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The role of EMS based on ISO 14001 in enhancing the green economy

Abstract

The concept of green economy plays an important role in economic development programmes around the world. It is also part of the economic policy and government regulations in Poland. The overall goal of the green economy, which is to ensure sustainable development of the country's economy, impacts the strategy and policy of each company. ISO 14001 is generally considered the main tool for addressing environmental issues in the management of an enterprise. The standard provides a proven and reliable foundation for the environmental management system (EMS). However, the relationship between the ISO 14001-based EMS and the economic aspect of environmental protection is still poorly studied. The study addresses the gap.

The article explores the relationship between the prevalence of ISO 14001-based EMS and the economic aspect of environmental protection in the green economy of Poland. The study covers the period from 2000 to 2022. Correlation analyses of the data obtained from the ISO survey and statistical indicators of the green economy of Statistics Poland (GUS) were used.

The results of the study show the impact of the prevalence level of ISO 14001-based EMS on the amount of capital expenditures for environmental protection, as well as on the amount of energy and resources taxes paid by the business sector. Furthermore, the relationship between the growth dynamics of the number of certified EMS and QMS was analyzed. The implementation of ISO 9001 was established as a prerequisite for the implementation of ISO 14001, but it is not the only factor that influences this decision. The direction for further research is proposed.

Keywords: EMS, ISO 14001, green economy, economic aspects of environmental protection
JEL Classification: O44, L15, Q56

Introduction

The green economy (GE) is aimed at improving the quality of life in local and global dimensions via enhancing environmental protection and reducing the use of the non-renewable resources. The GE mechanism has a complex structure that includes political, legal, economic, environmental, and social aspects with an emphasis on innovation, investment, and knowledge management.

ISO 14001 has received recognition in the business sphere as a tool for developing the environmental aspect of GE at the micro level through the implementation of the environmental policy of enterprises. However, the implementation of the company's environmental policy is related not only to the environmental aspect of GE, but also to the economic and, to some extent, social aspects. The requirements of ISO 14001 leave a large degree of freedom for the management of the company in the formation of environmental policies and goals. Therefore, the level of utilisation of the ISO 14001 potential can influence the company's EMS results. A fairly small share of companies across the country have implemented ISO 14001 in their management practice. However, we assume that the increase in the number of certified EMS affects the economic aspects of GE. Among the economic aspects, we are interested in costs for the implementation of environmental protection actions, as well as the dynamics of environmental-related taxes, as an economic indicator of the achieved environmental effects.

Companies, as the main beneficiaries of green investments, create fixed assets to protect the environment, bring environmentally friendly products to the market, and monitor the compliance with environmental and social standards in the supply chains. The significant environmental efforts of the enterprises involve large investments. The willingness to implement and improve the environmental management of enterprises is reflected in a large part in their willingness to bear relevant costs. Thus, the analysis of influencing the prevalence level of ISO 14001 on the dynamics of investments in fixed assets and current costs for environmental protection, as well as the dynamics of environmental-related taxes paid by enterprises, allows us to evaluate the motivation of business to carry out the environmental activities based on the certified EMS. The purpose of the article is to determine the relationship between the level of prevalence of ISO 14001 and the dynamics of investments in fixed assets, current costs for environmental protection, and environmental-related taxes paid by enterprises.

Definition and goals of the green economy

The green economy (GE) is a multi-aspect and multidimensional concept [Merino-Saum et al., 2020]. The GE is considered an interdisciplinary concept and is viewed as a type of socioecological system [Newton, Cantarello, 2014]. P. Misztal and P. Dziekaski apply the term 'multidimensional green economy' to it [2023]. The concept of GE does not form a clear

systematized theory [Merino-Saum et al., 2020]. The concept of GE is often defined in relation to other concepts and theories with which it is closely related: green growth, sustainable development, ecological economics, green new deal, low-carbon economy, and circular economy. A group of researchers from the Institute for European Environmental Policy (IEEP) proposed the following scheme of connections of the main concepts related to the GE: "the *Green New Deal* can be seen as a catalyst and the *Green Growth* an approach contributing to a *Green Economy*, which in turn is an essential means of achieving the objective of sustainable development." [ten Brink et al., 2012]. The low-carbon economy is proposed to be considered as a component of both the green economy and green growth [Newton, Cantarello, 2014].

The relationship and interpenetration between these concepts are explained by the evolution of the core premises, assumptions, and notions [Fernandes, Machado, 2022]. The concept of GE has its origins in neoclassical environmental economics [Spangenberg, 2016], as well as ecological economics, ecosocialism, and ecofeminism [Cato, 2009]. In the literature, there are separate terms of *green economics* and *green economy* to systematize the theoretical foundations and forms of their practical application. We cannot ignore the fact that the concept of GE was formed mainly as a practical model of the strategy of economic and ecological development at the level of regions and countries and has a powerful political context.

The relationship between the concepts of GE and the circular economy (CE) remains an open topic for discussion. D. D'Amato and J. Korhonen [2021] consider the GE and CE as equivalent levels of sustainable development that intersect in the field of creating ecotechnologies. According to them, the GE is a tool to improve human well-being through the use of ecosystems, while the CE is designed to reduce inputs/outputs in the production-consumption system. However, according to the approach of systems, the GE and CE are systems of different levels. The GE as a mechanism for ensuring sustainable development encompasses the following interrelated components: ecosystems, economy, and human well-being [Kanianska, 2017]. The CE is a relatively new organizational and economic model of production and consumption processes [Bruel et al., 2019] and has a large number of scaling limitations [Mayers et al., 2021]. That is, the CE in its essence should be considered as an element of GE.

We consider the GE as a type of economy, that is, a type of socioeconomic system with clearly defined environmental, social, and economic goals and a management focus on achieving an effective balance between them. The formation of the GE of each country is strongly influenced by the legal norms and decisions of the state authorities. Political decisions can have a diametrically opposite effect on sustainable business strategies of companies in different sectors of the economy [Lopes, Oliveira, 2023], thus stimulating green growth in some sectors, but inhibiting it in others.

Since the GE is seen as a way to achieve the Sustainable Development Goals (SDGs), it is logical to assume that the SDGs are the long-term goals of GE. Some researchers agree that the goals of GE and SDGs are formulated according to the three pillars of sustainable development (economic, environment, social) [Khoshnava et al., 2019], but claim that the UN SDG 2015–2030 does not correspond to the new paradigm of green economy and has been reviewed [Andersen, 2017].

The objectives of GE arise from the essence of GE. The purpose of GE is emphasized in most of its definitions. The basic, most frequently cited definitions of GE are those formulated during the formation of GE as a new concept of economic and political development in a global dimension by international organizations such as the UN, OECD, World Bank, Global Green Growth Institute, European Environmental Agency. They indicate the GE's focus on improving human life, reducing threats to the natural environment, minimising emissions (into the atmosphere and water), efficient use of resources, and ensuring social inclusion. Each of these complex objectives can be disaggregated. For example, the minimisation of emissions is specified by species; efficient use of resources refers to energy, natural, and other resources (for example, in circular supply chains); the provision of social inclusion can be detailed according to various criteria (income level, age, regional affiliation, etc.); the reduction of threats to the natural environment is expressed in the preservation of biological and landscape diversity, reduction of noise, radiation exposure, etc. The task of forming eco-innovations of all types (product, technological, organisational, and managerial), accompanied by investment, should be considered the goals of the second level. The creation of new eco-orientated processes should help in achieving the ultimate goals of GE by creating conditions to protect the environment, reducing the consumption of natural resources, by creating 'green' jobs, additional jobs, improving working conditions to preserve the health of employees, constantly expanding the offer of eco-products for all areas of consumption, providing access to limited natural resources to all who need it, etc. Among the goals regulated in EU countries, for example, are the implementation of the processes of obtaining alternative (renewable) types of energy and the parallel gradual reduction of the processes of the use of fossil fuels.

The role of ISO 14001 in achieving the goals of the green economy

Poland, along with other EU countries, adopted the concept of GE at the level of development of the country's economy. The country's government has outlined certain legal standards for the components of GE, including green finance, investment, and green government procurement. Official Polish government documents make very limited use of GE terms [Szyja, 2015], for example, green taxes are known as environmental-related taxes [Wagner, 2022]. However, Poland, like other EU countries, is gradually developing its GE and demonstrating positive results of green growth [Juszczak, Rabiega, 2021]. GE monitoring is established at the state level. The indicator system [GUS, 2022] shows that the control covers all target areas of GE: economic, environmental, and social.

The concepts of GE and the sustainable development of the country are expressed, in particular, in the combination of the concepts of quality and environmental safety in public perception of the characteristics of products and business processes. The process of forming quality management systems (QMS) and environmental management systems (EMS) became

the response of enterprises to society's needs for high-quality and environmentally friendly products and processes. ISO standards for management systems have become a common tool for optimizing business processes and creating an integrated enterprise management policy that facilitates the task of balanced green sustainable development. It is logical to assume that the main standardized management systems that ensure economic, environmental, and social results and enterprise development will be implemented with approximately the same intensity across the country. However, in fact, the number of management systems certified according to different types of ISO standards varies greatly. According to the International Organisation for Standardisation, QMS (ISO 9001) and EMS (ISO 14001) are the most common management systems in Poland and Europe as a whole.

The joint use of QMS (ISO 9001) and EMS (ISO 14001) by the enterprise is due to the need to make management decisions in a complex multivector system of GE goals and sustainable development of the country. Joint application of EMS and QMS leads to better environmental and social results according to the ESG score compared to the separate impact of each of the two MSs [Ronalter et al., 2023]. The success of ISO 9001 contributed to the prevalence of ISO 14001. Employees of a company can easily adapt the requirements of ISO 14001 much more easily if they already have experience in QMS (ISO 9001) [Wagner, 2013].

The versions of ISO 9001 and ISO 14001 developed in 2015 have the high-level structure (HLS), which greatly facilitates the joint application of management system (MS) standards by the enterprise and the formation of an integrated management system (IMS). The sequence of implementation of MS standards depends on the company's strategy, in particular on the IMS strategy. The IMS strategy is used to understand the number of specific target subsystems that the company has chosen to integrate into its management structure, and the sequence of their implementation [Bernardo et al., 2015].

In the studies published in the period from 1998 to 2005, three main sequences of implementation of standardized management systems and successful formation of IMS were identified: 1) implementation of QMS first, followed by the integration of the EMS; 2) implementation of EMS first, followed by integration of the QMS; 3) simultaneous implementation of the QMS and EMS with the formation of IMS [Bernardo et al., 2015; López-Fresno&Karapetrovic, 2010]. It should be noted, however, that the studies do not prove the comparative effectiveness of different configurations (structures) of the IMS, as well as the optimality of the selected IMS configuration. Thus, the question of the meaningful content of IMS, which best meets the needs of an enterprise, remains open for further discussion.

Since 2001, the Eco-Management and Audit Scheme (EMAS), which is an alternative model to ISO EMS, has been operating in the EU (since 2004 in Poland). Later, other alternatives to ISO EMS appeared. That is, the companies are not limited to choosing ISO 14001 for EMS formation. It must be recognized that ISO EMS is much more popular than EMAS and other alternative models. For example, in Poland in 2022 the number of certified ISO EMS was 2,786, and the number of EMAS-registered organizations was 68. However, over the period 2018–2022, the number of ISO EMS decreased by 4.62%, and the number of

EMAS-registered organizations increased by 13.3%. That is, the implementation of the ISO quality management system is not an unambiguous prerequisite for the implementation of the ISO environmental management system. The question of whether enterprises that have formed a quality management system based on the ISO 9001 standard choose ISO 14001 to form an environmental management system remains open. That gives us the basis for the following assumptions.

Hypothesis 1: There is a relationship between the prevalence processes of certified QMS and EMS within the country, and the use of ISO 9001 is a necessary prerequisite for the implementation of ISO 14001.

ISO 14001 has gained wide acceptance because it is based on the idea that environmental factors can be systematically identified and managed [Ofori et al., 2023]. This makes a significant contribution to the sustainable practice of GE entities at the microlevel through the implementation of their environmental policy and environmental objectives.

The implementation of environmental goals by enterprises is accompanied by certain economic processes and results. Firstly, the implementation of environmental protection goals requires investments and current costs. It is logical to assume that the prevalence of ISO 14001 (an increase in the number of enterprises that have implemented it) stimulates investment in fixed assets for environmental protection and, in a certain way, affects the amount of current costs regardless of the type of economic activity. An increase in the total number of fixed assets (e.g. equipment) for environmental protection, in turn, leads to an increase in the need for energy, which means an increase in energy taxes paid by enterprises. The introduction of new environmentally friendly technologies, products, and services should also pursue the goal of reducing the consumption of natural resources, and as a result, lead to a reduction in taxes on the use of natural resources. A decrease in air pollution should also be expected from the introduction of technological eco-innovations. For example, according to the study by a group of researchers [Ofori et al., 2023], obtaining ISO 14001 certification leads to a significant reduction in hydrogen emissions in European countries. The expected decrease in the volume of harmful emissions into the air should lead to a decrease in pollution taxes paid by enterprises.

Transport has a significant negative impact on the environment; therefore, this and the consequences of its operation are the object of control in the GE of Poland and other EU countries. Transport taxes are established as one of the types of environmental-related taxes. However, ISO 14001 does not contain unambiguous requirements for environmental management of transportation. According to the requirements of ISO 14001, the company must assess the environmental impact of all elements of its activity that interact or can interact with it, in particular transportation processes, and determine those that the company's EMS can control and influence. However, for further actions on the part of EMS, the enterprise independently selects only those elements of its activity that create the greatest (significant) impact on the environment (clause A6.1.2, ISO 14001:2015). Therefore, transportation may be outside the focus of an enterprise's EMS. As a result, we do not expect to find a clear connection

between the number of EMS-certified enterprises and the volume of transport taxes paid by companies in the country.

The proposed assumptions produce the following hypotheses.

Hypothesis 2: Implementing ISO 14001 has a positive effect on the volume of investment in fixed assets for environmental protection.

Hypothesis 3: The implementation of ISO 14001 has a positive effect on the amount of current costs of enterprises for environmental protection.

Hypothesis 4: Implementing ISO 14001 affects the increase in energy taxes paid by enterprises.

Hypothesis 5: The implementation of ISO 14001 affects the amount of resource taxes paid by enterprises.

Hypothesis 6: Implementing ISO 14001 affects the amount of pollution taxes paid by enterprises.

Hypothesis 7: The implementation of ISO 14001 does not affect the volume of transport taxes paid by enterprises.

Methodology

To test hypotheses 1–7, correlation analysis was used between the number of EMS certified according to ISO 14001 and QMS based on ISO 9001, on the one hand, and outlays on fixed assets for environmental protection, current costs for environmental protection, the total amount of environmental-related taxes paid by the business sector, the amount of energy taxes paid by enterprises, as well as transport taxes, pollution taxes, and taxes on the use of natural resources (resource taxes), among others.

Data from 2000 to 2022 were obtained from two sources: the International Organization for Standardization and Statistics Poland (Główny Urząd Statystyczny, GUS).

At the first stage of the analysis, the numerical series of each indicator were approximated, and trends were constructed. This made it possible to reveal signs of the influence of non-systemic factors on the dynamics of some indicators. In the second stage, a single-factor analysis of variance (ANOVA) was performed. The confidence interval is taken at the level of 95%. The statistical significance of the differences in the two data sets was assessed using Fisher's test.

Research results and discussion

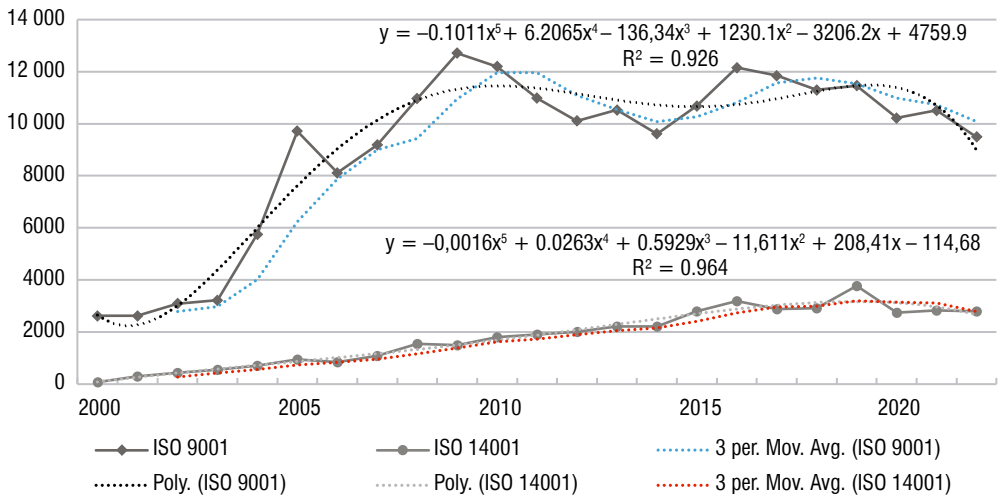
Figure 1 shows the number of certified EMS (ISO 14001) and QMS (ISO 9001) operating in Polish companies in 2000–2022.

It should be noted that there are periods in which the number of enterprises that implement the ISO 9001 standard increased and decreased. A noticeable period of growth covers 2003––2005 and 2006–2009. From 2009 to 2012 and again from 2015, there was a decrease observed

in the number of companies that use the ISO 9001 standard. The graph of the dynamics of the change in the number of companies using the ISO 9001 standard can be approximated by a moving average with a period of 3 and a polynomial line of the 5th order (the coefficient of determination $R^2 = 0.926$). Both trend lines appear to be pointing downwards, showing a general trend toward a reduction in the number of companies using the ISO 9001 standard.

The number of enterprises that use the ISO 14001 standard is much smaller, but the general trend is similar to the dynamics of the prevalence of ISO 9001. The trend line can be approximated by a polynomial of the fifth order, which gives the coefficient of determination $R^2 = 0.964$, showing a decreasing trend. The same trend is shown by the moving average with period 3. Based on this, it can be concluded that the direction of prevalence of ISO 9001 and ISO 14001 is the same with different levels of intensity.

Figure 1. The dynamics of the number of certified QMS (ISO 9001) and EMS (ISO 14001) operating in Polish companies in 2000–2022



Source: own elaboration based on International Organization for Standardization, 2023a, 2023b.

Hypothesis 1 was tested using correlation-regression analysis. Single-factor analysis of variance (ANOVA) of the array of initial data within the 95% confidence interval showed the statistical significance of the differences in two sets (the number of enterprises that use the ISO 9001 and ISO 14001 standards; $F = 103.44 > F_{crit} = 4.06$ – Table 1), allowing us to conclude about the suitability of the model in which the use of ISO 9001 is a prerequisite for the use of ISO 14001.

The results of the correlation-regression analysis (Table 2) show that the relationship between the use of these two standards is weak ($R^2 = 0.60$), but statistically significant within the 95% confidence interval (Significance $F = 0.0000133 < a = 0.05$). This means that there are other significant factors influencing the company's decision to implement ISO 14001.

Table 1. Analysis of variance of data on the prevalence of ISO 9001 and ISO 14001 standards

SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
ISO 9001	23	209070	9090	10603570.5		
ISO 14001	23	42035	1827.6087	1123864.07		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	606536766	1	606536766	103.438952	3.95611E-13	4.06170646
Within Groups	258003559	44	5863717.26			
Total	864540325	45				

Source: own elaboration based on International Organization for Standardization, 2023a, 2023b.

Table 2. The results of the correlation-regression analysis of the prevalence of ISO 9001 and ISO 14001 in Polish enterprises

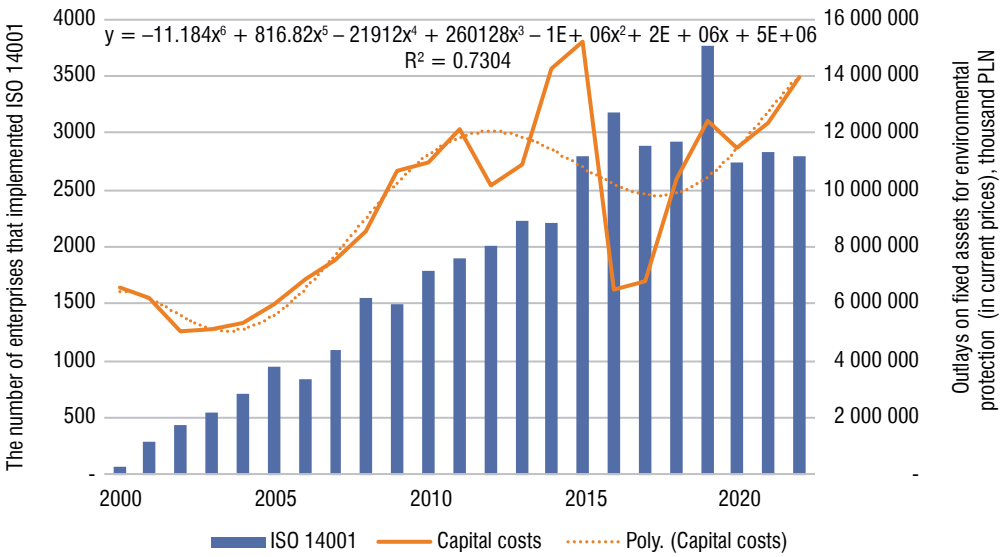
SUMMARY OUTPUT					
Regression Statistics					
Multiple R	0.77633639				
R Square	0.60269819				
Adjusted R Square	0.58377906				
Standard Error	683.941342				
Observations	23				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	14901718.5	14901718.5	31.8565429	1.33246E-05
Residual	21	9823290.93	467775.759		
Total	22	24725009.5			

Source: own elaboration based on International Organization for Standardization, 2023a, 2023b.

Figure 2 shows the dynamics of the number of companies that implemented ISO 14001 standards and expenditures on fixed assets for environmental protection in Poland. It should be noted that, in general, both indicators vary over time in the same direction.

The amount of capital expenditures related to environmental protection during 2000–2022 changed nonlinearly and is difficult to approximate using standard approaches. The maximum coefficient of determination corresponds to the approximation by a polynomial of the 6th order, and the value of $R^2 = 0.73$ is small. This allows us to assume that the change in the indicator of the size of capital expenditures over the years is under the influence of non-systematic, random factors.

Figure 2. The dynamics of the number of enterprises implementing ISO 14001 standards and outlays on fixed assets for environmental protection in Poland in 2000–2022



Source: own elaboration based on GUS, 2019–2023; International Organization for Standardization, 2023a, 2023b; GUS, 2023b.

Despite a significant drop in the outlays in fixed assets for environmental protection after the maximum value reached in 2014–2015, the general direction of the trend is aimed at growth. It can be expected that in the medium term the size of such costs will increase.

Table 3. The results of the single factor analysis of variance of the relationship between the number of enterprises implementing ISO 14001 and outlays on fixed assets for environmental protection

SUMMARY						
Groups		*Count*	*Sum*	*Average*	*Variance*	
ISO 14001		23	42035	1827.608696	1123864.067	
Outlays on fixed assets		23	215194703	9356291.413	1.01758E+13	
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.00632E+15	1	1.00632E+15	197.7864173	6.91424E-18	4.06170646
Within Groups	2.23868E+14	44	5.08791E+12			
Total	1.23019E+15	45				

Source: own elaboration based on GUS, 2019–2023; International Organization for Standardization, 2023a, 2023b; GUS, 2023b.

There is a weak, but statistically significant ($F = 197.79 > F_{crit} = 4.06$) correlation between the dynamics of the number of ISO 14001 standards implemented and the growth of expenditures on fixed assets for environmental protection (Tables 3, 4). The significance of the relationship was assessed using Fisher's test with a confidence interval of 95%.

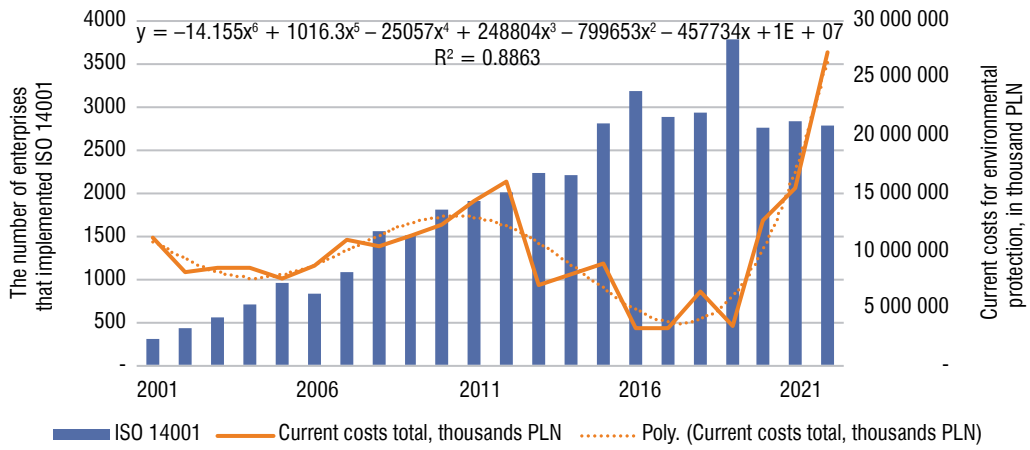
Table 4. The results of the correlation-regression analysis of the relationship between the number of enterprises implemented ISO 14001 and outlays on fixed assets for environmental protection

Regression Statistics	
Multiple R	0.679127967
R Square	0.461214795
Adjusted R Square	0.435558357
Standard Error	2396591.887
Observations	23

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.0325E+14	1.03251E+14	17.97657139	0.000366127
Residual	21	1.2062E+14	5.74365E+12		
Total	22	2.2387E+14			

Source: own elaboration based on GUS, 2019–2023; International Organization for Standardization, 2023a, 2023b; GUS, 2023b.

Figure 3. The dynamics of current costs of enterprises for environmental protection and the number of enterprises implementing ISO 14001 in 2001–2022



Source: own elaboration based on GUS, 2019–2023; International Organization for Standardization, 2023a, 2023b; GUS, 2023b.

Similarly to the previous one, it was of interest to investigate the correlation of the dynamics of changes in current costs for environmental protection and the prevalence of the ISO 14001 standard (the number of enterprises that implemented ISO 14001) (Figure 3).

The single factor analysis of variance showed no correlation ($R^2 = 0.001$) between the level of current environmental protection costs and the number of companies that use ISO 14001 (Table 5), and the correlation regression analysis proved the absence of such a relationship within the 95% confidence interval (Significance F=0.8852 > a = 0.05) (Table 6).

Table 5. The results of the single factor analysis of variance of the relationship between the number of enterprises implementing ISO 14001 and current costs for environmental protection

SUMMARY						
Groups		*Count*	*Sum*	*Average*	*Variance*	
ISO 14001		22	41969	1907.681818	1022889.85	
Current costs total		22	222476808.5	10112582.21	2.7308E+13	
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.1245E+15	1	1.12448E+15	82.3546192	1.8735E-11	4.07265376
Within Groups	5.7347E+14	42	1.36542E+13			
Total	1.698E+15	43				

Source: own elaboration based on GUS, 2019–2023; International Organization for Standardization, 2023a, 2023b; GUS, 2023b.

Table 6. The results of the correlation-regression analysis of the relationship between the number of enterprises implementing ISO 14001 and current costs for environmental protection

Regression Statistics	
Multiple R	0.03267888
R Square	0.00106791
Adjusted R Square	–0.0488787
Standard Error	5351926.16
Observations	22

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	6.12419E+11	6.12419E+11	0.02138102	0.88520955
Residual	20	5.72862E+14	2.86431E+13		
Total	21	5.73475E+14			

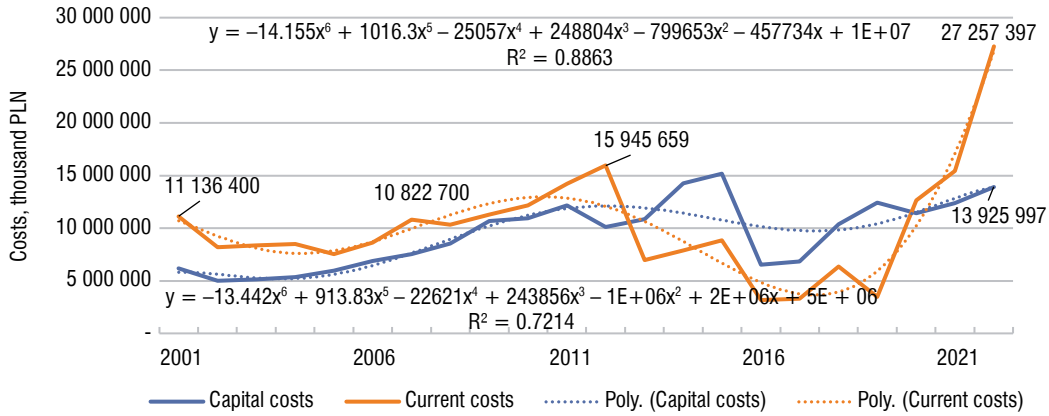
Source: own elaboration based on GUS, 2019–2023; International Organization for Standardization, 2023a, 2023b; GUS, 2023b.

A relatively small value of R^2 when constructing a trend line for the indicators 'Outlays on fixed assets for environmental protection' and 'Current costs for environmental protection' (approximation by a polynomial line of the sixth order) may indicate that the variation of these values over time occurred under the significant influence of non-systemic or random factors.

It is also of interest to investigate the correlation between capital and current costs for environmental protection (Figure 4). The general nature of the trend of both indicators during the studied period of 2001–2022 is similar.

The single factor analysis of variance does not show a statistically significant relationship between these parameters ($F = 0.232 < F_{crit} = 4.073$) (Table 7). The correlation-regression analysis also proved the absence of such a relationship (Significance $F = 0.0669 > a = 0.05$) (Table 8).

Figure 4. The dynamics of capital and current costs for environmental protection in 2001–2022



Source: own elaboration based on GUS, 2019–2023; GUS, 2023b.

Table 7. The results of the single factor analysis of variance of the relationship between the outlays on the fixed assets and current costs for environmental protection

SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Outlays on the fixed assets	22	208624378.1	9482926.277	1.0274E+13		
Current costs	22	222476808.5	10112582.21	2.7308E+13		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4.3611E+12	1	4.36113E+12	0.23208442	0.63248341	4.07265376
Within Groups	7.8923E+14	42	1.87911E+13			
Total	7.9359E+14	43				

Source: own elaboration based on GUS, 2019–2023; GUS, 2023b.

Table 8. The results of the correlation-regression analysis of the relationship between the outlays on the fixed assets and current costs for environmental protection

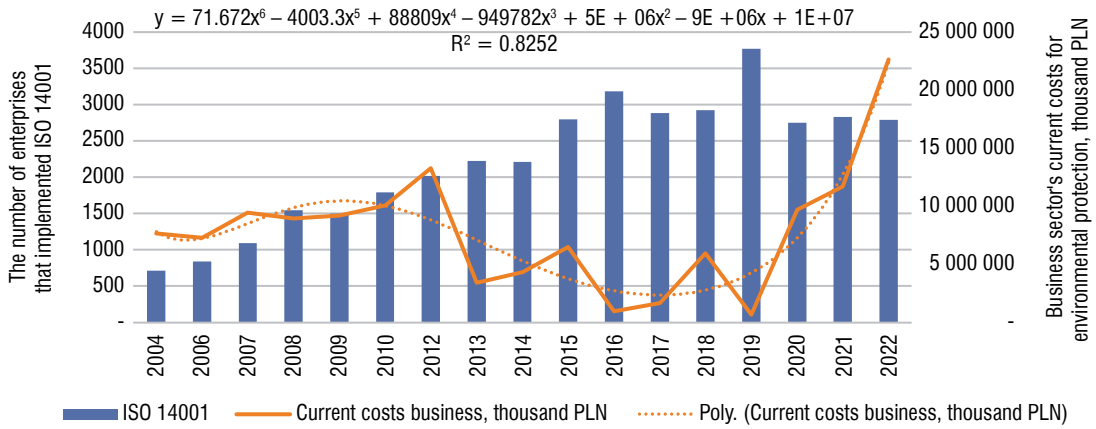
SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.39762813
R Square	0.15810813
Adjusted R Square	0.11601354
Standard Error	4913266.11
Observations	22

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	9.0671E+13	9.0671E+13	3.75601998	0.06686481
Residual	20	4.82804E+14	2.41402E+13		
Total	21	5.73475E+14			

Source: own elaboration based on GUS, 2019–2023; GUS, 2023b.

A different situation is observed if we consider only current expenses for environmental protection of the business sector (Figure 5).

Figure 5. The dynamics of business sector's current costs for environmental protection and the number of enterprises implementing ISO 14001 in 2004–2022



Source: own elaboration based on GUS, 2019–2023; International Organization for Standardization, 2023a, 2023b; GUS, 2023b.

In this case, it can be assumed that there is a relationship between the amount of current expenses for environmental protection of the business sector and the prevalence of ISO 14001. This relationship is evidenced by the results of the univariate variance analysis ($F = 37.053 > F_{crit} = 4.149$) (Table 9).

Table 9. The results of the single factor analysis of variance of the relationship between the number of enterprises implementing ISO 14001 and the business sector's current costs for environmental protection

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
ISO 14001	17	37838	2225.76471	764636.191
Current costs of business sector	17	133449210	7849953.53	2.8256E+13

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	5.2349E+14	1	5.2349E+14	37.0532858	8.4365E-07	4.14909745
Within Groups	4.521E+14	32	1.4128E+13			
Total	9.7558E+14	33				

Source: own elaboration based on GUS, 2019–2023; International Organization for Standardization, 2023a, 2023b; GUS, 2023b.

However, the revealed relationship (Table 9) should be considered as significant based on correlation-regression analysis within the 95% confidence interval (Significance $F = 0.384 > a = 0.05$). The coefficient of determination is low ($R^2 = 0.05$) (Table 10).

Table 10. The results of the correlation-regression analysis of the relationship between the number of enterprises implementing ISO 14001 and the business sector's current costs for environmental protection

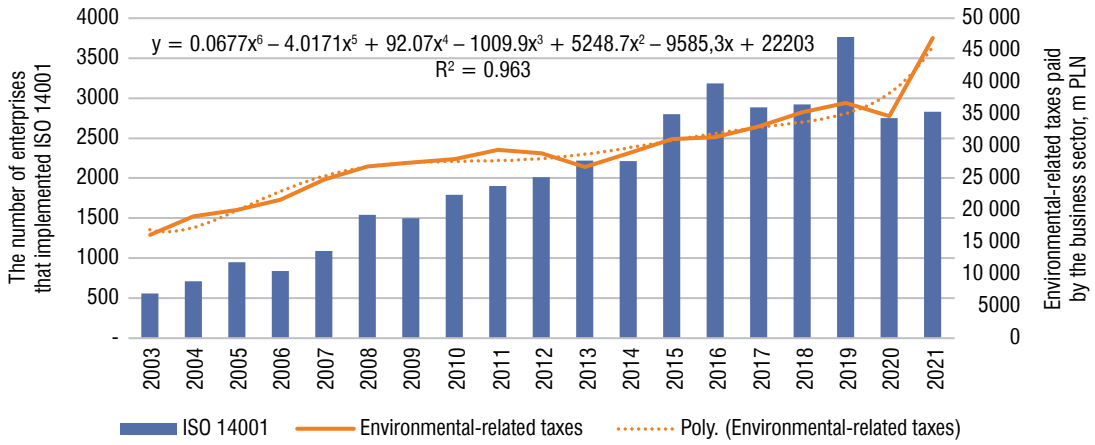
Regression Statistics	
Multiple R	0.22555127
R Square	0.05087338
Adjusted R Square	–0.0124017
Standard Error	5348493.36
Observations	17

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2.29996E+13	2.3E+13	0.80400298	0.38406444
Residual	15	4.29096E+14	2.8606E+13		
Total	16	4.52095E+14			

Source: own elaboration based on GUS, 2019–2023; International Organization for Standardization, 2023a, 2023b; GUS, 2023b.

Figure 6 shows the dynamics of environmental-related taxes and the number of enterprises that implemented ISO 14001.

Figure 6. The dynamics of the number of enterprises implementing ISO 14001 and environmental-related taxes paid by the business sector in 2003–2021



Source: own elaboration based on GUS, 2019–2023; International Organization for Standardization, 2023a, 2023b; GUS, 2023b.

There is a high level of correlation between these indicators: 0.85, the correlation is statistically significant ($F = 265.143 > F_{crit} = 4.113$) (Table 11).

A relatively high value of the determination index ($R^2 = 0.72$) is observed between these indicators, the statistical significance of the relationship is confirmed by Fisher's statistics (Significance $F = 0.0000039 < a = 0.05$) (Table 12).

Table 11. The results of the single factor analysis of variance of the relationship between the number of enterprises implementing ISO 14001 and environmental-related taxes paid by the business sector

SUMMARY						
Groups		*Count*	*Sum*	*Average*	*Variance*	
ISO 14001		19	38455	2023.94737	870927.83	
Environmental-related Taxes		19	547068.325	28793.0697	50479205.7	
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6807566173	1	6807566173	265.143076	3.4867E-18	4.11316528
Within Groups	924302404	36	25675066.8			
Total	7731868577	37				

Source: own elaboration based on GUS, 2019–2023; International Organization for Standardization, 2023a, 2023b; GUS, 2023b.

Table 12. The results of the correlation-regression analysis of the relationship between the number of enterprises implementing ISO 14001 and environmental-related taxes paid by the business sector

Regression Statistics	
Multiple R	0.85080209
R Square	0.72386419
Adjusted R Square	0.70762091
Standard Error	3841.75275
Observations	19

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	657721612	657721612	44.5639103	3.91E-06
Residual	17	250904091	14759064.2		
Total	18	908625703			

Source: own elaboration based on GUS, 2019–2023; International Organization for Standardization, 2023a, 2023b; GUS, 2023b.

Table 13. The results of statistics analysis of the relationship between the number of enterprises implementing ISO 14001 and the types of environmental-related taxes paid by the business sector in 2003–2021

Types of environmental-related taxes	F	F_{crit}	R	R^2	Significance F (a=0.05)	Conclusion
Energy taxes	203.22199	4.11316	0.85	0.72	0.0000039	Positive strong correlation, statistically significant relationship
Transport taxes	4.25737	4.11316	–0.23	0.05	0.35471	Insignificant negative correlation, no statistically significant relationship
Pollution taxes	2.32399	4.11316	0.27	0.07	0.26562	Insignificant positive correlation, no statistically significant relationship
Taxes on the use of natural resources (resource taxes)	78.69164	4.11316	–0.72	0.52	0.00046	Negative strong correlation, statistically significant relationship

Source: own elaboration based on GUS, 2019–2023; International Organization for Standardization, 2023a, 2023b; GUS, 2023b.

Regarding the connection of individual components of environmental-related taxes (transport, resource, pollution, and energy taxes) with the prevalence of ISO 14001, the summarised results of the single-factor analysis of variance and correlation-regression analysis within the 95% confidence interval are shown in Table 13.

Summary

The green economy is a trend for business in EU countries. Today, this trend has a theoretical framework, as well as a legal foundation. The most popular model of the environmental management system in Europe, particularly in Poland, is ISO 14001. In recent years, there has been a slight decrease in the number of certified ISO EMS. The large gap between the number of certified ISO QMS and ISO EMS has led us to doubt that companies that have implemented ISO 9001 are choosing ISO 14001 as a model for building an EMS.

Correlation analysis of the prevalence of ISO 9001 and ISO 14001 in Polish enterprises showed the existence of a connection between them. That is, the implementation of ISO 9001 is a prerequisite for the implementation of ISO 14001. In other words, the enterprises that choose the ISO model to build a quality management system tend to choose the ISO model to form an EMS. However, the analysis results indicate that this is not the only factor influencing such a decision: there are other important factors influencing the company's decision to implement ISO 14001.

The weakness of the connection between the dynamics of ISO 9001 and ISO 14001 application in Polish enterprises has led us to consider whether the ISO 14001 model provides a relationship with the economic aspect of the green economy development by the enterprises. The implementation of environmental goals by enterprises is accompanied by certain economic processes and results. We hypothesized that an increase in the number of ISO EMS should stimulate investment in fixed assets for environmental protection, increase the current costs of enterprises, and affect the amount of environmental taxes paid by an enterprise, such as energy, resources, and pollution taxes. We did not expect to find a clear relationship between the number of certified ISO EMS and the volume of transport taxes.

A weak but statistically significant correlation was found between the dynamics of the number of certified EMS implemented in enterprises according to ISO 14001 and the growth of capital expenditures for environmental protection. This indicates the presence of an impact of ISO 14001 on the volume of capital expenditures for environmental protection. However, the relatively small value of the coefficient of determination when constructing a trend line for indicators of 'outlays on fixed assets for environmental protection' when approximated by a 6^{th}-order polynomial may indicate that the variation in its values over time occurred under the significant influence of non-systematic or random factors.

The relationship between the dynamics of the number of certified EMS (ISO 14001) of enterprises and the growth in the volume of current costs for environmental protection was not found.

A strong positive correlation and statistically significant relationship was found between the number of EMS certified according to ISO 14001 and the energy taxes. This can be explained by the increase in energy demand as a result of the increase in the total number of fixed assets (e.g. equipment) for environmental protection under the influence of ISO EMS.

A strong negative correlation and a statistically significant relationship were found between the number of EMS certified according to ISO 14001 and resources taxes. That is, the implementation of ISO 14001 has a positive effect on reducing the use of natural resources.

No relationship was found between the number of certified EMS according to ISO 14001 and transport and pollution taxes. This may indicate, among other things, the incomplete use of the potential of ISO 14001 in the formation of EMS.

Thus, the analysis confirmed hypotheses 1, 2, 4, 5, and 7, but did not confirm hypotheses 3 and 6.

The results of the study prove the feasibility of implementing ISO 14001 in enterprises to improve the results of environmental management. They confirm that ISO 14001 is an EMS model capable of supporting the development of GE as a mechanism for ensuring sustainable development, achieving both environmental and economic objectives. Despite the relatively small number of certified ISO EMS in the country, they have an impact on fixed capital investment for environmental protection as well as resource tax reductions. However, it should be taken into account that the growing need for environmental protection technologies reinforces the trend of increasing energy consumption. This dualistic problem is the subject of joint actions of environmental and energy management.

The further direction of the research should be the analysis of the impact of the prevalence of ISO 14001 on the main economic aspects of environmental protection in GE conditions for certain types of economic activity of the business sector.

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