Environmental effects of ISO 9001 and ISO 14001 management system implementation in SSCM

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Abstract

Purpose – Comprehensive management systems such as ISO 9001 or ISO 14001 are designed to help organizations improve processes, ensure customer satisfaction, efficient information flow, efficient use of resources and many other prosperous management areas. These systems can also bring unintended direct and indirect effects on organizations. In this study, the authors examine the environmental effects that the implementation of these management systems cause.

Design/methodology/approach – A survey-based methodology was used for this study, with textile organizations in three countries – Poland, Slovakia and the Czech Republic. The research focused on four areas related to environmental effects. The first area was the level of improvement of the organizations' environmental performance, which was examined by the methods of descriptive statistics. The second area was analyzing differences in environmental effects concerning the implementation of the systems using inferential statistics. The third area was the analysis of latent links between individual effects using factor analysis.

Findings – This study's insights shed some light on the benefits of implementing more, not fewer systems with benefits to organizations and entire industries with new possibilities for economic growth that do not have to come at the expense of the environment.

Originality/value – Organizations implementing management systems can realize dynamic benefits across a supply chain and within a manufacturing organization. Here the authors see an opportunity for ISO systems as a stepping stone to a more sustainable textile manufacturing economy.

Keywords SSCM, Environmental effects, ISO 9001, ISO 14001, Standards, Textile industry

Paper type Research paper

1. Introduction

The textile sector has become an essential part of the European manufacturing industry. It plays a vital role in the economy and social well-being in many European regions (Czajkowski and Szymański, 2020). The European textile market is quite competitive and diverse in terms of production and potential. Medium-value products intended for the mass market are mainly produced by companies operating in Eastern and Southern Europe, where it is still easier to

find cheap labor. On the other hand, high-class luxury clothing is produced by developed Western European countries, such as Italy, Great Britain, France and Germany. With this in mind, the needs, expectations and aspirations of the organizations operating in different parts of Europe are different. A common feature of the textile industry in the European Union is that its emphasis is on small enterprises continually looking for solutions to improve management and production processes (Köksal *et al.*, 2017).

The Polish, Slovak and Czech clothing and textile market is one of the leading markets in Central and Eastern Europe and plays a vital role across Europe (Dziuba *et al.*, 2018). However, companies in this region focus on increasing productivity, improving staff's professional qualifications, boosting up logistics and manufacturing processes and committing to consumer requirements and sustainable development (Yilmaz and Karaalp-Orhan, 2015; Zimon and Domingues, 2018). The industry's development is due to the dynamic growth of e-commerce, personalization of production and the luxury goods market's development. Polish, Slovak and Czech enterprises can increase their participation in international projects, develop a distribution network and expand into non-European markets. The uprising trend of the world population and the growing wealth of societies, accompanied by the increased demand for clothing and textile products, favor this.

The clothing and textile industry operates in a highly competitive market dominated by the presence of global brands. In recent times, the textile sector has been hit particularly hard by the devastating effects of the coronavirus pandemic sweeping through the world. According to EURATEX more than half of the European companies expect a drop in sales and production by more than 50%. Almost 9 out of 10 companies face severe constraints on their financial situation, and 80% of companies are temporarily laying off workers. One out of four is considering closing down the company (EURATEX, 2020).

However, it is worth mentioning that consumers and managers are now aware of the environmental challenges that the textile and clothing industry face. Clothing accounts for between 2 and 10% of EU consumption's environmental impact (Šajn, 2019). More comprehensive knowledge about the process of product development and awareness of the adverse effects caused by both entrepreneurs, external stakeholders, and consumers began to notice the textile industry's real costs and look for new solutions. This popularized the implementation of strategies that consider the principles of sustainable development, which lead to the transformation of business processes and the dissemination of more informed production and supply chain management processes (Rahman and Koszewska, 2020). Therefore, effective and efficient supply chain management in the textile industry is a challenge for companies focused on expansion and development. A key challenge for companies operating in global textile supply chains is balancing between achieving a competitive advantage and acting sustainably while fulfilling their different stakeholders' expectations to preserve reputation, legitimation and credibility (Oelze, 2017). It has become a difficult task because supply chains in the textile industry are very complex. Whereas the different types of products offered, which is partly due to the large geographical dispersion generating the offshoring phenomenon, i.e. moving some of the processes abroad. The desire to reduce costs caused many large enterprises in Eastern and Central Europe to rely on outsourcing of production from developing countries, where labor costs are lower than host countries (Gadde and Jonsson, 2019). Economically, such action allows for cost reduction and is beneficial for the company; whereas, there are various challenges associated with offshoring. The longer the supply chain and the more dispersed business processes, the more difficult it is to monitor activities and control quality at the process and product levels (Viana and Sousa-Filho, 2017).

Moreover, this responsibility requires awareness of cultural and legal differences and risks associated with offshoring and outsourcing in general (Davis *et al.*, 2006). The offshore strategy could be risky for products characterized by volatile customer demand and rapid

fashion changes (Hilletofth and Hilmola, 2008). However, hidden costs and a complicated decision-making process include the limited possibility of a quick response to the environment's changing needs. Therefore, one can agree with Oelze (2017), who suggested that the most critical challenge for the textile industry at the present level is to make the supply chain management more optimized and sustainable. The textile industry significantly contributes to environmental degradation and climate change due to the dynamic growth in production and consumption (Paraschiv *et al.*, 2015; Ikram *et al.*, 2019a, b).

The retail clothing sector's economic growth in Europe and other industrialized markets has been paralleled by the offshoring of textile and apparel production to emerging economies and developing countries. Also, the clothing industry's supply chains have a substantial impact on the environment due to the intensive use of chemicals, water, energy and land in cotton growth and textile and apparel production. Lastly, the clothing industry's global supply chains have raised awareness of ethical dilemmas, social issues and societal factors, e.g. in the form of human resource exploitation (Oelze *et al.*, 2020; De Brito *et al.*, 2008). When analyzing the modern textile industry's impact on the natural environment, all stages of the product life cycle should be considered. It is worth mentioning that a product made of the most environmentally friendly raw material will not be recycled if, at the final stage of processing, a manufacturer uses chemicals harmful to the environment and or users of the products suffer adverse health impacts. Sustainable supply chain management in the textile industry, therefore, requires the improvement of the procurement, production, distribution and waste found in logistics processes (Charkha and Jaju, 2014). Enterprises from the textile industry should introduce solutions to improve the supply chain's management processes and make their activities compliant with environmental protection requirements (Koszewska, 2018). Managing the textile industry's supply chain requires: improving key management processes, constant monitoring of current customer needs, forecasting trends, optimizing the quality of products offered while subordinating these processes to the basic principles of sustainable development (Nayak *et al.*, 2019).

The textile industry is looking for solutions to improve all necessary logistics subsystems in the supply chain (supply, production and distribution). In the literature on the subject, there are many concepts to improve supply chain management (SCM) in the textile industry. It is worth getting acquainted with the works of such authors as Oelze *et al.* (2020), Riyadi (2020), or Maulina and Natakusumah (2020). When reviewing the literature, we noticed a lack of research that focuses on the impact of management standards on SSCM in this industry. Therefore there is a gap that must be certainly filled, because standardized management systems contain a number of guidelines that can improve SSCM in the textile industry. According to Sampaio *et al.* (2012) management systems support efficient and effective management, and their integration can significantly facilitate the implementation of key processes in supply chains. Gull and Idrees (2021) and Karthi *et al.* (2013) emphasize that sustainable management in the textile industry is a priority issue and there is a necessity for a wide application of ISO standards within the organizations operating within it. It is surprising that the literature does not include the subject of research covering the impact of management standards on SSCM in the textile industry. According to the authors, there is a need for research in this area, as the popularization of the implementation of standardized management systems in the textile industry can be a driving force for the implementation of pro-ecological and pro-social solutions in supply chains, which will have a noticeable impact on reducing the harmful effect of the textile industry on the environment. Why would this be important? Because, ISO standards can help this industry sector and other manufacturers because they enable a firm's ability to effectively design, produce and deliver quality products and services with a lower environmental impact. Despite widespread international acceptance, the implementation of these standards and their benefits still provide the

possibility of obtaining new insights as the impacts across all industry sectors and countries are not uniform (Zimon *et al.*, 2020). It is also particularly interesting to investigate whether the size of the enterprise has an impact on the assessment of standardized management systems (Arocena *et al.*, 2020; Aravind and Christmann, 2011) in the context of their impact on the SSCM and whether the implementation of one standard can increase the effectiveness of the SSCM in the textile industry or it is necessary to integrate two systems (de Nadae *et al.*, 2020)?

This study and the outcomes of our research, attempt to verify the impact of management standards such as ISO 9001 and 14001 on SSCM in the textile industry.

The structure of the paper is as follows. The next section provides a review of the literature on the effects of ISO 9001 and ISO 14001 on SCM in the textile and clothing industry. Section 3 formulates the research questions and explains the research methodology, while Section 4 presents the results. Section 5 provides a discussion of the study findings, including theoretical implications. Finally, conclusions, limitations of the study and areas for future research is presented in the last section.

2. The literature on environmental effects of ISO 14001 and 9001

In this review of the literature, we explore the environmental effects of ISO 9001 and ISO 14001 individually and in concert based on several studies across various industries. Given the focus of the current research on the textile industry, we also provide relevant studies in the textile industry and the challenges of managing these environmental impacts.

ISO (International Organization for Standardization) 14001 is an international management standard that assures an organization's effective environmental management system (EMS). It does not prescribe environmental performance requirements but provides the framework for guidance in achieving an effective EMS. The expectation would be that organizations that become certified would have a more effective EMS than those that choose not to be certified. ISO 9001 is an international certification for assuring an effective organizational quality management system (QMS), providing a framework for assuring and improving production processes. Due to increasing attention to environmental issues globally, it seems appropriate that ISO 9001 certification could serve as a catalyst for improving processes related to social responsibility and related environmentally friendly policies since ISO 9001 focuses on process improvement (Ikram *et al.*, 2020a, b, c; Freitas *et al.*, 2020). Anwar *et al.* (2020) asserts that ISO 9001 and ISO 14001 are paired documents with very similar structures.

Therefore, expectations for each of these certifications are to enhance an organization's EMS individually. By extension, one might also expect that organizations achieving certifications to both ISO 9001 and ISO 14001 have the most effective EMS's. In addition to their philosophic synergies, these standards have similar methodologies in structure, implementation and monitoring (Heras-Saizarbitoria *et al.*, 2018). Thus, the certification learning curve of one helps to shorten the other's learning curve and implementation.

Integrated management system (IMS) is not a new concept. For example, Rebelo *et al.* (2014) propose a generic model for integrating ISO 9001, ISO 14001 and OHSAS 18001. The model was designed based on survey responses of 160 employees in a Portuguese organization. The resulting model was implemented for the integration of the three systems resulting in several benefits. These included: resource optimization and elimination of wastes, integrated management of sustainability components, improvement of supplier relations and fewer audits. Ikram *et al.* (2020a, b, c) develop a dynamic IMS model through the inclusion of ISO, GRI (Global Reporting Initiative) and other management standards by applying the multi-criteria decision-making (MCDM) approach. They quantify that the ISO and GRI standards are the most suitable management standards to develop a dynamic IMS. Ivanova

et al. (2014) studied ten American plants that were certified to both ISO 9001 and ISO 14001. The case study analysis identified critical factors regarding joint implementation effectiveness and proposed a theoretical framework for implementation. The factors included a focus on internal improvement, top management support, design of the system around existing processes, use of information technology, positive employees' attitude and employees' usage of the system. Reideinger and Thevenot (2008) assessed the environmental efficiency of ISO 14001 on a large sample of French industrial companies. The data spanned the years between 2001 and 2005. They reported that ISO 14001 certification was accompanied by a significant and immediate reduction in organizations' water usage. This was followed by a gradual decrease in carbon dioxide emissions, fuel consumption and electricity consumption.

Peixe *et al.* (2019) investigated the Brazilian industrial companies, report that ISO 14001 was at the top of a ranked list of characteristics associated with EMS maturity. EMS was followed by participation in the carbon market, environmental reporting, water consumption reduction, etc.

In a longitudinal study of 11 Russian energy companies spanning years before and after ISO 14001 certification, Iosifov and Ratner (2018) found that ISO 14001 acts as a catalyst for the development of eco-innovation information transparency of the entire production system of a company. Further, adopting an EMS is associated with moving the organization to a process approach to management, which aligns well with an ISO 9001 approach to process management and improvement.

In a study by Zobel (2018) the environmental performance impacts of ISO 14001 in a group of Swedish firms were assessed. The researcher followed both certified and non-certified companies' performance at three-year intervals over 12 years, starting with the year 2000. A comparison was made of 66 certified manufacturing companies (EU class codes 10–33) to a random sample of 50 similar non-certified companies during the same time frame. Using a series of *t*-tests, the metrics studied included air emissions, water emissions, resource use, energy use and waste. The percent change in environmental performance before and after certification was compared to non-certified companies' control during the study period. A statistically significant difference was not observed between any of the metrics. Given the way the data were analyzed, the author notes that environmentally aware companies may choose to certify to the standard as a signal of their superior environmental performance. It is also pointed out that companies seeking to improve their environmental performance need to show a commitment that goes beyond the ISO 14001 certification. This has already been shown in prior research for both ISO 9001 and ISO 14001 performance benefits to the firm. External motivation to certify with minimal effort does not appear to be adequate for performance improvement, but internal motivation resulting in a sustained and substantial commitment to the ideals of the certification has been shown to be a significant driver of positive impacts from the certification standards (Pan, 2003; Corbett *et al.*, 2003; Llopis and Tarı', 2003; Gotzamani and Tsiotras, 2002; Talapatra and Santos, 2019; Carvalho *et al.*, 2020).

Ikram *et al.* (2020b) investigated how ISO 14001 in the company's IMS improves corporate sustainability performance. They collected data from 211 manufacturing companies in Pakistan of both EMS certified and non-certified and observed EMS certified companies that have higher sustainability performance than non-EMS certified companies. Sung and Lee (2011), a strategic approach to green management, appears to be a differentiator in the fashion industry. The textile industry should be impacted by extension, given its role as a fashion supply chain member. Green supply chain management through ISO 14001 was recently studied in the textile industry of Pakistan (Jawad and Zafar, 2019). Using a structural equation model and data collected from a survey of 272 textile manufacturers, they found that green supply chain management positively impacts firm performance in Pakistan's textile

industry. They did not assess the impact of ISO 14001 certification directly on environmental effectiveness.

In a study, Zimon (2020) investigated the impact of ISO 14001 on creating sustainable supply chains for Poland and Slovakia's textile industries. He surveyed top management at 200 ISO 14001 certified organizations, receiving 43 complete responses. The study found that top managers at these ISO 14001 certified organizations reported a noticeable impact on improving pro-ecological processes in the supply chain. The study's findings also suggested a benefit to the reverse-logistics process in the supply chain and reported an increase in the organization's environmental awareness. However, even with the noted benefits of ISO 14001, developing an overall strategy for managing sustainability in the supply chain remains a challenge. Research studies on the relationship of ISO 9001 with improved environmental performance are not as prevalent in the literature as those concerning ISO 14001. This is likely primarily because ISO 9001 does not directly address environmental performance.

Wiengarten *et al.* (2018) considered the performance implications of quality and environmental certifications at the supply chain level (with certified buying and supplying organizations). The study involved a survey of manufacturing plant managers at 59 firms in Ireland. Metrics included product conformance and performance, usage of energy and water, and emissions and waste. One-way ANOVA was conducted on factors developed from exploratory factor analysis. They report higher perceived environmental performance outcomes with ISO 14001 certified organizations. However, their results did not confirm that ISO 9001 certification results in higher perceived quality performance. They did not test whether there was an association between ISO 9001 certification and environmental performance. However, they do point out a benefit to having ISO 9001 certification in implementing ISO 14001 certification.

Zimon *et al.* (2020) investigated how ISO 9001 and 14001 positively impact sustainable supply chain management in the textile industries of Poland, Slovakia and the Czech Republic. Completed surveys were received from 105 organizations, all engaged in either textile or clothing manufacturing. These were split as 45 ISO 9001 certified, 32 ISO 14001 certified, and 28 certified to both standards. Nine benefits of certification were studied, including improved environmental performance, consumption and cost reduction, design of products taking into account environmental aspects, better adaptation to the changing business landscape, increase in environmental awareness, improving cooperation with external stakeholders, rationalization of reverse logistics, green shipping and distribution, and supply chain integration. They report that ISO 9001 supports environmental processes, stakeholder relations, supply chain processes, and SSCM. Also, they report that ISO 14001 supports the rationalization of other processes. They also found more significant supply chain impacts with both certifications than by either standard alone. However, they stopped short of examining the environmental effects of the two certifications in concert. Ikram *et al.* (2019a, b) conducted a study to check the impact of ISO 14001, ISO 9001 and SA 8000 on exports of goods and services of developing and developing countries by applying novel grey relational analysis (GRA) models method. They observed that ISO 14001 has a more intensifying impact on country exports than ISO 9001 and SA 8000 management standards.

The research literature paints a picture that ISO 14001 and ISO 9001 are complementary certifications. Given this relationship, their similarities and their philosophies of improvement, both certifications may create a reinforcing synergy. Together, they enhance the overall environmental effects of the supply chain compared to each certification individually (or no certification at all). It appears that the literature has not touched on this aspect of these two certifications. Given the growing concerns over global pollution and climate change, it would be essential to determine whether having both

certifications would significantly enhance complimentary supply chain environmental effects or if it is not worth spending additional effort and funds.

2.1 Research gap

The literature review presented in Section 2 leads to the following reflections:

(1) The literature on the subject lacks research on the impact of standardized management systems on the functioning of enterprises and supply chains in the textile industry,

(2) There has been no research conducted so far on the subject of the impact of the implementation of ISO 9001 on sustainable management in the textiles industry,

(3) There is not enough research on the integration of the requirements of ISO 9001 and ISO 14001 and its impact on SSCM in the textile industry.

In view of the above statements and knowing the significant role of the negative impact of the textile industry on the environment (Jawad and Zafar, 2019), it is concluded that there is a reasonable basis for conducting research aimed at minimizing the identified research gaps. These assumptions are confirmed in the works of such authors as Fonseca *et al.* (2019), Zimon and Madzik (2020), Calisir *et al.* (2005), who indicated the need to conduct research on the implementation of the requirements of standardized management systems in the context of SSCM in industries.

3. Methodology

This study aims to examine the environmental effects of ISO 9001 and ISO 14001 on organizational environmental performance. Our methods include a survey conducted in three countries – Poland, Slovakia and the Czech Republic. The operationalization of the research plan was realized by decomposing it into four research questions. The research questions enabled a more targeted focus on individual aspects of the environmental effects of organizations and, at the same time, served to determine the variables and formulate the questions in the questionnaire. These research questions were as follows:

(1) How does the implementation of ISO 9001 and/or ISO 14001 standards improve the organization's environmental performance? This research question aims to examine the basic attributes and intensity of environmental effects associated with the implementation of ISO 9001 and/or ISO 14001 (Tarí *et al.*, 2012). Its answer will offer a general overview of these effects, which can prioritize effects, further investigate specific effects or follow-up validation research in other countries.

(2) Does the intensity of environmental effects differ between organizations concerning the implemented management system? This research question aims to select the magnitude of environmental effects in cases where the organization has implemented only ISO 9001, only ISO 14001, or has both systems implemented. Emphasis on this area will allow a deeper understanding of the similarities and differences between the two systems examined (Melnyk *et al.*, 2003). At the same time, it will be possible to examine the potential synergy effect resulting from both systems' implementation simultaneously.

(3) Are there latent links between environmental impacts that would explain their interrelationship more comprehensively? A complex correlation structure can encounter interpretation barriers with a higher number of variables. The number of statistically significant relationships can be high, which increases the opacity. This

research question aims to identify the potential for information reduction by analyzing the existence of hidden factors. This will allow a more comprehensive view of the effects of ISO 9001 and/or ISO 14001 standards and can serve as an empirically based set of information for theoretical and research topics related to management systems (Boiral, 2007).

(4) If latent links exist, does their intensity differ concerning different types of organizations? In the case of latent links between the environmental effects of ISO 9001 and/or ISO 14001, we can assume that their intensity will vary concerning the organization's various identifying features (Campos *et al.*, 2015). This research question aims to examine the intensity of latent interconnections concerning the organization's size, the implemented management system and the country in which the organization operates.

These four research questions formed the basis for setting the variables and formulating the questions in the questionnaire. After collecting the responses, the results were tested and analyzed. This was followed by an interpretation, formulation of implications and answers to research questions. A brief overview of the necessary steps of this research can be found in Figure 1, which also lists the specific statistical procedures used in the research's analytical phases.

In the first step, a literature review was carried out to identify a research gap in the implementation of the examined management systems. The research gap leads to the formulation of the research problem and its justification – this is found in section 2 of this article. In the second step, the research problem was analyzed in more depth from several perspectives while searching for interesting areas from a research point of view. These areas were subsequently reformulated into the research questions above. In the third step, the variables related to the statistical processing of the results leading to each question's answers were determined. Four groups of variables were used – (1) identification marks, (2) supply area, (3) production area, (4) distribution and sale area. The variables from the first group were the nominal type of measure. The other groups' variables were the ordinal type of measure (a scale from 1 to 5 was used). An overview of the variables used and their characteristics are in Table 1.

In the fourth step, a questionnaire was compiled based on these variables, which was then tested in the fifth step to eliminate misinterpretation risks. In the sixth step, we identified a sample of organizations to participate in the survey. The potential sample included 600 organizations operating in the three chosen countries. Fully completed forms were received from a resulting sample of 105 organizations (a 17% response rate), with 66 engaged in the production of clothing and 39 in textile production organizations from the textile industry (operating in Poland, Slovakia and the Czech Republic), that have implemented the ISO 9001,

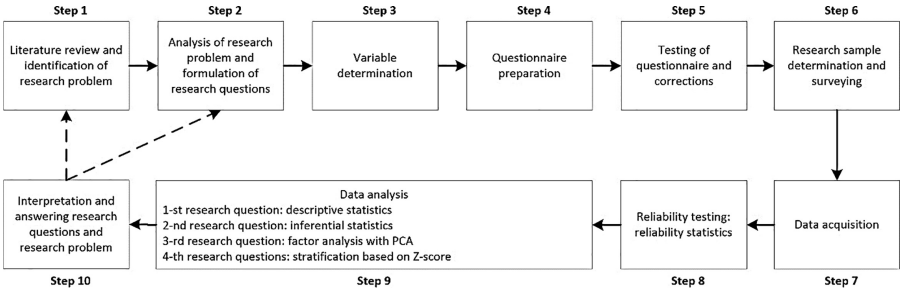

Figure 1.
Research design

Group	Question/variable	Abbreviation	Answers
ID	Size of organization	Size	Small, medium, large
	Management systems	MS	ISO 9001, ISO 14001 ISO9001&ISO14001
	Country	Country	Poland, Slovakia, Czech Republic
Supply	Green raw material procurement	GrRawMat	Scale from 1 (very weak influence) to 5 (very high influence)
	Supplier sustainability assessment	SupSustAs	
	Strategic supplier collaboration	StrSupCol	
Production	Waste, water management	WasWatMgm	Scale from 1 (very weak influence) to 5 (very high influence)
	Green manufacturing	GrManuf	
	Product recovery and remanufacturing	ProdRecRem	
Distribution and sale	Collaborative inventory management	CoInvMgm	Scale from 1 (very weak influence) to 5 (very high influence)
	Green warehousing	GrWare	
	Corporate green image management	CorGrImMgm	

Table 1.
Main characteristics of variables

the ISO 14001 standard, or both systems. Implementing the requirements of ISO 9001 or ISO 14001 and conducting business in the textile industry where the necessary conditions are classifying organizations for research in this study. The online survey was addressed to top managers (targeting managing directors). The participants access the survey via an individual link sent per mail. The survey was preceded by a pretest phase of the survey instrument. The pretest involved 15 organizations helping to check it for clarity and understanding of individual items. The survey structure encompassed five primary groups of questions addressing the following central themes: organizational characterization, supply (on a 5-point Likert scale), production (on a 5-point scale), distribution and sale (on a 5-point scale) and respondent data. The survey was conducted in electronic form, and data were collected (seventh step). Subsequently, the validity of the data was tested – for these purposes, the reliability test of the scale (Santos, 1999) used was conducted (eighth step). In the ninth step, the data were subjected to statistical investigation. As part of this survey, several statistical procedures were implemented to answer four research questions. For example, procedures for descriptive statistics (Liu *et al.*, 1999), inferential statistics and hypothesis testing (Sahu *et al.*, 2015), factor analysis (Harrington, 1999) and tools for stratifying results and testing for differences in *Z*-score between groups of organizations through analysis of variance (ANOVA) (Doncaster and Davey, 2007) were used. While in the previous steps, it was mainly a quantitative analysis, in the last – tenth – step, the set of research questions and the research problem were qualitatively answered. The implementation of the eighth to tenth steps can be found in the following sections of this article.

4. Results

The survey was conducted in the period from August to September 2019. Organizations from three monitored countries were contacted – Poland, Slovakia and the Czech Republic. A total of 105 valid questionnaires were collected. These questionnaires were gradually processed and used to answer the research questions and the statistical procedures needed. Table 2

provides an overview of the numbers of individual types of organizations concerning their ID characters. It should be noted that none of the categories showed a low number of cases, which contributes to better representativeness and reliability of the results.

In addition to these variables, 9 other variables were processed in the survey, which fell into three categories (Table 2). A scale from 1 to 5 was used in these variables. As the choice of scale may in some cases, affect the reliability of the results, we subjected the results to reliability testing. Summary statistics were Cronbach's alpha, according to Eqn (1).

$$r_{11} = \left[\frac{k}{(k-1)}\right]\left[1 - \frac{\sum \sigma_b^2}{\sigma_t^2}\right] \quad (1)$$

In this formula, r_{11} denotes reliability instruments, k indicates many of the items, $\Sigma {\sigma^2}_b$ presents the number of variants of the item, and ${\sigma^2}_t$ shows the total variances. Cronbach's alpha reached 0.720 after data processing. The minimum recommended value is 0.700, so the scale can generally be considered sufficient. The test also examined the relevance of each variable. This was done through an iterative procedure in which the value of Cronbach's alpha was monitored in cases where a given variable would be excluded from the set of variables. The result of this test is shown in Table 3.

Removing some variables would cause Cronbach's alpha to drop below the critical value of 0.700, making the results unreliable. Only in one case (GrWare) was that removing this variable can increase reliability – the value of Cronbach's alpha increased slightly compared to 0.731 compared to the original 0.720. However, this is not a dramatic increase that would require removing a variable from research – by removing it, we could slightly increase the reliability of the results, but in terms of quality, we could lose the valuable information

Variable	Category	Frequency
Size of the organization	Small	35
	Medium	50
	Large	20
Management systems	ISO 9001	45
	ISO 14001	32
	ISO 9001 & ISO 14001	28
Country	Poland	57
	Slovakia	21
	Czech Republic	27

Table 2. Characteristics of the organizations

Variable	Scale mean if variable deleted	Scale variance if variable deleted	Corrected variable–total correlation	Cronbach's alpha if variable deleted
GrRawMat	29.610	10.529	0.571	0.656
SupSustAs	29.429	12.497	0.351	0.703
StrSupCol	29.391	12.394	0.296	0.715
WasWatMgm	29.362	11.483	0.591	0.661
GrManuf	29.391	11.740	0.535	0.671
ProdRecRem	29.486	12.791	0.330	0.706
CoInvMgm	29.419	12.957	0.278	0.715
GrWare	29.295	13.710	0.159	0.731
CorGrImMgm	29.686	11.602	0.442	0.686

Table 3. Reliability test results

contained in this variable. These procedures confirmed the reliability of the results. The following subsections contain the results of the survey processing. The results are structured into four subsections, each subsection dealing with one research question.

4.1 Improvement of environmental effects by the implementation of ISO 9001 and/or ISO 14001

ISO 9001 and ISO 14001 standards are the basis for creating an effective managemental system. As it is a system, its effects should manifest in several areas. In our research, we focused on nine areas related to the organization's environmental aspect. The links between ISO 9001 and ISO 14001 have been empirically proven in the past (Heras-Saizarbitoria and Boiral, 2013). The link between the individual chapters of the ISO 14001 standard and the specific chapters of the ISO 9001 standard was identified in the ISO 14001 standard. Based on this direct link, it can be expected that the ISO 9001 standard will also affect the environmental aspect of the organization. Table 4 contains basic statistics of the overall effects – regardless of which management system the organization has implemented.

We can see the influence on environmental effects from the implementation of ISO 9001 and/or ISO 14001 is above average (average value was 3.000) for all variables. No significant differences were observed between effects, as the arithmetic mean values ranged from 3.448 (CorGrImMgm) to 3.838 (GrWare). This range represents only 9.75% of the scale used. These results suggest that managers view the implementation of the monitored management systems as having a positive influence on the organization's environmental effects. Further, the median value of 4 for all variables suggests the environmental effect is predominantly one of strong influence. If we look at the size of the standard deviation for individual variables, we can conclude that the results are relatively stable. No major differences in standard deviation were found to suggest underlying causes of data inconsistencies. The Kurtosis values are all relatively low (much less than ± 2), which also indicates the consistency of the responses for each variable. The distribution of the observed variables was in most cases, negatively skewed, which means that organizations tended to consider individual effects as above average. We would expect above the average effect of these systems like ISO 9001 and quality management help to identify, measure and manage waste. The reduction of all forms and the processes supporting supply, production and the distribution of products and sales adds to the face validity of the environmental effects of this system. Here, we also see the respondent's self-reported influences of ISO 14001 implementation. Organizations realize dynamic environmental effects from this system's capabilities to further measure and manage waste with a more intentional focus on environmental management. These systems' quality and environmental focus combine to form a one, two punch for organizations wanting to reduce waste and the negative environmental impacts of their operations.

Table 4.
Descriptive statistics of examined variables

Variable	Arith. Mean	Geom. Mean	Harm. Mean	*N*	Standard deviation	Median	Kurtosis	Skewness
GrRawMat	3.524	3.381	3.214	105	0.942	4.000	−0.532	−0.246
SupSustAs	3.705	3.623	3.531	105	0.746	4.000	−0.042	−0.309
StrSupCol	3.743	3.625	3.473	105	0.855	4.000	0.354	−0.604
WasWatMgm	3.771	3.699	3.621	105	0.724	4.000	−0.288	−0.087
GrManuf	3.743	3.672	3.600	105	0.721	4.000	−0.536	0.117
ProdRecRem	3.648	3.580	3.510	105	0.693	4.000	−0.283	0.071
CoInvMgm	3.714	3.637	3.549	105	0.717	4.000	0.263	−0.473
GrWare	3.838	3.779	3.715	105	0.652	4.000	0.254	−0.249
CorGrImMgm	3.448	3.328	3.185	105	0.855	4.000	−0.208	−0.258

4.2 Differences between environmental effects regarding implemented managerial system

The previous analysis showed a relatively stable intensity of environmental effects of implementing the monitored management systems. In this part of the article, we will focus on analyzing results based on stratification according to specific management systems. The question about management systems had three options: either the organization implemented ISO 9001, or the organization implemented ISO 14001, or it implemented both ISO 9001 and ISO 14001. The results will be displayed across three groups – each represents one option. Figure 2 provides an overview of the environmental effects regarding the implemented management system. This interval graph shows the average value of the effect (on a scale of 1–5) and the 95% confidence interval (CI). Individual standard deviations are used to calculate the intervals by Eqn (2). In this formula, x-bar denotes to mean, Z denotes the confidence level, σ denotes the population variance, and n denote to sample size.

$$\text{CI for mean} = \left(\overline{x} \pm Z^* \frac{\sigma}{\sqrt{n}}\right) \tag{2}$$

Results and CIs in this figure are shown in different colors and symbols: green with squares represent results for organizations with ISO 14001, blue with circles representing results for organizations with ISO 9001, and red with diamonds representing results for organizations ISO 9001 and ISO 14001. From the graph, it is possible to see several results, which are then statistically supported by analysis of variance (ANOVA) in Table 5, and their interpretation is as follows:

(1) The highest environmental effects were achieved by organizations that implemented ISO 9001 and ISO 14001 at the same time

(2) The lowest environmental effects were achieved by organizations that have implemented only ISO 9001, but even in this case, these effects are above average

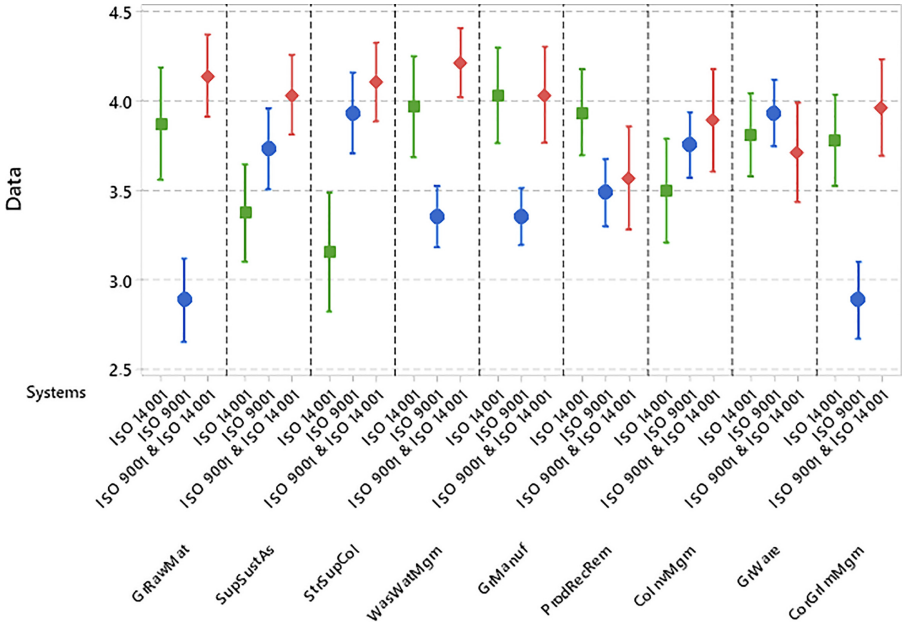

Figure 2.
Overview of environmental effects with respect to the management system

Variable/statistics		Sum of squares	df	Mean square	F	Sig
GrRawMat	Between groups	32.817	2	16.409	28.189	0.000
	Within groups	59.373	102	0.582		
	Total	92.190	104			
SupSustAs	Between groups	6.583	2	3.292	6.549	0.002
	Within groups	51.264	102	0.503		
	Total	57.848	104			
StrSupCol	Between groups	16.360	2	8.180	13.976	0.000
	Within groups	59.697	102	0.585		
	Total	76.057	104			
WasWatMgm	Between groups	14.520	2	7.260	18.516	0.000
	Within groups	39.994	102	0.392		
	Total	54.514	104			
GrManuf	Between groups	11.813	2	5.906	14.261	0.000
	Within groups	42.244	102	0.414		
	Total	54.057	104			
ProdRecRem	Between groups	3.985	2	1.993	4.421	0.014
	Within groups	45.977	102	0.451		
	Total	49.962	104			
CoInvMgm	Between groups	2.439	2	1.219	2.439	0.092
	Within groups	50.990	102	0.500		
	Total	53.429	104			
GrWare	Between groups	0.858	2	0.429	1.009	0.368
	Within groups	43.389	102	0.425		
	Total	44.248	104			
CorGrImMgm	Between groups	25.084	2	12.542	25.145	0.000
	Within groups	50.877	102	0.499		
	Total	75.962	104			

Table 5.
Results of analysis of variance

(3) The type of implemented management system causes a statistically significant difference in the magnitude of environmental effects.

Normality tests of nine analyzed variables showed that all variables are normally distributed. Tests also confirmed the assumption that data should have outliers' values. The necessary precondition of ANOVA has been met. To testing type 1 error probability, we used Tukey and Bonferroni tests. The literature states that the Tukey test is more suitable for a larger sample size, while Bonferroni shows higher power for a lower sample size (Field, 2009). In our case, the sample size was medium, so we used both tests. Tukey, as well as Bonferroni tests, demonstrated the suitability of the data for factor analysis.

Analysis of variance showed that except for two cases – collaborative inventory management and green warehousing – there were statistically significant differences in all other variables between the three groups analyzed. On this basis, it can be concluded that by implementing the ISO 9001 and ISO 14001 standards, synergistic effects can be achieved. These standards complement each other and significantly support the correct implementation of most of the processes affecting SSCM. Here we see the earlier ISO standard, 9001 as a building block to reducing waste in supply practices involving procurement, supplier assessment and collaboration; production involving wastewater, green manufacturing, product recovery and distribution involving inventory management warehousing and image. QMSs alone are a great place to reduce environmental impacts and enable greener operations, but a tragic place to stop. Organizations already familiar with and gaining benefits from ISO 9001 can build on this standard's benefits and process improvement opportunities. The successful implementation of a QMS provides the

building blocks to systems integration and additional benefits in environmental effects from also implementing ISO 14001 and a focus on EMSs as an extension of total quality environmental management. Further, we would posit that these systems' internal benefits can be expanded to supply chains and increases in sustainable supply chain management.

4.3 Deeper analysis of mutual relationships between environmental effects of ISO 9001 and/or ISO 14001

Previous analysis has shown that environmental effects are one of the results of the implementation of management standards. The relationship between them can be considered causal, although it should be noted that it would be necessary to implement statistical modeling using data-mining methods to confirm causality. Since the amount of data obtained would be insufficient for these purposes, we used a two-way examination of the interdependence between effects – bivariate correlation analysis. It was used to examine the correlation structure of variables to obtain a basic overview of the intensity of relationships. Correlation identifies statistically significant bidirectional dependencies (not unidirectional as in the case of causality). The 9 effects (variables) were analyzed, and the Pearson linear correlation coefficient r was used as a metric of relationship intensity. Eqn (3) was used to calculate r, where X-bar denotes the mean of the X variable and Y-bar denotes the Y variable. The results are in Table 6.

$$r = \frac{\sum \left(X - \overline{X}\right)\left(Y - \overline{Y}\right)}{\sqrt{\sum \left(X - \overline{X}\right)^2}\sqrt{\left(Y - \overline{Y}\right)^2}} \tag{3}$$

It can be seen from the results that although statistically significant links exist between many of the studied variables, they are mostly below 0.500, which is considered to be a weak correlation. At the same time, we can state that practically only positive significant correlations were identified; it is possible to speak of the concurrence of phenomena. The implementation of the monitored management systems thus synergistically influence the environmental effects. The most intense correlations were identified among the four variables. GrRawMat was found to have relatively intense correlations with WasWatMgm ($r = 0.601$), GrManuf ($r = 0.484$) and CorGrimMgm ($r = 0.530$). These four variables cut across the three main variable groupings of Supply, Production, and Distribution and Sale, demonstrating linkages among them. They also appear to represent the most salient or visible variables in their respective groups. For example, within the Supply grouping, Green

Variables	Gr RawMat	Sup SustAs	StrS upCol	Was WatMgm	Gr Manuf	Prod RecRem	CoInv Mgm	Gr Ware
SupSustAs	0.277**							
StrSupCol	0.157	0.392**						
WasWatMgm	0.601**	0.212*	0.215*					
GrManuf	0.484**	0.215*	0.063	0.457**				
ProdRecRem	0.241*	0.113	0.057	0.259**	0.317**			
CoInvMgm	0.081	0.218*	0.287**	0.188	0.136	0.163		
GrWare	0.077	−0.020	0.114	0.145	0.197*	0.149	0.147	
CorGrImMgm	0.530**	0.134	0.093	0.416**	0.454**	0.220*	0.085	−0.024

Note(s): *Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed)

Table 6. Relationships between environmental effects of ISO 9001 and/or ISO 14001

raw material procurement is quite tangible and visible by comparison to Supplier sustainability assessment and Strategic supplier collaboration. The Production grouping is quite visible for waste, water management and Green manufacturing, whereas Product recovery and remanufacturing are not so much. Finally, Corporate green image management is more visible (especially externally) in the Distribution and Sale grouping than Collaborative inventory management and Green warehousing.

Several statistically significant relationships between variables indicate that latent interconnections may exist in the correlation structure. These links were examined by exploratory factor analysis. The data were tested for suitability to factor analysis. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Barlett's test of sphericity were chosen as the primary metric. KMO reached a value of 0.752 (the minimum recommended value is 0.700), and the significance of Barlett's test of sphericity reached 0.000. Communalities analysis examined the suitability of variables for factor analysis. The extraction rate did not decrease for the variables ranging from 0.391 (for the ProdRecRem variable) to 0.714 (for the GrWare variable). Therefore, the results of both KMO and communalities analysis led to the conclusion that the data structure is suitable for the implementation of factor analysis.

PCA – principal component analysis was used as the extraction method, and the number of extracted factors was not defined. To help decide the resulting number of factors, we used Keiser's rule, according to which the number of factors is determined based on the size of the eigenvalue. The results of the factor analysis explaining the variance of the date are in Table 7.

The analysis showed three latent factors in the data, which explain 60.372% of the variability. Each variable affects each of these three factors, only to a different extent. The component/factor matrix was rotated to achieve factor independence and the highest possible degree of interpretation. Varimax was used as the rotation method. The final solution was achieved by rotating the factors – a total of 5 iterations of rotation took place. The results are in Table 8.

The values in the table represent the factor loadings of individual variables. The higher the value in a given factor, the more the variable affects the factor. According to the intensity and composition of these influences, every factor can be named. The procedure identified these three factors is directly from their composition:

(1) *Factor 1: Waste reduction* – This factor consists of the following areas: green raw material procurement; corporate green image management; waste, water management, green manufacturing. A common feature of these areas is reducing the environmental burden by the organization focusing on the efficient use of

Table 7. Total variance explained by the calculated factor model

	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
Factor	Total	% of var	Cum. %	Total	% of var	Cum. %	Total	% of var	Cum. %
1	2.936	32.623	32.623	2.936	32.623	32.623	2.565	28.501	28.501
2	1.378	15.310	47.934	1.378	15.310	47.934	1.613	17.918	46.419
3	1.119	12.438	60.372	1.119	12.438	60.372	1.256	13.953	60.372
4	0.832	9.240	69.612						
5	0.741	8.230	77.842						
6	0.624	6.937	84.779						
7	0.562	6.249	91.028						
8	0.459	5.103	96.131						
9	0.348	3.869	100.000						

Variable	Component (factor) Factor 1	Factor 2	Factor 3
Green raw material procurement (GrRawMat)	*0.827*	0.151	−0.010
Corporate green image management (CorGrImMan)	*0.781*	0.015	−0.091
Waste, water management (WasWatMgm)	*0.726*	0.212	0.168
Green manufacturing (GrManuf)	*0.726*	0.032	0.283
Strategic supplier collaboration (StrSupCol)	0.042	*0.813*	0.052
Supplier sustainability assessment (SupSustAs)	0.241	*0.736*	−0.162
Collaborative inventory management (CoInvMgm)	0.013	*0.584*	0.402
Green warehousing (GrWare)	−0.003	0.031	*0.845*
Product recovery and remanufacturing(ProdRecRem)	0.395	0.014	*0.485*

Table 8. Rotated component/ factor matrix

materials and resources. This factor helps confirm prior work by Sroufe (2003), Florida and Davison (2001), Hui *et al.* (2001), Young *et al.* (2000).

(2) *Factor 2: Relationships with suppliers* – This factor consists of the following areas: strategic supplier collaboration; supplier sustainability assessment; collaborative inventory management. It is characteristic of this factor that all its essential components are related to suppliers and cooperation with them. This factor aligns with and supports prior findings by Lippmann (1999), Geffen and Rothenberg (2000), Hollos *et al.* (2012).

(3) *Factor 3: Ecological production and warehousing* – This factor consists of the following areas: green warehousing; product recovery and remanufacturing. The variables that affect this factor have in common, in particular, that they relate to environmentally responsible behavior in the life cycle of a product at all stages. This factor helps to confirm prior work by Rüdiger *et al.* (2016), Moreira *et al.* (2010).

4.4 Examination characteristics of identified environmental factors

Factor analysis confirmed three latent factors – waste reduction, relationships with suppliers, and ecological production and warehousing. This chapter will take a closer look at how these factors' intensity differs concerning different types of organizations. In the factor analysis, a factor *Z*-score was recorded in each case (one respondent). Its calculation was based on linear regression. The *Z*-score is a standardized metric that allows you to assess the characteristics of a given distribution. The data are normalized so that the mean value represents a *Z*-score of 0.000. The above-average value of one standard deviation represents a *Z*-score of 1.000, and the below-average value of one standard deviation represents a value of −1.000. The *Z*-score was calculated according to Eqn (4) in which *x*-bar denote to mean of the sample and *S* denote to standard deviation of the sample.

$$z = \frac{x - \overline{x}}{S} \tag{4}$$

Z-scores were analyzed for distribution. One-level stratification was used for in-depth analysis. Stratification variables represented the three ID characters of organizations. Three analyzes were performed to examine whether the intensity of the three latent factors (waste reduction, relationships with suppliers, and ecological production and warehousing) differed depending on the specific ID characteristics. One-way ANOVA was used to examine statistically significant differences in distributions. The first analysis monitored the intensity of factors according to the type of management system. Thus, the results were analyzed

regarding the organizations that implemented ISO 9001, ISO 14001, and ISO 9001 and ISO 14001. The results can be found in Figure 3.

Several findings can be identified from the graphical and statistical analysis of Figure 3. The first is that organizations with ISO 9001 achieved statistically lower performance in the field of waste reduction – histogram of Factor 1. The average value of this factor was −0.830 for ISO 9001, 0.585 for ISO 14001 and 0.665 for ISO 9001 & ISO 14001. This result may indicate that the implementation of ISO 9001 will not lead to waste reduction, which would not be a correct statement. Previous results have shown that the implementation of ISO 9001 also achieves effects in the field of waste reduction. Therefore, the correct interpretation would be as follows: By implementing the ISO 14001 and ISO 14001 together with ISO 9001, the organization will achieve more significant effects in the field of waste reduction than if it implemented only the ISO 9001.

The second finding from this analysis is that by implementing only the ISO 14001, organizations will not achieve significant effects in relationships with suppliers – histogram of Factor 2. The average value of Factor 2 was −0.783 for ISO 14001, 0.258 for ISO 9001 and 0.481 for ISO 9001 & ISO 14001. This means that by implementing ISO 9001, organizations will achieve statistically better relationships with suppliers than they would if they implemented only ISO 14001. However, the best effects in this area can be achieved by implementing both management systems – ISO 9001 and ISO 14001.

The third finding is that both ISO 9001 and ISO 14001 affect ecological production and warehousing approximately the same way – histogram of Factor 3. One-way ANOVA did not reveal statistically significant differences for this factor for organizations with ISO 9001, organizations with ISO 14001 and organizations with both systems.

In the same way, as in the previous analysis, further analyzes were performed, but the organization's size was used as the stratification variable. In the questionnaire, organizations had three options – small, medium and large. Therefore, the results are analyzed in terms of the distribution of three factors for the three groups of organizations according to their size. One-way ANOVA determined the statistical significance of the differences. The results are in Figure 4.

The histograms and statistics of Figure 4 offer several findings. Large organizations showed higher effects on waste reduction than smaller organizations – histogram of Factor 1. The average value of the *Z*-score of the waste reduction factor was 0.677 for large organizations, −0.054 for medium organizations and −0.310 for small organizations. This result can be interpreted relatively easily. Larger organizations usually produce more goods and services, which is associated with higher turnover. Economic indicators such as profit are the difference between the two main components – costs and revenues. However, with a large turnover, even small cost items at the level of a few percent represent a relatively high amount of money in absolute numbers. Therefore, it is logical that large organizations see the potential for cost reduction in waste reduction, which they achieve (among other targeted activities) through the implementation of ISO 9001 and ISO 14001. Even in this case, however, it should be noted that this result does not mean that small and medium organizations do not achieve a waste reduction in the implementation of these standards. Previous analysis has shown that even small and medium-sized organizations will achieve waste reduction, but not as significantly as large organizations.

The second finding from this analysis is that large organizations achieve better relationships with suppliers than small and medium-sized organizations – histogram of Factor 2. This is a statistically significant difference, while this factor's average values were 0.606 for large organizations, −0.106 for medium organizations and −0.195 for small organizations. Suppliers are a critical element for large organizations, and this result only confirms this. The importance of managing supplier relationships grows with the size of the organization. Whether an organization handles its supplies through a smaller number of

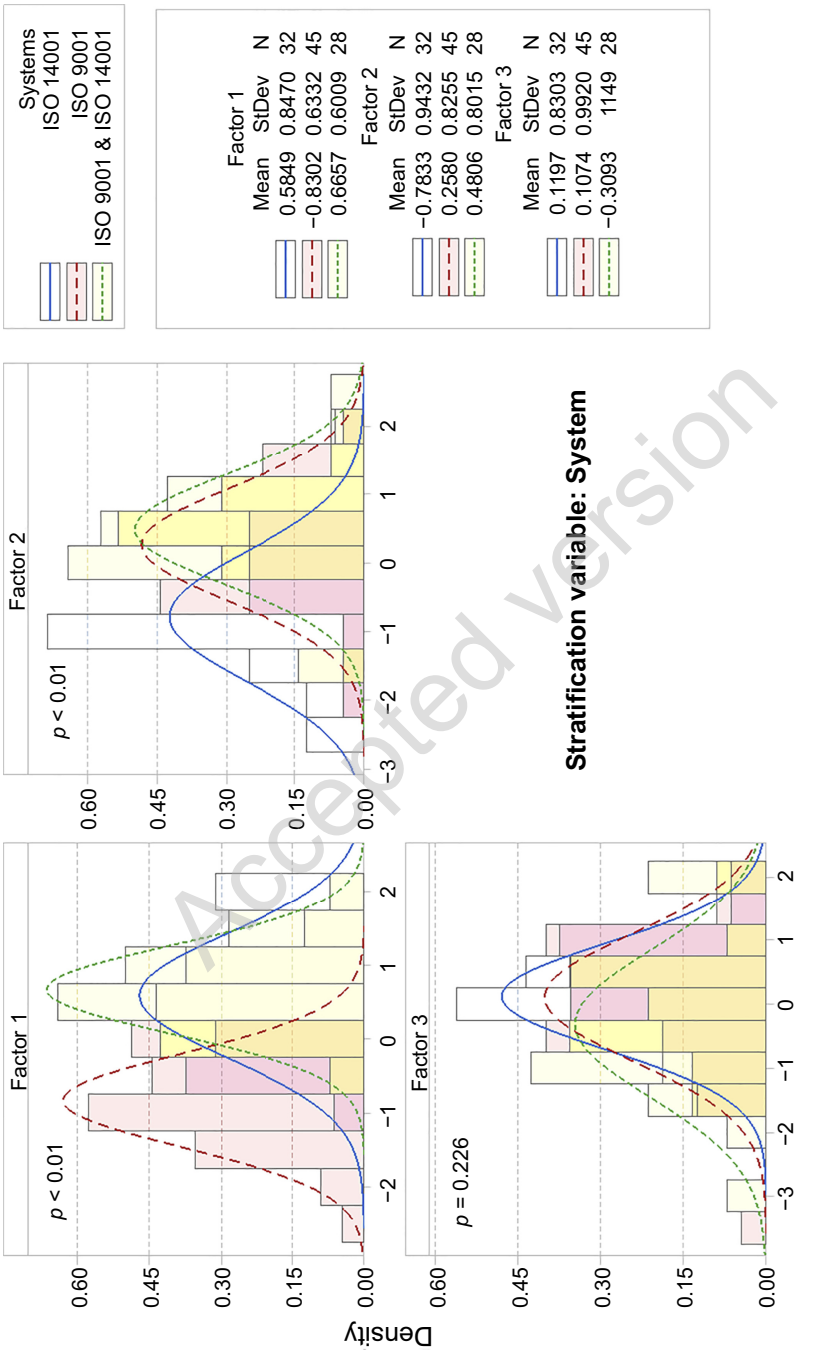

Figure 3.
Intensity of particular factors regarding to implemented management system

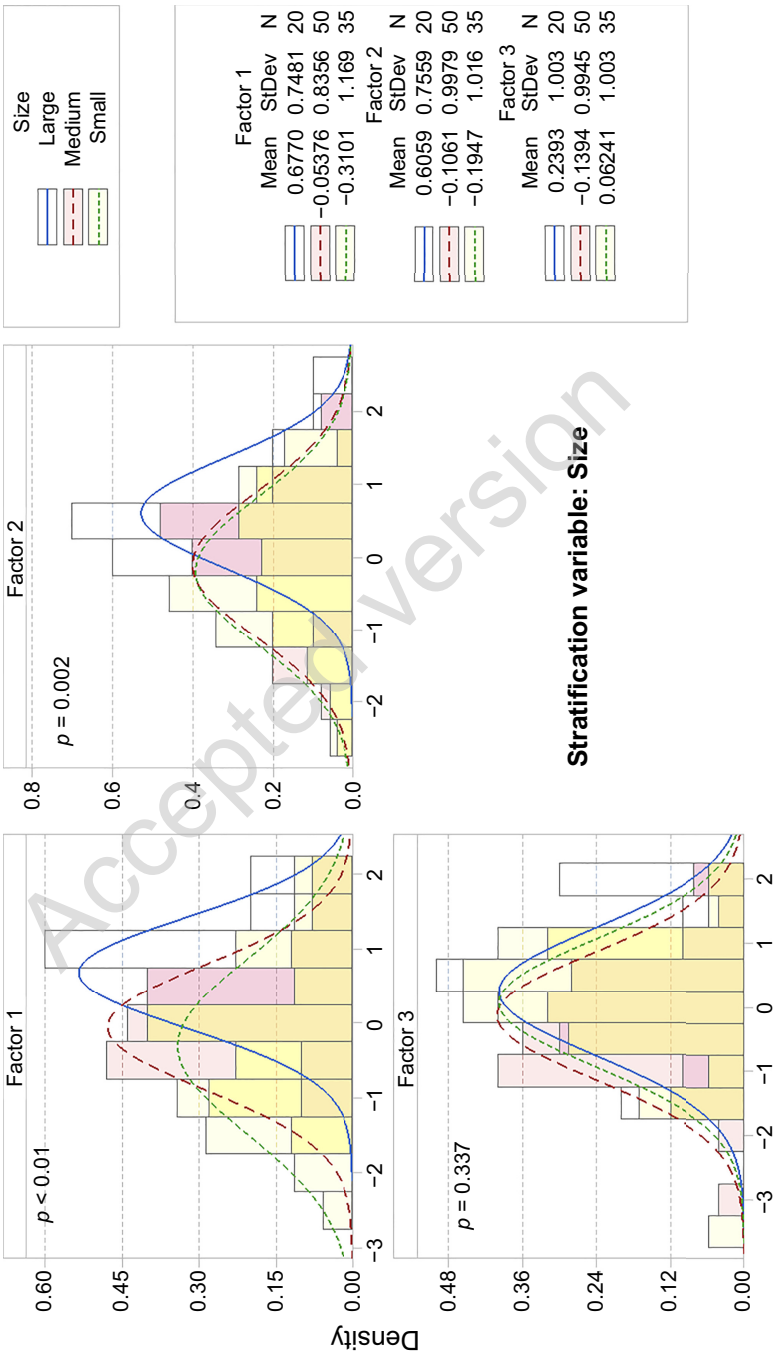

Figure 4.
Intensity of particular factors regarding the size of the organization

critical suppliers or a larger number of smaller suppliers must be delivered on time, in a given quantity and the appropriate quality. An essential criterion for selecting suppliers is their flexibility and ability to respond to unexpected situations. All of these attributes are directly related to the level of relationships with suppliers.

The third finding is that the level of ecological production and warehousing is approximately the same for small and medium and large organizations – histogram of Factor 3. No statistically significant difference was found, and therefore, as in the previous case, it can be stated that the effects related to ecological production and warehousing are relatively constant.

The last analysis was to determine the intensity of three factors concerning the country. The survey was conducted in three countries – the Czech Republic, Poland and Slovakia (Figure 5). One-way ANOVA performed the testing of differences in Z-score values of individual factors.

Testing revealed only one statistically significant difference: in the second factor (relationships with suppliers), Slovakia achieved less intense effects than the other two participating countries. However, given the broader context (sample size, p-value, differences in the other two factors), this result can be taken as indicative. Our results indicate that the effects of ISO 9001 and ISO 14001 will not differ depending on the country in which the organization operates. This only confirms that the standards are generic and universally valid. However, for the sake of correctness, it should be noted that it cannot be ruled out that the effects may differ across culturally distant countries, but our results have not been able to prove this.

5. Discussion

The presented study offers a quantitative review of the environmental effects resulting from the implementation of ISO 9001 and/or ISO 14001. A questionnaire was used to examine these effects, and data were collected in three countries. The statistical and graphical analysis focused on answering four research questions. The following subchapters provide an overview of the main findings and a discussion of the theoretical and practical implications and the limitations of the research and other potential directions of research in this area.

5.1 Summary of main findings

An overview of the environmental effects of ISO 9001 and 14001 made it possible to identify more new information. This section will try to summarize them and create a conceptual model that would systematically explain the various aspects of these effects. At the same time, in this part, we will focus on interpreting findings regarding the identified research questions. Implemented research and statistical data processing made it possible to uncover the following new findings:

(1) 1-st research question: "How does the implementation of ISO 9001 and/or ISO 14001 standards affect the organization's environmental effects?". The results of this research question can be found in section 4.1. These results suggest that examined management standards affect a range of environmental effects. We examined nine different effects, each of which identified their above-average intensity due to the implementation of ISO 9001 and ISO 14001. To this end, we can confirm that the implementation of both ISO 9001 and 14001 provides dynamic benefits to an organization. Both quality management and EMSs help organizations in this study reduce waste in processes supporting inbound supply management, internal production and externally in distribution and sales elements.

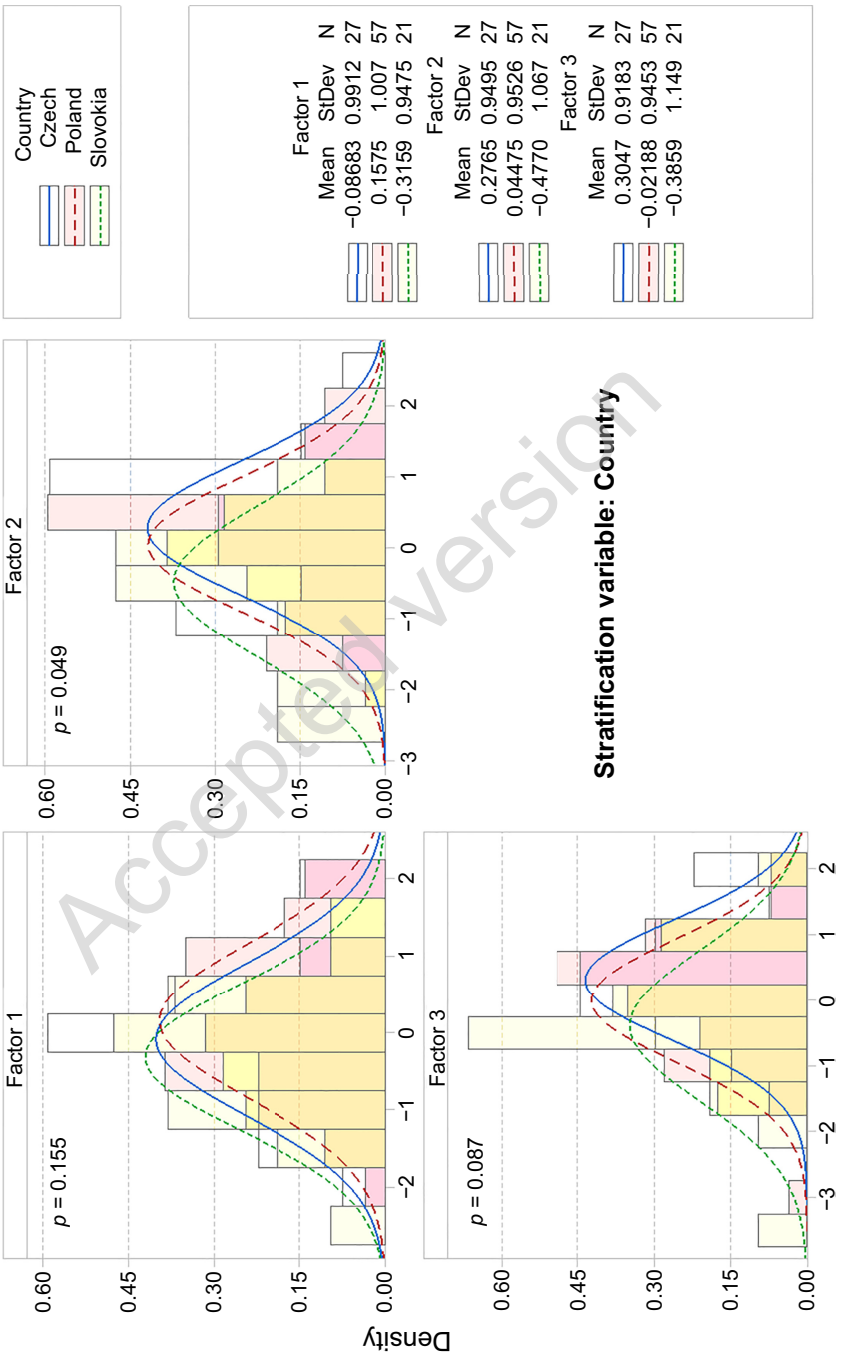

Figure 5.
Intensity of particular factors regarding to country

(2) 2-nd research question: "Does the intensity of environmental effects differs between organizations regarding the implemented management system?". The results of this research question can be found in section 4.2. According to our results, it can be stated that the type of implemented management system causes a statistically significant difference in the intensity of environmental effects. In general, it can be said that the highest environmental effects were achieved by organizations that implemented ISO 9001 and, at the same time, ISO 14001. Therefore, the combined effects of implementing both quality and EMSs will be greater than the benefits of only implementing a single system. While quality management should be important to any organization, there is also a growing need to extend waste reduction to include the green benefits that EMSs provide in more current efforts to reduce and eliminate all waste forms.

(3) 3-rd research question: "Are there latent links between environmental impacts that would explain their interrelationship more comprehensively?". The results of this research question can be found in section 4.3. Based on these results, it can be stated that three factors can explain the correlation structure between environmental effects and variability: (1) waste reduction, (2) relationships with suppliers and (3) ecological production and warehousing. These factors build on and support prior research studies. The additional context provided by the sample of firms in this study further validates these factors as necessary to practitioners and researchers while at the same time, including new variables in need of further exploration.

(4) 4-th research question: "If latent links exist, does their intensity differ concerning different types of organizations?". The results of this research question can be found in section 3.4. Statistical analysis showed the following findings:

- In the case of the implementation of ISO 9001, organizations achieved a statistically lower intensity of waste reduction than implementing ISO 14001 or ISO 14001 & ISO 9001.
- ISO 14001 did not cause a high intensity of the second factor – relationships with suppliers.
- The intensity of the third factor – ecological production and warehousing – was not influenced by the management system type.
- Large organizations achieved statistically higher effects in waste reduction than smaller organizations by implementing the monitored management systems.
- Large organizations achieved better relationships with suppliers than small and medium-sized organizations.
- The intensity of the third factor – ecological production and warehousing – was not affected by the organization's size.
- Organizations from the three participating (culturally close) countries achieved a similar intensity of three factors, indicating that the environmental effects of ISO 9001 and ISO 14001 are not geographically limited.

These four research questions provided a conceptual view of ISO 9001 and ISO 14001 standards from an environmental point of view. For better interpretability, we tried to create a graphical model that would summarize our findings. This model is shown in Figure 6.

Contributions of this study to the field include, but are not limited to, ISO systems improvements of environmental effects for organizations. These system standards can

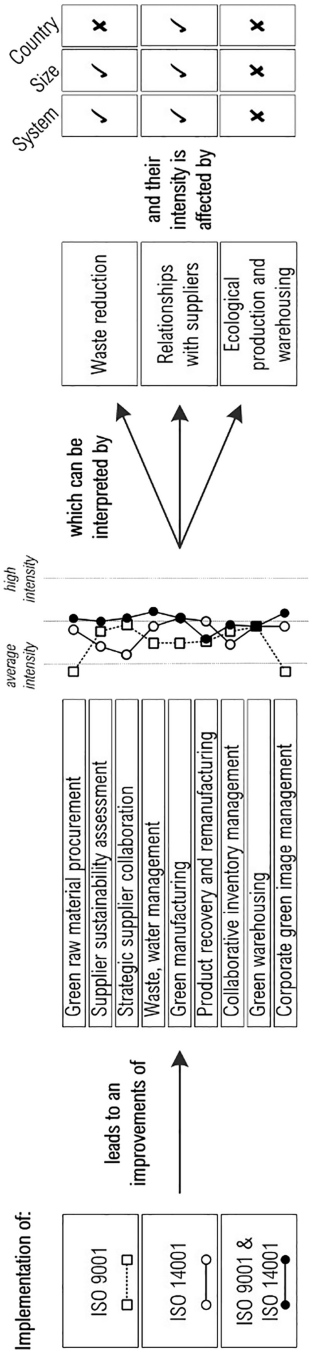

Figure 6.
Main finding of the research

provide varying levels of impact and improvements involving supply management, production, distribution and the organization's image. The higher intensity of these improvements should be of value to practitioners. Our more in-depth analysis of this study's variables includes confirming three factors of waste reduction, relationships with suppliers and ecological production and warehousing as an essential future construct for scholars. We can show that the implementation benefits are not uniform for all types of sizes of organizations and that the biggest impacts are found when implementing both systems at the same time, that target organizations realize more significant impacts and can develop better relationships with their supply chains and that these benefits span multiple countries.

Talking about the managerial implications, our results show that the implementation of ISO 9001 and ISO 14001 standards is a wise strategic choice, because the implementation of their requirements allows companies not only to reduce the negative impact on the environment, but also to improve important aspects of the functioning of supply chains. As the observed benefits are independent of the country, it can be concluded that standardized management systems are a universal solution recommended for most organizations and also facilitate long-term relationships with companies that apply similar standards (Xuan and Trung, 2020). However, it should be emphasized that large organizations gain greater benefits from the implementation of the studied management standards. Therefore, managers of such companies should be aware of the additional benefit that can be obtained from the implementation and integration of standardized management systems (Arocena *et al.*, 2020).

5.2 Theoretical and practical implications

This study's theoretical implications include a European and textile industry-centric view for the realization of environmental effects. Organizations implementing management systems can realize dynamic benefits across a supply chain and within a manufacturing organization. Here we see an opportunity for ISO systems as a stepping stone to a more sustainable textile manufacturing economy. We would posit that the relationships found in this study are transferable to other industries and manufacturing environments. We can see these dynamic relationships being valid in other countries to plan to conduct similar studies to test our future assumptions.

The research results may prove very valuable to textile companies looking for proven solutions to accomplish the key aspects of SSCM. Based on the article, managers can make a more conscious decision about the possible need to voluntarily implementation of ISO 9001 and ISO 14001 standards or a decision of implementation and integratation of two standards.

The article provides answers to questions important for managers, namely to what extent individual standards can support the implementation of processes affecting the sustainable management of the supply chain. The analysis of the research results will facilitate the process of selecting and implementing the standard for managers, which will support the implementation of the strategy chosen by specific supply chains. The conducted research is particularly important for managers as it shows the attitude of enterprises of various sizes to the implementation of management standards. Therefore, the management of smaller organizations that have limited resources can, on the basis of the presented research results, make a detailed analysis of the validity of the implementation of standardized management systems in terms of their potential advantages, costs and time required for their proper implementation and improvement. On the other hand, managers of larger organizations who have the necessary resources to implement the requirements of standardized management systems can use the results presented in this article to select the most optimal strategies for implementing system requirements into the implemented pro-quality strategy.

The practical implications should be important to management decision-makers regarding where and how to allocate scarce resources to systems investment decisions.

ISO standard certifications become an order looser in a global marketplace if you do not have any, an order qualifier if you have at least one and an order winner with multiple certifications. These systems standards can reduce waste, improve supply-side management and production while enabling increases in sustainable supply chain management. With proven quality and EMS development, entire industries can become more sustainable when these standards become a requirement for standard operating procedures.

5.3 Limitations of research

This study's limitations include the country context in which our data was solicited, the size of our sample and the industry context. To this end, the results are not generalizable globally but are valid and reliable for future studies and continuation of this field of research. Further, the variables used in this study did not encompass all of the possible impacts of the implementation of management systems. Instead, we were able to draw from the literature to build upon and further develop measurement items and constructs relevant to a geographic region of countries, size of firms and industry context to implement two crucial ISO management system standards.

Another limiting factor may be the methodological side of research. The main research tool was a questionnaire. It carries with it several limiting elements. The first is the sample size – 105 organizations were involved. Although the individual statistical procedures took into account the sample size, it can generally be said of medium size at which the generalization of the results is partially limited. Another limiting factor is the reliability of the results. We used a five-point scale to evaluate the intensity of individual environmental effects. The choice of scale can significantly affect the results. It would also be possible to use a more detailed scale in the research (e.g. 7-point or 10-pointe scale), but this could increase respondents' complexity in practical terms. To at least partially eliminate the risk of the negative impact of the scale, we performed a reliability test, which proved that the scale is sufficiently reliable. The third limiting factor is geographical constraints – the research was carried out in three Central European countries – Poland, Slovakia and the Czech Republic. The intercultural differences between these countries are minimal, and it is possible that if research were extended to other countries, the results could differ. Despite these limitations, however, the presented research offers a relatively new perspective on the quantitative analysis of environmental impacts. It can serve as one of the starting points for a more in-depth analysis of management systems' impacts.

6. Conclusions

The Polish, Slovak and Czech clothing and textile industry is essential to European manufacturing's resilience. This competitive and diverse market can repeat the mistakes of larger, more developed regions of the world and have a different trajectory in doing less harm to the environment while reducing waste and realize the shared benefits of integrated management (Sroufe, 2018) and integrated manufacturing systems. The competition within this part of the world will come only with globalization. With this global, competitive marketplace, environmental challenges will continue to grow as consumers, customers and individual organizations look for ways to diversity operations and manage their supply chains with fewer waste goals. Small enterprises' future and the benefits they can realize from the use of best practices and ISO standard certification can bring about improvements in procurement, production and supply chains. The future of business management, operations and maintaining a license to operate will depend on the proliferation of best practices.

Despite the vital role of the clothing and textile industry in Central and Eastern Europe, it is considered quite hermetic. Some companies set trends and show how to find themselves in

complex relationships in the supply chain so that the offered product meets not only quality criteria but also the practical implementation of sustainable development principles. However, I recognize that most entrepreneurs do not know about business models and pro-ecological and social concepts implemented by their partners in supply chains. However, it does not mean that these entrepreneurs do not look for patterns and solutions that could support them in sustainable supply chain management. On the contrary, it is noted that entrepreneurs from the clothing and textile industry are looking for information on how they could increase the effectiveness and efficiency of processes implemented in the supply chain and focus more on meeting the needs of customers and external stakeholders. Therefore, the article's considerations fit into the needs of the industry and show how the implementation of popular management standards can improve critical processes in supply chains. This study's insights shed some light on the benefits of implementing more, not fewer systems with benefits to organizations and entire industries with new possibilities for economic growth that do not have to come at the expense of the environment. Thus, Polish, Slovak and Czech enterprises will make a more informed decision about the possible implementation of standardized management systems, which are not obligatory but can be a good foundation for building a broader supply chain management strategy.

Finally, we call for research to continue the line of research initiated here, in two directions. First, it is worth researching the impact of other management standards (e.g. industry standards or ISO 50001 standard) on SSCM in the textile industry. Second, this research should be carried out in Western Europe and compared with the obtained results.

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