ARCHIVES OF TRANSPORT *ISSN (print): 0866-9546*
Volume 65, Issue 1, 2023 ***e-ISSN (online):*** *2300-8830*
DOI: *10.5604/01.3001.0016.2479*

EXPECTATIONS OF INDUSTRIAL ENTERPRISES TOWARDS SUPPLIERS RELATED TO MANAGEMENT OF QUALITY, ENVIRONMENT AND OCCUPATIONAL HEALTH AND SAFETY SYSTEMS

Maciej Urbaniak[1], Dominik Zimon[2], Peter Madzík[3]

[1] *Department of Logistics, Faculty of Management, University of Lodz, Lodz, Poland*

[2] *Department of Management Systems and Logistics, Rzeszow University of Technology, Rzeszow, Poland*

[3] *Department of Business Administration and Management, Technical University of Liberec, Liberec, Czech Republic*

Abstract:

The aim of the article is to present the expectations of industrial enterprises towards suppliers related to quality, environment, occupational health and safety management systems (QEOH &SMS). The article presents the results of empirical research conducted in 151 companies operating on the Polish B2B market. The study was commissioned to a specialised research agency that conducted a targeted selection of companies registered in the Bisnode database, which is a business directory search platform. The expectations of production companies towards their suppliers regarding the implementation of QEOH&SMS were assigned a rank on a scale from one (the least important criterion) to five (the most significant). The methodological apparatus in this study was set so that it was possible to fulfil the research goal based on empirical data. A questionnaire was used to verify the characteristics of the operational process after the implementation of particular managerial systems. This article examines the relationship between the requirements for suppliers and the implementation of management systems by manufacturing companies. The results of the conducted research indicate that expectations of industrial enterprises towards suppliers related to QEOH&SMS are strongly focused on their development. Research shows that companies that adhere to the requirements of standardised management systems have a greater requirement for suppliers than companies that do not implement QEOH & SM requirements. In particular, the implementation of quality and environmental management systems by the surveyed organisations translates into increased requirements for suppliers. The article contributes to the existing scientific literature by analysing the impact of the implementation of individual management systems on the expectations towards suppliers. This study shows which of the 18 examined aspects are particularly important for manufacturing companies. Additionally, the expectations towards suppliers were classified into four groups (Corrective, Preventive, Improvement, Innovation).

Keywords: *suppliers, QMS, OH&SMS, EMS, supply chain*

To cite this article:

Urbaniak, M., Zimon, D., Madzík, P. (2023). Expectations of industrial enterprises towards suppliers related to management of quality, environment and occupational health and safety systems. Archives of Transport, 65(1), 87-104. DOI: https://doi.org/10.5604/01.3001.0016.2479

Contact:
1) maciej.urbaniak@uni.lodz.pl [https://orcid.org/0000-0003-4127-1192]; 2) zdomin@prz.edu.pl [https://orcid.org/0000-0002-3097-5445] - corresponding author; 3) peter.madzik@gmail.com [https://orcid.org/0000-0002-1655-6500]

1. Introduction

In the last decade, competition in the manufacturing sector has increased with globalisation, the evolution of customer requirements and external stakeholders. Today, organisations compete not only with their internal resources, processes and competences, but also with their ability to take advantage of opportunities to collaborate with suppliers in the supply chain. (Cui et al., 2021; Jacyna-Gołda et al., 2018; Vachon et al., 2009). Therefore, manufacturing companies require innovative solutions from suppliers, investments in improving the quality of their products and in meeting environmental requirements (Aral et al., 2021; Dolgui and Ivanov, 2021; Kumar et al., 2019; Wang et al., 2021; Sacristán-Díaz et al., 2018). Managers of enterprises and chains realise that choosing the right suppliers can lower costs, provide high-quality products and improve the competitive position (Vedantam and Iyer, 2021; Gören, 2018). On the other hand, raw materials, products and components that do not meet the accepted quality standards and supplied by suppliers have an impact on the quality of the final product and cause economic, environmental, image and social losses. (Negash et al., 2020; Khatab et al., 2019; Bastas and Liyanage, 2018). Manufacturing companies implement systems that improve their internal processes and whose recommendations can be considered more broadly in the supply chain (Zimon et al., 2021; Kush et al., 2020; Field and Meile, 2008). Buying companies expect suppliers to be able to adapt their processes to their requirements QEOH&SMS (Zimon et al., 2020). Among the many requirements, a particularly important element in building relationships with suppliers is ensuring the technical quality of the offered products (González-Benito and Dale, 2001). Quality assurance requires strict compliance with legal requirements relating to safety (included, inter alia, in legal regulations and technical standards) and special supervision over processes. (Su et al., 2020). An important role in ensuring product safety is played by the effectiveness of planning, implementation, monitoring and evaluation of operational processes (design, purchase, production, maintenance, storage and delivery to customers). The international organisational standard ISO 9001 contains unified requirements for supplier companies in the field of process and product quality assurance (Su et al., 2015; Sweis et al., 2021). Mixed results from research on quality initiatives show that organisations achieved a distinct operating advantage when they used the ISO standards in daily practice and when these standards served as a catalyst for change (Naveh and Marcus, 2004). Sroufe and Curkovic (2008) emphasise that the ISO 9001 standard provides particularly important guidelines for improving the quality of products and processes along the entire supply chain. The latest edition of ISO 9001 based on the risk management concept (described in ISO 31000) should oblige suppliers to ensure the safety of products and processes to a greater extent (Cagnin et al., 2019; Zimon and Madzik, 2020; Mu-Seong et al., 2003). Dellana et al., (2020) on the basis of research, they found that organisations wchich have a quality management system (QMS) according to the ISO 9001 standard manage risk in the supply chain more effectively. This is due to the fact that, in order to ensure product safety, suppliers must exercise special supervision over their production processes (Tse et al., 2012; Fonseca et al., 2015). In accordance with the latest requirements of ISO 9001, this supervision should include, among others:

– identification of risks associated with processes and products,
– defining measurable goals and methods of assessing their achievement,
– compliance with legal regulations,
– ensuring product identification in flow processes,
– using of appropriate infrastructure (buildings and related installations, equipment, including computer hardware and software, means of transport, communication technologies),
– ensuring safe work places,
– qualification of personnel who should have appropriate training,
– reducing the level of risk in processes and products through effective preventive and corrective actions, especially in the case of complaints (Fonseca, 2015; Gray, et al., 2015).

The scope of controls required by buyers relates to the acceptance assessment of the purchased materials / infrastructure elements, the assessment conducted at individual stages of product processing, as well as the final assessment of the finished product (Andres-Jimenez et al., 2020; Chiarini, 2015). This scope of supervision determines the safety of products delivered to customers and is essential in the event of complaints. Many manufacturers require

their suppliers to supervise the research and development processes of new and modified products, especially with regard to their validation (Li et al., 2020; Chiarini, 2019; Hu et al., 2018; Jedynak, 2018; Dowlatshahi, 2011). According to Dellana and Kros (2019), a number of requirements contained in the ISO 9001 standard mean that companies that meet them have a higher process maturity.
Many researchers emphasise that there is a close relationship between quality management systems and the environment (Fonseca et al., 2022; Hu et al., 2022; Abdallah et al., 2021; Zimon et al., 2021; Curkovic and Sroufe, 2011). Both quality management systems (QMS) and environmental management systems (EMS) emphasise waste reduction, efficient use of raw materials and energy sources, and control of internal processes. (Tarí et al., 2012). Standardised quality and environmental management systems encourage the use of continuous improvement models to ensure the environmental improvement of the production system (Ghadge et al., 2020; Mami et al., 2019). There are strong complementary relationships between QMS and EMS that emphasise both organisational and environmental improvement (Gomes et al., 2020). Many companies (and especially international corporations) that have implemented the concept of environmental management also expect the introduction of reducing the negative impact on the natural environment from their suppliers (Habidin et al., 2018). The scope of requirements for suppliers may include compliance with legal regulations related to environmental protection (relating to both products and processes), as well as implementation and improvement of an environmental management system based on the requirements of the ISO 14001 standard. This action is understandable because research shows that a more complete orientation of suppliers towards sustainable development has a positive effect on the environmental and social sustainability of supply chains (Kumar, D., & Rahman, 2016). Supplier's environmental responsibility can be fostered through both stakeholder pressure and relational factors; while supplier social responsibility is more difficult to stimulate (Villena et al., 2020).
Enterprises wishing to ensure the continuity of processes in supply chains also expect suppliers to effectively implement systemic management of occupational health and safety (Cabecinhas et al., 2020). The requirements of this system (OH & SMS), currently included in the ISO 45001 standard, have been developed compatible with quality and environmental management systems, taking into account the integration of these systems and synergistic effects (Rajaprasad and Chalapathi, 2015). OH & SMS affects not only work safety, but also reduces downtime and interruptions in production (Ozturkoglu et al., 2019). The use of such systems that meet the requirements of ISO 9001, ISO 14001 or ISO 45001 may positively affect the sustainable, safe and pro-quality management of the enterprise. (De Oliveira Matias and Coelho, 2002). Companies also use the Toyota Production System (TPS), which focuses on increasing the profitability, quality and efficiency of production systems (Chen et al., 2019) to raise the demands placed on suppliers.
Based on the above considerations, it can be concluded that manufacturing companies use a number of different systems to improve their operational processes. When reviewing the literature, it can be noted that there are many studies on the impact of these systems on the functioning of enterprises (de Nadae et al., 2021; Hernandez-Vivanco et al., 2019; Tuczek et al., 2019). However, there are no studies that deal with the issue of the impact of the implementation of management system requirements on the expectations of industrial enterprises towards suppliers. As rightly noted by Su et al. (2020), enterprises can implement standardised management systems to improve internal operational processes and thus compete with other enterprises, but they must not forget about the impact of these systems on other links in the supply chain, e.g. suppliers. When systems affect the supply chain, it is possible to talk about a more effective use of their capabilities. It seems reasonable, therefore, the question whether enterprises, when complying with the QEOH & SMS requirements, notice this fact and transfer the requirements contained in the systems to the closest links in the supply chain. The purpose of this article is to present the expectations of industrial enterprises towards suppliers related to systemic management of quality, environment and occupational health and safety (QEOH & SMS) in relations with suppliers.
The paper is structured as follows. Section 2 presents the theoretical background, including a conceptual explanation of the variables that have shaped the research model. Section 3 offers a description of

the methodologies. Subsequently, Section 4 provides a detailed description of the main results derived from the data analysis. Finally, Sections 5 and 6 presents the conclusions, implications, and limitations of this study.

2. Conceptual framework

More and more companies, especially original equipment manufacturers (OEMs), when setting requirements for their suppliers, focus on the organisational guidelines contained in quality, environment, occupational health and safety international management standards (QEOH&SMS). OEMs publish requirements for suppliers in the form of handbooks and manuals to prepare them for initial and periodic assessment. Supplier evaluation begins with the delivery of self-assessment questionnaires. The content of these questionnaires in the form of questions is based to a very large extent on the requirements contained in the QEOH&SMS.

By analysing the content of several dozen (over 30) self-assessment questionnaires for suppliers published on the websites of purchasing enterprises, the most frequently taken into account expectations regarding QEOH&SMS were selected. To the identified expectations of industrial enterprises towards suppliers related to management of QEOH&SMS one could include:

– Product quality control status,
– Identification of the sources of the reasons for the complaint,
– Ensuring health and safety at work,
– Increasing the awareness and knowledge of the staff,
– Documenting corrective actions,
– Product identification at various stages of its production,
– Management of the environmental aspect,
– Evidence of validation of new products,
– Identification of threats related to operational processes,
– Supervising equipment for measuring and monitoring products and processes,
– Use of measures for processes,
– Planning operational processes (e.g. product design, production, purchasing, sales),
– Defining measurable goals for operational processes,
– Evidence of validation of new processes,
– Workstation instructions available in operational processes,
– Identification of operations performer,
– Infrastructure supervision.

Suppliers are required to complete self-assessment questionnaires, answering the questions contained therein and providing evidence of compliance with the requirements for the QEOH&SMS areas. The credibility of the information contained in the self-assessment questionnaires is verified by audits at suppliers. Purchasing companies expect suppliers to implement measures aimed at their development. Therefore, buyers set suppliers specific periodic goals. Achievement of these goals is periodically verified by the system of measures included in the Performance Feedback Reports Cards and by audits at suppliers.

3. Methodology

In order to determine the significance of the expectations of industrial enterprises towards suppliers related to QEOS&SMS, empirical research was conducted. The methodological apparatus in this study was set so that it was possible to fulfil the research goal based on empirical data. A questionnaire was used to verify the characteristics of the operational process after the implementation of particular managerial systems. The study was conducted in the period from October to November 2019 using the Computer Assisted Telephone Interview technique (CATI). The research covered 151 producers operating in Poland on the B2B market (employing over 49 employees) from the automotive (25,17%), metal (28,47%), chemical (19,21%) and furniture (27,15%) sectors. The study was commissioned to a specialised research agency that conducted a targeted selection of companies registered in the Bisnode database, which is a business directory search platform. The expectations of production companies towards their suppliers regarding the implementation of QEOH&SMS were assigned a rank on a scale from one (the least important criterion) to five (the most significant). Most of the business entities participating in the research (66.22%) had an implemented QMS based on the requirements of the international management standard ISO 9001. The implemented EMS was owned by 29.80% of the surveyed producers. On the other hand, 23.84% of the surveyed enterprises had an implemented OH&SMS

and 17,88% of the surveyed producers had implemented Toyota Production System tools like Kaizen, 5S, TPM.

Concerning the nature of the research and the research goal, the variables listed in Table 1 were used. Three ID variables were used - size, presence of research department and source of capital. 18 variables describing the characteristics of the operational process in a particular company were used. The ordinal scale from 1 to 5 was utilised to assess these characteristics. As the scale was generic, the risk that respondents would consider the specifics of their company in the assessment should be at least partially eliminated, which could result in inconsistent assessment and lower reliability of results. At the end of the questionnaire, stratification variables were used - four management systems examined and no system - using a dichotomous yes / no scale.

From the methodological point of view, the data was processed in the software Minitab and SPSS Statistics. Descriptive and inferential statistics procedures were used. After the initial validation of the questionnaire, the scale was tested using reliability analysis, with Cronbach's Alpha as the primary assessment criterion. Indicators of descriptive statistics included measures of position, variability, and asymmetry. Test statistics were used mainly to analyse the relationships between the observed variables.

From this group of procedures, a bivariant correlation analysis was used to verify the interdependencies, while the main indicator of the intensity of relationships was Pearson's linear correlation coefficient r. Formula 1 was used to calculate r, where X-bar denote to mean of X variable and Y-bar denote to mean of Y variable.

Table 1. Variables used for research

Variable description	Code	Type	Options
Organisational size	Size	Ordinal	medium, large
Does the enterprise have a separate research and development department?	ReserchDep	Nominal	yes, no
What is the source of your capital?	Capital	Nominal	national, foreign
Defining measurable goals for operational processes	MeasGo	Ordinal	1 - no intensity 2 - low intensity 3 - medium intensity 4 - high intensity 5 - very high intensity
Supervision of infrastructure elements	ElemSup		
Identification of position risks for individual work positions	RisksId		
Evidence of validation of new processes	NewPrVal		
Identification of performed operations	OperId		
Raising awareness and knowledge of the staff	StaffKn		
Product identification at various stages of its production	ProdId		
Supervising equipment for measuring and monitoring products and processes	MeasEq		
Evidence of validation of new products	NPVal		
Management of environmental aspects	EnvMan		
Use of measures for processes	ProcMeas		
Documenting corrective actions	CADoc		
Planning operational processes (e.g., production, purchasing, sales)	ProcPlan		
Identification of threats related to operational processes	ThrId		
Workplace instructions available in operational processes	WpInstr		
Ensuring health and safety at work	HaSWork		
Identifying the causes of the complaint	ComCausId		
Product quality control status	PQC		
Quality management system compliant with the requirements of ISO 9001	ISO 9001	Nominal	yes, no
Environmental management system compliant with the requirements of ISO 14001	ISO 14001		
Occupational health and safety management system compliant with the requirements of ISO 45001	ISO 45001		
Toyota Production System (Kaizen, 5S, TPM)	TPS		
None of the above	X-none		

$$r = \frac{\sum(X-\bar{X})(Y-\bar{Y})}{\sqrt{\sum(X-\bar{X})^2}\sqrt{(Y-\bar{Y})^2}} \quad (1)$$

Exploratory factor analysis was used to examine the correlation structure's complexity and test for latent variables. Principal component analysis was used as the extraction method, and the rotated component matrix determined the resulting composition of factors. The component matrix was rotated using the Varimax method. The resulting factors were named, and the factor scores assigned to the factor were calculated for each case examined. Factor scores were calculated based on a linear regression model.

4. Results

The research was conducted in the period from October to November 2019 using the Computer Assisted Telephone Interview (CATI) technique. The research covered 151 producers operating on the B2B market (employing over 49 employees) from the automotive (N=38), metal (N=43), chemical (N-29) and furniture (N=41) sectors. The expectations of production companies towards their suppliers regarding the implementation of concept of management quality, environment and occupational health and safety systems were assigned a rank on a scale from one (the least important criterion) to five (the most significant).

One hundred fifty-one valid questionnaires were involved in the analysis - and this size is the main determinant for the determination of sample power. With a sample of this size, it can be stated that if 90% power is considered (1 - β error probability) and the level of α error probability was set to the standard 0.05, it would be possible to detect differences of half the standard deviation (in the case if groups frequency is equal). This information is essential mainly in order to consider in the interpretation the possibility that there may be smaller differences between the compared management systems, which will not be detectted due to lack of data. Figure 1 shows the sample power at the parameters determined above.

In other variables that represented the characteristics of the operational process, a scale from 1 to 5 was used. A reliability analysis was used to validate it. With 18 scale variables, Cronbach's Alpha reached 0.943, well above the recommended minimum value at level 0.700. The relevance of all analysed variables was also tested, and the results are shown in Table 2.

It can be seen from the results that the value of Cronbach's Alpha was higher in only one case - in the case of deleting the ElemSup variable. As this was only a very slight improvement from 0.943 to 0.944, it was decided to keep this variable in the analysis. Therefore, the reliability test showed that the scale used is valid and should not adversely affect the reliability of the results.

4.1. Operational process characteristics

In the survey, 18 characteristics of the surgical process were monitored. The extent of their application in individual organisations is shown in Figure 2. Most variables do not have a normal distribution, as the frequency of the value 1 is relatively strongly represented, which meant that they do not apply the given characteristics of the operational process in the given organisation. Based on the analysis of the

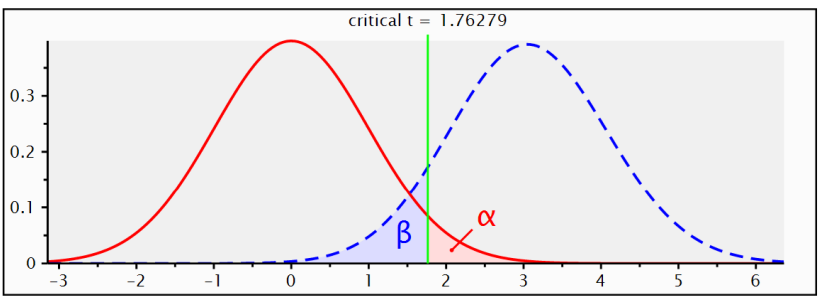


Fig. 1. Power of sample size

Table 2. Reliability of scale if item (variable) deleted

Variable	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
MeasGo	48.2781	310.589	.635	.940
ElemSup	48.4636	315.850	.477	.944
RisksId	48.8675	317.636	.571	.941
NewPrVal	48.3113	311.336	.636	.940
OperId	48.4437	307.862	.699	.939
StaffKn	47.8808	311.852	.652	.940
ProdId	48.0993	304.090	.758	.938
MeasEq	48.2185	303.612	.768	.938
NPVal	48.1722	308.237	.674	.940
EnvMan	48.1523	311.863	.643	.940
ProcMeas	48.2185	308.199	.719	.939
CADoc	47.9073	308.911	.714	.939
ProcPlan	48.2252	304.496	.762	.938
ThrId	48.2053	301.084	.805	.937
WpInstr	48.3907	307.773	.665	.940
HaSWork	47.8344	305.366	.712	.939
ComCausId	47.2517	317.883	.609	.941
PQC	47.0662	320.342	.586	.941

results, it was found that companies that did not implement QEOH&SMS systems in many cases do not have such stringent expectations towards their suppliers. On the other hand, companies that have at least one management system implemented have higher expectations towards suppliers for each of the examined aspects. When analysing the combined results in both surveyed groups, it is noticed that although many aspects transpire/happen to be insignificant for a large part of organisations, there are still aspects whose correct implementation by suppliers is crucial for the surveyed companies. These include product quality control status and identifying the causes of the complaint.

The descriptive statistics of the individual variables, together with the interval graph, are shown in Figure 3. The confidence intervals were set to 95% by a calculation based on the standard deviation.

The research results indicate that a particularly important expectation towards suppliers is product quality control status & identifying the causes of the complaint. Buying firms also expect suppliers to take effective preventive action to avoid potential non-conformities. This is particularly important in the event of possible complaints. In such situations, expectations towards suppliers focus on a detailed explanation of the root causes of complaints, proposals for corrective and preventive actions (which is documented through 8D reports).The expectations towards suppliers also concern the aspect of identification of position risks for individual work positions, which seems to have a significant impact on the continuity of operational processes. This aspect is particularly important in the event of emergency or serious accidents at workplaces. Such situations may lead to delayed delivery or interruption of the systematic continuity of supplies.

In the initial analysis, the requirements for supplier regarding implemented management systems were looked at. The differences between the levels of these expectations separately for each of the four analysed systems were evaluated. For each system, the organisations were divided into two groups - the first group consisted of those organisations that did not have the system implemented and the second group of those organisations that had the system implemented. The differences between the two groups were then compared using two-sample t-tests. The test determined whether the value of a given characteristic (variable) is statistically higher in the group with the particular management system than in the group without this system. The evaluation of statistical significance was based on the p-value. If the p-value was lower than 0.05 (y-axis), it was stated that organisations which have implemented particular management system has a statistically different level of requirements for suppliers than organizations without particular management system (x-axis). The results are shown in Figure 4.

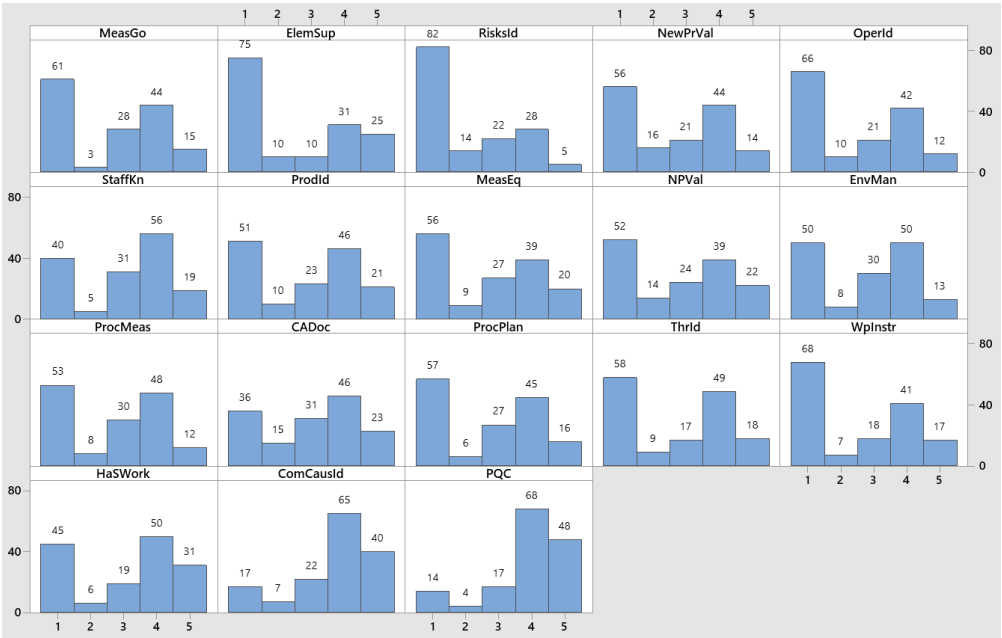
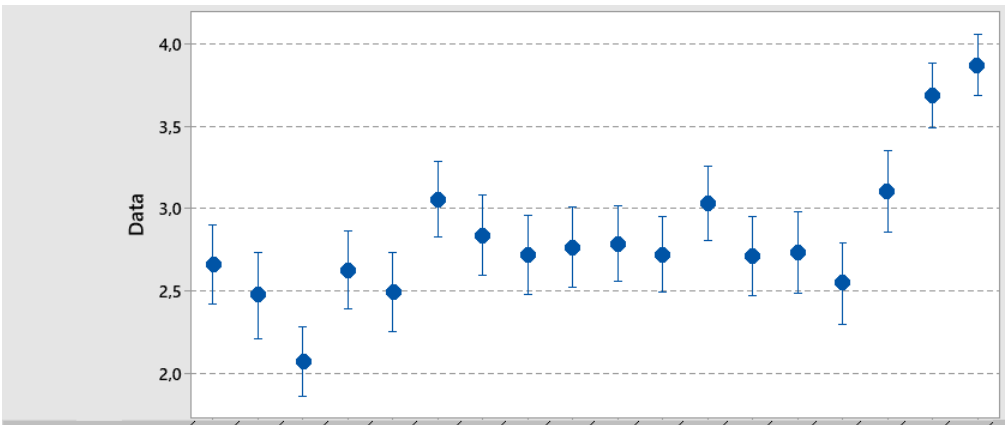


Fig. 2. Distributions of responses in analysed variables



	MeasGo	ElemSup	RiskId	NewPrVal	OperId	StaffKn	ProdId	MeasEq	NPVal	EnvMan	ProcMeas	CADoc	ProcPlan	ThrId	WpInstr	HaSWork	ComCausId	PQC
Mean	2,66	2,48	2,07	2,63	2,50	3,06	2,84	2,72	2,77	2,79	2,72	3,03	2,72	2,74	2,55	3,11	3,69	3,87
SE Mean	0,12	0,13	0,11	0,12	0,12	0,11	0,12	0,12	0,12	0,12	0,12	0,11	0,12	0,13	0,13	0,13	0,10	0,10
StDev	1,49	1,63	1,32	1,46	1,47	1,41	1,51	1,51	1,51	1,42	1,42	1,41	1,49	1,53	1,54	1,55	1,23	1,17
Median	3,00	2,00	1,00	3,00	2,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	4,00	4,00	4,00
Skewness	0,03	0,42	0,72	0,12	0,23	-0,41	-0,08	0,06	0,05	-0,14	-0,07	-0,25	-0,01	0,00	0,23	-0,33	-1,00	-1,28
Kurtosis	-1,58	-1,56	-1,04	-1,54	-1,56	-1,21	-1,54	-1,53	-1,52	-1,48	-1,51	-1,26	-1,56	-1,64	-1,61	-1,45	0,14	1,01

Fig. 3. Descriptive statistics of analysed variables

It can be seen from the figure that the introduction of the analysed management systems will will lead to higher expectations or requirements for suppliers. The only exceptions are the requirements identification of performed operations (OperId) and raising awareness and knowledge of the staff (StaffKn), for which no statistically significant positive effect was demonstrated. On this basis, it can be concluded that the processes related to employees (their knowledge and qualifications) are of low importance for the surveyed organisations. 18 characteristics were monitored. The EMS had the most significant effects on the requirements for suppliers, in which positive effects were identified for 14 requirements. Subsequently, the QMS, where 13 positive effects were identified. 11 positive influences were identified in the OH&SMS and 8 positive influences in the TPS system. Therefore, the implementation of QMS and EMS by the surveyed organisations implies expectations towards suppliers. The implementation of these organisational improvement tools undoubtedly influences the improvement of operational processes in the supply chain, as confirmed by previous studies (Zimon et al., 2020; Dellana et al., 2020). This can have a significant impact on increasing the efficiency and effectiveness of the results achieved by partners in the supply chain. More and more OEMs are identifying key performance indications (KPIs) for efficiency and effectiveness by expecting relevant supplier performance through feedback reports. However, it should be noted that the sample size limited the detection capability of the t-test, and smaller size differences may not have been observed.

4.2. Relationships between operational process characteristics

An analysis of the interrelationships between the requirements for suppliers can help better understand the effects of management systems. From the data collected in this research, such an analysis was performed. A bivariate correlation analysis was used for this, using Pearson's linear correlation coefficient as a unit of measure. The results of the correlation analysis are shown in Figure 5.

The results in the figure show a relatively complex correlation structure between all analysed requirements. However, all correlation coefficients in this figure were statistically significant at a significance level of less than 0.01. It can therefore be stated that the levels of particular requirements are strongly interconnected. This means that the examined aspects contribute to a larger whole, the implementation of which supports the improvement of operational processes in supply chains.

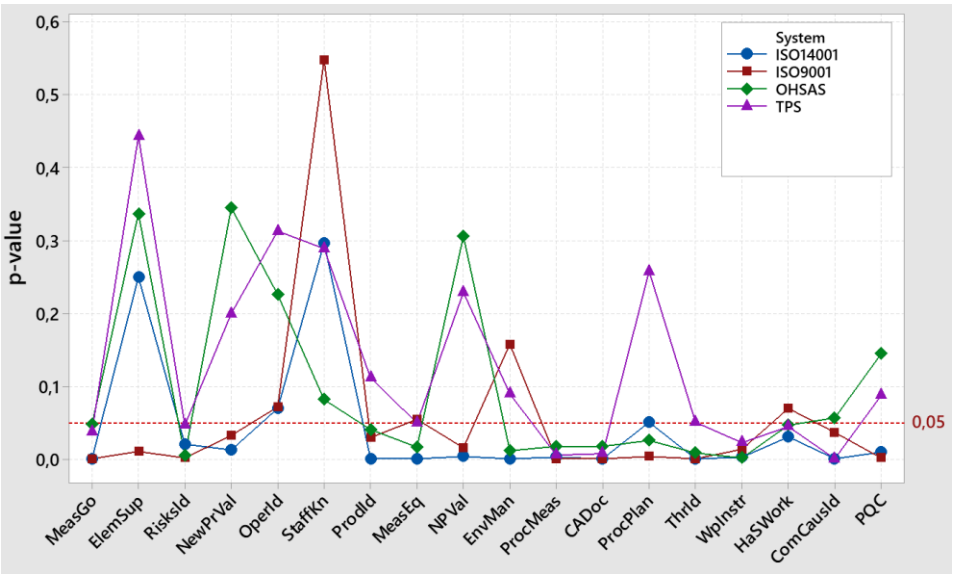


Fig. 4. Statistical signifficance analysis

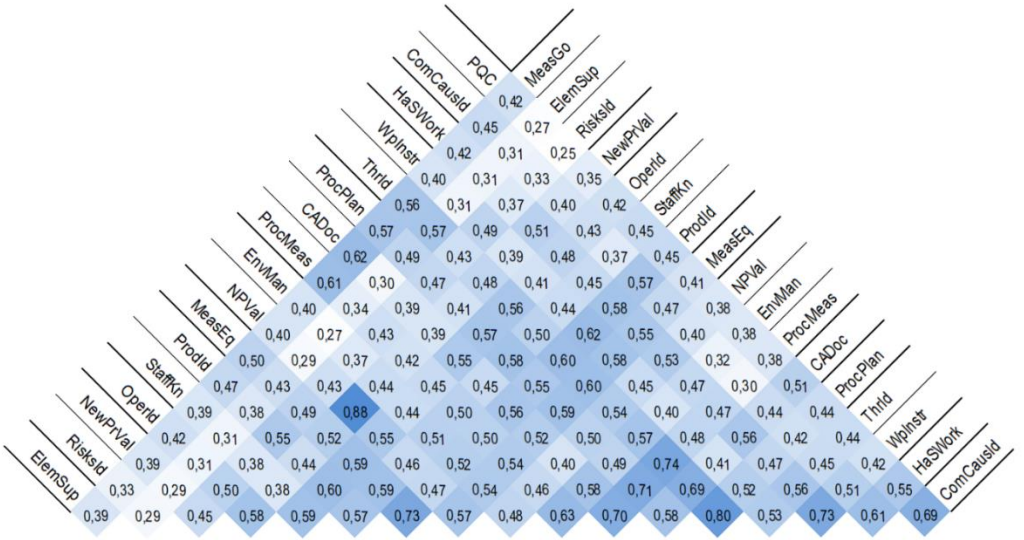


Fig. 5. Values of Pearson linear correlation coefficient

As can be seen in Figure 5, the complex correlation structure is relatively difficult to interpret with a large number of variables. There are many relationships with different intensities in this case, so the data was subjected to factor analysis. An attempt was made to detect whether it would be possible to identify hidden factors in the given structure of relationships, which could be used to comprehensively evaluate the requirements for suppliers regarding QMS, EMS, OH&SMS and TPS.

The initial data suitability test for factor analysis consisted of two indicators - the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) and Bartlett's Test of Sphericity. Both tests confirmed the suitability of the data for factor analysis. The KMO indicator reached the value of 0.908 (the minimum recommended value is 0.700). The Bartlett's Test of Sphericity reached approx. Chi-Square at 1912.9 at a significance level of less than 0.001. At the same time, the relevance of each variable in the factor analysis was verified - using the analysis of communalities. The extraction values in such an analysis significantly exceeded the minimum recommended value of 0.200 and ranged from 0.494 to 0.863. This means that each of the analysed 18 variables - i.e., requirements for suppliers - is relevant for factor analysis.

For the resulting number of factors, an attempt was made to follow the recommendations of the so-called Kaiser's rule. According to this rule, the number of factors should be one for which the eigenvalue value is higher than 1. The factor analysis procedure identified three such factors. After analysing their composition, however it was necessary to state an inadequacy of interpretation. It is recommended to change the number of factors in such cases - either add one or remove one. In order to achieve a higher degree of explained variability, it was decided to add one factor. The analysis resulted in four factors that explain 69.790% of the variability - Table 3.

The resulting composition of factors was obtained through a rotating matrix. The rotation method was Varimax, and the resulting values of the correlation coefficients of the variables against the four factors were obtained through six iterations. The results are shown in Table 4, with values less than 0.300 not shown for clarity reasons.

Table 3. Factor analysis results – Total variance explained by principal component analysis

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %
1	9,234	51,301	51,301	9,234	51,301	51,301	3,946	21,922	21,922
2	1,250	6,944	58,245	1,250	6,944	58,245	2,949	16,384	38,306
3	1,168	6,490	64,735	1,168	6,490	64,735	2,851	15,839	54,145
4	0,910	5,055	69,790	0,910	5,055	69,790	2,816	15,645	69,790
5	0,857	4,759	74,549						
6	0,730	4,053	78,602						
7	0,643	3,574	82,176						
8	0,522	2,898	85,074						
9	0,503	2,796	87,870						
10	0,450	2,503	90,373						
11	0,361	2,004	92,377						
12	0,296	1,647	94,024						
13	0,255	1,418	95,442						
14	0,222	1,233	96,675						
15	0,197	1,094	97,769						
16	0,166	0,925	98,694						
17	0,133	0,736	99,430						
18	0,103	0,570	100,000						

Table 4. Rotated component/factor matrix

Variable	Factor 1	Factor 2	Factor 3	Factor 4
Use of measures for processes	**0,822**			
Documenting corrective actions	**0,762**		0,347	
Identification of threats related to operational processes	**0,703**	0,452		
Defining measurable goals for operational processes	**0,672**		0,307	
Planning operational processes (e.g. production, purchasing, sales)	**0,657**	0,495		
Management of environmental aspects	**0,616**			0,396
Supervision of infrastructure elements	0,316	**0,651**		
Identification of position risks for individual work positions		**0,637**		0,397
Product identification at various stages of its production		**0,606**	0,427	
Supervising equipment for measuring and monitoring products and processes	0,344	**0,579**		0,399
Workplace instructions available in operational processes		**0,563**	0,521	
Raising awareness and knowledge of the staff	0,400	**0,407**		0,326
Identifying the causes of the complaint			**0,837**	
Product quality control status	0,336		**0,788**	
Ensuring health and safety at work			**0,668**	0,332
Evidence of validation of new processes				**0,873**
Evidence of validation of new products				**0,849**
Identification of performed operations	0,338	0,382		**0,532**

There are four factors in the rotated factor matrix. The strongest links between them and between variables are highlighted in bold. The composition of the factors was the basis for their naming and interpretation:

– Factor 1 - Corrective aspect. This factor is characterised by the fact that it consists of such effects, which are linked to corrective measures. These measures usually serve to eliminate or identification of an existing error.
– Factor 2 - Preventive aspect. This factor consists mainly of effects related to error prevention. Prevention should, as a rule, prevent the occurrence of errors by appropriate measures such as measurement, risk identification, product phase management, etc.

– Factor 3 - Improvement aspect. This factor is characterised by a focus on improving elements such as identifying the causes of the complaints or product quality control status.
– Factor 4 - Innovation aspect. This factor consists mainly of elements that have, in a way, features in common with product and process innovations.

The four factors explain almost 70% of the variability of all 18 variables, which can be considered a relatively high value. To better understand the expectations for suppliers regarding the four management systems that were monitored (QMS, EMS, HSMS and TPS), the factor scores of each case/respondent were recorded. Factor Z-scores were calculated using linear regression. Positive values of the factor Z-score indicate that the factor is above average intensity and negative values indicate that it is below average intensity. Thus, the intensity of the four factors in the four analysed management systems were compared and the results are shown in Figure 6.

All management systems significantly stimulate production companies to enforce from suppliers the implementation of actions contributing to the elimination of non-conformities and to introduce corrective actions. It can be seen that companies that have implemented OH & SMS put great emphasis on suppliers introducing solutions to prevent errors and mistakes. Companies that have implemented TPS and EMS are particularly interested in introducing improvement actions by suppliers. The implementation of environmental standards by manufacturing companies translates to a noticeable degree into the requirement to implement innovative solutions by suppliers.

5. Discussion

5.1. Main findings

The results of the conducted research indicate that expectations of industrial enterprises towards suppliers related to QEOH&SMS are strongly focused on their development. Research shows that companies that adhere to the requirements of standardised management systems have a greater requirement for suppliers than companies that do not implement QEOH & SM requirements. In particular, the implementation of quality and environmental management systems by the surveyed organisations translates into increased requirements for suppliers. This study can therefore agree with the authors (Zimon et al., 2021; Jawaad and Zafar, 2020), who recognise that standardised management systems contribute to the development not only of enterprises that use them, but also of other links in the supply chain. It should be emphasised, however, that in relation to many of the examined aspects, production companies do not have very high requirements towards suppliers. An average level of their implementation is expected. The respondents are most interested in

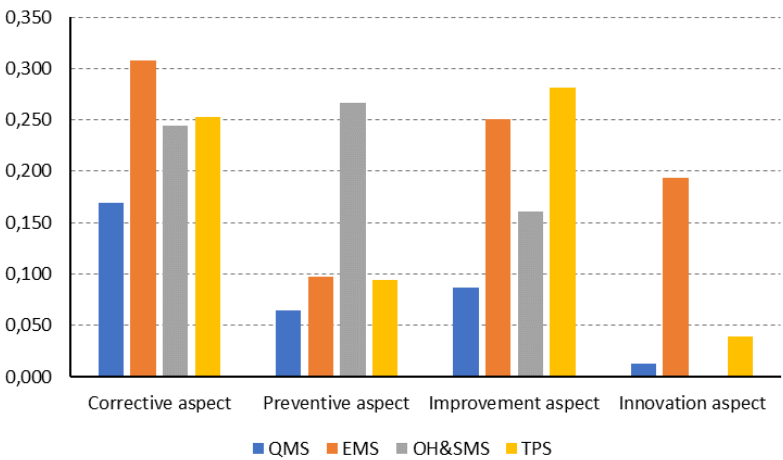


Fig. 6. Intensity of identified factors according to management systems

the efficient implementation by suppliers of aspects such as product quality control status and identifying the causes of the complaint. Therefore, it can be concluded that the organisational development of suppliers should be conducted through effective corrective actions, preventive actions, and improvement actions. Buyers' expectations regarding the efficient development of suppliers focus on reducing non-compliance, in particular those that result in complaints. Therefore, corrective actions taken by suppliers are expected to be more effective (and more accurately documented) and contribute to reducing the level of non-compliance. Supplier development through improvement actions can be ensured by more effective product control and thus avoiding complaints (Wiengarten et al., 2017; Savic et al., 2017).

Based on the research results, it can also be concluded that buyers have low expectations of the identification of position risks for individual work positions and the raising awareness and knowledge of the staff. This proves that manufacturing companies do not want to interfere in matters related to the management of personnel at suppliers. This does not mean, however, that suppliers should minimise the importance of activities such as: ensuring occupational health and safety or increasing the knowledge and awareness of staff, as these are typical preventive actions that can eliminate disruptions in the supply chain (Fernández-Muñiz et al., 2012). However, their efficient implementation is not one of the main aspects that the surveyed companies are interested in. This is all the more surprising as supplier development programs are very often based on the transfer of knowledge and experience (good practices) in the field of implementing tools to ensure the quality of products and processes in order to improve them. (Benton Jr. Et al., 2020; Saghiri S. & Wilding R. 2021) This transfer takes place through theoretical training and practical thematic workshops that are devoted to the use of individual improvement tools to achieve the goals set by buyers, such as shortening time cycles , reducing the negative impact on the environment, or lowering the costs of operating processes. (Bai Ch. & Satir A., 2020).

Further analysis of the obtained research results made it possible to conclude that the companies implementing the examined systems expect suppliers to implement actions contributing to the elimination of errors and the implementation of corrective actions. Organisations that implement the requirements of environmental systems have specific requirements for the development of suppliers through activities related to the implementation of new products and processes. Successful implementation of new products and processes by suppliers is confirmed to customers through positive validation results (Rebelo et al., 2014). Enterprises complying with OH & SMS requirements put the greatest emphasis on suppliers introducing solutions that contribute to preventing the occurrence of non-compliance. This is due to the fact that these systems are aimed at improving the health and safety conditions of employees and the environment (Wu et al., 2021). Enterprises that have implemented TPS are particularly interested in introducing improvement actions by suppliers. This may be due to the fact that TPS is an integrated social and technical system based on the implementation of processes to improve and eliminate waste based on the organisation of logistics and production in cooperation with suppliers (Kim, 2015).

It can also be stated that companies that have implemented the QEOH & SMS requirements are more focused on cooperation with suppliers and initiating improvement actions (Jedynak. 2018). Support in the form of knowledge transfer very often takes place through direct advice, also in terms of meeting the requirements QEOH&SMS. Knowledge transfer is coordinated by supervisors of suppliers / project managers focused on the development of partners, employed in positions such as supplier development advisors, supplier development supervisor, supplier development project manager, supplier development engineers. Their role is also to coordinate the work of interdisciplinary teams created to implement joint ventures of partners (customers and suppliers). These teams include representatives of the sales, purchasing, design, production, logistics and maintenance departments. These teams implement joint projects that focus on improving products and processes (shortening implementation cycles and reducing costs). These teams also play an important role in the joint implementation of new products and processes. To ensure the effectiveness of supplier development programs, it is necessary to create an atmosphere of cooperation based on mutual commitment, trust and open exchange of information be-

tween partners (Yoo et al., 2018). Successfully implemented supplier development programs undoubtedly contribute to building the intellectual capital of partners, especially by strengthening mutually beneficial relationships, as well as by implementing product and process innovations (Chen et al., 2020; Arab, 2021).

5.2. Theoretical implications and practical implications

This article examines the relationship between the requirements for suppliers and the implementation of management systems by manufacturing companies. The article contributes to the existing scientific literature by analysing the impact of the implementation of individual management systems on the expectations towards suppliers. This study shows which of the 18 examined aspects are particularly important for manufacturing companies. Additionally, the expectations towards suppliers were classified into four groups (Corrective, Preventive, Improvement, Innovation). Further analysis allowed for the determination of which systems provoke manufacturing companies to increase their requirements for suppliers. The research therefore has several important theoretical and practical implications. Consequently, business representatives can better understand the impact of management systems on the implementation of operational processes in the supply chain and make more informed decisions about their possible implementation. Scientists may try to replicate this research in other European countries and compare the results and try to extend the research to further aspects and systems. Above all, supply chain managers may consider implementing the QEOH & SMS implementation in their supplier cooperation development strategy.

6. Conclusions

Summarising the above considerations, it should be stated that the expectations posed by the purchasing companies to their providers regarding the implementation of QEOH&SMS brings significant benefits to partners in the supply chains. The implementation of QMS contributes to the more effective implementation of corrective actions, as well as the supervision of operational processes and the achievement of the set goals. The implementation of EMS contributes to increasing expectations towards suppliers in terms of process and product improvements. The implementation of OH&SMS influences the reduction of the risk level of threats through preparedness and response in emergency situations. This allows for the continuity of processes in the supply chains to be ensured. The implementation of TPS contributes to the improvement of processes at the suppliers. It should be noted that the purchasing companies not only set expectations for their suppliers, but also offer them special support programs. Many companies, especially OEMs, offer their suppliers special development programs in the form of training, consultations and implementation of joint projects. In business practice, these programs are most often implemented through the implementation of joint projects aimed at introducing new or improving existing products. These programs can also focus on providing basic or specialised support for product and process improvement by assisting with the implementation of QEOH&SMS.

From a statistical point of view, the research limit may be the sample size. Concerning the number of involved companies that responded only to a certain extent could differences be identified. The detection ability to observe statistically significant differences in Figure 1 has been partially explained. However, the test statistics procedures considered the sample size, and the results should correspond to this and additionally a larger sample could also identify smaller differences that may have gone unnoticed in this research. The research limitation was due to conducting surveys in manufacturing companies operating on the Polish B2B market. However, the choice of sectors such as the automotive, electromechanical and chemical sectors may constitute preliminary and well-established diagnostics for further research. Further research to be conducted in the coming years will be extended to companies operating in Central and Eastern Europe, and then in other European Union countries.

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