
The Impact of Requirements Identification on the Preventive Approach to Quality Management

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Abstract:

Purpose: The aim of the article is to answer the question: Does requirements identification and application positively influence the preventive approach of manufacturing enterprises to quality management? The data analysis considers aspects such as the size of manufacturing enterprises and their perception of the importance and implementation of factors such as F1 – constant tracking of the requirements of the interested parties and F2 – tracking and using the state of technology standardization. Attention is also given to the relationships between requirements identification and factors such as F3 – predicting controlled variability and F4 – raising the qualifications of employees and improving their skills. Answering the research question within the context of the presented variables and their relationships with other factors provides a preliminary insight into enterprises' readiness to implement actions oriented toward preventive quality management. This topic is important due to technological advancements and the resulting changes in technology standardization, as well as the continuously evolving and growing demands of the interested parties. The requirements of interested parties evolve in alignment with emerging concepts such as corporate social responsibility, sustainable development, Industry 5.0, and Quality 5.0.

Design/Methodology/Approach: The research was conducted on 380 enterprises registered in 2020 located in Poland in the Wielkopolska province, which do not have an implemented and certified quality management system compliant with ISO 9001:2015. Due to the sample size, data collection was conducted using the CATI technique, i.e., computer-assisted telephone interviewing. The article employs the method of quantitative empirical research analysis.

Findings: Requirements identification and application positively influences the preventive approach of manufacturing enterprises to quality management, as evidenced by analyses of the significance and implementation of factors such as F1 and F2. This conclusion is further supported by research findings on the relationships between factors F1 and F2, which represent requirements, and the undertaking of actions in areas such as forecasting controlled variability and enhancing employee qualifications and skills development.

Practical Implications: The conclusions presented in the article can help to understand the significance of requirements identification and application in decision-making processes aimed at preventive quality management by manufacturing enterprises. The authors view requirements as a driver of organizational development and, to some extent, advocate for a

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preventive quality management approach based on requirements identification. In this approach, requirements are considered opportunities, as their implementation is associated with specific benefits. Demonstrating to enterprises the importance of requirement identification, its impact on process implementation, and resource preparation is a suitable direction for enhancing their readiness to tackle challenges such as sustainable development and Quality 5.0.

Originality/Value: The conducted research and analyses indicate that requirements identification and application positively influences the preventive approach of manufacturing enterprises to quality management. This conclusion takes on new significance when considering that the group of respondents consisted of manufacturing enterprises that do not have an implemented and certified quality management system compliant with ISO 9001:2015.

Keywords: Quality management, prevention of non-conformities, sustainable development, corporate social responsibility, Industry 5.0, Quality 5.0.

JEL Codes: L15.

Paper Type: Research article.

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1. Introduction

In traditional business theory, the primary goal of an organization is profit and its maximization (Noga, 2009). Survival is also identified as a key objective for organizations in crisis (Bacior, 2015) or ensuring the conditions for operation and growth (Buczowska, 2012). However, increasingly, other objectives are being prioritized: maximizing sales, utility, or growth; enhancing value for owners; fostering autonomy and innovation (Wilczyński, 2014); promoting corporate social responsibility (Bacior, 2015), or pursuing goals aimed at continuously reducing the negative environmental impact of the organization, closely tied to the concept of sustainable development (Jasiulewicz-Kaczmarek, 2023; Weiland *et al.*, 2021; Lemańska-Majdzik, 2012).

When pursuing the goals set by the enterprise, often treated as a bundle of objectives, it is crucial to consider the turbulence of the environment, which accelerates the pace of change (Skalik, 2018). This turbulence shortens the time horizon of objectives and forces enterprises to more frequently adjust their strategies and goals (Kałkowska *et al.*, 2010).

Therefore, enterprises must be aware of their own potential to seize market opportunities and their resilience to identified and unidentified risks. Such actions

are possible only with continuous analysis of the organization's context, one element of which is the analysis of requirements.

In this article, the authors explore whether manufacturing enterprises consider requirements as input data in preventive quality management, despite not having implemented or certified a quality management system compliant with ISO 9001:2015. Thus, the research question posed is: Does requirements identification and application positively influence the preventive approach of manufacturing enterprises to quality management?

2. Literature Review

Industry 4.0 is based on the collection, analysis, and utilization of vast amounts of data to make informed decisions. Effective information management, which is an integral part of prevention, enables organizations to quickly identify potential issues and take preventive actions at an early stage of process implementation, as well as to prepare resources for taking action (including appropriately qualified and experienced staff). In relation to Industry 5.0, prevention becomes even more significant. Industry 4.0 introduced automation and digitization of processes, which increased the complexity of production systems, and, consequently, the risk of failures and errors (Řeháček, 2019).

On the other hand, Industry 5.0, which focuses on the synergy between humans and machines, requires even more advanced preventive systems that account for both technical aspects and the human factor (Pizoń *et al.*, 2023). "Adopting the Quality 5.0 concept should create conditions for the dynamic development of a company in the context of sustainable development" (Skrzypek and Skrzypek, 2023). Quality management 5.0 focuses on social and environmental issues in the context of adopting the company's development strategy (Lagrosen and Lagrosen, 2019).

The challenges associated with Quality 5.0 include (Deleryd and Fundin, 2020):

1. Shaping new roles for quality managers – In their new roles within processes, quality managers should focus on integrating economic, social, and environmental aspects to support sustainable development.
2. Increased importance of management teams – In the future, their task will be to collaborate with producers, partners, and competitors. Developing appropriate management models that can quickly adapt to the constantly changing environment will be crucial. Particularly important will be examining the role and scope of decision-making with the help of artificial intelligence and machine learning.
3. Adaptation of measurement – This refers to the need to extend quality measures not only to the customer but to society as a whole and to shift from traditional customer satisfaction metrics to those that encompass societal impacts. It is important not only to use existing tools but also to continually

- search for new ones that allow customer satisfaction measurements to align with social, environmental, and economic factors.
4. Searching for tools to manage the transition from the fourth to the fifth generation of quality – This transition is tied to the fundamental shift in external stakeholders' values. The question to address is how to adopt new values stemming from standards related to CSR (Corporate Social Responsibility) and environmental care.
 5. Resolving the issue of simultaneously adopting internal company values and the main external values desired by society.

Therefore, there is a noticeable return to recognizing the importance of interested parties in the strategy formulation process by enterprises (Skrzypek, 2016), as well as identifying potential challenges related to the transition from the fourth to the fifth generation of quality. These aspects are also addressed by Frick and Grudowski, who suggest a multi-dimensional approach to this issue (Frick and Grudowski, 2023).

It is clear that any type of change should not take place without identifying the requirements that must be met in relation to the recognized problem. Such action also has a preventive nature, provided that requirements are treated as an aspect that needs continuous updating, and that the information gathered can be used to improve processes, products, or secure appropriate resources.

3. Research Methodology

The data presented in the article were obtained from an interview conducted with representatives of manufacturing companies using the CATI technique (Computer-Assisted Telephone Interviewing). A computer-assisted telephone interview was conducted. The data were gathered as part of the project Study of the Preventive Approach in Managing Manufacturing Enterprises. The rationale for the research based on the established criteria is presented in the article by Misztal, Drzewiecka-Dahlke, and Marczewska-Kuźma, 2022.

When planning the research, data about the number of enterprises in Poland in the Wielkopolska province, which in 2020 amounted to 36,549, were available. A maximum error of 5% was assumed. The sample size was 380 manufacturing companies that did not have an implemented and certified quality management system compliant with ISO 9001:2015.

The sample selection used the criterion of the minimum sample size, considering the number of entities in the Polish national economy registered in the REGON register, declaring business activity, and belonging to section C of the Polish Classification of Activities - Manufacturing Industry, according to the state as of June 30, 2020.

The aim of the article is to answer the question of whether the identification of requirements has a positive impact on the preventive approach to quality management in manufacturing companies. The analysis of the data took into account aspects such as: the size of manufacturing enterprises, the perception by companies of the importance and implementation of factors such as F1 - constant tracking of the requirements of the interested parties and F2 - tracking and using the state of technology standardization.

Attention was also given to the relationships between the identification of requirements and factors such as F3 - predicting controlled variability and F4 - raising the qualifications of employees and improving their skills.

The chi-square independence test was applied to check the statistical significance of the relationships between factors. The number of degrees of freedom (df) was calculated and compared with the critical values of the chi-square distribution table, with a significance level of 0.05. For values greater than the result read from the table, the Pearson's correlation coefficient was calculated. Additionally, to determine the strength of the relationship between the analysis variables, Cramér's V coefficient was calculated.

4. Research Results

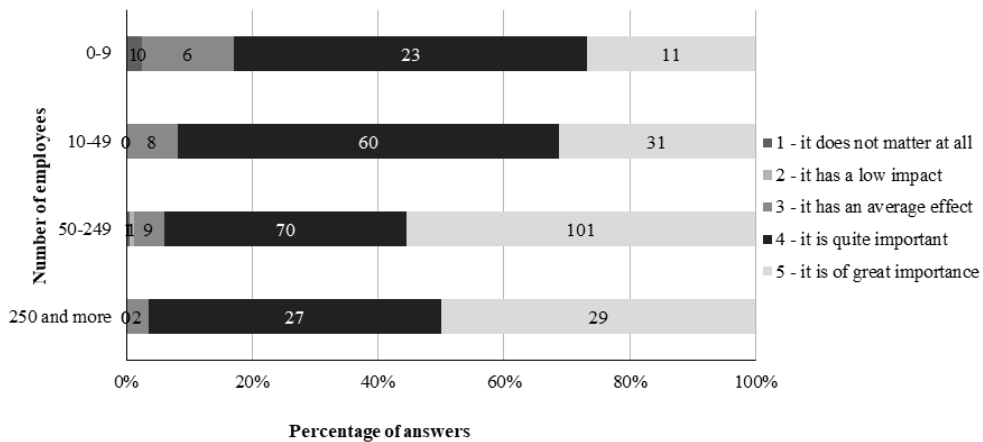
Figures 1, 4, 7, and 10, the results of the research on the importance assessment of factors by manufacturing enterprises are presented. Figures 2, 5, 8, and 11 show the results of the research on the realization assessment of factors. In Figures 3, 6, 9, and 12, a comparison of importance assessment and realization assessment of factors is presented, considering the size of the enterprises (0-9 – micro, 10-49 – small, 50-249 – medium-sized, 250 and above – large enterprises).

In the research sample of 380 enterprises, there are 41 micro-enterprises, 99 small enterprises, 182 medium-sized enterprises, and 58 large enterprises. Figures 1, 2, and 3 present the results of the research on the constant tracking of the requirements of the interested parties – importance assessment of factor (F1).

Over 90% of the surveyed enterprises rated the constant tracking of the requirements of interested parties as an important factor, choosing responses such as "quite important" and "of great importance" (Figure 1). The highest percentage of positive responses can be observed in larger enterprises. This was also examined using Pearson's correlation coefficient, which was 0.27.

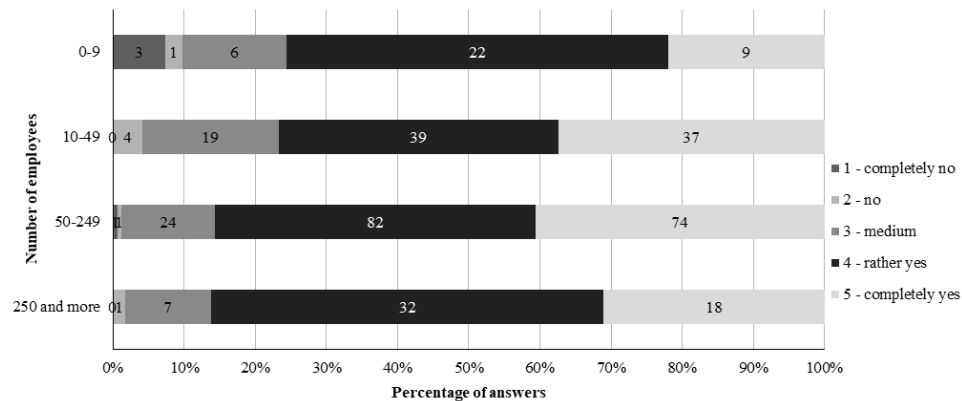
Regarding the results of the survey on the implementation of F1 by manufacturing enterprises, it can be observed that there were more neutral and negative responses compared to the assessment of the importance of this factor (Figure 2). Approximately 10% fewer enterprises indicated the actual implementation of the factor than those who rated its importance highly.

Figure 1. Constant Tracking of the Requirements of the Interested Parties – Importance Assessment of Factor



Source: Authors' calculations.

Figure 2. Constant Tracking of the Requirements of the Interested Parties – Realization Assessment of Factor



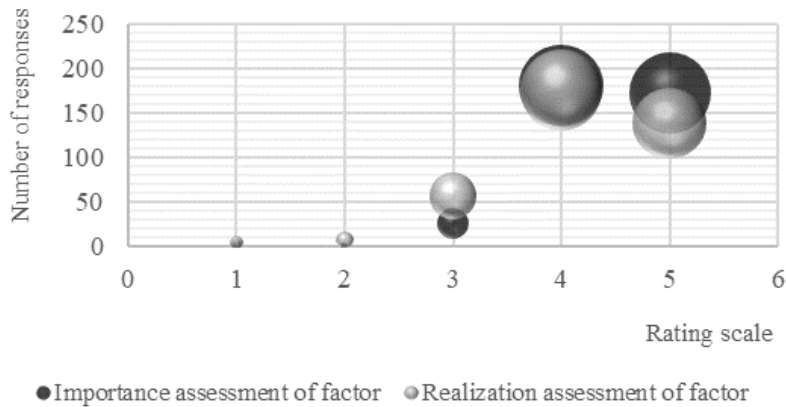
Source: Authors' calculations.

However, it still represents a high value of 80%. The realization and importance assessment of factor F1, in relation to the number of employees, were also examined using Pearson's correlation coefficient. For both aspects, the coefficient was approximately 0.27, with a correlation strength of 0.198.

This indicates a low positive correlation between the number of employees and the weight and implementation of tracking the requirements of interested parties.

Figure 3 presents the number of responses from respondents regarding A comparison of the importance and implementation of a factor: constant tracking of the requirements of the interested parties in relation to enterprise size.

Figure 3. A Comparison of the Importance Assessment and Implementation of the Factor Constant Tracking of the Requirements of the Interested Parties in Relation to Enterprise Size

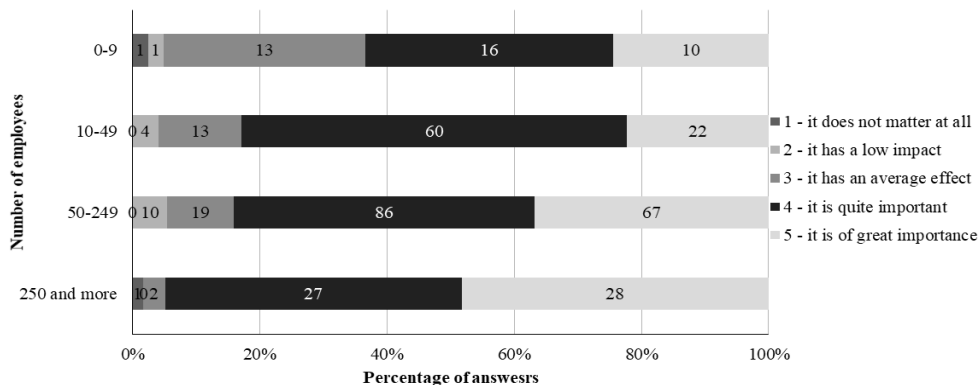


Source: Authors' calculations.

Based on the analysis of Figure 3, it can be stated that regardless of the size of the enterprises that provided responses, the most frequently chosen rating was 4 for both the importance and implementation of factor F1. In the positive responses (4 and 5), the importance of the factor was rated higher than its implementation, which is particularly noticeable in the level of response 5. 172 people indicated the highest value in the importance assessment (45% of all responses), and 138 people in the implementation assessment (36% of all responses).

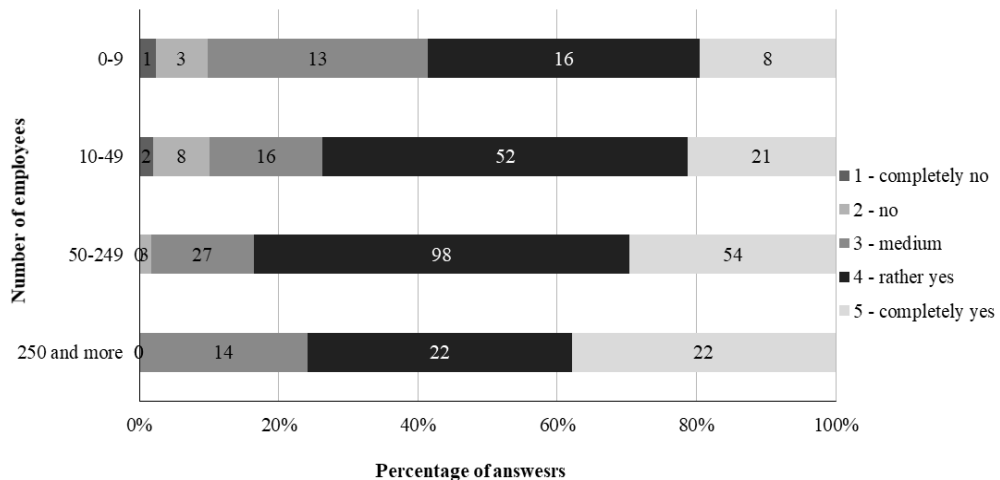
Figures 4, 5, and 6 present the research results concerning tracking and using the state of technology standardization – importance assessment of factor (F2).

Figure 4. Tracking and Using the State of Technology Standardization – Importance Assessment of Factor



Source: Authors' calculations.

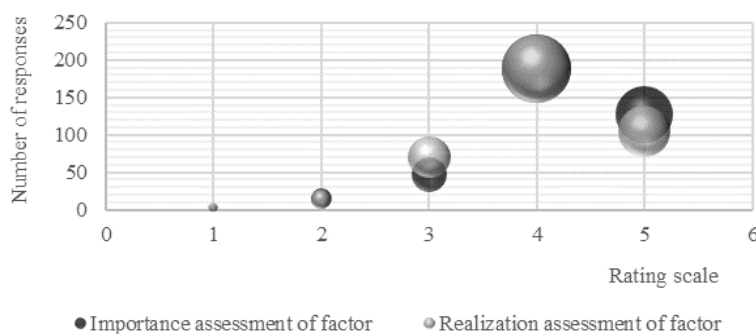
Figure 5. Tracking and Using the State of Technology Standardization – Realization Assessment of Factor



Source: Authors' calculations.

More than 95% of large enterprises assess tracking and utilizing the state of technology standardization as a "quite important" factor or even rate it higher. Among microenterprises, only 63% gave a positive assessment (Figure 4). The correlation between the number of employees and the importance assessment of the factor showed a Pearson correlation of 0.3, indicating a positive relationship.

Figure 6. A Comparison of the Importance and Implementation of a Factor Tracking and Using the State of Technology Standardization in Relation to Enterprise Size



Source: Authors' calculations.

Figure 6 shows the responses of the respondents regarding the factor "tracking and utilizing the state of technology standardization" (F4), from which it can be concluded that this factor is rated lower in terms of both importance and

implementation compared to factor F1, i.e., constant tracking of the requirements of interested parties.

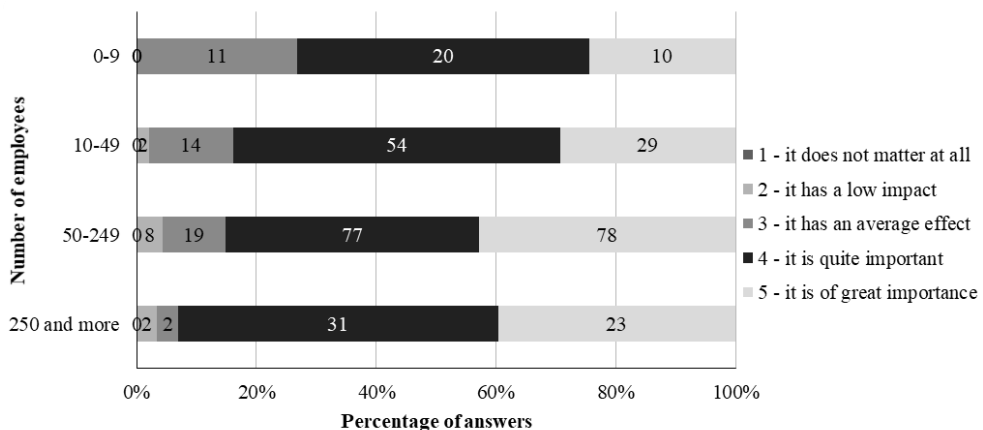
This is particularly evident when looking at the level of assessment 5. 127 out of 380 respondents rated the importance of the factor as "it is great importance" while 105 out of 380 respondents rated its implementation as "completely yes".

Over 80% of the respondents marked its importance as "quite important" or "extremely important," and over 75% actively implement such aspects in their organizations.

Factors F3 and F4 are presented by the authors primarily because they will serve as the basis for analyzing correlations with factors F1 and F2. A potential relationship between the implementation of factors F1 and F2 and the willingness to implement F3 and F4 is being explored, which will be presented in the discussion of the research results.

Figures 7, 8, and 9 present the results of the study on predicting controlled variability (recognizing disturbances and being able to monitor them) (F3).

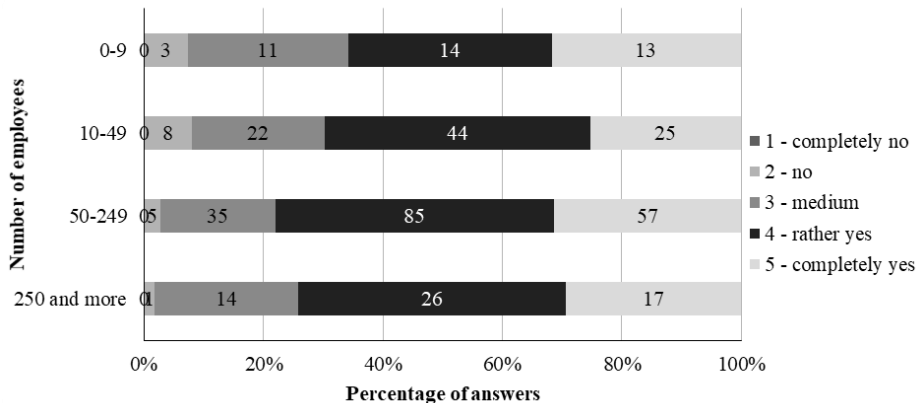
Figure 7. *Predicting Controlled Variability – Importance Assessment of Factor*



Source: *Authors' calculations.*

Predicting controlled variability aims to prepare the organization to operate in a turbulent environment (F3). This factor should, therefore, be one of the key elements for organizations managing with a focus on prevention. It can be concluded that, despite some negative responses, this factor is regarded as highly significant by all companies in preventive quality management.

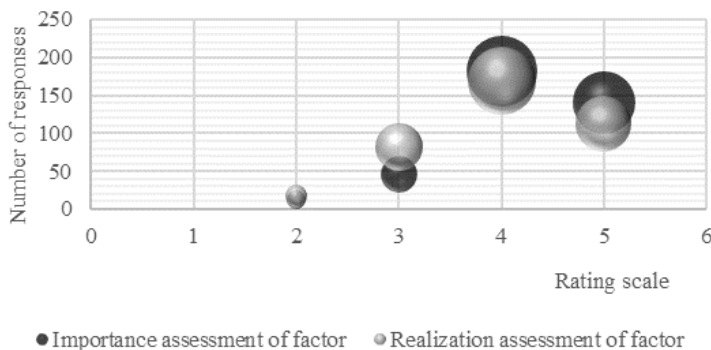
Figure 8. *Predicting Controlled Variability – Realization Assessment of Factor*



Source: Authors' calculations.

Larger organizations value the importance of this factor and are actively involved in its implementation, as confirmed by a positive Pearson correlation of 0.23. Among large companies with 250 or more employees, this factor is almost entirely implemented at a medium or higher level. Among large companies with 250 or more employees, this factor is almost always implemented at a medium or higher level.

Figure 9. A Comparison of the Importance and Implementation of a Factor Predicting Controlled Variability in Relation to Enterprise Size

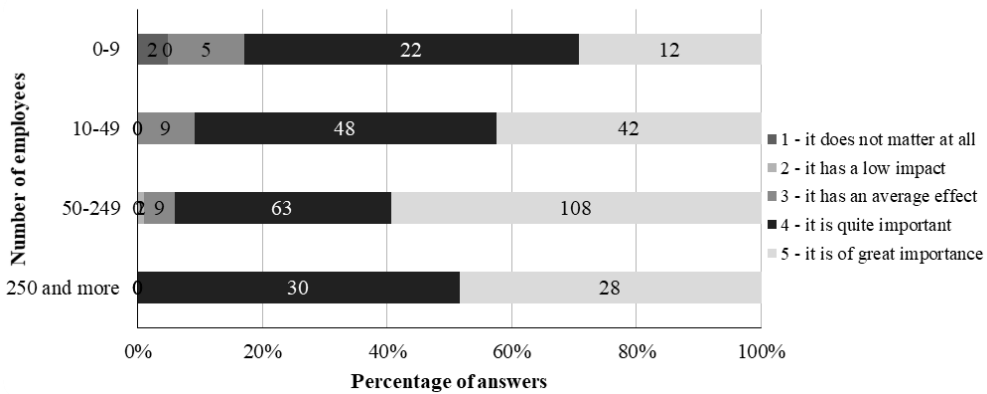


Source: Authors' calculations.

The prediction of controlled variability proved to be equally important, especially in larger enterprises, where it is more frequently implemented. However, the difference between recognizing its importance and actual implementation (41 for affirmative responses, 36 for neutral responses) indicates the need to strengthen preventive actions in order to effectively prepare for changes in the environment.

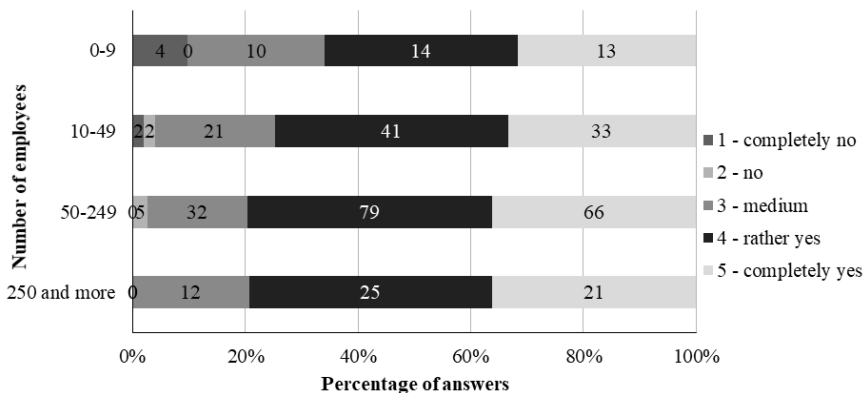
Figures 10, 11, and 12 present the research results concerning raising the qualifications of employees and improving their skills (F4).

Figure 10. Raising the Qualifications of Employees and Improving Their Skills – Importance Assessment of Factor



Source: Authors' calculations.

Figure 11. Raising the Qualifications of Employees and Improving Their Skills – Realization Assessment of Factor



Source: Authors' calculations.

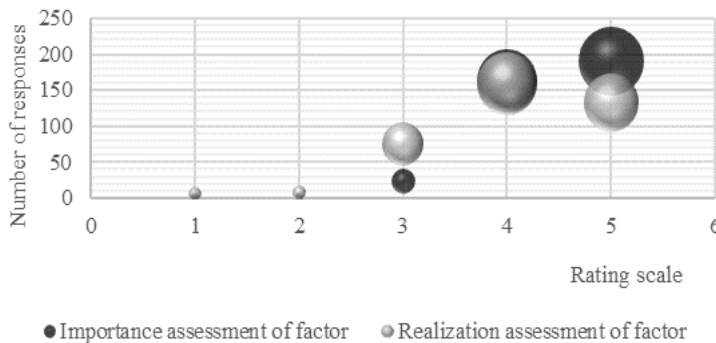
It is worth noting that a few enterprises considered the factor of raising employee qualifications and improving skills to be of little significance in the context of preventive quality management (Figure 9). Among large companies, 100% of responses were rated 4 or 5.

In large enterprises, the raising of qualifications and improving employees' skills is more frequently implemented, but this aspect is evaluated at a lower level.

In the case of medium-sized enterprises, there are significant differences between how the importance of factor F4 is perceived and its actual implementation. For importance, 108 respondents considered the factor to be very important, but only 40 fewer companies actually implemented training, which represents a 22% decrease.

Considering Pearson's correlation between the importance and implementation of factor F4 with the number of employees, positive values of 0.31 and 0.25 were obtained, indicating a low dependence between the variables.

Figure 12. *A Comparison of the Importance and Implementation of a Factor Raising the Qualifications of Employees and Improving Their Skills in Relation to Enterprise Size*



Source: *Authors' calculations.*

When evaluating the factor of raising the qualifications of employees and improving their skills, 190 respondents indicated the highest level of importance (50% of all responses), and 133 respondents indicated the highest level of implementation (35% of all responses).

5. Discussion

The authors have prepared an interpretation of the research results organized according to two factors F1 and F2, in relation to the topic and objective of the article:

1. Constant tracking of the requirements of the interested parties (F1):
 - 20% of manufacturing enterprises assess the implementation of the factor "constant tracking of the requirements of interested parties" as insufficient, i.e., as "average," "rather not," or "completely not." These data should raise concern, as a significant percentage of enterprises are not interested in meeting the requirements of interested parties and do not analysis their impact on these stakeholders,
 - the importance and implementation of factor F1, depending on the number of employees, were examined using Pearson's correlation. The index was approximately 0.27, with a dependency strength of 0.198, indicating a low positive correlation between the number of employees and the significance and implementation of tracking the requirements of interested parties,
 - factor F1 is rated better by respondents in terms of both importance and

- implementation compared to factor F2,
- the Pearson correlation coefficient calculated between constant tracking of the requirements of interested parties (F1) and raising employee qualifications and improving their skills (F4) is 0.504, suggesting a moderately strong positive correlation between these factors,
- the Pearson's correlations between constant tracking of the requirements of interested parties and the number of employees (0.27) and between raising employee qualifications and the number of employees (0.25) indicate weak but positive relationships.

The identified problem, namely the lack of constant tracking of the requirements of interested parties, can be considered a risk that may result in inadequate quality management and the inability to effectively achieve sustainable development goals (affecting 20% of the surveyed enterprises). The authors attribute the root cause of this threat to the absence of an implemented and certified quality management system compliant with ISO 9001. Among the seven principles of quality management in ISO 9001 is relationship management, which involves building, maintaining, and developing lasting and beneficial relationships with customers, business partners, employees, and the local community. Enterprises that fail to monitor requirements of interested parties will be unable to meet the standard of socially responsible and sustainable management required by ESG standards (short for Environmental, Social, and Governance). In the context of sustainable development goals, this issue relates to Goal 17: strengthening the means of implementation and the global partnership for sustainable development.

The result indicates that enterprises that actively monitor the requirements of interested parties tend to invest more in developing their employees' qualifications. Enterprises are therefore aware of the need for continuous process improvement based on requirements and are also conscious that this necessitates the involvement of qualified employees. The Cramér's V coefficient is 0.41, further confirming a moderate relationship between these factors, suggesting a significant correlation between tracking requirements and improving employee skills. Employee competences and skills enhancement through training directly relates to corporate governance efforts within the ESG framework. In terms of sustainable development goals, it supports Goal 8: decent work and economic growth.

2. Tracking and using the state of technology standardization (F2):
 - more than 95% of large enterprises assess tracking and utilizing the state of technology standardization as a "quite important" factor or even rate it higher,
 - the Pearson correlation coefficient between the implementation of tracking and utilizing technology standardization and the number of

employees is 0.27. This indicates a weak positive correlation, which may suggest that larger enterprises, with more human resources, are more likely to implement technological standards. This could result from their greater organizational and financial capabilities, enabling more advanced technology management,

- the perception of the importance of tracking and utilizing the state of technology standardization in a preventive quality management approach is related to the size of the enterprise,
- the Pearson correlation coefficient of 0.637 between tracking and utilizing the state of technology standardization and predicting controlled variability suggests a moderately strong positive relationship,
- the analysis of factors related to tracking and utilizing the state of technology standardization in companies (F2) and raising employee qualifications and improving their skills (F4) showed a moderate correlation with a Pearson correlation coefficient of 0.459 and a Cramér's V coefficient of 0.365.

Companies that effectively track and utilize the state of technology standardization are also better prepared to recognize disturbances and monitor variability. The Cramér's V coefficient of 0.584 confirms that there is a significant relationship between these two factors, although not very strong. The presented correlation should serve as a guideline for enterprises, as it pertains to the ability to identify disruptions in production processes and monitor them. Undoubtedly, this is crucial from the perspective of implementing sustainable development goals. In the context of ESG, it is worth recognizing the link between reducing process disruptions and variability and minimizing negative environmental impact, as well as maintaining corporate governance.

In companies that are more engaged in standardizing technology, there is also a noticeable trend towards investing more resources in the development of employee skills. This correlation may suggest that organizations advanced in tracking and utilizing technology standardization recognize the need for continuous improvement in human resources, which is important in the context of dynamic technological development, adaptation to new standards, and building a strong competitive advantage.

The aspects discussed in point 2 are directly related to Sustainable Development Goal 9: Industry, Innovation, and Infrastructure. Enterprises that monitor and implement solutions reflecting technological process standardization and adjust human resource competencies to new challenges demonstrate innovation potential. According to research, such enterprises primarily include large companies (95%). The absence of a certified ISO 9001-compliant quality management system did not negatively affect the responses provided by respondents from the group of large enterprises.

6. Limitation of the Study

The conducted research was limited to respondents representing a representative sample of manufacturing companies from Poland in the Wielkopolska province. These companies did not have an implemented and certified quality management system in place according to ISO 9001:2015 at the time of data collection, i.e., in the year 2020.

7. Conclusions

The article presents research findings on the preventive approach to quality management conducted on a sample of 380 manufacturing enterprises. The group of respondents involved in the study consisted of manufacturing companies that did not have an implemented and certified quality management system compliant with ISO 9001:2015. Based on the presented research results and analyses, it can be concluded that identifying and complying with requirements of interested parties and technology-related standards positively influences the preventive approach to quality management.

The benefits of such an approach include anticipating variability in production processes and adjusting human resource competencies and skills to new challenges. Therefore, manufacturing enterprises should take action based on requirements to address internal factors (weaknesses of the enterprises). According to the research results, this issue remains a significant challenge for micro, small, and medium-sized manufacturing enterprises.

Companies that implement best practices, stay up-to-date with the latest industry trends and standards, and address the requirements of interested parties – or even create such requirements – can be regarded as companies with the potential to leverage market opportunities. These are also companies that help raise the technical level of the industrial sector in line with development tasks. The research indicates that primarily large manufacturing enterprises possess this potential.

The factors analysis by the authors in terms of their perceived importance and applicability by enterprises such as identifying and complying with requirements of interested parties, technology-related standards, anticipating variability in production processes, and enhancing employees' qualifications and skills are related to Sustainable Development Goals 8 (Decent Work and Economic Growth), 9 (Industry, Innovation, and Infrastructure), and 17 (Partnerships for the Goals).

According to the literature, incorporating sustainability issues into quality management in manufacturing enterprises is the pathway to Quality Management 5.0. Therefore, quality management and sustainability should not be treated as separate challenges for manufacturing enterprises but as one cohesive direction for responsible business development.

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