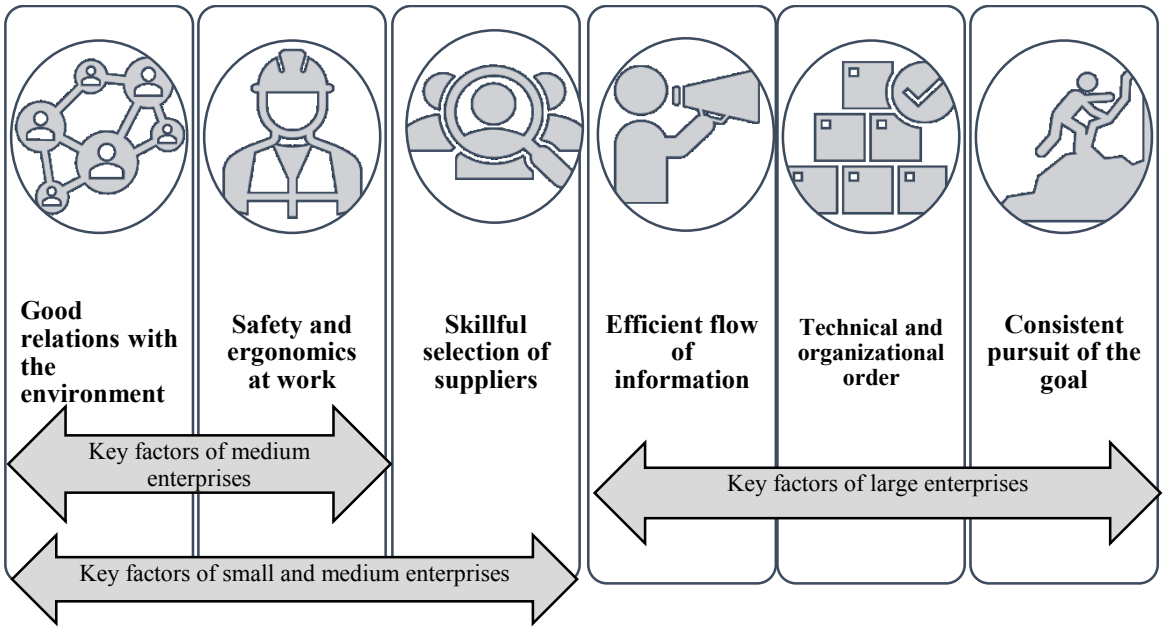


Figure 6. The key factors of a preventive approach in quality management due to the size of the enterprise.

Source: own elaboration.

However, the differences in the ratings assigned to individual groups of enterprises are not significant. In an in-depth way, the authors recognized the correlations between the identified factors and the size of enterprises, determining the strength of the relationship between the factor and the size of the enterprise. Due to the fact that the correlation is a symmetrical measure, for the factor K3 the dependence was recognized that the larger the enterprise, the lower the assessment of the importance of skilful selection of suppliers, and for K4 the consistent pursuit of the set goals is directly proportional, *i.e.* the larger the enterprise, the greater assessing the importance of consistent pursuit of goals. The dependence on K3 may result from the long-term cooperation of enterprises with the same suppliers or the suppliers providing evidence that the requirements, *e.g.* certificates of the supplied materials, semi-finished products have been met. It is possible that the lack of problems with the continuity and quality of supplies resulted in respondents giving answers that seemed inconsistent with the actual state. On the other hand, the increase in the importance of consistency in achieving goals in larger enterprises probably results from the division of responsibilities in these enterprises in accordance with extensive organizational structures. In this case, consistency in making

decisions and timely implementation of them are of particular importance for the effective functioning of the company. In flat organizational structures it is easier to ensure consistency in achieving goals, therefore this factor is less important for smaller enterprises.

5. Conclusion

This article makes important contributions to understanding and initiating preventive action. First, the areas, issues and criteria have been identified that essentially stimulate the prevention of non-conformities of products and processes. Moreover, based on empirical research, the expected essence of these factors was indicated. Similarities and differences between importance in small, medium and large enterprises were also shown.

For the purposes of multi-criteria decision-making processes, it is valuable to know the key stimuli characteristic of effective preventive actions. The complexity of the process also requires taking into account the size of the enterprise. Research has shown that in large industrial enterprises the key stimulants of preventive actions are, above all, efficient information flow, technical and organizational order, as well as consistent pursuit of the goal. A different situation occurs in smaller enterprises, which put the main emphasis on maintaining good relations with the environment, safety and ergonomics of work, as well as skilful selection of suppliers. Such an approach of entrepreneurs means that decision-making becomes to a greater extent conscious and focused on a targeted analysis of data in order to search for relevant premises to prevent non-compliance.

To sum up, the essence of the preventive approach in the quality management process should be the broadly understood decision support system for quality managers. The results of research related to the identification of key factors influencing the preventive approach may act like such a support system. The authors of the paper see the need to continue research in the field of in-depth analysis of selected factors in relation to the effectiveness of the actions taken and the possibility of supporting information.

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