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# Qualitative-environmental aspects of products improvement in SMEs from V4 countries

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**Abstract**
Sustainable development has caused companies to try to adapt their activities to changing customer expectations, but also to climate change. This poses a particular challenge for SMEs from developing countries. Therefore, the objective of the investigation was to analyse the qualitative-environmental aspects of the improvement of the products in SMEs from the countries of the Visegrad Group (V4). The results analysed constituted a research sample of 379 companies in the electrical machinery industry (machine processing industry), which were obtained in the period from March to September 2023 through a targeted survey. The area of analysis included, e.g.: (i) environmental issues of selected areas of activity, (ii) measures of environmental activity, and (iii) selected qualitative-environmental aspects. Analyses of the research results were carried out using quantitative and qualitative analyses, including comparative analyses, e.g. regarding the implementation status of ISO 14001, EMAS, and ISO 9001. These techniques were used: word cloud, ANOVA test and Mann Whitney U test at the significance level of $\alpha$=0.05. It has been shown that SMEs in V4 countries focus their activities on improving products to improve their quality rather than limiting their negative environmental impact. Originality of the research is the identification of significant differences in the qualitative-environmental aspects undertaken when SMEs from V4 countries. Research results may contribute to the development activities more effective and coherent in the V4 countries, to achieve a stable and competitive advantage on the market as part of the qualitative and environmental improvement of the products. The research results and the conclusions drawn from them can be used by scientists and practitioners to shape the target states of enterprises in the period of increasing involvement in pro-ecological ideas.

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## 1. Introduction

Modern companies producing products care about the high quality of their products (Ulewicz 2018; Ulewicz & Ulewicz 2020; Ulewicz et al., 2023). This is particularly important for small and medium-sized enterprises (SMEs) (Maladzhi et al., 2010), which have an important role in providing employment and are the driving force behind the development of the economy (Ertuğrul, 2012; Ingaldi and Ulewicz, 2019). This is due to the fact that, despite its small size and limited resources, SMES has a significant impact on the global supply chains of products, resources, and innovation (Siwiec and Pacana, 2022; Talbot S., 2005). However, to gain a competitive advantage, these companies should pay attention to other; additional aspects (Deja et al. 2021). One of them is the impact on the natural environment (Misceo et al., 2004; Siwiec and Pacana, 2021). This situation is a consequence of the growing awareness of society in the practical implementation of the idea of sustainable development (Gajdzik et al., 2023). However, the implementation of innovations in the field of environmental products (so-called ecodesigns) by SMEs remains a challenge (Civancik-Uslu et al., 2019; Nagy and Veresné Somosi, 2022). This is due to the need to adapt SMEs to the economic model, having appropriate knowledge in the field of production and management processes and their relationship with product

innovation and the environment (Ali et al., 2021). For this reason, environmental innovations within products are more willingly practised in large enterprises, as shown (Talbot S., 2005), most SMEs are still reluctant to adopt ecodesign initiatives. Therefore, the activity of SMEs in this area focusses mainly on taking into account customers' expectations regarding the environmental impact or regulatory authorities. However, dynamic changes in customer expectations can cause difficulties in effectively improving environmental impact results in the area of product improvement (Ostasz et al., 2022; Pacana and Siwiec, 2022a, 2021). At the same time, this increases the risk of exclusion from supply chains in markets sensitive to environmental aspects (Talbot S., 2005).

Hence, to meet global market expectations, SMEs are forced to simultaneously take into account quality and environmental criteria in their products, remembering the need to minimise the price of their products (Ključnikov et al., 2022; Misceo et al., 2004; Krynke and Klimecka-Tatar 2022; Pacana et al., 2014; Siwiec, 2021; Ulewicz et al. 2021). This is more difficult in less developed countries, such as the Visegrad Group countries (V4, i.e.: Poland, Slovakia, Hungary, and the Czech Republic), in which SMEs have a key role. In this countries, SMEs create jobs of Slovakia, 67% in the Czech Republic, 69% in Hungary and 68% in Poland (Kovacova et al., 2019; Oláh et al., 2019; Siničáková et al., 2017). This Group is a regional form of cooperation between neighbouring countries (the so-called New Europe) (Ivanová and Masárová, 2018). The V4 countries are characterized by similar development directions, e.g. due to their location and history. Similar economic development, but also similar geopolitical ideas and level of development connect these countries (Oláh et al., 2019). One of the most important goals of the V4 is to ensure energy security in all member states (Brodny and Tutak, 2021; Gumen et al. 2017). At the same time, the aspect that connects these countries is the fact that their energy transformation started later than in the case of other European Union countries (Sulich and Sołoducho-Pelc, 2021). It is important to mention that the V4 countries have an important role in the European economic system (Rokicki and Perkowska, 2020).

Therefore, the objective of the investigation was to analyse the selected qualitative-environmental aspects of product improvement. This research was based on the experience and knowledge of SMEs from the countries of the Visegrad Group (Kljucnikov et al., 2023; Szataniak et al. 2014). The SMEs surveyed were companies belonging to the electromechanical industry (machine processing industry), which is a key development industry in these countries.

The research results and the conclusions drawn from them can be used by scientists and practitioners to shape the target states of enterprises in the period of increasing involvement in pro-ecological ideas.

## 2. Literature review

The issue of quality is fundamental in achieving the products expected by customers. This is the main factor initiating the need to implement process relationships or an ISO 9001 quality management system, which is part of the overall management mechanism. The implementation of this system supports the achievement of competitiveness of SMEs on the domestic and foreign markets (Kutnjak et al., 2019). In turn, issues of the organization's environmental impact are considered within the ISO 14001 environmental management system and the EMAS system. As reported by the authors of the articles (Palacios Guillem, 2019; Santos et al., 2011), the mentioned ISO 9001, ISO 14001 and EMAS systems are the most frequently implemented in SMEs. According to the literature review, it was shown that research in the area of ISO 9001 in SMEs mainly concerned: motivation and benefits from implementation (Khan and Farooquie, 2016; Magodi et al., 2022; Vasilevska and Rivza, 2018; Zimon et al., 2018), main problems occurring during implementation and certification (Unterreiner and Gisbert Soler, 2019), as well as the impact of increasing customer satisfaction with product quality (Usman et al., 2019). In the case of the ISO 14001 system and the EMAS system in SMEs, the research concerned, for example: the impact of the system on the substantive results of the company (Johnstone, 2022), type and application of sustainability controls (Johnstone, 2021), factors, barriers and benefits of implementation (Salim et al., 2018).

Despite this, no research has been found that would refer to qualitative-environmental aspects of product improvement in SMEs from the V4 countries in terms of the ISO 9001, ISO 14001, EMAS management system. Hence, in connection with the ideas of the applicability of these systems, a further literature review covered the qualitative and environmental aspects of product improvement in SMEs.

For example, (Misceo et al., 2004) developed a tool supporting the product design stages of SMEs. The tool involves analysing the implementation of the quality function (QFD) (Sakao, 2007; Wolniak, 2018) and combining its results with environmental aspects of the product life cycle (LCA) (Pacana et al., 2023). Its use is intended to examine customer expectations and key environmental aspects in LCA, on the basis of which a checklist for environmental analysis of the product is created. However, in the study (Nuryakin et al., 2022), the impact of open innovation strategies on the creation of ecoinnovations was analysed. Quantitative research was conducted in SMEs, which proved that open innovation strategies had a significant impact on ecoinnovations, which in turn had a positive impact on the competitive advantage and results of SMEs (Krynke et al., 2022). Another example is research (Hemel and Cramer, 2002), which concerned barriers in SMEs to green products, including improving their quality. Greening of products has been shown to be effective when motivated by other aspects, not only by reducing the negative impact on the environment. The most important stimuli are, for example, an increase in product quality, including potential market opportunities to achieve customer satisfaction. In turn, in development (Ghag et al., 2022) SMEs were examined in terms of reviewing and monitoring sustainability performance indicators as part of achieving long-term competitiveness. Preliminary conclusions indicate that these companies should initially implement the social dimension (e.g., sustainable leadership, knowledge sharing), then the economic dimension (e.g., quality, innovation), and then the environmental dimension (e.g.,

green marketing, waste reduction). In relation to leadership, the approach of SME managers to product improvement was also examined. For example, the authors of the study (Zuraidah Raja Mohd Rasi et al., 2014) conducted research to determine the connections between the practices used in SMEs and the stakeholders of these enterprises. They showed that decisions about environmental practices are significantly influenced by interactions between stakeholders, e.g., customer and employee involvement is focused on process changes, where senior managers are interested in internal management improvements. However, in the study (Maladzhi et al., 2010), SME managers were assessed in terms of their leadership qualities. The idea was to verify whether managers would be able to introduce new products with appropriate effectiveness.

Based on a synthetic review of the literature on the subject, it has been shown that decisions made as part of product improvement in the area of quality and environmental impact have an impact on the functioning of SMEs. It was concluded that SMEs strive to improve their products, taking into account their environmental impact. However, the primary aspect of product improvement is its quality (customer satisfaction), not impact on the natural environment. Development of SMEs in terms of quality and environment also depends on the implemented management systems.

Despite this, no works have been found that would cover this research scope in SMEs from the Visegrad Group (V4) countries. This refers to the lack of work that would include:

- simultaneous analysis of product quality and its impact on the natural environment during product improvement in SMEs from V4 countries;
- analysis of the quality and environmental aspects of product improvement in SMEs from the V4 countries due to the implementation status of management systems, i.e. ISO 9001, ISO 14001 and EMAS.

The identified research gaps were filled as part of the conducted research.

## 3. Method research

The research carried out concerned the qualitative-environmental aspects of product improvement and was carried out as part of the international project „Qualitative-environmental aspects of products improvement" (IVF 22230264). Research was carried out as part of a survey. The survey was conducted among entrepreneurs of small and medium companies (SMEs) belonging to the electromechanical industry (machinery processing industry). These were SMEs from the countries of the Visegrad Group (Poland, Czech Republic, Slovakia and Hungary).

The survey was conducted in traditional (paper) form, and electronic form using Microsoft FORMS (MS FORMS). Some of the surveys were completed face-to-face in a traditional (paper) version. The results obtained from surveys obtained in a traditional form (paper survey) were entered into an electronic database dedicated to the survey in MS FORMS. It is not possible to indicate a specific number of paper surveys and electronic surveys, as they were downloaded separately by members of V4 countries. Due to the fact that the number of paper surveys was much smaller than the number of electronic surveys, and no missing data were observed in the paper surveys, it was concluded that the form of data collection did not have a significant impact on the results.

The survey questions were constructed based on a review of the subject literature, i.e. (Benito-Hernández et al., 2023; Bryła, 2020; Hudakova et al., 2021; Saqib et al., 2023; Wysocki, 2018).

Survey research questionnaire was developed also after preliminary research presented in the literature on the subject (Hajduk-Stelmachowicz et al., 2022; Siwiec et al., 2022; Siwiec et al., 2023). Preliminary research was followed by validation of the survey questionnaire to ensure that it effectively captured the intended data. The validation methodology covered 5 categories in accordance with (Drwal, 1995), but focused mainly on assessing appropriateness, relevance and accuracy. Consultations were held to ensure the fidelity of the translations. The cultural issue did not play a key role in this validation due to the location and history of the V4 countries involved in the study.

The survey questions were answered on a five-point Likert scale. The choice of this scale resulted from its popularity in surveys whose respondents are customers. The Likert scale is simple and is used in quantitative research, including examining customer attitudes or opinions on a given topic (Sullivan and Artino, 2013).

The developed survey is presented in the literature on the subject, i.e., (QuEn - Research Questionnaire For Enterprise, 2023).

The method of disseminating the survey was on via an e-mail with a request to participate in the survey, or by directly giving the survey to respondents.

The choice of SMEs were based on "Colist" database and after a review of SMEs located in the V4 countries, where the company selection categories were as follows:

a) SMEs;
b) industrial processing;
c) branch of the electromechanical industry;
d) geographical location:V4 (Poland, Hungary, Czechia, Slovakia).

In this case, it was assumed that if the company does not design new products "from the cradle", it largely contributes to significant improvement modifications forced by the competition. To ensure representativeness, the surveys were sent to small and medium-sized enterprises. The interviewees also mainly visited such enterprises. Based on estimates, the return rate of the surveys was 10%. No missing data were observed. Some uncertainty may be associated with the responses completing the surveys. Every effort was made to select competent representatives of top management. Unfortunately, their competences were not verified because it was difficult to carry out this verification in practice.

The results of the analysed survey research were obtained from March to September 2023 and included 379 SMEs from the countries of the Visegrad Group, i.e.: Czech Republic (10%), Poland (41%), Hungary (25%), Slovakia (24%). Most of the surveyed SMEs from the V4 countries were located in city from 150 000 to 500 000 residents (30%), and the city

from 20 000 to 150 000 residents (26%). Most of them were international companies (46%).

Based on the method for estimating the research sample presented in the literature on the subject, i.e. (Siwiec and Pacana, 2021) and taking into account the criteria for selecting enterprises, it was decided that the sample was sufficient for testing and formulating preliminary conclusions.

Due to the purpose and hypotheses of the study and its limited volume, it was decided to select the following questions for partial analysis: To what extent do you agree with the statements regarding the enterprise's activities?, Which measures of environmental performance are used in your company?, Define the company's current approach to taking actions aimed at improving the quality of products in terms of quality and the environment. In the completed survey, according to the authors, these questions were key from the point of view of qualitative-environmental aspects of products improvement. The remaining questions concerned secondary, related issues.

The analysis of the survey results obtained from SMEs from the V4 countries was carried out in three main stages. The analysis were supported by Mann Whitney U test and ANOVA test.

The repeated measures ANOVA test allows you to analyze multiple variables in your repeated measures data. The choice of this test resulted from the possibility of analyzing groups with different numbers of observations. At the same time, it is possible to analyze groups of related dependent variables that represent different measurements of the same attribute (Rana et al., 2013).

The Mann Whitney U test was used to analyse statistically significant differences in the assessments for analyzed questions. Mann Whitney U test can be used to compare groups that have different sizes. At the same time, it is a non-parametric test and can be used when the quantitative variable is ordinal. These conditions resulted in its selection for analysis (Oláh et al., 2019).

**Stage 1. Analysis of environmental issues undertaken in selected areas of activity of SMEs from the V4 countries**

In the first stage of the investigation, environmental issues carried out in selected areas of activity of SMEs from the V4 countries were analysed. The aim was to analyse the consideration of environmental issues carried out in selected areas of activity of SMEs from the V4 countries, including the type and status of the implementation of the management system. The research verified the following research hypotheses:

**$H_1$:** Does the implementation status of the environmental management system and EMAS affect the consideration of environmental issues in selected areas of activity of SMEs from the V4 countries?

**$H_2$:** Does the implementation status of the quality management system influence the consideration of environmental issues in selected areas of activity of SMEs from the V4 countries?

The results obtained in response to the question 1, as in Appendix. The analysis was carried out in terms of the implementation status of: (i) the ISO 14001 environmental management system and the EMAS system, and (ii) the ISO 9001 quality management system. The implementation status of these systems was distinguished as: implemented, not implemented, during implementation, and the respondent's lack of knowledge regarding this scope.

The Mann Whitney U test was used to analyse statistically significant differences in the assessment of environmental issues in the case of the implementation of these systems. The results obtained for the analysed issues, distinguished by management systems, were then subjected to in-depth analysis. The aim was to determine which environmental issues are important due to the implementation status of the management system. For this purpose, the ANOVA test (repeated measurement design) was used.

The analyses were performed at the significance level of $\alpha=0.05$ using the STATISTICA 13.3 programme.

**Stage 2. Analysis of environmental performance measures used in SMEs from the V4 countries**

This stage of the research involved analysing which environmental performance measures are used in the SMEs surveyed in the V4 countries. The question 2 was used in the survey research (as in Appendix).

The analysis of measures was carried out according to the number of occurrences of a given measure, where the more often a measure was indicated, the more popular (more frequently used) it is. Additionally, a word cloud was developed that visually presents the results obtained.

**Stage 3. Analysis of the qualitative-environmental aspects of SMEs in the V4 countries**

This part of the research analyzed selected aspects of product improvement in SMEs from the V4 countries from a qualitative and environmental perspective. The analyzes were conducted based on the results obtained from the research questions 3-6, as in Appendix.

The ANOVA test (repeated-measures designs) was used at the significance level of $\alpha=0.05$, which was performed using the STATISTICA 13.3 program.

## 4. Results

### 4.1. Environmental issues addressed in selected areas of activity of SMEs from the V4 countries

In the first stage of the investigation, environmental issues carried out in selected areas of activity of SMEs from the V4 countries were analysed. The aim was to analyse the consideration of environmental issues in selected areas of activity of SMEs from V4 countries, including the type and status of implementation of the management system.

Initially, Mann Whitney U test was performed at the significance level $\alpha=0.05$. The result is shown in Table 1.

Statistically significant differences were found in the case of the implementation status of the ISO 14001 environmental management system and the EMAS system (i.e. $p<\alpha$). It was concluded that the implementation status of the environmental management system and the EMAS system has a significant impact on the consideration of environmental issues in

selected areas of activity of SMEs from V4 countries. Thus, hypothesis ($H_1$) was confirmed.

**Table 1.** Results of the Mann Whitney U test for environmental issues undertaken in selected areas by SMEs from the V4 countries, divided by the status of implementation of management systems

| No. | Question | ISO 9001 | ISO 14001 |
|---|---|---|---|
| 1 | store (storing/ warehouse operations) | 0.000 | 0.196 |
| 2 | transport (logistics) | 0.001 | 0.238 |
| 3 | produce (manufacturing/production) | 0.006 | 0.219 |
| 4 | do research, design and make development works (R&D) | 0.002 | 0.236 |
| 5 | implement waste management | 0.043 | 0.083 |
| 6 | modify and/or purchase devices/machines/equipment (purchasing/procurement) | 0.001 | 0.119 |
| 7 | offering e-customer services | 0.000 | 0.430 |
| 8 | handling of raw materials and their processing (supply processes) | 0.014 | 0.081 |

In turn, no statistically significant differences were demonstrated in the case of the implementation of the ISO 9001 quality management system (p>α). Therefore, as part of hypothesis ($H_2$), it was shown that the status of implementation of the quality management system does not have a significant impact on the consideration of environmental issues in product improvement in SMEs from V4 countries. For this reason, the analysis of environmental issues in selected areas of activity of SMEs from V4 countries was subject to a deeper analysis only in terms of the implementation status of the ISO 14001 environmental management system and the EMAS system. The aim was to determine which environmental issues are important at particular stages of the implementation of this system. An ANOVA test (repeated measurement designs) was used for this purpose. The analyses were performed at the significance level of α=0.05. The result is shown in Fig. 1.

It was observed that environmental issues are definitely important in the areas analysed of SMEs from V4 countries if an environmental management system and/or an EMAS system have been implemented or are in the process of being implemented. The most important areas are: implementation of waste management (3.97), research, design and make development work (R&D) (3.75), and produce (manufacturing/production) (3.71).

After implementing these systems, the following areas are definitely important for SMEs from the V4 countries: store (storing/ warehouse operations) (3.59), transport (logistics) (3.56), produce (manufacturing/production (3.71), offering e-customer services (e.g. e-invoices, electronic customer service) (3.67), and handling of raw materials and their processing (supply processes) (3.68).

It was shown that environmental issues were at a relatively similar and low level of importance in the analysed areas if the environmental management system and/or the EMAS system were not implemented or the respondent did not have knowledge of the analysed issue.

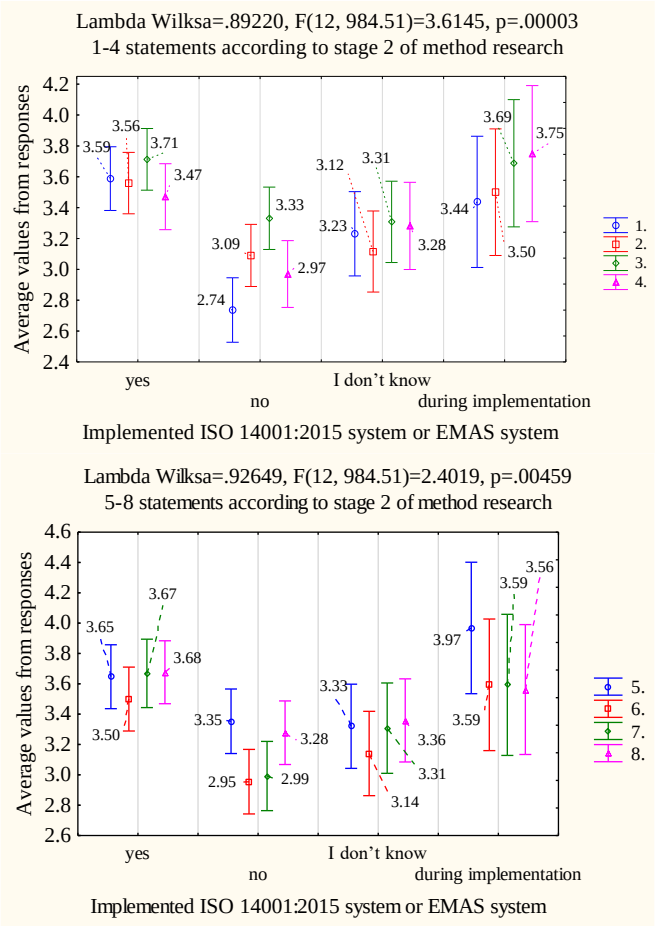


**Fig. 1.** Average values of entrepreneurs' assessments for environmental issues of SMEs from the V4 countries

## 4.2. Environmental performance measures used in the surveyed SMEs from the V4 countries

Then, the measures of environmental performance that were used in the SMEs surveyed in the V4 countries were analysed. Twelve different measures were analysed. Based on the results obtained from the survey, the number of indications given by the respondent was analysed. This is presented in Table 2.

**Table 2.** Analysis of the use of environmental performance measures by SMEs from the V4 countries

| Environmental performance measure | Quantity [pcs] |
|---|---|
| Waste generated per unit of finished product | 188 |
| Percentage of recycled waste | 166 |
| Efficiency in the use of materials and energy | 153 |
| environmental failures (e.g. exceeding the established pollution limits, unplanned releases) | 153 |
| Number of incidents | 153 |
| Emission volume, e.g. $CO_2$ | 152 |
| For official reports (related to legal regulations) | 126 |
| Number of investments in environmental protection | 115 |
| The amount of specific pollutants emitted (e.g. $NO_x$, $SO_2$, Pb, CFC, VOC, CO) | 115 |

| | |
|---|---|
| The number of kilometers traveled by the vehicle per unit of production | 105 |
| The area of land around the enterprise that is preserved as a natural environment | 103 |
| I have no such knowledge | 85 |
| Number of allegations | 56 |
| I think there won't be any.. | 1 |
| If law does not require any | 1 |

A total of 1.672 measurement readings were obtained from 379 surveyed SME entrepreneurs from the V4 countries. This resulted from the possibility of indicating any number of metres.

Therefore, based on a summary of the use of environmental metrics by SMEs from V4 countries, a word cloud was developed. The keyword cloud presents the main (key) measures, i.e. those most frequently used in SMEs from the V4 countries. At the same time, it visually presents the frequency of the meter's occurrence (the larger the font size, the more often the meter was repeated).

In order to develop the word cloud, all respondents' answers were collected. They were expressed in a qualitative way (name of the measure). The answers were systematized by presenting them in the same font size, the same size of the first letters of the words and the spaces between the words regarding one measure. The words were repeated, which determined their size in the word cloud. The more often a given word (meter) was repeated, the larger its size in the cloud. Based on the keyword cloud, research results can be presented in an illustrative and intuitive way. The cloud of environmental metres is shown in Fig. 2.

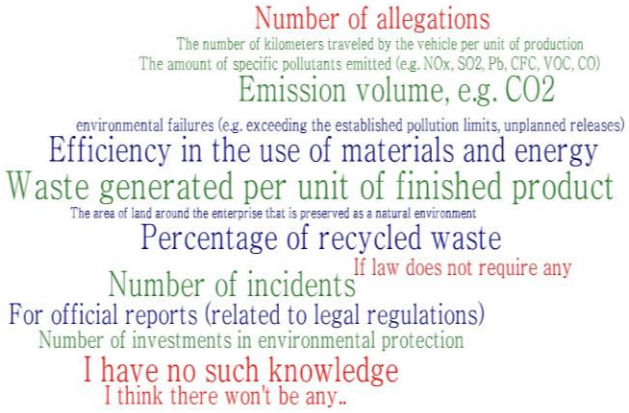


**Fig. 2.** Cloud of environmental performance measures used by SMEs from the V4 countries. Own study based on WordArt

The analysis carried out showed that the most frequently used measure of environmental activity in SMEs in V4 countries is waste generated per unit of finished product (50%). Slightly fewer indications were given by the following indicator: percentage of recycled waste (44%). The following metres received a slightly smaller number of indications (40%): efficiency in the use of materials and energy, environmental failures (e.g. exceeding the established pollution limits, unplanned releases), and number of incidents. In turn, the metre received relatively the fewest indications, i.e., number of allegations (15%). The analysis was used to create questions in the survey offered to respondents. It may be an inspiration to design further research in this area.

### 4.3. Qualitative-environmental aspects in SMEs from the V4 countries

As part of this part of the investigation, aspects of SMEs in the V4 countries were analysed to take actions to improve the quality of products in terms of quality and environment. The general nature of these activities was also verified. The result is presented in Table 3.

It was observed that SMEs from the V4 countries practice two approaches to taking actions aimed at improving the quality of products from a qualitative-environmental perspective, i.e., taking into account customer requirements and the impact on the natural environment at the same time (48.55% of responses), as and taking into account customer requirements and environmental impact separately (48.29% of responses).

Most of the SMEs surveyed from the V4 countries (39.31% of responses) declared that improving the quality of products is definitely more focused on achieving the quality of products that satisfy customers than on reducing the negative impact on the natural environment. Slightly fewer (30.61% of responses) indicated that their approach concerns the statement, i.e.: improving the quality of products is aimed at reducing the negative impact on the natural environment as well as at achieving the quality of products that satisfy customers. The smallest number of SMEs surveyed in the V4 countries (28.76% of responses) declared that, in their companies, improving the quality of products is definitely more focused on reducing the negative impact on the natural environment than on achieving the quality of products that satisfy customers.

**Table 3.** Current approach and activities of SMEs from the V4 countries to quality and environmental improvement of products

| No. | Answer | % of responses |
|---|---|---|
| 1 | Activities are undertaken simultaneously taking into account customer requirements as to the quality of products and taking into account the impact of products on the natural environment | 48.55% |
| 2 | Activities are undertaken separately, taking into account customer requirements as to the quality of products and taking into account the impact of products on the natural environment | 48.29% |
| 3 | Improving the quality of products is definitely more focused on achieving the quality of products that satisfy customers than on reducing the negative impact on the natural environment | 39.31% |
| 4 | Improving the quality of products is aimed at reducing the negative impact on the natural environment as well as at achieving the quality of products that satisfies customers | 30.61% |
| 5 | Improving the quality of products is definitely more focused on reducing the negative impact on the natural environment than on achieving the quality of products that satisfy customers | 28.76% |

The smallest number of SMEs surveyed in the V4 countries (28.76% of responses) declared that, in their companies, improving the quality of products is definitely more focused on reducing the negative impact on the natural environment than on achieving the quality of products that satisfy customers.

Therefore, although the impact on the environment is important for SMEs in the V4 countries, in most of the companies surveyed, achieving customer satisfaction with the quality of the product is more important.

Then, the frequency and degree of impact of activities carried out by SMEs from the V4 countries were analysed. For this purpose, respondents were asked how often they take actions to improve the quality of their products while caring for the natural environment. The results are shown in Fig. 3.

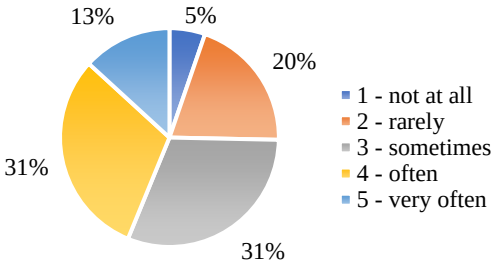


**Fig. 3.** Frequency of undertaking quality and environmental activities during product improvement in SMEs from V4 countries

It was shown that relatively most (31%) of the SMEs surveyed from the V4 countries sometimes or often take actions aimed at improving the quality of their products while caring for the natural environment. It was observed that approximately 13% of the companies surveyed perform these activities very often, while approximately 25% of the companies undertake these activities not at all or rarely.

The respondents were asked to what extent the need to care for the natural environment influences the activities carried out in the company when improving product quality. The results are shown in Fig. 4.

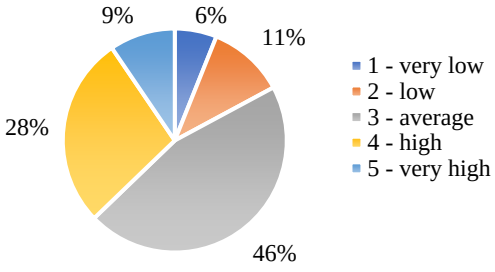


**Fig. 4.** Degree of impact of undertaking quality and environmental activities on product improvement in SMEs from V4 countries

The majority (46%) of the V4 countries declared that the need to care for the natural environment has a medium impact on the activities carried out in the company when improving the quality of the products. Virtually half as many (28%) indicated that this impact is high. A minority of respondents relatively similarly rated this impact as low (11%) or very high (9%). Only 6% of the respondents showed that the impact is very low.

Then, it was verified whether the implementation status of the ISO 14001 quality management system and the ISO 9001 environmental management system and/or the EMAS system had an impact on the issues analysed. For this purpose, an ANOVA test (repeated measure designs) was used, with a significance level of $\alpha = 0.05$. The result is shown in Fig. 5.

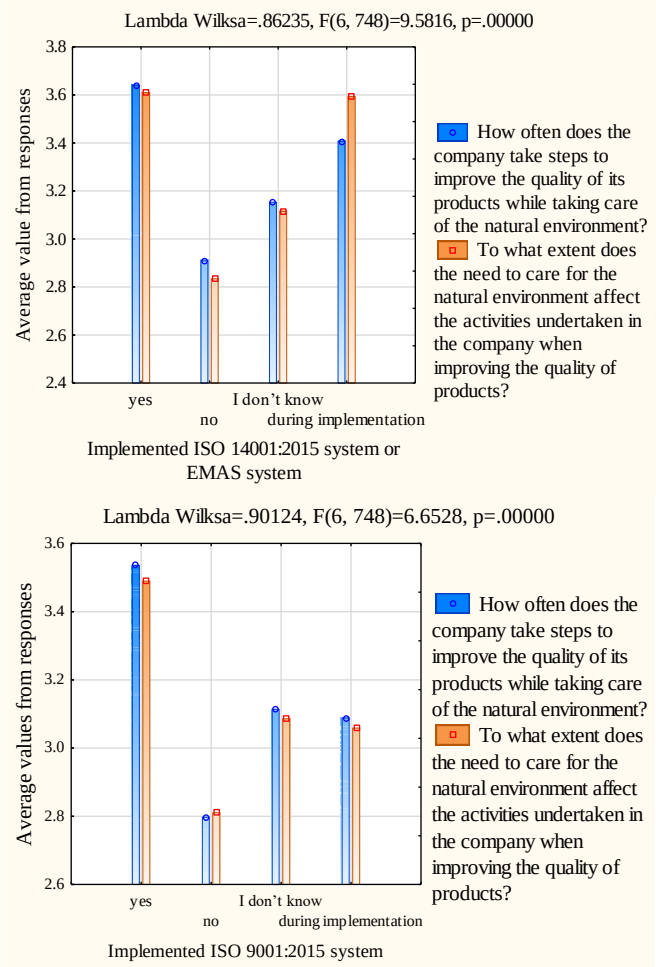


**Fig. 5.** The impact of the implementation status of management systems in terms of qualitative-environmental activities in SMEs from the V4 countries

It was observed that the SMEs surveyed in the V4 countries are much more willing to take actions aimed at improving the quality of their products while caring for the natural environment when they have implemented or are implementing the ISO 14001 system or the EMAS system. A similar observation occurs with regard to the increase in the need to care for the natural environment as part of activities that improve the quality of the product. If the company has not implemented these systems, the willingness to take these actions is much lower.

A different phenomenon occurs in the implementation of the ISO 9001 system. If the SMEs surveyed in the V4 countries have implemented this system, as before, they are much more willing to take actions aimed at improving the quality of their products while caring for the natural environment. At the same

time, there is a greater need to care for the natural environment as part of activities that improve the quality of the product. However, such an approach by companies was not observed during the implementation of the ISO 9001 system. Then, the willingness to take such actions is noticeably lower and even comparable to the situation when the respondent is not sure about the implementation of this system. If SMEs from V4 countries have not implemented this system, their participation in the issues discussed is negligible.

Confirming hypotheses ($H_3$) and ($H_4$), it was shown that the implementation status of ISO 9001, ISO 14001, or the EMAS system affects the participation of SMEs in quality and environmental activities during the improvement of the product.

## 5. Discussion

Improving products in SMEs while taking into account quality and environmental aspects is still a challenge (Belas et al., 2022; Gavurova et al., 2022; Pacana and Siwiec, 2022b), mainly after the COVID-19 pandemic (Civelek et al., 2021; Czerwińska and Pacana, 2019; Wu et al., 2022).

These challenges mainly concern developing countries, such as the V4 countries (Bednárová And Liberko, 2008; Domarackcá et al., 2018). Due to the lack of current research in this area, the objective was to analyse selected qualitative-environmental aspects of product improvement in SMEs from V4 countries. Survey research was used, through which 379 entrepreneurs were surveyed between March and September 2023.

On the basis of the analysis, the following conclusions were drawn:

1. The implementation status of the environmental management system (ISO 14001, EMAS) has a significant impact on the attention to environmental issues in SMEs from V4 countries.
2. The status of implementation of the quality management system (ISO 9001) does not affect activities aimed at minimising the negative impact on the environment in SMEs in the V4 countries.
3. The most important areas of activity of SMEs from the V4 countries in which environmental issues are important are: implement waste management, research, design and make development works (R&D), and produce (manufacturing/production).
4. The most frequently used measure of environmental activity in SMEs from the V4 countries is waste generated per unit of finished product, and then percentage of recycled waste, efficiency in the use of materials and energy, environmental failures (e.g., exceeding the established pollution limits, unplanned releases) and number of incidents.
5. SMEs in V4 countries relatively often take actions aimed at improving the quality of their products while caring for the natural environment.
6. The status of ISO 14001 or the EMAS system affects the participation of SMEs in quality and environmental activities during product improvement, where these companies are more willing to take actions to improve the quality of their products while caring for the natural environment.
7. The ISO 9001 status affects the participation of SMEs in quality and environmental activities during the improvement of products.
8. SMEs in V4 countries practice two approaches to taking actions aimed at improving the quality of products from a qualitative-environmental perspective, that is, taking into account customer requirements and the impact on the natural environment at the same time, or taking into account customer requirements and the impact on the natural environment separately.
9. Most of the SMEs surveyed from the V4 countries declared that improving the quality of products is definitely more focused on achieving the quality of products that satisfy customers than on reducing the negative impact on the natural environment.
10. The environmental impact is important for SMEs in the V4 countries, but in most of the companies surveyed, achieving customer satisfaction with the quality of the product is still more important.

## 6. Summary and conclusion

Enterprises strive to meet customer expectations. This translates into achieving high-quality products that will satisfy customers. However, increasing climate change and global warming require taking into account the environmental impact of these activities.

Hence, the objective of the investigation was to analyse the qualitative-environmental aspects of product improvement in SMEs from the countries of the Visegrad Group (V4). Research was carried out through surveys among SME entrepreneurs belonging to the electromechanical industry (machinery processing industry). These were SMEs from the countries of the Visegrad Group (Poland, Czech Republic, Slovakia, and Hungary). The analysis was carried out on the basis of the results of the survey obtained in the period from March to September 2023. During this period, the research sample consisted of 379 companies from V4 countries.

The analysis covers environmental issues undertaken in selected areas of activity of these companies, as well as the environmental performance measures used. An analysis of the qualitative and environmental aspects of product improvement was also carried out.

Quality and environmental aspects are important for SMEs in V4 countries in improving product quality. However, the level of commitment of these countries to improving products in terms of quality and/or environment varies. The differences may result from the economic development of these countries, the level of wealth in society, and the effects of the COVID-19 pandemic.

The originality of the research is the identification of significant differences in the quality and environmental aspects undertaken by SMEs in V4 countries as part of product improvement. Therefore, research results may contribute to more effective and coherent development activities in V4 countries, to achieve a stable and competitive advantage on the market as part of qualitative and environmental improvement of products.

The main limitation during the research was identifying entrepreneurs from SMEs in the electrical machinery industry and persuading them to complete the survey. It was a time-consuming and labor-intensive process.

The potential future directions of work are compare SMEs from the Visegrad Group countries with enterprises in Western Europe or other regions of the world.

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## Appendix

**Question 1:** To what extent do you agree with the statements regarding the enterprise's activities? Mark one answer for each statement in scale: 1 - I don't agree at all, 2 - I partly agree, 3 - I agree, 4 - I mostly agree, 5 - I totally agree.
We pay attention to environmental issues in the following areas:

- make purchases;
- store (storing/warehouse operations);
- transport (logistics);
- produce (manufacturing/production);
- do research, design and make development works (R&D);
- implement waste management;
- modify and/or purchase devices/machines/equipment (purchasing/procurement);
- offering e-customer services (e.g. e-invoices, electronic customer service);
- handling of raw materials and their processing (supply processes).

**Question 2:** Which measures of environmental performance are used in your company? Please indicate all that apply to:

- Waste generated per unit of finished product;
- Number of incidents, environmental failures (e.g. exceeding the established pollution limits, unplanned releases);
- Percentage of recycled waste;
- The number of kilometers traveled by the vehicle per unit of production;
- Number of investments in environmental protection;
- Emission volume, e.g. $CO_2$;
- Efficiency in the use of materials and energy;
- The amount of specific pollutants emitted (e.g. NOx , $SO_2$, Pb, CFC, VOC, CO);
- Number of allegations;
- The area of land around the enterprise that is preserved as a natural environment;
- For official reports (related to legal regulations);
- I have no such knowledge;
- Other (what ?) .....

**Question 3:** Define the company's current approach to taking actions aimed at improving the quality of products in terms of quality and the environment. Mark one sentence:

- Improving the quality of products is definitely more focused on achieving the quality of products that satisfy customers than on reducing the negative impact on the natural environment.
- Improving the quality of products is definitely more focused on reducing the negative impact on the natural environment than on achieving the quality of products that satisfy customers.
- Improving the quality of products is aimed at reducing the negative impact on the natural environment as well as at achieving the quality of products that satisfies customers.
- None of the above statements is true, because in the company improving the quality of products is focused on (please complete the sentence) ……...

**Question 4:** What quality and environmental measures are taken by the company to improve the quality of its products.

- Activities are undertaken separately, taking into account customer requirements as to the quality of products and taking into account the impact of products on the natural environment
- Activities are undertaken simultaneously taking into account customer requirements as to the quality of products and taking into account the impact of products on the natural environment
- other, i.e.:.....

**Question 5:** How often does the company take steps to improve the quality of its products while taking care of the natural environment? Mark one: 1 - not at all, 2 – rarely, 3 – sometimes, 4 – often, 5 - very often

**Question 6:** To what extent does the need to care for the natural environment affect the activities undertaken in the company when improving the quality of products? Mark one: 1 - very low, 2 – low, 3 – average, 4 – high, 5 - very high.

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