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Model of the Factors Affecting the Eco-Innovation Activity of Bulgarian Industrial Enterprises

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Abstract: In recent years, modern society has faced a number of challenges related to the achievement of global goals for sustainable development. Industrial enterprises are challenged to generate, stimulate, and demand changes in networks and supply chains, but these challenges require flexibility and innovation activity in different directions. The data for Bulgaria show that the country is last among the countries of the European Union in terms of the creation and implementation of eco-innovations. Despite this result, the pace at which the country is developing shows that in the next few years, Bulgaria has the potential to move from a modest to a moderate eco-innovator, provided that it succeeds in filling the structural gaps in the system of ecological innovation. These gaps are related not only to the need for changes in the investment of resources but also to the need for changes in individual and related systems such as science and innovation, support for SMEs, the energy system, etc. Most of the research on sustainable innovation and eco-innovation has, however, focused on firm innovation models dominated by short-term profit-maximizing approaches. Therefore, there is a need to conduct research and propose adequate strategies for modern business environments and design models that facilitate the implementation of eco-innovations in industrial enterprises. The purpose of this report is to investigate the factors influencing the development of eco-innovation activities of Bulgarian industrial enterprises, examining how they can help to achieve success through eco-innovation and improve business results. A factorial model is proposed, through which the relationships between technological, financial, organizational, informational resources, research and development activities (R&D), and company cooperation are analyzed. The PLS structural equation modeling technique was used to validate the proposed theoretical model. The survey was conducted among 380 industrial enterprises from all over the sectors of the economy in Bulgaria with the help of a specially developed questionnaire within the period of April 2019 to December 2021. The obtained results show that human resources, financial resources, and cooperation positively influence research and development activities. In addition, the achievement of a positive effect on the management of eco-innovations affects the innovation activities of industrial enterprises, their ability to carry out research and development activities, as well as their ability to manage the technical and technological resources at their disposal effectively. Finally, the innovation activity aimed at carrying out scientific research and development activity, products and processes obtained as a result of the eco-innovation activity, and adequate information management directly affect the efficiency of business processes and financial results.

Keywords: eco-innovation activity; eco-innovation; eco-efficiency; innovation; industrial enterprises

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1. Introduction

Today, the world faces a number of challenges related to climate change, environmental protection, economic development, and overcoming social imbalances. The Special Report of the Intergovernmental Panel on Climate Change, "Global Warming at 1.5 °C", confirms that the impact of climate change is increasing as the average temperature rises. It is emphasized that at 2 °C, the world could face dramatic consequences. According to the report, in order to limit the rise in temperature to 1.5 °C, zero net carbon dioxide (CO_2) emissions should be achieved worldwide by 2050, and neutrality later in the century for all other greenhouse gases.

In response to these challenges, on 4 March 2020, the EC officially presented the European Green Treaty. The main aim of the European Union's renewed growth strategy is to build a fair and prosperous society that relies on a competitive economy modernized on the basis of resource efficiency. The main challenge for the new strategy is the development of economy and industrial growth, in which by 2050, net emissions of greenhouse gases will not be released, and economic growth must be resource-independent. The EU's drive to achieve a cleaner nature and environment, carbon neutrality, competition, sustainable economic growth, social equality, and prosperity has placed eco-innovation at the heart of European policy over the last few years. Finding a balance between the pursuit of greater economic competitiveness and a clean environment requires the effective adaptation of industrial enterprises to ongoing changes through the development and implementation of eco-innovation.

Regardless of the wide variety of scientific developments concerning the problems of innovation and sustainable development, the scientific and practical point of view is on the study of them and their interrelation in relation to the role of eco-innovation activity on the sustainable development of enterprises. At the same time, it should be taken into account that this aspect of the manifestation of the two phenomena has not been sufficiently investigated and considered in the scientific literature. The study of eco-innovation and sustainable development and their relationship is essential to the development of modern industrial enterprises.

The relevance and significance of the problem under consideration are determined by the fact that industrial enterprises in Bulgaria are significantly behind in their eco-innovation development. The reasons and factors for this are different. The development of the circular economy and the knowledge-based economy poses a number of questions related not only to the essence of eco-innovations and their diversity, the course of innovation processes, and the results achieved but also about the factors that stimulate or hinder eco-innovation activities, business performance and hence their sustainable development.

Therefore, the approach to implementing eco-innovations, which underestimates the role of research and development activity and the contribution of human resources to the innovative capacity of the enterprise, is inadequate, and it is necessary to propose a new model through a corresponding new set of variables. At the same time, the increase in innovation activity leads to an increase in the enterprise's productivity and, from that, an increase in the economic, social, and environmental effects of its activity. These are the hypotheses that the authors raise and prove in the course of this study using the proposed factor model. The main objective of this report is to present the research related to the factors that have the strongest influence on the development of eco-innovation activities in Bulgarian industrial enterprises, exploring how they can help to achieve success through eco-innovation and improve business results. The choice of **the subject** of the present study was dictated by the particular importance of innovation processes for the development of the economy and the role of eco-innovations in achieving economic, social, and environmental effects. At the same time, the reason for this choice is also due to the insufficient research and analysis of the relationship between the two phenomena in the scientific literature. The choice of the research topic is also related to the need to solve some theoretical–methodological and practical-applied problems related to the eco-innovative development of enterprises under the conditions of the knowledge-based economy and circular economy; ensuring human resource management and ensuring the implementation of the established model of eco-innovation development and the active transfer of knowledge; assessment of the formation and effectiveness of the use of eco-innovations as a factor of innovative development, increasing the efficiency of management eco-innovations as a factor for the development of innovation processes and innovation activity in Bulgarian industrial enterprises.

The theoretical and methodological bases of scientific research are fundamental positions of the theory of innovation and sustainable development. In the process of a theoretical clarification of the problem, a literary review of the works of a number of Bulgarian and foreign authors was conducted, and systematization of their views on the impact of eco-innovations on sustainable development and achieving an economic, social, and ecological effect, both for the enterprise and for society as a whole, was also performed. Based on the analysis of theoretical views and the conducted research, the connection between eco-innovations, the potential of human resources for their implementation, and the positive effect of their implementation on the enterprise's activity was made.

The methods used to achieve the objectives of the study are as follows: methods of description, comparison, analysis, and synthesis, a method of grouping, tabular and graphic methods, and a survey method. The survey was conducted across 380 industrial enterprises from all over the sectors of the economy in Bulgaria with the help of a specially developed questionnaire from April 2019 to December 2021. The authors applied correlation, regression, factor, and dispersion analysis in order to derive the direct and indirect interdependencies between the factors affecting the eco-innovation activity of industrial enterprises in Bulgaria. The data were processed using SPSS statistical software. The PLS structural equation modeling technique was used to validate the proposed theoretical model. The indicated methods provide the necessary possibilities for evaluation and solution of the research tasks.

The main sources of information were the statistics published by the National Statistic Institute (NSI); European and national strategic documents; the analytical materials of The European Commission and the World Bank; research and development of scientific institutions; and the results of a survey carried out on industrial enterprises in the Republic of Bulgaria.

Scientific research is limited in terms of the object, subject, and purpose, which are defined in the context of the role of eco-innovations and the human factor in the development of innovation processes in industrial enterprises in Bulgaria. The research is also limited in terms of the research period, namely from 2019 to 2021. The research was accompanied by some difficulties in connection with the conduct of the survey, as well as with the absence of scientific literature on a methodology for revealing the role of eco-innovation management in the innovative development of industrial enterprises. In this regard, there were difficulties in choosing a methodological approach to the research.

2. Literature Review

Innovation and sustainable development issues are the subject of the attention of a number of scientists. The foundations of the theory of innovation were laid as early as the 18th century by the French educator J. Condorcet (The Great Soviet Encyclopedia 1970–1979), who explored the relationship between science and industry. Among the classic researchers of economic science who contributed to the development of the theory of innovations are A. Smith, J. B. Say, D. Ricardo, and others. Special importance at the beginning of the 20th century, and to this day, is placed on the works of the representative of the Austrian school, J. Schumpeter. In modern Western scientific literature, the ideas of P. Drucker and M. Porter. Opinions on these issues can also be found in the developments of I. Kirzner (Kirzner 1973), F. Kotler and F. T. De Bes (Kotler and De Bes 2011), B. P. Shapiro, R. J. Dolan, and J. A. Quelch (Shapiro et al. 1985), P. Aghion and P. Howitt, (Aghion and Howitt 1992), F. Lichtenberg (Lichtenberg 1992), Salehi, M. (Salehi et al. 2021), H. Ulku (Ulku 2007), Br. Solis (Brian 2013), T. P. Danko (Danko 2019), N. E. Bondarenko (Bondarenko et al. 2019), А. В. Сак, В. А. Журавлев (Сак and Журавлев 2010), К. Х. Хоппе, К. Пецольдт, С. В. Валдайцев, Н. Н. Молчанов (Хоппе et al. 2004), V. Roleders, T. Oriekhova and G. Zaharieva (Roleders et al. 2022), O. Laktionova, O. Dobrovolskyi, T. S. Karpova, and A. Zahariev (Laktionova et al. 2019), S.Seitzhanov, N. Kurmanov, M.

Petrova, U. Aliyev, and N. Aidargaliyeva (Seitzhanov et al. 2020), T.Odinokova, M. Bozhinova, and M. Petrova (Odinokova et al. 2018), O. Em, G. Georgiev, S. Radukanov, and M. Petrova (Em et al. 2022). The problems of innovations and innovative development find a place in the works of a number of Bulgarian authors—R. Chobanova (Chobanova 2011), I. Georgiev, Ts. Tsvetkov and D. Blagoev (Georgiev et al. 2013), A. Zahariew, A. Radulova, A. Aleksandrova and M. Petrova (Zahariev et al. 2021), A. Zahariev, P. Angelov and S. Zarkova (Zahariev et al. 2022), K. Todorov (Todorov 2005), M. Slavova (Slavova 2019), M. Petrov (Petrov and Georgiev 2008), D. Pavlova (Pavlova 2019), P. Dimitrova-Davidova (Olson et al. 2005), M. Velev (Velev and Atanasova 2013), M. Petrova (Baklanova et al. 2020), V. Nikolova-Alexieva (Nikolova-Alexieva and Krasteva 2019), B. Hadjiev (Hadjiev 2009), L. Varamezov and I. Panteleeva (Varamezov and Panteleeva 2021), Ts. Stoyanova and N. Shterev (Stoyanova and Sterev 2018), and many others.

Innovation is a concept with complex content that cannot be unambiguously and completely defined so as to satisfy the requirements of different practical situations. In this sense, it should be considered from different points of view:

- From a production point of view—innovation is defined as the technical implementation of new ideas or new combinations of existing scientific knowledge and ideas applied for the first time in practice.
- From a marketing (market) point of view—this is any new idea realized, which, launched on the market, delivers such a benefit to the consumer that he is willing to pay for it.
- From the consumer's point of view—innovation is any product, service, or procedure that the consumer perceives as something new and unfamiliar, satisfying his needs.

The working definition provided by the Organization for Economic Co-operation and Development (OECD) in Europe for the essence of innovation defines it as the introduction of a new or significantly improved product or process, marketing approach, or organizational method in the business practice. This definition largely applies to eco-innovations in the green economy, which stand out with two clear and significant characteristics, namely:

- To be aimed at reducing the impact on the environment;
- In addition to product, process, technical, technological, marketing, and organizational innovations encompassing social structures and institutional units.

The concept of eco-innovation was first mentioned in the scientific literature by Fussler and James (1996). They consider eco-innovation as "new products and processes that provide value to customers and businesses but significantly reduce environmental policy" (Fussler and James 1996). Klemmer's definition is similar: "Eco-innovations are all measures of relevant actors (firms, politicians, unions, associations, churches, private households) which develop new ideas, behavior, products and processes, apply or introduce them and which contribute to a reduction in environmental burdens or to ecologically specified sustainability targets" (Klemmer Lehr and Lobbe 1999).

The market orientation of eco-innovations was first mentioned by Keeble et al. and Andersen. According to Keeble et al., "Sustainability-driven innovation is the creation of new market space, product and services or processes driven by social, environmental or sustainability issues." (Keeble et al. 2005). For Andersen, eco-innovation is capable of attracting green rent to the market (Andersen 2008).

In the Framework Program for Competitiveness and Innovation, in 2007 the European Commission defined eco-innovation as "any form of innovation aimed at significant and demonstrable progress towards the goal of sustainable development, by reducing the impact on the environment or achieving a more efficient and responsible use of natural resources, including energy" ("Competitiveness and Innovation Framework Programme" (CIP), European Commission 2007). It looks at the interrelationship between sustainable development and the main goal of eco-innovation. The European Commission's INNOVA initiative affirmed that "Eco-innovation is the development and offering of new products, goods or services that are designed to satisfy needs at affordable prices, while improving the quality of life through minimal resources and with minimal release of toxic substances and pollution."[1]

This definition of eco-innovation combines two main theses. The first considers eco-innovation as a specific type of innovation capable of opening up new markets and satisfying human needs. The second is the topic of environmental protection and the achievement of economic, ecological, and social effects.

Kemp and Foxon provided an interpretation of eco-innovation. According to them, "Eco-innovation is the production, application or exploitation of a good, service, production process, organisational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction in environmental risk, pollution and the negative impacts of resources use (including energy use) compared to relevant alternatives" (Kemp and Foxon 2007).

An analogous definition was also proposed by the OECD in 2009. The OECD observer document says that eco-innovation is the creation or implementation of new, or significantly improved, products (goods and services), processes, marketing methods, organizational structures and institutional arrangements which—with or without intent—lead to environmental improvements compared to relevant alternatives (OECD 2009).

Under the ETAP (Environmental Technology Action Plan),[2] "Eco-innovation is the production, application or exploitation of a good, service, production process, organisational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction in environmental risk, pollution and the negative impacts of resources use (including energy use) compared to relevant alternative."

The *OSLO Manual* states that "Eco-innovation can be generally defined as innovation that result in the reduction in environmental impact, no matter whether or not that effect is intended. Various ecoinnovation activities can be analyzed along three dimensions:

- Target (the focus areas of eco-innovations: products, processes, marketing methods, organizations and institutions);
- Mechanisms (the way in which changes are made in the targets: modification, redesign, alternatives and creation);
- Impacts (effects of eco-innovation on the environment)" (EK, OSLO MANUAL n.d., European Commission 2007).

The authors cited above perceive eco-innovation as the progress caused by innovative products, processes, and services, achieving the efficient use of available resources with minimal impact on the environment (Matus 2019). Eco-innovations can be called any new or improved products, services, processes, structures, etc., leading to economic, environmental, and social improvements. Eco-innovation also involves the application of new approaches to product and process value chains that reduce input intensity and, at the same time, increase service and welfare intensity (León-Bravo et al. 2019). In order to characterize an eco-innovation as such, it is necessary to meet at least one of the following conditions (De Marchi and Grandinetti 2013):

- Minimizes destructive impact on the environment;
- Efficient manner in the use of natural resources;
- Application of renewable energy;
- Achieving energy efficiency;
- Waste recycling and use of waste-free technologies;
- Application of ecological standards.

Another look at eco-innovations reveals the possibility of analyzing them in terms of their purpose, implementation mechanism, and environmental impact (Neutzling et al. 2018).

Purpose refers (Parthibaraj et al. 2018) to the main meaning of eco-innovation, namely the creation and implementation of new products, processes, marketing approaches, and new forms of organization.

Regarding the mechanism—it is aimed at the approach by which eco-innovation implements the changes. They can be technological and/or non-technological, affecting different aspects of the activity of industrial enterprises (Ramanathan et al. 2014). There are four main mechanisms:

- *Modification*. It is perceived as a minor change in the object undergoing modification.
- *Redesign.* It is aimed at radical changes in already existing products, processes, organizations, etc.
- *Alternatives*. It is seen as the implementation of goods and services that can be used as substitutes because they satisfy the same functional need.
- *Implementation of innovations* (products, processes, services, etc.)

Impact specifies the effect that an eco-innovation achieves in protecting the environment.

By achieving the main goal of reducing the harmful impact on the environment, eco-innovations make significant progress towards realizing the sustainable development of modern society, the more efficient and responsible use of natural resources and achieving economic, ecological, and social impacts. The impact of eco-innovation covers the four areas—economy, ecology, social sphere, and policies—these are summarized in Figure 1.

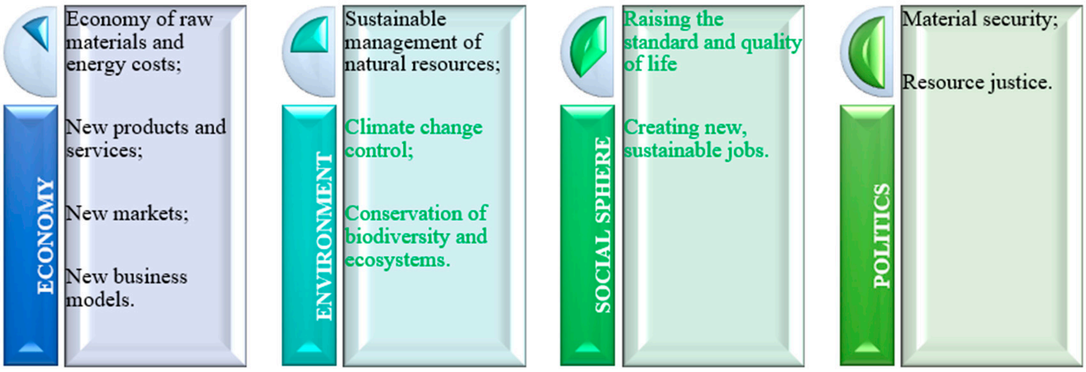


Figure 1. Sectors where eco-innovation has an impact.

Eco-innovations have a significant positive impact on the three pillars of sustainable development—the environment, the economy, and society as a whole—making them a major factor in achieving the global goals set in the policy for the sustainable development of modern society.

The problem related to the degree of interaction between a company's characteristics, its innovative activity, and business output has been of interest to scientific authors for several decades.

A survey of the economic literature showed that the first publication dealing with the problems related to the econometric analysis of research and development activities dates back to 1979. It was presented as the Griliches function for the production of technical knowledge (Griliches 1979). The Griliches function covers the basic factors of production, which are supplemented by one more called "technological capital". It covers company R&D investment, university R&D spending, and technology center spending. (Audretsch 1998; Porter and Stern 1999). However, the Griliches function is not taken into account by all activities, incorporating an innovative process that is multidimensional and interactive (Kline and Rosenberg 1986). Traditional industries, especially small firms, underestimate factors such as human resources and R&D, which play a huge role in making the innovation process happen. Many studies by Bulgarian authors show that from the birth of the idea to its overall development and the market commercialization of their share in the cost structure of innovation activity is small (Nikolova-Alexieva and Krasteva 2019; Mihova and Nikolova-Alexieva 2020; Gigova et al. 2019). Based on the research carried out in Bulgarian industrial enterprises (Mihova et al. 2020), it was found that about 45% of those who implemented process innovations and more than 72% of them who implemented product innovations do not have the personnel for research and development. There are a variety of models that examine the relationship between innovation activity and the business transformation of the firm. There are a variety of models that examine the relationship between innovation activity and the business transformation of the firm. Analyzing the company's innovation activity, Hurley and Halt realized that some structural elements and characteristics of the innovation process (enterprise size, resource availability, control of operations, information, etc.) influence innovation activity (Hurley and Hult 1998). It can be added that cultural characteristics (market orientation, decision-making process, etc.) influence the receptivity to innovation. The competitive advantage of the company depends on its ability to carry out innovative activities, its ability to implement structural changes, and on the presence of an adequate corporate cultural environment. Other authors (Baklanova et al. 2020; Fussler and James 1996; Klemmer Lehr and Lobbe 1999) emphasize the role of organizational resources in innovation activity and company performance. These authors proved that the innovative projects undertaken are the result of an accumulation of resources, the greatest importance being the growing new knowledge. In Bulgaria, Proffesor M. Velev came to the conclusion that companies that have sufficiently prepared human resources and the capacity to imitate other companies have a competitive advantage (Velev and Atanasova 2013; Velev et al. 2017). Velev proposes a model in which organizational characteristics influence innovation activity, and this affects the performance of industrial enterprises.

3. Comparative Analysis of the Eco-Innovation Activity of Bulgaria and the EU Countries

According to the latest data on the Eco-IS panel and the eco-innovation index, illustrating the effectiveness of eco-innovation in the EU Member States in 2021, Bulgaria is in last place, as it is in the group of catching-up countries (see Figure 2). Figure 3 presents the dynamics of the indicator in the period over the last ten years among the group of countries; the catching-up with eco-innovation countries continuously display fluctuations in their scores.

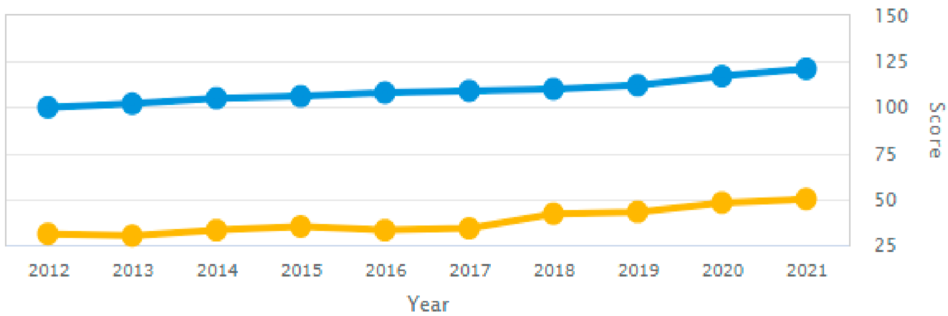


Figure 2. EU countries ranking according to the average value of the EU countries (2012–2021); Source: https://ec.europa.eu/environment/ecoap/sites/default/files/eco-innovation_policy_brief_2021.pdf (accessed on 1 March 2022).

The data show that in terms of the eco-innovation indicator, Bulgaria lags behind significantly. Bulgaria was ranked last among the countries of the European Union. Despite the significant difference reflected in Figure 3, the results show a significant increase in the value of the index after 2017, around 50% in the last five years. If this growth rate is maintained in the next 4–5 years, Bulgaria has a real opportunity to jump from the modest eco-innovator group to the moderate group.

The results for Bulgaria on the five indicators, which are included in the indicator for the effectiveness of eco-innovation, compared to the average in the Eunion, and the result of the best-represented country for 2021 are summarized in Figure 4.

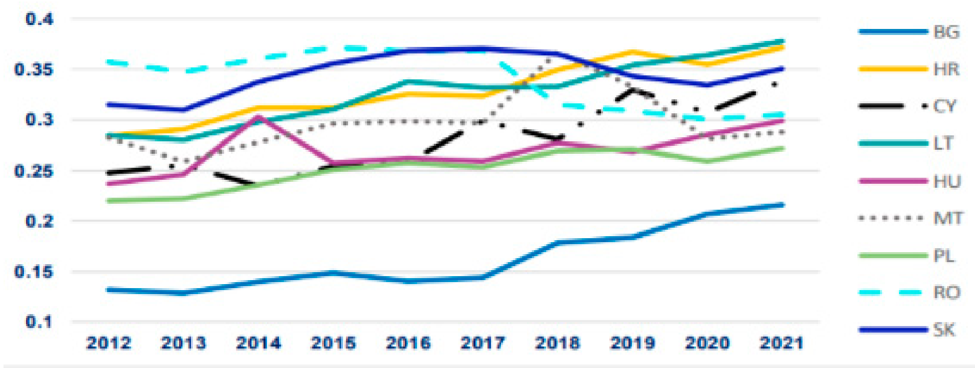


Figure 3. Dynamics of the index for Bulgaria and the eco-innovation index, 2021. Source: https://ec.europa.eu/environment/ecoap/indicators/index_en (accessed on 2 March 2022).

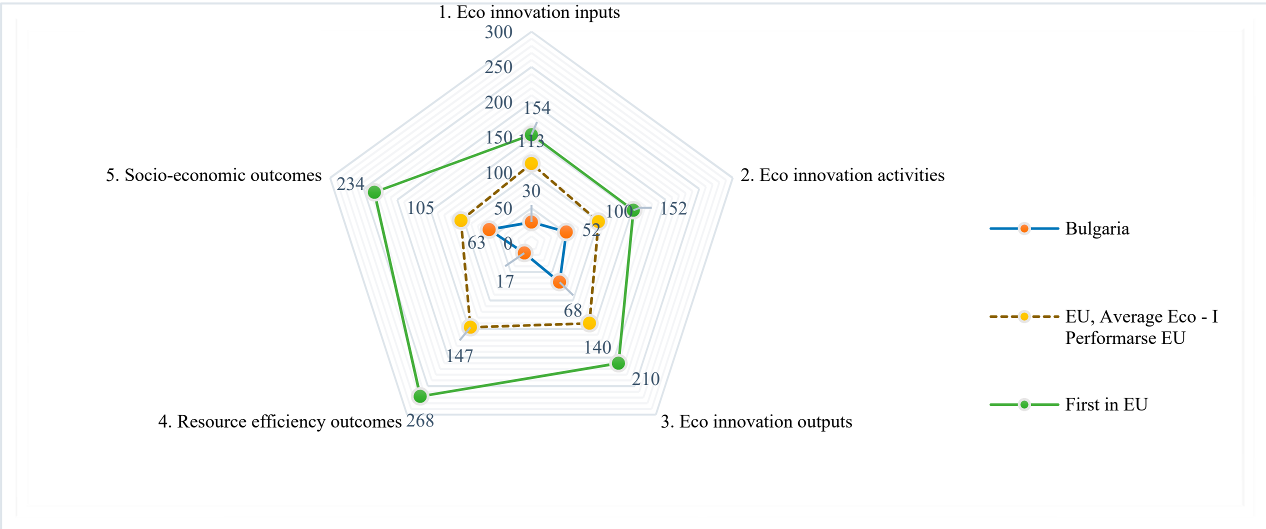


Figure 4. Values of the indicators in the eco-innovation efficiency indicator, 2021; Source: https://epi.yale.edu/epi-results/2020/country/bgr (accessed on 2 March 2022).

The most serious lag is in the indicator "Resource efficiency results" (130 positions compared to the European average and 251 positions compared to the leading country in the group) and "Eco-innovation at the entrance" (83 positions compared to the European average and 124 positions to the leader in the group).

The benefits of developing and implementing eco-innovation in industrial enterprises can be grouped in several directions:

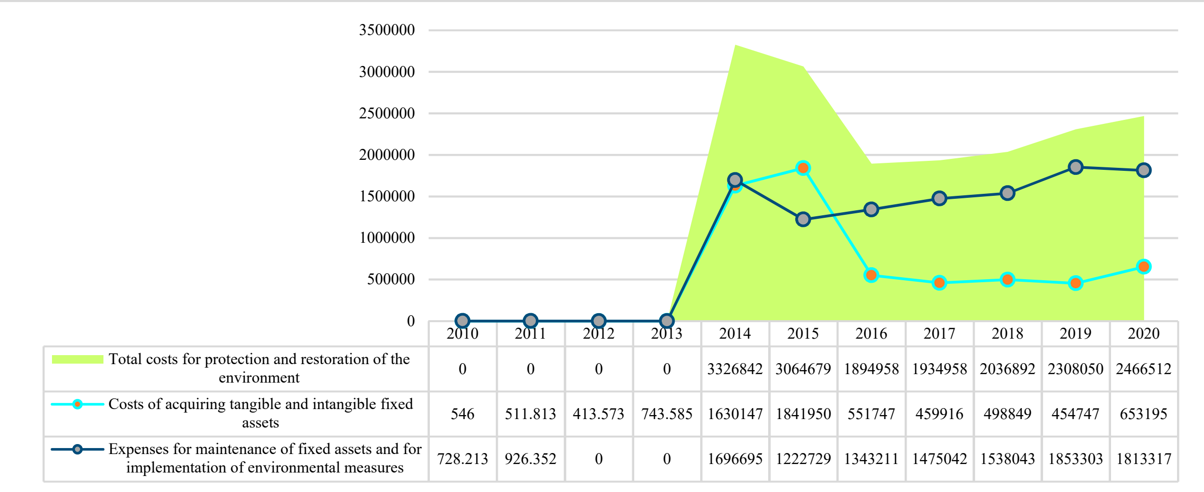
- *Environmental benefits*—is expected to reduce the use of natural resources and limit the release of hazardous substances into the atmosphere.
- *Social benefits*—the creation of new jobs, changes in people's behavior and lifestyle that lead to a healthy and quality life.
- *Economic benefits*—increasing revenues, realizing new market opportunities, achieving competitive advantages for businesses.

The expectations from the introduction of eco-innovation in the industrial sectors are related to the achievement of the following results:

- Increasing the share of enterprises with the introduction of low-carbon, energy- and resource-efficient technologies;
- Achieving energy savings by 2030—761.06 ktoe and an intermediate target for 2027, 532.74 ktoe (according to INPEC);
- Contribution to increasing the share of preparation for multiple uses through the recycling of waste to 60% by 2035 at the latest;

- Contribution to the recycling of at least 70% by weight of all packaging waste;
- Increasing the share of secondary wastewater treatment up to 78% and an increase by 15% of urban wastewater treatment;
- Reduction in the share of the population living at levels of PM10 and PM2.5 pollution, which are above the permissible norms, by at least 50% compared to 2017;
- Ensuring effective and efficient management of the Natura 2000 Network;
- Reducing the share of the population living at risk of disasters (floods, fires, processes related to the movement of land masses, earthquakes) by at least 35%, etc.

Industrial enterprises in Bulgaria act responsibly in the pursuit of environmental protection. The data show an upward trend in their investment costs for the environment over the last 11 years (Figure 5).



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total costs for protection and restoration of the environment	0	0	0	0	3326842	3064679	1894958	1934958	2036892	2308050	2466512
Costs of acquiring tangible and intangible fixed assets	546	511.813	413.573	743.585	1630147	1841950	551747	459916	498849	454747	653195
Expenses for maintenance of fixed assets and for implementation of environmental measures	728.213	926.352	0	0	1696695	1222729	1343211	1475042	1538043	1853303	1813317

Figure 5. Dynamics of the costs for protection and restoration of the environment of indust rial enterprises (2010–2021). Source: www.NSI.bg (accessed on 11 March 2022).

The distribution of investment costs with ecological purposes in ecological directions by 2022 is presented in Figure 6. Despite the growing trend of expenditures for the protection and restoration of the environment (Figure 3), the country remains last among EU countries. The investment costs, distributed to individual directions in the country, aimed at environmental protection, are indicated in Figure 4. The distribution of a large part of them (44%) was made for wastewater treatment. The waste recycling costs were 31%, and the volume of air protection costs was 21%. A small share is occupied by the costs of soil protection (1.60%) and investments in equipment, monitoring, and control (1.39%). Industry investment spending on research, education, and related activities (0.41%), biodiversity conservation (0.4%), and forest conservation and restoration (0.18) remained below one percent.

The results of investments made in eco-innovation in the country's industrial sectors in recent years are reflected in a 2020 report by the Yale Center for Environmental Law and Policy and the Center for the International Earth Science Information Network (CIESIN) of the Institute for Columbia University Land. According to the index of environmental indicators, Bulgaria climbs to 41st place, with 57.0 points out of 180 countries surveyed in the world, although it remains last among the 27 member countries of the European Union. However, a study carried out shows that, compared to the countries of Eastern Europe (Figure 7), the results of Bulgaria on most eco-indicators are above the average level for the region. The data show that the greatest lag is observed in terms of the indicators that consider air quality, the management of water systems and facilities, and the presence of heavy metals. The development, implementation, and dissemination of eco-innovative technologies, products, and processes have a key role to play in overcoming important economic, environmental, and social issues set out in the UN's goals for the sustainable development of modern society. This requires priority to be paid to the eco-innovative product, technological innovation, and market restructuring of production, i.e., the eco-innovation activity of industrial enterprises. All this would be impossible and unthinkable without taking a certain risk, initiative, entrepreneurship, perseverance, material and labor costs, and investments to implement and materialize eco-innovative ideas and developments in company policy and practice for sustainable business development.

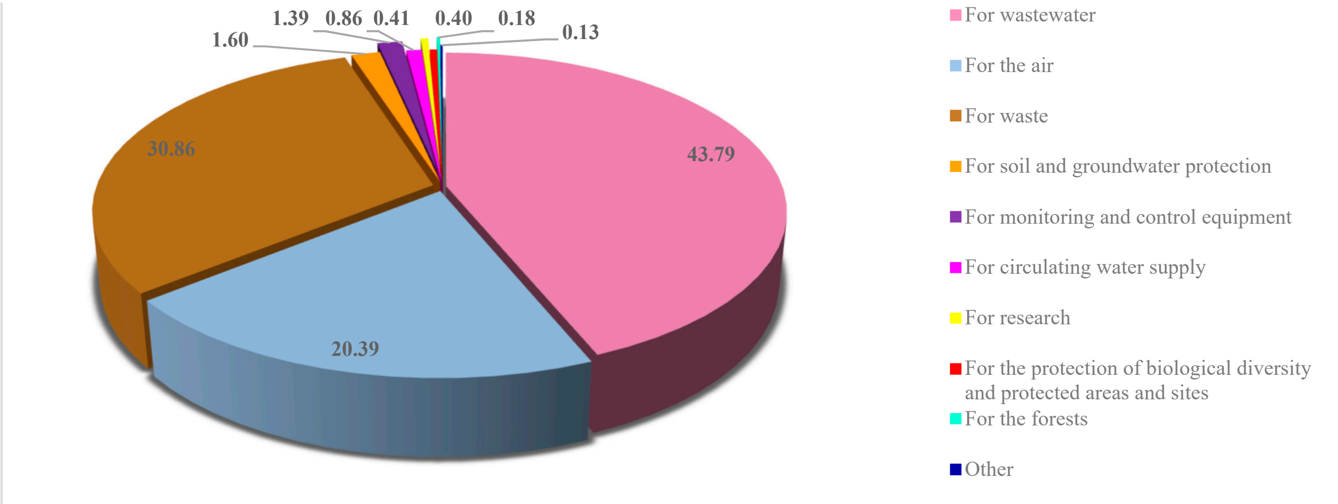
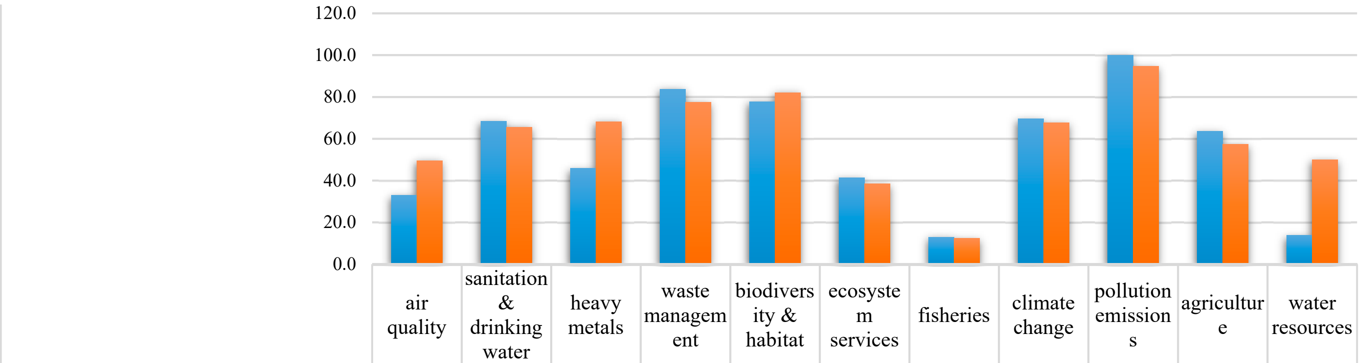


Figure 6. Investments of industrial enterprises in environmental areas in Bulgaria for the period 2010–2021 (in %); Source: www.NSI.bg (accessed on 11 March 2022).



	air quality	sanitation & drinking water	heavy metals	waste management	biodiversity & habitat	ecosystem services	fisheries	climate change	pollution emissions	agriculture	water resources
Value, Bulgaria	33.0	68.3	45.8	83.6	77.7	41.4	12.9	69.5	100.0	63.6	13.9
Average Values / Eastern Europe	49.5	65.5	68.2	77.5	82.0	38.6	12.4	67.7	94.8	57.4	50.0

Figure 7. Data for Bulgaria and average values for the region of Eastern Europe, 2020. Source: https://epi.yale.edu/epi-results/2020/country/bgr (accessed on 11 March 2022).

At its core, eco-innovation activity is related to the creation of models for business structures that spare the environment by reducing the intensive use of products and services while at the same time contributing to building competitive and efficient companies.

4. Analysis of the Factors Influencing the Eco-Innovation Activity of Bulgarian Industrial Enterprises

Summarizing the multiple points of view and theories regarding the factors determining the effect of the innovative activity of enterprises, the possibility of their systematization in two main directions is revealed: factors of the external and factors of the internal company environment.

Among the external factors influencing the management processes, the following stand out: the political stability of the country, legislation, the normative base and regulations, and the presence of bureaucratic difficulties and corruption. This group also includes macroeconomic stability, the fiscal policy of the state, and the amount of income among the population. Government policies aimed at small, medium, and large businesses also have an impact. The last external factors are the climatic conditions, natural resources and deposits, and the availability of infrastructure contributing to the development of the industrial sectors. Of essential importance are the levels of internal and external trade, the intensity of competition in individual industrial branches, and the competitiveness of related industries or clusters.

The internal factors include the presence of an automated or robotic technical and technological park, the contractual relationships and obligations of the enterprise with counterparties, the availability and access to quality incoming raw materials and materials, and achieving financial stability. The qualifications of the employed staff and the presence of experts at the management level are internal factors that contribute to achieving better marketing, a stable image, and the prestige of the company trademark. All this leads to ensuring loyalty among consumers to the company's products, the stimulation of innovation activity in the production sphere, and easier access to human resources, as well as the enhanced social commitment of the company in the industry it has chosen to develop.

Figure 8 presents a proposed structural model of the factors influencing the eco-innovation activity and the eco-efficiency of Bulgarian industrial enterprises. The model reflects the linear relationship between research and development, eco-innovation, and eco-efficiency, summarizing the various elements (conditional factors, human, organizational and financial resources, cooperation, and information management) that determine the results of eco-innovation affecting eco-innovation and the efficiency of the company.

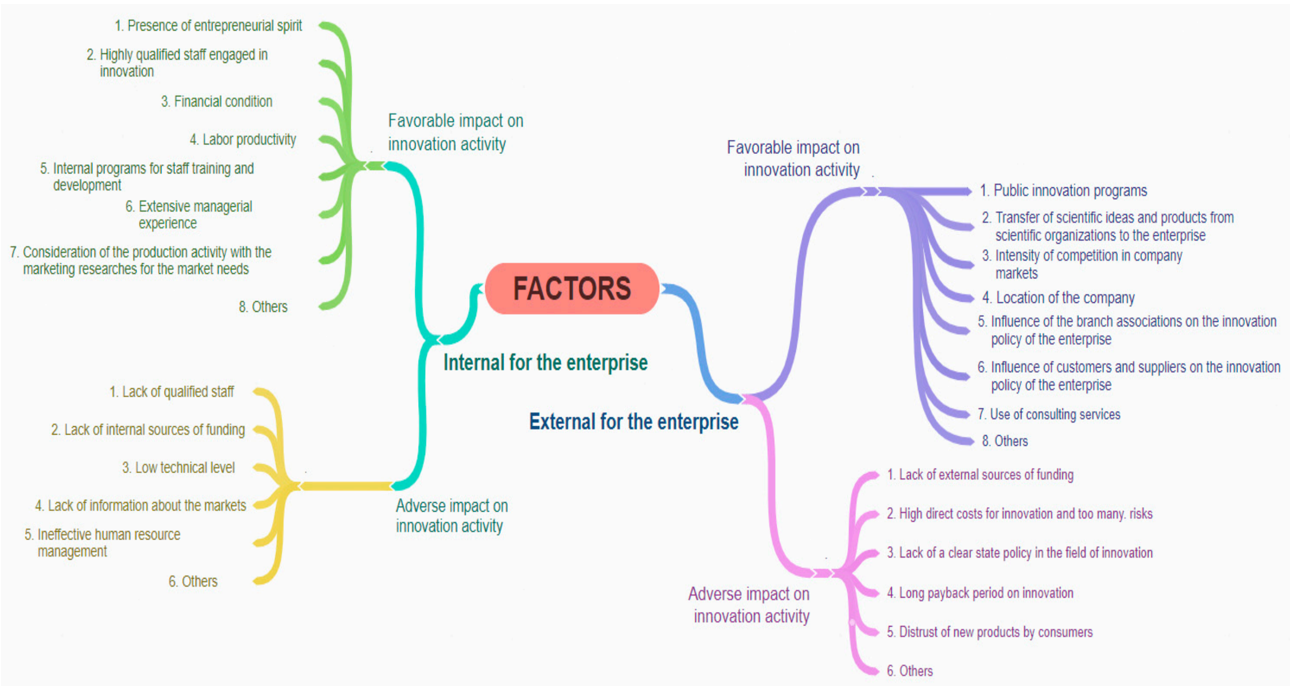


Figure 8. Structural model of the factors influencing the eco-innovation activity.

In the study, the authors propose a structural model built from elements (conditional factors, human, organizational and financial resources, and information management) that influence eco-innovation activities. These activities determine the results of eco-innovations, affecting the company's productivity and business results.

The model is characterized by flexibility, disrupting the estimation of the linear structure of the relationship between R&D, innovation, and business performance. The proposed effects model has a more flexible design: first, it uses latent variables, also called constructs, derived from observed variables; second, it is versatile and adaptable because it identifies different types of causal relationships between these constructs.

The proposed model is built from three constructs (latent variables composed of the observed variables) related to R&D: the "Human resources" variable related to R&D personnel, "Financial resources" related to research and development expenditure, and "Collaboration" with other companies. The construct of R&D activities is captured using two variables: "Internal R&D activities" and "External R&D activities". They influence innovation outcomes as well as the firm's performance.

The model also includes "conditional factors" derived from the size and type of variables observed in the market, which significantly influence "R&D activities" as well as "Innovation Outputs".

Another latent variable, Innovation Outcomes, is derived from two empirical variables: Product Innovation and Process Innovation. "Innovation outcomes" depend on four constructs: "R&D", "Conditional factors", "Technological and organizational resources", and "Information management".

"Technological and organizational resources" is a latent variable construct using four observed variables: "Technology and equipment acquisition", "External technological knowledge acquisition", "Production preparation", and "Commercialization preparation".

"Information management" is another latent variable composed of three information variables: "Use of internal sources of information", "Market-related sources", and "Other sources of information".

"Company efficiency" is the final construct, a latent variable derived from three variables: "Effects on products", "Effects on processes", and "Other effects". The authors assume that the company's success can be attributed to research and development, innovation activity, and information management.

The variable "Effects on products" can be measured by the following variables: increasing the product portfolio, increasing market share, improving product quality, and improving the flexibility of production.

The variable "Process effects" can be measured by the following variables: improving the flexibility of production, increase in production capacity, reduction in labor costs, and the economy of raw materials and energy.

The variable "Other effects" can be measured by the following variables: reduction in environmental impact and compliance with regulations.

The **formulated hypotheses** from the research are as follows:

Hypothesis 1 (H1). *Size and type of market have a positive effect on research and development.*

Hypothesis 2 (H2). *Market type and size have an indisputable impact on eco-innovation activity.*

Hypothesis 3 (H3). *Human resources have an indisputable impact on R&D.*

Hypothesis 4 (H4). *Financial resources have a indisputable impact on research and development*.

Hypothesis 5 (H5). *Cooperation with other agents has a positive effect on research and development*.

Hypothesis 6 (H6). *Technological and organizational sources have a positive effect on the results of eco-innovation activities*.

Hypothesis 7 (H7). *Both external and internal research and development activities have a positive effect on eco-innovation activity.*

Hypothesis 8 (H8). *External or internal R&D activities have a positive effect on company efficiency*.

Hypothesis 9 (H9). *Information management has a positive effect on eco-innovation activity.*

Hypothesis 10 (H10). *Information management has a positive effect on company efficiency.*

Hypothesis 11 (H11). *Eco-Innovation activity has a positive effect on company efficiency.*

5. Materials and Methods

5.1. The Proposed Methodological Approach Includes the Following Phases

First phase: The preparation of a primary profile of industrial enterprises to identify which factors influence the localization, strategic planning, and innovation development of the enterprise.

Second phase: The preparation of a proxy profile of the investigated enterprises in order to establish which factors influence the eco-innovation activity of individual categories of industrial enterprises.

Third phase: Designing an integral profile of the respondents to establish the strength of the influencing factors on the eco-innovation activity of individual categories of enterprises.

The object of the empirical study was 380 industrial enterprises, members of KRIB, which were classified in the Top 500 as innovators. These enterprises generate a tangible share of sales revenue in the country and occupy a key position in terms of the number of employed persons and the volume of production. A questionnaire was developed and sent by e-mail to all of the selected enterprises from April 2019 to December 2021. Responses were received from 345 industrial enterprises. This sample is representative since it covers 69% of all Bulgarian industrial enterprises with innovation activity and innovation potential, which allows conclusions to be drawn at the country level (Table 1). The authors applied correlation, regression, factor, and dispersion analysis in order to derive the direct and indirect interdependencies between the factors affecting the eco-innovation activity of industrial enterprises in Bulgaria. The data were processed using SPSS statistical software. Structural equation modeling and the PLS technique were used to validate the proposed theoretical model. The methods described above provide the necessary opportunities for evaluating and solving the research tasks.

Table 1. Main characteristics of the sample.

	Number of Enterprises	Share
Industry Technological level		
High	*108*	*31.3*
Medium—High	*87*	*25.2*
Medium—Low	*118*	*34.2*
Low	*32*	*9.3*
Size (number of employee)		
Less then 100	123	35.6
Between 100 and 500	156	45.2
Between 500 and 1000	58	16.8
Between 1000 and 5000	8	2.4

5.2. Methodology for Studying and Validating the Proposed Model

Building a model of factors influencing eco-innovation activity includes the following activities:

- Defining eco-innovation activity in its role as a dependent variable;
- Formulation of research hypotheses;

- Analyzing the strength and direction of influence of influencing factors through correlation analysis;
- Measuring the degree of dependence of the selected (dependent) variable on changes in independent variables using regression analysis;
- Testing the significance of the hypothesis describing the dependence;
- Conducting control studies, through expert assessments, to compare the adequacy of statistically proven hypotheses;
- Refining the formulations of the proven hypotheses.

For the analysis and evaluation of the proposed model shown in Figure 9, the authors used the PLS technique and structural equation modeling (SEM). The model establishes interdependence and relationships between endogenous and exogenous variables while recognizing that there is an interaction between the dependent and independent variables. According to Vites and Calvo, in SEM, we considered two types of models (Vieites and Calvo 2010):

(1). A model using factor analysis.

The model explores the alignment and strength of theoretical constructs. The composition of the theoretical constructs includes reflective or formative indicators. The authors' proposed model of influencing factors in Figure 9 is composed mainly of the formative variables, excluding the construct representation of the company.

(2). A structural model for the analysis of causal interactions.

The reflective indicators are defined by constructs and covary, so factor loadings are used to estimate these constructs. On the other hand, constructs based on formative variables can be analyzed using their weights. Therefore, the estimation of a PLS model has two stages:

(1) Analysis of whether the theoretical concepts are correctly measured by the research variables
(2) Evaluation of a structural model. At this stage, the relationships between the constructs are explored by going through:
    (a) Estimation of the ratio of variation of the variables comprising the separate constructs.
    (b) Estimating the variance of the dependent variables as affected by the independent variables.

The size of the sample depends on the number of constructs, indicators, and the structural connections between them. It can be determined according to the rule: the minimum sample is either the number of indicators included in the most complex forming construct multiplied by 10 or the largest number of constructs multiplied by 10.

To validate the proposed model, the authors used data from the National Statistical Institute for Eco-Innovationas as well as the expert assessments of managers of industrial enterprises, members of the Confederation of Employers and Industrialists in Bulgari (CRIB). A qualitative method was used—an in-depth interview—which aimed to establish to what extent representatives of industrialists agree with the statements, relationships, and dependencies derived from the correlation and regression analysis.

The survey started by specifying the industrial sectors in which the respondents professionally develop. The classification of the categories is in accordance with the one applied in Bulgaria and developed by the Ministry of Labour. The predominant group (67%) marked the Food/Beverage sector. The second largest group among the respondents is from the Light Industry sector, with 56%. The surveyed companies from both industrial sectors realize and report large annual profits. They are highly competitive and rely on computer technology to successfully implement and develop their business activities. It is characteristic of them that they periodically update their information and communication technologies. They invest purposefully in any new IT hardware or software that can provide them with a competitive advantage. The next group (52%) is from the telecommunications and information technology sector (47%) and retail trade (42%). The majority of sector-marking computers, including consumer electronics or software, work in the IT sector. In this industry group, a distinction should be made between those who provide software products and services and the second group of respondents whose business companies use software products to support work processes. The remaining groups include Energy, 41%; Heavy Manufacturing, 34%; Chemicals, 32%; Business Consulting, 33%; Travel/Entertainment, 28%; Financial Services, 18%; Healthcare/Medical Equipment, 19%; and Education, 13%. Overall, 23% of the respondents chose the "Other" group, specifying that they are from the consulting services sector.

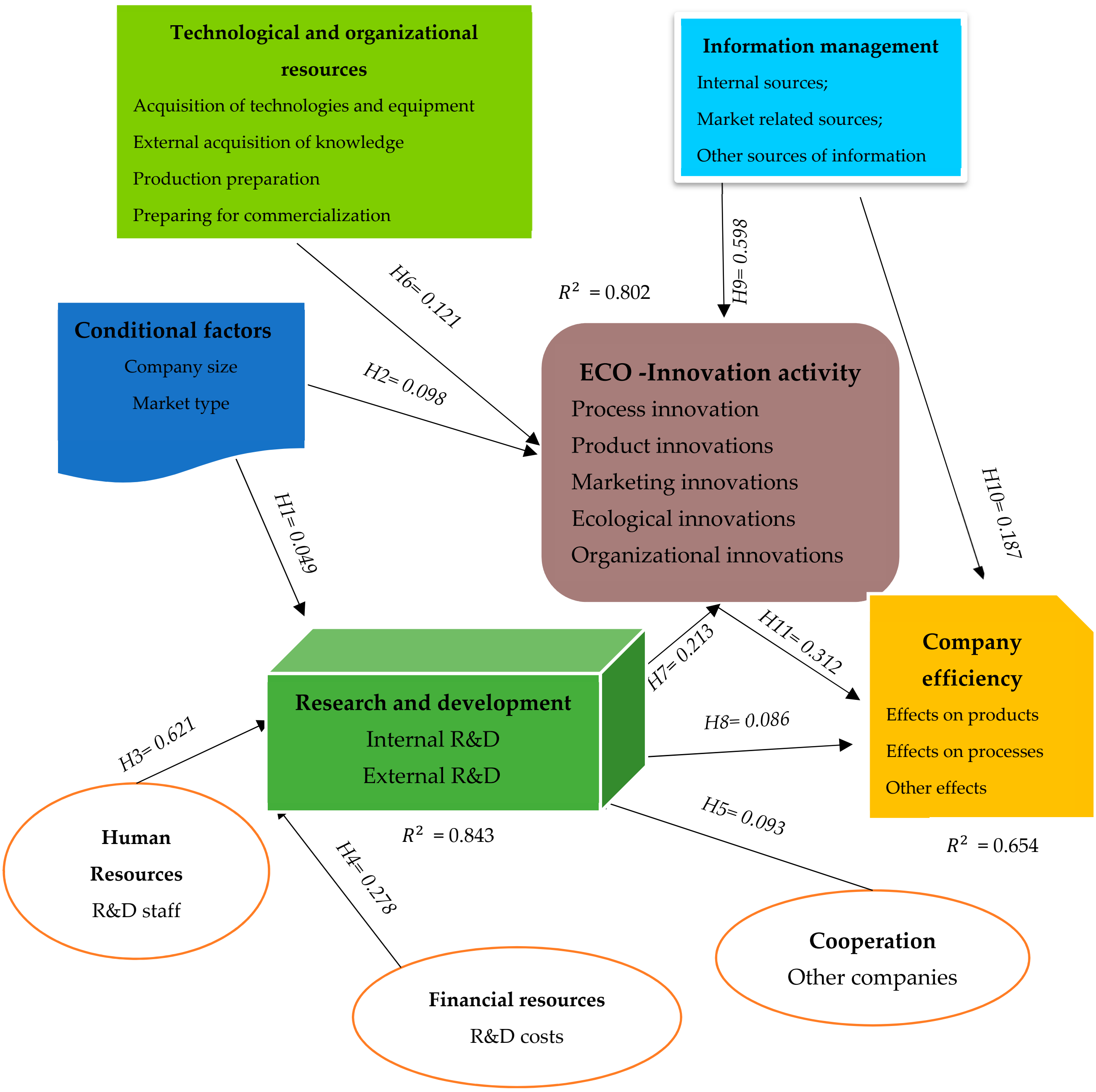


Figure 9. Measurement results.

6. Results and Discussion

The main results of the study are included in Figure 9. Since a PLS technique was used to estimate the model, the regression weights and factor loadings were first calculated for the various constructs, as, in order to evaluate the model, we should use loadings for reflective indicators and weights for the formative variables (Table 2).

Table 2. Weights of variable and factorial loads.

Construction	Type of Construction	Variable	Regression Weights	Factor Load
Con tingent factors (CF)	Independent	Company size Market Type	0.1234 0.8762	0.2912 0.8654
Human Resources (HR)	Independent	R&D staff	1	1
Technological and organizational resources (TOR)	Independent	*Acquisition of technologies and equipment* *Production preparation* *Preparing for commercialization* *External acquisition of knowledge*	0.5998 0.2001 0.4993 0.2007	0.6998 0.3998 0.7003 0.4342
Information Management (IM)	Independent	*Internal sources* *Market-related sources* *Other sources of information*	0.3998 0.2134 0.6012	0.9002 0.6789 0.8765
Financial resources (FR)	Independent	*R&D costs*	1	1
Cooperation (CO)	Independent	*Cooperation with other companies*	1	1
Research and Development (R&D)	Addicted	*Internal R&D* *External R&D*	0.8654 0.4223	0.9877 0.7662
Eco-innovation activity (EIA)	Addicted	*Process innovation* *Product innovations* *Marketing innovations* *Ecological innovations* *Organizational innovations*	0.2145 0.8765 0.5990 0.4001 0.5644	0.6754 0.9811 0.7998 0.7089 0.8997
Company efficiency (CE)	Addicted	*Effects on products* *Effects on processes* *Other effects*	0.3012 0.4127 0.4871	0.9654 0.8965 0.7890

The regression coefficients (path values) between exogenous (independent) and endogenous (dependent) constructs are shown in Table 3.

The following tests are used to assess the consistency of the model:

(1) **Reflective indicators:**

(a) The responsibility of each construct assessing the factor load. The criterion is that the factor loads are greater than 0.700. In this case, the variables on firm efficiency satisfy this constraint, as the Effect on products = 0.965, the Effect on processes = 0.896, and Other effects = 0.789.

(b) Structural reliability is used to test the internal consistency of the constructs. The criterion assumes that it is greater than 0.707. In the present study, the value obtained is 0.965.

(c) Convergent validity. The averaged variance (AVE) proposed by Fornell and Larcker is used:

$$AVE = \frac{\sum \lambda \mathrm{i}^2}{\sum \lambda \mathrm{i}^2 + \sum \mathrm{i} \ \mathrm{var} \ (\varepsilon \mathrm{i})}$$

must be greater than 0.5, as more than 50% of the variation of the structure must be explained by its variables. In the present study, it reaches a value of 0.800.

Table 3. Path coefficients.

Path (ɜ)	CF	HR	TOR	IM	FR	CO	R&D	EIA	CE
CF									
HR									
TOR									
IM									
FR									
CO									
R&D	*0.049*	*0.621*			*0.278*	*0.093*			
EIA	*0.098*		*0.121*	*0.598*			*0.213*		
CE				*0.278*			*0.086*	*0.312*	

(2) **Forming indicators:**

(a) **Multicollinearity.** To avoid the problem of multicollinearity, it is necessary to calculate the inflation variation factor (FIV), which requires a value of less than 5 for all indicators (Table 4).

Table 4. Inflation variation factor (FIV).

Factors	FIV
Contingent l factors (CF)	*1.04*
Human Resources (HR)	*1.07*
Technological and organizational resources (TOR)	*1.23*
Information Management (IM)	*1.07*
Financial resources (FR)	*1.09*
Cooperation (CO)	*1.67*
Research and Development (R&D)	*1.20*
Eco—Innovation activity (EIA)	*1.89*

(b) **Discriminatory validity.** To test the differences between the structures, two criteria are used:

First, the AVE is checked, which must be greater than any other correlation coefficient between the variables. All of the variables meet the criterion (Table 5).

Second, an analysis is made of whether the structure shares more deviations with its adjacent indicators than with other indicators.

Table 5. Discriminatory analysis.

Path (ɜ)	CF	HR	TOR	IM	FR	CO	R&D	EIA	CE
CF	*0.765*								
HR	*0.231*	*1.00*							
TOR	*0.167*	*0.651*	*0.600*						
IM	*0.312*	*0.278*	*0.391*	*0.743*					
FR	*0.189*	*0.765*	*0.154*	*0.512*	*1.00*				
CO	*0.065*	*0.287*	*0.108*	*0.398*	*0.267*	*1.00*			
R&D	*0.367*	*0.712*	*0.217*	*0.522*	*0.813*	*0.357*	*0.749*		
EIA	*0.412*	*0.277*	*0.389*	*0.812*	*0.518*	*0.366*	*0.901*		
CE	*0.387*	*0.451*	*0.512*	*0.765*	*0.399*	*0.287*	*0.544*	*0.977*	*0.871*

The cross-load is shown in Table 6. As it can be seen from the table, the variables of External knowledge, Other sources of information, External research and development activities, and Product innovation are a problem.

Table 6. Cross-load.

	CF	HR	TOR	IM	FR	CO	R&D	EIA	CE
Company size	*0.3561*	*0.1178*	*0.1223*	*0.7654*	*0.1291*	*0.1008*	*0.1009*	0.1009	**0.1234**
Market Type	*0.8752*	*0.2122*	*0.0092*	*0.1998*	*0.3216*	*0.2387*	*0.0987*	0.3912	**0.4321**
R&D staff	*0.2367*	*1.009*	*0.1765*	*0.2943*	*0.5671*	*0.2362*	*0.9021*	0.4568	**0.2786**
Acquisition of technologies and equipment	*0.2778*	*0.1223*	*0.8632*	*0.2981*	*0.2918*	*0.2676*	*0.2097*	0.5002	**0.4098**
Production preparation	*0.1128*	*0.0998*	*0.5211*	*0.2876*	*0.1891*	*0.2998*	*0.1901*	0.1009	**0.0987**
Preparing for commercialization	*0.2146*	*0.1876*	*0.7821*	*0.3287*	*0.2134*	*0.3456*	*0.2345*	0.2991	**0.1034**
External acquisition of knowledge	*0.1789*	*0.1897*	*0.5321*	*0.0098*	*0.1003*	*0.2567*	*0.1008*	*0.0094*	**0.2943**
Internal sources	*0.1732*	*0.2998*	*0.4589*	*0.8799*	*0.3298*	*0.9870*	*0.5002*	*0.6422*	**0.6582**
Market-related sources	*0.2673*	*0.5632*	*0.2999*	*0.8881*	*0.2399*	*0.8001*	*0.6211*	*0.7098*	***0.9127***
Other sources of information	*0.0987*	*0.3211*	*0.4091*	*0.6778*	*0.1998*	*0.9060*	*0.4223*	*0.6144*	***0.6953***
R&D costs	*0.1874*	*0.5778*	*0.0089*	*0.5201*	*1.0976*	*0.5009*	*0.8961*	*0.3434*	***0.5209***
Cooperation with other companies	*0.3217*	*0.2345*	*0.2399*	*0.7991*	*0.5678*	*1.000*	*0.3998*	*0.8001*	***0.8765***
Internal R&D	*0.2742*	*0.8751*	*0.0076*	*0.4224*	*0.3481*	*0.2564*	*0.8975*	*0.4545*	***0.4823***
External R&D	*0.3289*	*0.4321*	*0.8441*	*0.8760*	*0.7532*	*0.4378*	*0.5098*	*0.5634*	***0.4281***
Process innovation	*0.2998*	*0.2999*	*0.3246*	*0.6788*	*0.2983*	*0.8007*	*0.3998*	*0.8976*	***0.6899***
Product innovations	*0.2111*	*0.4111*	*0.2231*	*0.4998*	*0.4521*	*0.6001*	*0.5332*	*0.5765*	***0.5678***
Marketing innovations	*0.5882*	*0.2856*	*0.5431*	*0.4567*	*0.4554*	*0.5907*	*0.3451*	*0.0098*	***0.8701***
Ecological innovations	*0.3217*	*0.4001*	*0.2871*	*0.5671*	*0.8971*	*0.0123*	*0.3452*	*0.4998*	***0.3276***
Organizational innovations	*0.7612*	*0.1009*	*0.6219*	*0.7611*	*0.3874*	*0.50021*	*0.6521*	*0.7001*	***0.3901***
Effects on products	*0.4321*	*0.4881*	*0.5432*	*0.9001*	*0.5009*	*0.8002*	*0.5387*	*0.6897*	***0.9654***
Effects on processes	*0.3277*	*0.2345*	*0.5321*	*0.7991*	*0.2995*	*0.6890*	*0.2099*	*0.8003*	***0.8965***
Other effects	*0.3321*	*0.2561*	*0.5001*	*0.8034*	*0.4002*	*0.5231*	*0.4222*	*0.7345*	***0.7890***

To analyze the structural model, it is necessary to measure the proportion of variance of each dependent construct explained by the independent variables (R^2). The value should be greater than 0.1 (Table 7).

Table 7. Dispersion of each dependent construct explained by independent variables.

Constructs	R^2
R&D	*0.843*
Eco—innovation activity (EIA)	*0.802*
Company efficiency (CE)	*0.654*

(3) To study the contribution of independent variables to the explained variance of dependent variables, the empirical rule is used, where the variable predictor must explain at least 1.5% of the variance (Table 8).

Table 8. Contribution of dependent structures to the explained variance.

Constructs	Path	Correlation	Explained Dispersion (%)
		Consruct **R&D**	
Contingent factors	0.049	0.367	0.013
R&D staff	0.621	0.749	0.327
Financial resources	0.278	0.814	0.187
Cooperation	0.093	0.357	0.098
		R^2	**0.843**
		Construct **Eco-Innovative activity**	
Contingent factors	0.098	0.412	0.092
Technological and organizational resources	0.121	0.389	0.120
Information management	0.598	0.812	0.456
R&D	0.213	0.901	0.341
		R^2	**0.802**
		Construct **Company efficiency**	
R&D	0.086	0.544	0.101
Eco-innovation activity	0.312	0.977	0.381
Information management	0.187	0.765	0.458
		R^2	**0.654**

All of the variables met the criterion and contributed more than 1.5% to the variance. The exceptions are the two variables—Contingent Factors (CF) and Cooperation (CO). In addition, it can be noted that the most influential variable in the R&D construct is R&D Personnel, which explains the deviation of 32.1%, followed by Financial Resources (18.7%). At the same time, Contingent Factors (CF) have an insignificant share. In the construct of Eco-innovation Activity (EIA), the most important factor is Information Management (which explains almost 45% of the variance). Finally, in the construct of Company Efficiency (CE), again, the greatest contribution is Information Management, which explains 46% of the deviation. Overall, 38.71% of the deviation explains eco-innovation activity, and research and development have a very small contribution, which explains 10% of the deviation.

In our case, we employed the Bootstrap technique, obtaining the following results:

Hypothesis 1 (H1). *it is accepted with* $p < 0.05$.

Hypothesis 2 (H2). *accepted with* $p < 0.05$.

Hypothesis 3 (H3). *assumed with* $p < 0.001$.

Hypothesis 4 (H4). *accepted with* $p < 0.001$.

Hypothesis 5 (H5). *accepted with* $p < 0.001$.

Hypothesis 6 (H6). *it is assumed with* $p < 0.001$.

Hypothesis 7 (H7). *accepted with* $p < 0.001$.

Hypothesis 8 (H8). *it is assumed with* $p < 0.01$.

Hypothesis 9 (H9). *accepted with* $p < 0.001$.

Hypothesis 10 (H10). *it is accepted with $p < 0.001$.*

Hypothesis 11 (H11). *accepted with $p < 0.001$.*

Finally, the Stone–Geisser test was used to measure the predictive capacity of the dependent structures. In this case, the value of Q^2 (cross-validated reduction) is calculated and is greater than 0. Consequently, the model has a predictable value (Table 9).

Table 9. Measure the predictive capacity of dependent structures.

Factors	Q^2
Company efficiency (CE)	*0.628*
Eco—innovation activity (EIA)	*0.446*
R&D	*0.474*

7. Conclusions

Innovations are of vital importance for the success of industrial enterprises in Bulgaria. Businesses need not only product or process innovation but also innovation in the way business is run, building partnerships, winning over consumers, and ensuring sustainable development. It is not enough to use innovation only to develop a new product or reduce production costs; it is necessary to apply new methods to gain prestige and the trust of society. For the purposes of research, the theoretical statements related to innovation activity and efficiency have been examined. The definitions of eco-innovations have been studied, and a connection between eco-innovation activity and the increase in the efficiency of industrial enterprises has been substantiated.

In this context, the present work considers eco-innovation activity as a means of increasing the efficiency, competitiveness, innovation, and adaptability of enterprises. The main goal has been achieved, namely—to examine the state of the eco-innovation activity of industrial enterprises and how it affects the efficiency of their activity in the conditions of a turbulent business environment and transit to a circular economy.

A comparative analysis of the innovation potential of Bulgaria in relation to the member states of the European Union was also carried out. It can be concluded that Bulgaria is in the last place in the European Union according to the eco-innovation indicator. The difference from the average European level is very large. The results for Bulgaria on the five indicators, which are included in the indicator for the effectiveness of eco-innovation, compared to the average in the EUnion and the result of the best-represented country for 2021 show the most serious lag in the "Resource efficiency results" (130 positions compared to the European average and 251 positions compared to the leading country in the group) and "Eco-innovation at the entrance" (83 positions compared to the European average and 124 positions to the leader in the group). Regarding the Investments in environmental areas for the period 2010–2021, Bulgaria added 57.0 points to its score, which helped the country climb to 41st place out of the 180 countries surveyed in the world, although it remains last among the 27 member countries of the European Union. For the purposes of the empirical research, a model for analysis of the eco-innovation activity of industrial enterprises and evaluation of its effects on company efficiency is proposed. Its main feature is flexibility, as there are significant correlations between the individual structural elements (constructs) affecting the innovation activity of companies, active links with R&D, and efficiency. All of this leads to the need to apply the model of structural equations (SEM) and PLS techniques.

Since the connections between the structures are complex, we use a model of structural equations in order to find a solution. The data come from our own research and include a sample of 345 Bulgarian industrial enterprises. The results of the author's study were used to determine the innovation activity of enterprises and to establish the factors affecting it.

This study reveals that R&D personnel are of the utmost importance for R&D, as they contribute 32% to the variation in design, followed by Financial Resources (contributing 18% of the variance). Conversely, Contingent Factors and Cooperation have very little weight.

Regarding the eco-innovation activity of the Bulgarian industrial enterprises, it was proved that Information Management is the most important factor (49% of the variation of the design), both for the implementation of Process and Product innovations and for marketing, organizational, and eco-innovation. The other two factors—Contingent factors and Technological and Organizational resources—are not very important.

The factors most important for the efficiency of the company are Information Management (32%), followed by Innovation (24%), and Research and Development (13%).

The analysis of the results of the conducted survey showed that: about 68% of all surveyed enterprises carry out some kind of innovation activity. Comparing this result with the data from the official statistics showed that they match. In Bulgaria, according to the official statistics, most enterprises managed to implement product innovations, 64%; there is an increasing trend of new products; there is a decline in organizational innovations and a serious growth in eco-innovations, 34%.

As a result of the research, the conclusion was reached that the largest employment of a person engaged in R&D is observed among the group of medium-sized enterprises (50%), and the smallest share of personnel engaged in R&D is found in large enterprises (2%). One of the reasons for this serious divergence is the availability of financial opportunities among large enterprises to acquire licenses, patents, or know-how. Moreover, they do not have financial difficulties in taking advantage of external consulting services to realize their innovation intentions. The second-largest group with a high share of people employed in R&D are small enterprises with 35%, followed by the group of micro-enterprises with 13%. In terms of R&D expenditure as a % of total enterprise expenditure, the results show that large enterprises invest the most in R&D, followed by the group of medium-, small-, and micro-enterprises.

Bulgarian industrial enterprises still lack the entrepreneurial innovation culture and the understanding that it is necessary to invest in human capital, which is key to the creation of R&D and the increase in economic results and efficiency. It is necessary to invest in technological development and concentrate efforts on R&D to achieve better eco-innovation activity, efficiency, and competitiveness.

In the future, the authors intend to investigate critical factors that significantly influence the ability to implement innovations aimed at achieving sustainable supply chains and contribute a process model for sustainable innovation development in supply chains. This will provide transformative changes to linear and one-way supply chains and make them circular and more sustainable.

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Notes

[1] Eco-innovation Observatory, http://www.ecoinnovation.eu/ (accessed on 13 March 2022).

[2] https://ec.europa.eu/environment/ecoap/about-action-plan/etap-previous-action-plan_en (accessed on 13 March 2022).

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