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ECO-INNOVATION IN THE IMPLEMENTATION OF ESG GOALS ON THE EXAMPLE OF POLISH LISTED COMPANIES

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ABSTRACT: The article addresses the issue of companies' implementation of eco-innovations, which are part of the ESG activities they undertake. The main objective of the research was to present and evaluate the relationship between eco-innovation and the ability to achieve ESG goals in small, medium and large listed companies. In addition, an attempt was made to determine the type of eco-innovations most often implemented by these companies. Research methods included critical literature studies, desk research, mixed-mode CAT/CAWI on a sample of 140 companies, and selected statistical tests. The primary result from the research was to demonstrate the link between eco-innovation and ESG goals. Seventy-four percent of the companies surveyed were found to have such a relationship. With regard to the types of eco-innovations, product, organisational and marketing eco-innovations were implemented in all large companies, while small and medium-sized companies were dominated by product and marketing eco-innovations. The least involvement was found in the area of process eco-innovation. The results obtained highlight the need to expand the research to OTC companies and provide insights into the current state of the market regarding the role of eco-innovation in shaping ESG policies and actions.

KEYWORDS: eco-innovations, ESG concept, Polish listed companies

Introduction

The quest for climate neutrality to avoid climate catastrophe means that the pressure on modern companies to reduce pollution and protect the environment is steadily increasing. For this reason, it becomes so important to recognise the determinants of sustainable business development and the operating ways and methods to meet the expectations in this regard. The former involves knowledge of the global concept of sustainability, as well as the related concept of ESG, which boils down to non-financial reporting of a company's activities in three areas, i.e. environmental, social and corporate, and to indicate future commitments in this regard. The latter, on the other hand, as requiring a longer perspective, are related to the search for innovative solutions based on technological advances, that is, preferably innovations or eco-innovations, which stimulate and significantly support development with respect for the environment.

In Poland, there is still insufficient involvement of businesses in the implementation of sustainable economic development activities, especially those related to the implementation of eco-innovation. This is best seen through the data of the Eco-innovation ranking (European Commission, 2023, 2022), which shows that Poland is still classified in the group of countries catching up in this area, despite gradually progressing positive developments. Meanwhile, eco-innovations are a kind of panacea for the environmental and economic ills of business entities, as they make it possible to pursue both economic and environmental goals simultaneously. Consequently, they are perfectly in line with the implementation of the assumptions and objectives of the ESG concept, which include, among other things: assessing the risks and opportunities of business entities' activities in relevant areas, assessing the impact and effectiveness of environmental protection activities implemented as part of the implemented development strategy, applying environmental policies, following the principles of sustainable development, implementing environmental management systems, or the company's overall care and responsibility for the natural environment.

As a result, a necessary solution seems to be the promotion and application of eco-innovations on a decidedly larger scale than before, especially since the area of their use in the transition to low- and zero-carbon technologies is very extensive, and they themselves fit into the goals of sustainable business development, coinciding with those of the ESG. The growing importance of eco-innovation as a solution leading to emission reductions is demonstrated, for example, by the expansion of emissions trading to include the construction and transportation industries (Dyrektywa, 2023). One example is also Goal 9 under the global Sustainable Development Goals (UNIC Warsaw, 2016), which refers to building resilient infrastructure, promoting sustainable industrialisation, and fostering innovation (EPRS, 2021). The results of a meta-analysis on ESG implementation published in 2020 showed that companies with robust sustainability standards have a reduced cost of capital, improved operating performance that improves cash flow, and high values for traditional financial ratios, as indicated by 90%, 88%, and 80% of sources surveyed, respectively (Hill, 2020). The cited data is another weighty argument for promoting eco-innovation as a factor significantly stimulating green transformation.

For an increasing number of companies, the introduction of ESG standards is becoming an inevitable obligation over time. Pursuant to the Corporate Sustainability Reporting Directive (CSRD), announced by the European Commission at the end of 2022, all large entities and small and medium-sized listed companies will have to provide information on environmental, social and corporate governance activities in their business report. This will be helpful in assessing their commitment to implementing green solutions and in determining whether their operations can be considered environmentally sustainable. The conditions for considering an activity as green are defined in the so-called Taxonomy (Regulation, 2020).

The first companies will be required to implement the requirements of the aforementioned directive as early as 2024 and submit relevant ESG reports starting in 2025 (Dyrektywa, 2022). They will include public interest entities, i.e., listed companies, banks, insurance companies and parent companies of large organisations, i.e., with more than 500 employees and meeting one of two conditions: a balance sheet total exceeding EUR 50m or net sales revenues exceeding EUR 25m (Pinkos, 2024). An additional consideration is also the need for integrated reporting, including both financial and non-financial information, which is extremely useful to investors, customers and employees who value companies that are responsible and committed to sustainability. ESG reports provide transpar-

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ency in the operations of such entities, affect their reputation and competitiveness, facilitate their access to capital and build trust among stakeholders (Wojtowicz, 2024).

In view of the above, the purpose of the article was to show the existence of a link between eco-innovation and the ability to achieve ESG goals in listed companies of different sizes, as well as to identify the type of eco-innovation most often implemented by these companies. In pursuit of the stated research objective, the authors supported themselves with empirical research to show whether companies, or rather their managers, understand the importance of the issues and recognise their interplay.

A short overview of the subject literature

In the literature, the issues of eco-innovation and ESG have been the subject of much research and academic discussion for a long time, which makes them quite well recognised and described, although they are still slow to "break through" in business practice. The fundamental driver here, however, is technological progress and innovative solutions that result in innovations and eco-innovations that not only revolutionise the economic activities of companies but also contribute to the protection of the natural environment, which is part of the economic ecosystem.

Eco-innovations are conceived as, among other things, new products, services, or processes that deliver tangible benefits to consumers and other economic actors while minimising harmful environmental impacts (Fussler & James, 1996). They are also treated as solutions that reduce the use of material resources while increasing the quality of products or services (Carley & Spapens, 1998), or are characterised by the ability to generate "green" profits (Andersen, 2008). A more practical approach to eco-innovation is proposed by the European Commission and the Organisation for Economic Co-operation and Development. In both cases, it is not difficult to see a rather broad view of eco-innovation, according to which, in principle, "every environmentally improved product or service should be regarded as an eco-innovation, not only new or better environmental technologies" (European Commission, 2011; OECD, 2009). At the same time, in the case of the EU, the definition of eco-innovation also has an impact on the interpretation of legislation and the assessment of whether a given enterprise meets the environmental requirements placed on it and, therefore, whether it can count on assistance under the numerous programmes supporting the development of eco-innovation and environmental protection measures (Wysocki & Michalak, 2023).

Table 1. Selected definitions of eco-innovation from English and Polish literature.

Authors:	Eco-innovation defined
C. Fussler, P. James	Eco-innovation refers to the development of new products, processes or services that provide both customers and businesses with appropriate value while significantly reducing negative environmental impacts.
M. Carley, P. Spapens	Eco-innovation is a deliberate course of action constituting a manifestation of entrepreneurship yet accounting for ecological issues when developing certain products and processes related to their life cycle, as well as contributes to the reduction of material resources while increasing the quality of these products or services.
M. M. Andersen	Eco-innovation is an innovation which exercises positive impact on the environment whose implementation may generate "green" profits.
J. Przychodzeń	Eco-innovation is a particular type of innovation that involves new technologies, products and services, management, supply, distribution and promotion which generate profit and improve competitiveness while taking into account the socioeconomic calculus (i.e., the economic calculus extended by the natural and social dimensions), where the beneficiaries of eco-innovation implementation are businesses, people and the environment.
European Commission	Eco-innovation is a combination of two key objectives that condition the simultaneous improvement of the economic situation and the environmental situation, allowing the company and the environment to benefit /according to the ECODRIVE Project (Sixth Programme of the European Community)/.
OECD	Eco-innovation is an innovation that is distinguished from others by the fact that it leads to a reduction in negative environmental impacts, whether intended or unintended, and its scope may extend beyond the conventional organisational boundaries of the entity introducing the innovation in question.

Source: authors' work based on the literature (Fussler & James, 1996; Carley & Spapens, 1998; Andersen, 2008; Przychodzeń, 2015; OECD, 2009; ECODRIVE Report to the EC, 2008).

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In addition to the aforementioned authors and institutions, the definition of eco-innovation was also addressed by: K. Rennings, T. Zwick, M. Charter, T. Clark, B. Ziółkowski, A. Leszczyńska, J. Łunarski or J. Przychodzeń (Wysocki, 2016). An overview of selected definitions of eco-innovation found in the literature is presented in Table 1.

Despite the definitional differences indicated, the essence of the issue of eco-innovation remains the same and oscillates around the implementation of economic activities of an innovative nature that do not have a negative impact on the environment, or strongly reduce this impact. The second feature common to all definitions is the aspect of environmental protection and the ecological benefits that accrue to all beneficiaries of such activities, not just the companies implementing them. The division of eco-innovations, on the other hand, does not raise significant doubts, referring to the division of innovations, which distinguishes three basic generic criteria, namely: subject matter, implementation mechanism and environmental impact (OECD, 2009). According to the first criterion, we distinguish product, process, organisational, and marketing innovations. The second criterion divides eco-innovations into: modifying, improving and redesigning products, services or production processes, and seeking new solutions. And the third criterion distinguishes eco-innovation at the micro, meso and macro scales.

In the current economic situation of Poland, as well as the world, eco-innovation is and will be undertaken by companies primarily with a view to engaging in environmental protection, specifically, enabling them to build an image of an ecological entity and thus be more competitive, as they build a competitive advantage on this very aspect (Wysocki, 2021). In addition, the scope of application of eco-innovation is quite broad and is not related to only one area of economic activity. In the case of businesses, it can include: alternative types of energy, more efficient use of natural resources, energy conservation, decarbonization, environmental remediation, electric transportation, recycling, design of new production processes, production of new products, creation of new business models, alternative use of existing products and materials, promotion of friendly construction and agriculture or eco-tourism (Sarkar, 2012; Bartoszczuk, 2016; Koźlak & Pawłowska, 2017; Rutkowska & Pakulska, 2018; Wysocki & Dec, 2023).

The incentive for eco-innovation is also that it allows companies to implement sustainable solutions that simultaneously materialise economic (e.g., reducing production, logistics or customer service costs) and environmental (e.g., offering environmentally safe products and services, using renewable energy, reducing pollutant emissions) goals (Wysocki, 2021). As a result, eco-innovation becomes not only convergent with the principles of sustainable development, but forms a core component that popularises this sustainability and results in the realisation of its goals (Diaz-Garcia et al., 2015).

In terms of the implementation of eco-innovation, it is impossible to ignore the role of the European Union, which has long sought to stimulate economic activity based on sustainable development principles. An example of this is the action plan focused on supporting the implementation of eco-innovation in companies, which is one of the elements of the EU's Europe 2020 initiative, i.e. the strategy for smart and sustainable economic growth (European Commission, 2010, 2011). Within the framework of this plan, measures to stimulate the creation of demand for eco-innovation, including in the implementation of the joint environmental policy, were recognised (European Commission, 2010):

- using environmental policy and legislation to promote eco-innovation,
- supporting demonstration projects and partnering to bring promising, smart and ambitious operational technologies to market,
- developing new standards to boost eco-innovation,
- mobilising financial instruments and support services for SMEs,
- promoting international co-operation,
- supporting the development of emerging skills and jobs and related training programmes to match labour market needs,
- promoting eco-innovation through European Innovation Partnerships.

Thus, it is not difficult to note that the role of eco-innovation will steadily increase, and the modern approach to managing an enterprise in the context of its development must necessarily take into account the principles of sustainable development and environmental protection. Such an approach becomes a *sine qua non* requirement of business operations and corresponds perfectly with the "ESG idea," where the environmental aspect is also extremely important.

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ESG is an acronym for three English words – Environment, Social, Governance. The ESG concept lays out principles for assessing a company's performance in the interrelated three areas of environmental, social and managerial performance, with the implementation of the tasks of adopting ESG standards requiring a great deal of courage and perseverance from companies and their managers.

The materials of the Polish Agency for Enterprise Development contain the following information: "ESG is environmental, economic and social sustainability. (...) ESG (...) is otherwise a multifaceted approach that takes into account simultaneous actions for the environment, economy and society. It addresses the company's internal policies, processes and practices. It includes environmental issues, human resource management, corporate governance and business ethics." (PARP, 2024). The Polish Development Fund, in turn, accepts that "ESG is an acronym for a range of non-financial factors that will help companies report on their activities unrelated to purely economic development indicators. These are the following indicators – Environmental, Social and Corporate Governance." (PFR, 2022).

The term ESG has been in official and widespread use since 2004, when it was used in a report by Global Contact, a United Nations green transformation advocacy entity (UNGC, 2004). Since then, it has not only been inextricably associated with the concept of sustainable development, but, in broad practice, the two terms are used interchangeably, as is evident, for example, in the ESG definitions (not without a reason). The two terms, though similar, can hardly be considered the same. The academic nature of this study makes the differences that exist between them worth noting, especially since this is not the subject of too many studies. In addition, such a comparison makes sense as a method of verifying the validity of the said practice.

In comparing the two categories, first of all, it should be noted that the concept of sustainability has a longer history than the idea of ESG. According to some sources, the roots of the concept of sustainability date back to the time of Aristotle and Hippocrates, and its foundations can be traced back to the doctrine of classical economics, such as the theory of diminishing returns in agriculture (Siekierski & Rutkowska, 2008). In today's era, the problem of limits to growth was significantly signalled in the global forum in the first so-called Club of Rome report of 1972, in the context of, among other things, the Earth's increasing population and dwindling natural resources. The document called for the rejection of the theory of unlimited economic growth as causing permanently progressive environmental degradation (Meadows et al., 1972). In a second report published two years later, the concept of sustainable development was proposed as an alternative to the existing path of economic growth (Mesarović & Pestel, 1977). The UN not only initiated the use of the concept of sustainable development internationally, but also contributed to its dissemination (Bołtromiuk, 2003). The term "sustainable development" itself was used as early as the 19th century and, according to some sources, even in the 18th century (Płachciak, 2011), primarily in forestry, to describe such forest management that, thanks to its "restoration," it would never cease to exist (Siekierski & Rutkowska, 2008). In a sense significantly similar to that currently accepted, the term sustainable development appeared in the early 1970s, in documents published under the UN's control as: "such a course of inevitable and desirable economic development that does not significantly and irreversibly violate the human living environment, does not lead to degradation of the biosphere and reconciles the laws of nature, economics and culture" (Poskrobko, 1998; Siekierski & Rutkowska, 2008).

The next stage in the evolution of the idea of sustainable development began with the publication of the so-called Brundtland Report in 1987, in which sustainable development was defined as follows: "at the current level of civilization, sustainable development is possible, that is, development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs." (United Nations, 1987). And while the document has become known primarily for the definition it formulates, it also addresses a long list of perceived problems identified as an obstacle to maintaining the level of prosperity achieved. In turn, the concept of sustainable development, combining further economic growth with environmental protection, has been identified as a way to overcome the existing barriers (Borowy, 2013). The prominence of the concept of development, balancing ecological, social and managerial aspects and the inevitability of its implementation on a global scale were sealed by the provisions of the 1992 Rio de Janeiro Earth Summit.

The latest "era" of sustainable development began in 2015 with the UN General Assembly's adoption of the 2030 Agenda for Sustainable Development (United Nations, 2015). This agenda presents 17 Sustainable Development Goals and 169 specific tasks to support the achievement of these goals.

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In this situation, meeting the requirements of sustainable economic development has become mandatory for all societies, communities and entities involved in its implementation. Running a sustainable business in particular implies certain responsibilities for companies, being a real challenge for many of them, primarily in financial and technical terms.

The focus of corporate activities on achieving sustainable development has increased the business world's interest in the ESG concept, which has proven to be not only a way of managing an organisation that effectively promotes sustainable development, but also a tool to help evaluate, according to certain criteria, the behaviour of companies and their performance (Kahn, 2022).

For nearly a decade, ESG has attracted growing interest and assumed increasing importance for one reason – it is a way of managing a company to enable its sustainability. At this point, it is worth pointing out further elements that distinguish the categories being compared. In this comparison, the concept of sustainable development appears as an evolutionarily evolved long-term global strategy to lead our Planet out of the environmental crisis and create the conditions for economic activity in the near and distant future. ESG, on the other hand, is a tool for implementing this strategy, a set of criteria for evaluating the activities carried out, which determines its secondary nature – without timely efforts aimed at saving nature and the concept of sustainable development that grew out of it, ESG would not exist. Finally, the difference in scale of the two categories – sustainability not only has older roots, but is also a significantly broader, "roomier" concept than ESG in its instrumental essence. And one more point of importance in the conducted comparison – noting the above, one should not underestimate the role that the idea of ESG has played in popularising social issues to which little importance was attached in earlier periods of promoting the concept of sustainable development. Meanwhile, in the era of striving to equalise differences in the standard of living of people around the world, they are as important as caring for the natural environment. The demonstrated differences between the concepts of sustainability and ESG are sufficient to make the use of the two terms interchangeably a significant simplification.

The environmental origin of the concept of sustainable development, and necessarily ESG, is an excellent argument for the application of eco-innovation on the largest possible scale, not only in companies, but also in business activities carried out by public administration. Companies adopting green sustainability solutions through ESG reporting (Regulation, 2020; Dyrektywa, 2022) receive financial support. This gives companies a kind of advantage over investments by the public sector, which is also committed to supporting the green transition. Meanwhile, the resources and technologies needed to carry out environmentally friendly public tasks can be lent by private sector entities through sustainable public-private partnerships, i.e. aimed at supporting sustainable development through the use of ESG. The use of such partnerships for pro-environmental development of the public sector is in line with the implementation of Agenda 2030. It is all the more so that the public sector is one of the addressees of Sustainable Development Goal 17, which is to revitalise global partnerships for sustainable development (United Nations, 2015).

Research methods

In pursuit of the research objective, the authors supported themselves with empirical research to show the existence of links between eco-innovation and the ESG concept in listed companies. The subject of the study, therefore, included companies listed on the Warsaw Stock Exchange. In particular, it was decided to find answers to questions regarding the existence of a relationship between eco-innovation and ESG goals, as well as the dominant type of implemented eco-innovation within this relationship.

The survey was conducted using a mixed-mode CAT/CAWI electronic questionnaire in 2023. The questionnaire was addressed to randomly selected representatives of companies listed on the Warsaw Stock Exchange, assuming that they have relevant competence and knowledge of such issues as ESG and/or sustainability, for example. The choice of listed companies was not accidental, as these companies are a special and avant-garde group of entities due to their importance for the smooth functioning and development of the market economy, which is confirmed, among other things, by statistical economic and financial data. Only the best companies are listed on the stock exchange; they must be convincing and transparent in their actions in order to gain additional opportunities to raise

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capital from the sale of shares for further development. In addition, it is this group of entities that will be the first to report mandatorily on the achievement of ESG goals in accordance with the CRSD's findings and guidelines.

The research population consisted of a total of 140 large, medium and small listed companies. Out of the entire research population, 100(N) companies responded. They were represented by listed companies of different sizes from different industries. These companies formed the strata of small, medium-sized and large enterprises, i.e. with 10 to 49 employees, 50 to 249 employees and more than 249 employees, respectively, according to the Statistics Poland's nomenclature. The distribution of companies for each stratum in the study group of listed companies by size was as shown in Table 2.

Table 2. Distribution of the survey sample for each group of companies.

Size of listed company by employment	Research population	Sample (N)	Percentage in the sample (%)
Small businesses	-	-	64%
Medium-sized enterprises	-	-	21%
Large enterprises	-	-	15%
Total companies	140	100	100%

In this survey, listed companies were represented by directors (27%), management board members (18%) or managers (55%). At the same time, the survey made the assumption of a random sample, which allowed a maximum statistical estimation error of +/-5% with a confidence level of 95%.

The statistical analysis used included the Chi-square test for independence of variables and the Chi-square test-based coefficients: Phi and Cramer's V. The Chi-square test was used to assess the relationships between the qualitative variables, and the aforementioned coefficients were used to determine the strength and direction of the relationship between the variables. The statistical analysis was carried out using the IBM SPSS 29.0 package with the Exact Tests module. All relationships, correlations and differences were considered statistically significant when $p \leq 0.05$.

Results of the research

When analysing the results obtained, the authors took into account the different sizes of each of the three subgroups of subjects surveyed, which has an impact on the interpretation of the survey results. The majority of the companies examined were small, with over four times as many as large companies and more than three times as many as medium-sized ones. For this reason, the authors sought to draw conclusions not only in general terms in relation to the companies studied, but also taking into account their size by number of employees.

With regard to the question on the existence of a link between eco-innovation and ESG objectives in listed companies of different sizes, it should be noted that up to 74% of the surveyed representatives of the listed companies surveyed confirmed the existence of such a link. These included 100% of large companies, 71.43% of medium-sized companies and 68.75% of small companies. And this is quite an important piece of information, as it shows not only the knowledge, but also the understanding of both of these issues by business managers, which bodes positively for the dissemination and acceptance of sustainable development principles in business and gives room for the application of eco-innovations, which are specific carriers of this development, on a larger scale. The remaining 26% of subjects in the entire sample do not perceive such a link between eco-innovation and ESG objectives or have no knowledge of it. It is therefore important to conduct a detailed analysis of the structure of this group of companies in terms of their size and to identify which of the three studied groups predominates, as this will enrich the interpretation of the results. As a result of this approach, we found that among the listed companies surveyed that did not see a link between eco-innovation and ESG or had no knowledge on the subject, there were only small and medium-sized companies, by a ratio of 77% to 23%; large companies, quite understandably, were not included in this group. At the same time, the small and medium-sized listed companies that did not see the mentioned connection

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represented 31.25% of all small companies surveyed and 28.57% of all medium-sized listed companies surveyed, respectively. The lack of perception of such a link in relation to small and medium-sized entities was most likely due to the lack of knowledge of these issues, as indicated by one of the responses, as well as the failure to include eco-innovations and ESG goals in the management processes of these entities and their development plans.

The results presented also show another important relationship – the larger the listed company, the more pronounced the link between eco-innovation and ESG goals, whereas in smaller companies, the link is perceived as less important, and is necessarily less visible. In addition, they show significant differences in the level of awareness of the issues discussed for listed companies of different sizes. And although awareness of both of these issues compares rather unfavourably with that of small and medium-sized companies compared to large companies, the affirmative responses of more than two-thirds of these companies may inspire some optimism for the future.

The percentage distribution of the responses provided by the respondents of the listed companies surveyed regarding the existence or absence of a link between eco-innovation and ESG objectives, taking into account the different sizes of listed companies, is presented in Figure 1.

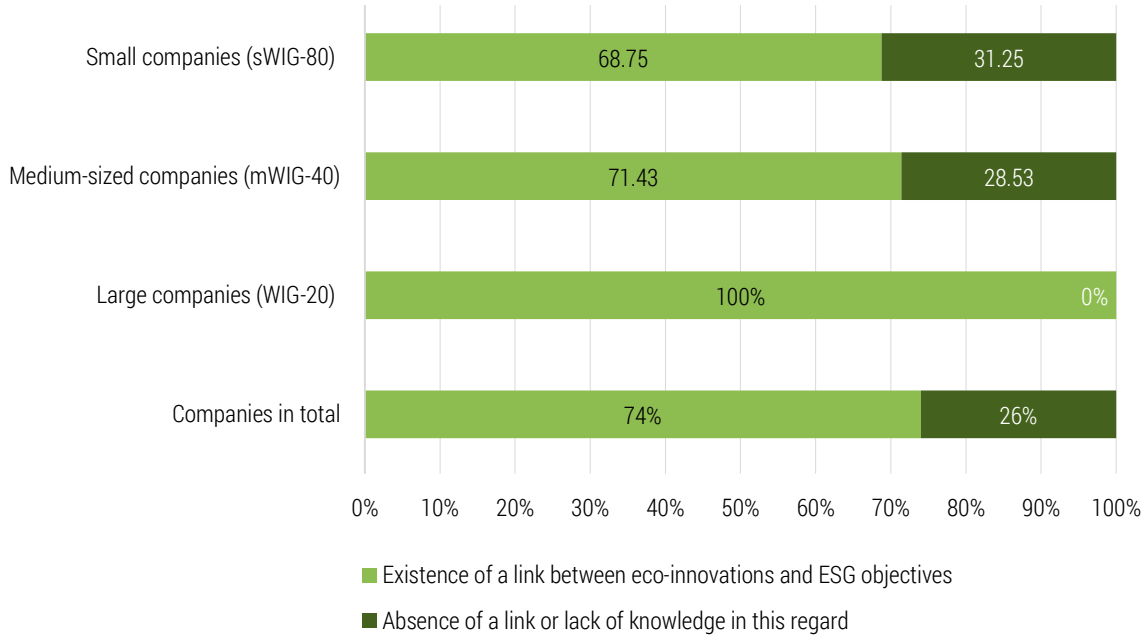

Figure 1. Percentage distribution of the responses given by the surveyed respondents on the topic of the existence or absence of a link between eco-innovation and ESG objectives across subgroups of listed companies

In turn, the statistical analysis calculated a Cramer's V coefficient of (0.315), indicating a moderate correlation between the analysed variables. As such, it suggests that there is some relationship between eco-innovation and ESG goals, albeit not a very strong one. The results of the Chi-square test also confirm the existence of a relationship between the variables. At the same time, the calculated "p" value using both the exact method ($p = 0.011$) and the Monte Carlo method ($p = 0.009$) confirms the statistical significance of the results obtained, which is important in view of the validity of the conclusions formulated.

The results of the statistical analysis of the responses to the ongoing survey are presented in Table 2.

DOI: 10.34659/eis.2026.96.1.955

Table 2. Results of the statistical analysis of responses obtained from the listed company respondents.

	Values obtained by statistical analysis
Cramer's V coefficient	0.315
Chi-square test of independence	19.857 (df=8)
p-value exact method (statistical significance)	0.011
Monte Carlo p-value	0.009

In terms of identifying the type of eco-innovation that was most frequently implemented by the listed companies surveyed, it turned out that the leading responses were product eco-innovation (77% of indications) and marketing eco-innovation (76% of indications). Only in the last place did respondents mention process eco-innovation (44% of indications), and in penultimate place, organisational eco-innovation (49% of indications). The situation was slightly different for the various subgroups of companies surveyed. Namely, large listed companies were implementing all types of eco-innovation, and only 13% of them did not indicate the implementation of process eco-innovation. This demonstrates the understanding of the rationale for using eco-innovation and the environmental maturity of those entities that, despite the high costs of implementation, recognise the benefits of approaching environmental protection and financially engaging in such solutions.

In the case of medium-sized companies, the situation was already a little worse. And while only 14% of the surveyed entities did not indicate the implementation of product or marketing eco-innovations, organisational eco-innovations were not used by 43% of these companies, while process eco-innovations, i.e. those most desirable from a sustainability perspective, were not used by more than 57%. Even more worrying results were revealed in small listed companies, of which product eco-innovation was not pursued by 31% of the entities, marketing eco-innovation by 33%, and organisational and particularly important process eco-innovation by as many as 66% of these entities. This means that small and medium-sized companies significantly underestimated the level of process eco-innovation realisation within the entire surveyed group, and their percentage was lower than the percentage of all surveyed companies implementing process eco-innovation.

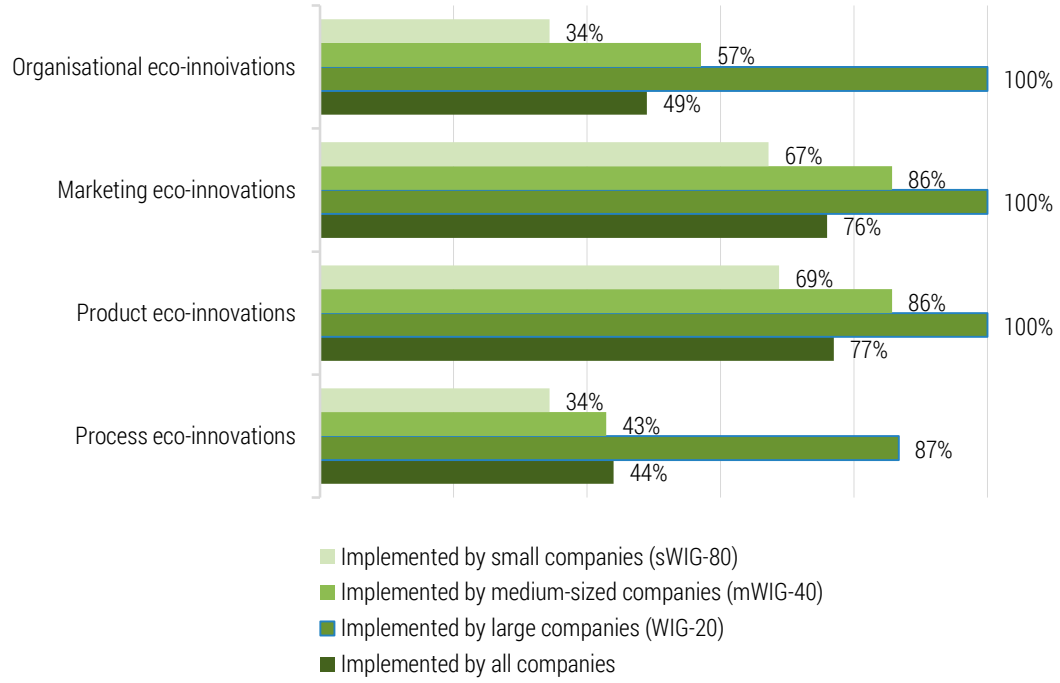

Figure 2. Percentage distribution of the responses given by the surveyed respondents from the subgroups of listed companies on the topic of the implementation of different types of eco-innovation

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In summary, product, organisational and marketing eco-innovations were implemented in all large companies, while the relatively highest proportion of small and medium-sized companies used product and marketing eco-innovations. At the same time, all three subgroups of entities declared relatively little involvement in process eco-innovations, yet it is these, along with product eco-innovations, that bring the greatest environmental effects, although they are in fact associated with the highest implementation costs. The percentage distribution of responses given by survey respondents of listed companies of different sizes with regard to the eco-innovations implemented is presented in Figure 2.

On the other hand, within the framework of the statistical analysis of the variables covering product eco-innovation, process eco-innovation, organisational eco-innovation and marketing eco-innovation, it should be emphasised that the Cramer's V coefficients obtained in the range (0.280 – 0.465) indicate a moderate correlation between the variables under study. Chi-square independence tests and the calculated "p" value using both the exact and Monte Carlo methods confirm the statistical significance of the results. On this basis, it can also be concluded that the differences between the groups are statistically significant.

The results of the statistical analysis of the responses to the ongoing survey are presented in Table 3.

Table 3. Results of the statistical analysis of the responses obtained from listed company respondents in relation to the types of eco-innovation implemented.

	Values obtained by statistical analysis			
	product eco-innovation	process eco-innovation	organisational eco-innovation	marketing eco-innovation
Cramer's V coefficient	0.280	0.367	0.465	0.292
Chi-square test of independence	7.841 (df=2)	13.500 (df=2)	21.647 (df=2)	8.548 (df=2)
p-value (statistical significance)	0.020	0.001	0.001	0.014
Monte Carlo p-value	0.018	0.001	0.001	0.014

Summarising the results obtained, one can be tempted to make a general statement that the observed variation in responses to the questions asked indicates a greater "eco-innovation maturity" and a better understanding of ESG objectives on the part of representatives of large listed companies compared to other entities.

Discussion

The implementation of the Agenda 2030 commitments is an undertaking of unprecedented scale and scope, which in itself is a sufficient reason to mobilise all possible resources. The enormity and diversity of the tasks to be performed in pursuit of the goals formulated in Agenda 2030, in turn, require systematic, multi-criteria monitoring of the activities carried out and evaluation of their effects according to ESG criteria.

One of the key aspects of green transformation is eco-innovation, which is the focus of this article. As has been shown, eco-innovation, as a kind of vehicle for sustainable development, has a considerable role in the implementation of ESG strategies. Indeed, in reducing the environmental impacts of global development, it is difficult to overestimate their importance as solutions with greater environmental performance than their traditional alternatives (Bocken et al., 2014). It is for this reason that eco-innovation is worthy of attention as a subject of scientific research. It should also be emphasised that the environmental potential of eco-innovation was recognised by academics even before Agenda 2030 was published.

In presenting the results of their study, the authors set out to fill, at least in part, the scientific gap in the field in question, while at the same time contributing to the current growing academic interest in ESG issues. It is worth noting at this point that the number of academic studies referring to ESG issues started to increase with the publication of the directive introducing mandatory non-financial reporting for business entities (Kahn, 2022).

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Eco-innovation as an object of research work deserves attention primarily on two levels. Firstly, because of their nature recognised by the scientific world a considerable time ago, which shows them to be a tool that significantly and actively supports the implementation of environmental solutions (Bocken et al., 2014; Reid & Miedzinski, 2008). Secondly, because of the cost of their implementation, which poses quite a challenge for the companies undertaking them. On the first point, the relationship is straightforward – the more eco-innovation is undertaken, the more complete and rapid the implementation of Agenda 2030 should turn out to be. As far as costs are concerned, in the face of permanently limited access to financial resources, in the vast majority of cases an entrepreneur considering eco-innovation must take into account the fact that such an investment will deprive him or her of the opportunity to undertake other tasks with a higher rate of return (including those within the scope of the core business), i.e. those allowing greater benefits, especially in the short term. In the short-term assessment, the profitability of eco-innovation, from the point of view of the company's benefits, especially in financial terms, therefore loses out to alternative resource allocation options. In the face of the above, entrepreneurs who, acting according to the logic of the market, seek to maximise their profits, can be helped in making a pro-environmental decision by an appropriate government attitude. Firstly, by being proactive in raising awareness of the benefits possible from eco-innovation, especially in the long term. And not just because of the increased competitiveness, but also, and perhaps even more importantly, because of access to finance. After all, the effects of the taxonomy's requirements on the flow and allocation of capital will compound over time, secondly, by launching government financial support programmes for those interested in implementing eco-innovation.

Assessing the benefits of companies committed to sustainability and ESG goals is not straightforward. Individual studies give conflicting results as to the situation of these entities. In contrast, the metadata shows that around 80% of entities with high ESG activity rank highly according to traditional financial metrics. In addition, around 90 per cent show a reduction in the cost of capital and an increase in operational efficiency, resulting in improvements in cash flow (Hill, 2020). It is worth noting that the size of the research sample used by Hill to reach the conclusions outlined above (200) was similar to the sample size surveyed by the authors of this article (100). Naturally, this doesn't mean there's a single, specific cause for this relationship, but rather a complex interaction in which increasing financial performance can provide resources for achieving ESG goals. These, in turn, can generate future financial benefits through reputational enhancement or risk mitigation. Therefore, we're dealing with a reciprocal relationship, implying that profitable companies can afford to invest more in pursuing ESG goals, and these investments lead to better future financial performance.

Continued research on ESG, deepened in terms of eco-innovation, will establish what proportion of those introducing eco-innovation are reaping the pertinent benefits from this alone. In addition, although in light of the results of the survey presented here, the vast majority of entrepreneurs (74%) perceive a link to eco-innovation, this is not enough information to conclusively resolve the following questions. Namely, is innovation as a vehicle for sustainable development also a driver for ESG activities, or is eco-innovation a consequence of ESG implementation, or is eco-innovation pursued independently? The results obtained are so diverse that any attempt to systematise them would be accompanied by too much distortion of the picture thus obtained. As an important reason for the signalled ambiguity of the results, and therefore the impossibility of generalising them, despite the generally similar conditions for the implementation of eco-innovation, the authors of the study recognise the significant diversity in the specific characteristics of entities applying green solutions. A particular difficulty was perceived in the differences between the operational and management spheres of companies and the divergence of decision-making processes in eco-innovation. The observation presented is in line with the authors of other studies dedicated to innovation (Passaro et al., 2022).

On the other hand, a study by Albitar et al. (2024), which included data from 6093 companies from G7 countries that looked at the impact of eco-innovation on waste management and determined the role of ESG measures implemented in this regard in the surveyed entities, showed that higher levels of eco-innovation can lead to a decrease in the total amount of waste generated by companies and an increase in the scale of reuse and recycling. The cited authors have also shown that implemented eco-innovations, coupled with the fine-tuning of ESG measures in companies, lead not only to a reduction in waste generation but also to better waste management in such entities. Indeed, for a company, reducing the volume of waste and optimising the processes involved in handling it can

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translate into both a reduction in financial costs in this category and a reduction in the burden on the staff responsible for this area.

The need to continue and deepen similar research in order to obtain a more complete, reliable picture of the importance of eco-innovation in the ESG area than has been the case to date is virtually indisputable. In the authors' view, further studies should take more account of strategies and long-term plans in companies, rather than just the current operational benefits, often shown for the sake of equity investors. Without hard figures, the doubts and questions that arise in the public space about the validity and effectiveness of ESG measures will only increase. This is due to the fact that variables in this area are often non-numerical, categorical, or qualitative in nature, which can impact the conclusions drawn from conventional causal analysis techniques and therefore require qualitative comparative analyses.

Conclusions

The authors' stated aim of the article, which was to show the relationship between the implementation of eco-innovation and the ability to achieve ESG goals in listed companies of different sizes, was achieved through empirical research. In addition, the most frequently implemented eco-innovations by the surveyed entities were identified. The results of the research primarily showed that while product, organisational and marketing eco-innovations are implemented in large companies, small and medium-sized companies mainly implement product and marketing eco-innovations. On the other hand, process eco-innovations, which are of the greatest importance (similarly to product eco-innovations) in the context of environmental protection, were least frequently indicated in the activities of the surveyed entities.

Undoubtedly, this situation is influenced by the financial aspect related to the high expenses required to implement such initiatives. And these are not only the high upfront costs of introducing eco-innovations (such as financing the purchase of technology, training, organisation, logistics, etc.), but also the inevitable expenses incurred once they have been implemented (maintenance, upgrades, improvements, etc.). In a very dynamic and uncertain environment for businesses, such categories of expenditure, especially for small and medium-sized entities, are beyond their financial capacity. This is all the more so because the potential return from implementing eco-innovation (unless it is a regulatory requirement) is, in many cases, very difficult to estimate. The frequent lack of pressure from lawmakers and state institutions on businesses to achieve environmental goals more quickly is not encouraging, either. At the same time, the incentive or discount schemes sometimes applied to companies making green investments are insufficient and may not compensate for potential losses on the part of companies as a result of the failure of such projects.

The ubiquitous expectation on the part of consumers that economic entities offer the lowest possible price for the services provided or products sold also does not motivate entrepreneurs to take actions that may result in price increases. As such, it would be necessary to strengthen all initiatives (both at the central and local level, even at the neighbourhood level) aimed at raising citizens' awareness of the enormous benefits that the introduction of eco-innovations by enterprises, and more broadly ESG activities, brings them. Such "bottom-up" pressure, but based on the demonstrated positive consequences of implemented eco-innovations, could be an impulse to take bolder actions by the legislature or regulators, as well as by company management boards. At the same time, according to the authors, a particularly important problem that requires not only further research and discussion, but above all systemic solutions from specific state authorities, is the issue of simulating "green", "clean", "ecological" or "environmentally friendly" projects by some economic entities solely for the purpose of achieving short-term profit, and not with sustainable development in mind.

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The contribution of the authors

Conceptualisation, J.W, P.D, A.C.; literature review, J.W, P.D, A.C.; methodology, J.W, P.D, A.C., formal analysis, J.W, P.D, A.C.; writing and discussion, J.W, P.D, A.C.; conclusions, J.W, P.D, A.C.

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EKOINNOWACJE W REALIZCJI CELÓW ESG NA PRZYKŁADZIE POLSKICH PRZEDSIĘBIORSTW GIEŁDOWYCH

STRESZCZENIE: Artykuł dotyczy problematyki wdrażania przez przedsiębiorstwa ekoinowacji, wpisujących się w podejmowane przez nie działania ESG. Głównym celem badań były przedstawienie i ocena związku między ekoinnowacjami a możliwościami realizacji celów ESG w małych, średnich i dużych spółkach giełdowych. Dodatkowo podjęto próbę określenia rodzaju ekoinnowacji najczęściej realizowanych przez te spółki. Metody badawcze obejmowały krytyczne studia literatury przedmiotu, desk research, mixed-mode CAT/CAWI na próbie 140 spółek oraz wybrane testy statystyczne. Podstawowym wynikiem z przeprowadzonych badań było wykazanie związku między ekoinnowacjami a celami ESG. W 74% badanych spółek stwierdzono występowanie takiego związku. W odniesieniu do rodzajów ekoinnnowacji, to ekoinnowacje produktowe, organizacyjne i marketingowe były realizowane we wszystkich dużych spółkach, podczas gdy w małych i średnich spółkach dominowały ekoinnowacje produktowe i marketingowe. Najmniejsze zaangażowanie stwierdzono w obszarze ekoinnowacji procesowych. Uzyskane wyniki uwidoczniają potrzebę rozszerzenia badań na przedsiębiorstwa pozagiełdowe i dostarczają wiedzy na temat bieżącego stanu rynku w zakresie roli ekoinnowacji w kształtowaniu polityki i działań w obszarze ESG.

SŁOWA KLUCZOWE: ekoinnowacje, koncepcja ESG, polskie przedsiębiorstwa giełdowe

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