

Environmental Management for Sustainable Business in Chemical Industry in Bulgaria

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Abstract. Implementing effective environmental management for sustainable business is expressed in the integration of digital innovations, responsible sustainable practices, morals and motivation, environmental ethics, added value and recycling policies. The relevance of the topic is substantiated by the serious challenges modern businesses face regarding climate change, ecological sustainability, and social responsibility. The present study aims to prove that in the conditions of increasing public and corporate interest in environmental issues, organizations are brought to a growing need to adapt their business models by incorporating sustainability principles. Investors, regulators and consumers are directing their attention towards companies demonstrating commitment to environmental and social standards. The following research tasks have to be settled for reaching the above-mentioned goal: 1. to research the impact of the chemical industry on the environment; 2. to research the evolution of the way business is conducted; 3. to determine the extent of compliance of the business model of companies in the chemical industry with Sustainable Development Goals; 4. to identify new professions and roles in the context of environmental management for business needs. In the course of the study shall be justified the thesis that the combination of digital technologies, ethical principles and sustainability strategies provides Bulgarian companies in the chemical industry with the opportunity to adapt to current challenges, developing innovative business models, resp. meet regulatory requirements, create added value, competitive advantages and long-term sustainability. The methodology of questionnaire survey was used. The sample was formed by the method of random non-recurrent selection. The results of the research are expressed in the identification of best practices to serve as catalysts for balancing economic profitability and environmental responsibility. Additionally, innovative digital technologies to support businesses in environmental management, potential technological solutions to enhance the efficiency and sustainability of business processes and proposals for new professions and roles within the context of environmental management in enterprise practices are outlined.

Keywords: added value, chemical industry, environmental management, sustainable business

I. INTRODUCTION

The chemical industry plays an important role in economic growth and societal development. The significance of the sector is evidenced by the fact that chemical products are utilized by both large industrial enterprises and individual consumers in the production of everyday goods, agriculture, manufacturing and service activities. This includes the production of materials such as fuels, plastics, cosmetics, fertilizers and plant protection agents [1].

At the same time, today, environmental and climate policies are at the forefront of a comprehensive package of industrial, innovative and societal ambitions. The European Commission has announced its European Green Deal (EGD). The EGD includes a number of significant innovations including a Climate Law that enshrines the goal of net zero greenhouse gas emissions by 2050 and a revised EU Adaptation Strategy that recognizes that more ambitious and urgent efforts are needed to improve resilience to climate impacts. Taken together, it constitutes the most ambitious sustainability strategy produced by a supranational entity to date, with ambitious climate action at its core [2]. The condition, regulations and prospects within the chemical industry play a pivotal role in these processes.

The chemical sector is the 4th largest manufacturing producer in Europe in turnover terms and employs over 1.2 mln people directly. This makes Europe the second largest producer of chemicals in the world, with 2021 sales amounting to 594 billion EUR according to the report from CEFIC “The European Chemical industry Facts and Figures 2023. A vital part of Europe’s Future” from 05 December 2023 after China (Fig. 1) [3].

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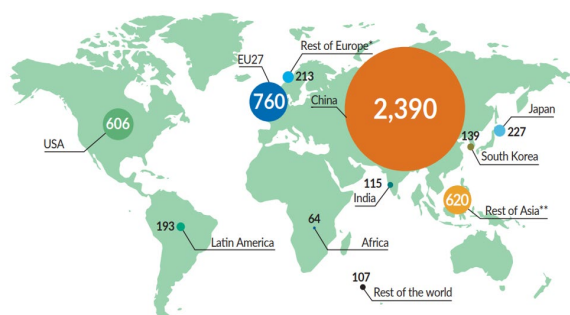


Fig. 1. World chemical sales, 2022 (€5,434 billion). Source: 2023 Facts And Figures Of The European Chemical Industry, <https://cefic.org/a-pillar-of-the-european-economy/facts-and-figures-of-the-european-chemical-industry/>

The Bulgarian chemical industry has traditionally been a leading sector for the country, contributing to enhanced productivity, GDP and improved foreign trade in selected products. Data up to date for 2022 indicate that the sector is characterized by a turnover of €4.541 billion, Capital Spending of €432 million and R&D Investment of €856 million. The number of companies is 634 with a direct employees of 12,850 [4].

The processes in chemical production are often associated with negative impacts on the environment. All of them cause a threat to the life, health and safety of people, animals and plants. This has prompted the widespread recognition today of the need for sustainable practices in business, including in the field of the chemical industry, to overcome existing risks to the environment, economy and society. In order to meet these expectations, the chemical industry is undergoing a significant transformation aimed at reducing negative impacts on the environment and maintaining a balance between the economic, social and ecological aspects of the business.

To regulate the sector and ensure accountability and promotion of sustainability, a series of international agreements, regulations, standards and voluntary instruments have been adopted, the most important of which are: The European Green Deal, Transition pathway for the chemical industry, Chemicals strategy for sustainability, Regulations for Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), etc. [5]-[10].

The review of scientific literature highlights the opportunities for intelligent, innovative and sustainable industry including Bulgaria [11] – [14], etc.

Chemical enterprises are faced with the necessity of transforming their business models by incorporating sustainability principles.

II. MATERIALS AND METHODS

To achieve the research tasks, a practical study has been conducted through the methodology of questionnaire survey among 28 chemical enterprises in Bulgaria. The sample was formed by the method of random non-recurrent selection (January 2023- January 2024). The research is divided into three categories for diagnosing the economic, social and environmental sustainability of the respondents in accordance with the classical three pillars of sustainable development. (Triple Bottom Line/TBL). The survey technique is built on the Likert scale of questions. Each

question has five optional answers, ranging between number 1 for “strongly disagree”, number 2 for “disagree”, number 3 for “neutral”, number 4 for “agree” and number 5 for “strongly agree”. A company meeting the criteria for an Eco-Minded Business was randomly selected for a fragmentary study using the Case method. NOISE Analysis was also conducted to identify the distinguishing characteristics of this company to the highest possible extent.

III. RESULTS AND DISCUSSION

A. Impact of the Chemical Industry on the Environment

The processes in chemical production have impacts on the environment in two directions: direct (environmental) impact and indirect (social and economic) impact.

Direct negative impact is associated with environmental pollution of the air, water and soil. The specific pollutants generated depend on the type of chemical processes involved and the substances used. Some of the main environmental pollutants from the chemical industry include:

- air pollutants (ammonia (NH₃), volatile organic compounds (VOCs), nitrogen oxides (NO_x), fine particulate matter (PM) and sulphur oxides (SO_x), etc.),
- water pollutants (heavy metals, chlorides, sulfides, nitrates, and oxides),
- soil pollutants (heavy metals, organic compounds, pesticides and herbicides, salts and acids, petroleum hydrocarbons, dioxins and furans),
- greenhouse gas (GHG) emissions (carbon dioxide (CO₂)).

Indirect negative impact relates to interference with biodiversity, inefficient resource management, high energy consumption, the risk of emergency situations, working in hazardous conditions, etc.

The results indicate that the policies of companies in chemical industry should be oriented towards environmentally responsible practices, promoting commitment to climate change, effective management of chemicals and waste and stimulating innovative business practices to achieve sustainability. There is a need for the adoption of an appropriate managerial strategy for such a business model.

B. Analysis of Traditional management and Environmental management in chemical industry in Bulgaria

Traditional management and environmental management represent two different approaches to business management. While traditional management primarily focuses on financial results and short-term goals, environmental management aims to achieve a balance between economic, environmental and social responsibility. Integrating sustainable practices into the business model can enhance the company’s reputation, reduce risks and contribute to long-term success.

Traditional management (Profit-Minded Business) is a standard approach applied to companies, including those in the chemical industry. It primarily focuses on short-term profit, efficiency in achieving specific business goals, centralized decision-making, etc. In traditional

management, the priority is typically on financial metrics. *Environmental management* is a strategic approach focused on integrating sustainable and environmentally responsible practices into all aspects of a company's operations. This approach involves actively complying with environmental regulations and standards, improving energy efficiency, sustainable resource utilization, innovation in production processes and designing products with minimal environmental impact. The primary goal of environmental business management is not only to comply with regulations but also to engage in responsible and sustainable management that generates benefits not only for the company but also for society and the environment.

The research among companies in the chemical industry identified the following fundamental aspects, typical of traditional business management: Profit orientation (PO); Short term perspective (STP); Standard manufacturing methods (SMM); Traditional energy sources (TES); Not responsible for raw materials and water resources (NRRMWR); Passivity towards waste and recycling (PWR); Limited strategic focus (LSF) (Fig. 2).



Fig. 2. Traditional management.

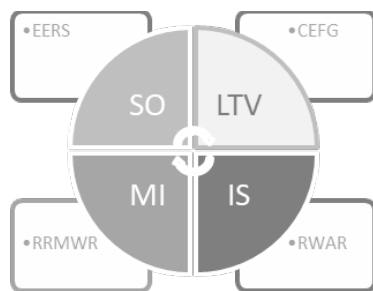


Fig. 3. Environmental management.

Results, regarding the important aspects in Environmental management, have found expression in: Sustainability orientation (SO); Long term vision (LTV); Care for the environment and future generations (CEFG); Manufacturing innovation (MI); Energy efficiency and renewable sources (EERS); Responsible use of raw materials and water resources (RRMWR); Reduces waste, actively recycles (RWAR); Integrating sustainability (IS) (Fig. 3).

Another aspect of our research found expression in the relationship between Environmental Management and Sustainable Business. It expresses the aspiration to achieve a balance between business objectives and the environmental responsibility of companies in the chemical

industry, as follows: \surd *Environmental Management* focuses on developing and implementing strategies, policies and practices that reduce the negative impact of business operations and production processes on the environment. This includes waste management, optimization of energy and water usage, as well as compliance with environmental standards. \surd *Sustainable Business* is a broader and more comprehensive approach that encompasses the management of business in environmental, social, and economic aspects. This model aims for long-term success by combining profitability with social responsibility and environmental stewardship.

\surd Companies in chemical industry in Bulgaria, aiming for sustainable business, frequently incorporate environmental principles into their *corporate social responsibility* (CSR) strategies. This involves caring for employees, the community, society and the environment, as they seek to create a positive societal and environmental impact. \surd The integration of Environmental Management into Sustainable Business promotes *innovations* in production processes, designs and technologies. The approach is reflected in more *efficient* resource utilization and the creation of products/services with a lower environmental footprint.

C. Concept of Eco-Minded Business

In the context of the research *Eco-Minded Business* refers to enterprises actively adopting and implementing practices and strategies for environmental conservation. These are businesses that strive to minimize their negative impact on nature, embrace green technologies and processes and incorporate environmental principles into decision-making strategies. To present itself as an environmentally conscious company in the chemical industry to businesses and society, it should have developed and implemented strategies such as:

- environmental management and certifications;
- transparency in environmental and social practices, including publishing annual sustainability reports;
- participation in Ecosystem restoration programs;
- innovations in products and services with a focus on sustainability;
- employee training and cultivating an eco-responsibility culture;
- ecological partnerships;
- communicating and sharing corporate sustainability achievements.

All of these efforts contribute to the company showcasing its environmental reputation to both the business community and the wider society.

For the purposes of the research, one company from the sample that meets the criteria of an Eco-Minded Business has been selected. A fragmentary investigation has been conducted using the NOISE Analysis (Table 1) to identify as many distinctive characteristics of this company as possible.

D. Determination the extent of compliance of the business model of companies in the chemical industry with Sustainable Development Goals

The research covers three categories of indicators related to the economic, social and environmental aspects of sustainable development, in accordance with

TABLE 1 NOISE ANALYSIS

<p>STRENGTHS</p> <ul style="list-style-type: none"> • Extensive experience and a history in the chemical products industry; • A wide range of products and services that can meet various customer needs; • Stable financial position and strong resources for investment; • Expertise in research and development activities. 	<p>NEEDS</p> <ul style="list-style-type: none"> • Optimization of production processes for greater efficiency; • Comply with strict regulatory requirements in safety and environmental areas; • Development of new products that meet market demand; • Improvement in business sustainability in response to changes in societal preferences.
<p>OPPORTUNITIES</p> <ul style="list-style-type: none"> • Market expansion in developing countries; • Potential for developing innovative products that cater to the demand for green technologies; • Strategic partnerships with other companies for joint research and development; • Growing societal interest in sustainable and environmentally responsible products. 	<p>IMPROVEMENTS</p> <ul style="list-style-type: none"> • Enhancing the efficiency of production lines to reduce costs; • Investments in new technologies to improve manufacturing processes; • Improvement of quality management systems to achieve high-quality standards; • Development of training and programs for staff.
<p>EXCEPTIONS</p> <ul style="list-style-type: none"> • Risks associated with instability in raw material prices; • Possible challenges in the supply chain connectivity; <ul style="list-style-type: none"> • Competition from emerging technologies and new market participants; • Potential reputation issues in the event of accidents or environmental incidents. 	

(Source: authors' own research)

TBL. In each of the three categories, eight indicators have been included, selected as a result of a review of specialized literature, indicators for assessing the degree of integration of sustainability into the business practices of the chemical companies in the sample [1], [15] – [22].

The indicators are following:

a) Economic Indicators (EI): The company's economic strategies align with global best practices for sustainable development (EI1); The organization recognizes the economic impact of its operations within the chemical manufacturing sector (EI2); The company actively invests in economically sustainable technologies to enhance efficiency (EI3); The company prioritizes the development of economically viable and sustainable products (EI4); The company has a well-defined economic efficiency plan in place (EI5); The organization is committed to optimizing resource utilization and minimizing economic waste (EI6); The company has strategies in place to enhance economic value while minimizing negative impacts on stakeholders (EI7); The organization consistently explores innovative economic approaches in its business model (EI8).

b) Social Indicators (SI): The company's social vision and strategies align with global best practices for sustainable development (SI1); The organization recognizes the social impact of its chemical manufacturing operations (SI2); The company actively adopts socially responsible practices, considering the welfare of its workforce (SI3); The company prioritizes the development of socially responsible and inclusive products (SI4); The company has a comprehensive social responsibility plan in place (SI5); The organization is committed to promoting social well-being and community engagement (SI6); The company has strategies to ensure fair and ethical labor practices in its chemical manufacturing processes (SI7);

The organization consistently innovates to address social challenges within the industry (SI8).

c) Ecological Indicators (EL): The company's ecological vision and strategies align with global best practices for sustainable development (EL1); The organization recognizes the ecological impact of its chemical manufacturing operations (EL2); The company actively adopts ecological technologies to minimize environmental impact (EL3); The company prioritizes the development of environmentally friendly and sustainable products (EL4); The company has a well-defined ecological efficiency plan in place (EL5); The organization is committed to minimizing wastage and implementing recycling practices (EL6); The company has strategies to reduce energy consumption and promote ecological sustainability (EL7); The organization continuously innovates to introduce new ecological products and processes (EL8).

For evaluating the results, the one-dimensional statistical method of summing up Likert rating scores has been used. It assumes that the individual rating

TABLE 2 DISTRIBUTION OF THE NUMBER OF RESPONSES WITH REGARD TO THE ECONOMICS INDICATORS FOR DIAGNOSTIC AND ASSESSMENT SUSTAINABILITY IN CHEMICAL ENTERPRISES IN BULGARIA

EI	1	2	3	4	5	TRS	R
EI1	8	5	4	2	9	-1	VI
EI2	0	0	1	11	16	43	I
EI3	1	6	4	7	10	19	III
EI4	2	7	1	10	8	15	IV
EI5	0	10	5	4	9	12	V
EI6	0	4	2	7	15	33	II
EI7	5	12	3	1	6	-9	VII
EI8	4	9	6	2	6	-1	VI

(Source: authors' own research)

score for each of the responses is from -2 to +2, corresponding to "completely disagree" the score is -2, for "rather disagree" is -1, for "neutral" is 0, for "rather agree" is +1 and for "completely agree" is +2. After multiplying them by the number of respondents who preferred the respective answer and summing up the obtained products, the total rating score (TRS) for a specific indicator and a specific part of the scale is obtained. It is the basis for ranking the indicators and determining their rank (R), which serves to draw the respective conclusions.

The results of the arrangement, assessment and ranking of the indicators for diagnostic and assessment the economics, social, ecological sustainability in chemical companies in Bulgaria are presented in a tabular format (Table 2, Table 3, Table 4). They provide the foundation for the following conclusions:

First, companies acknowledge the economic impact of their activities and commit to optimizing resource utilization while minimizing economic losses (EI2 и EI6). The lowest rating concerns the companies' performance regarding their long-term economic strategies, which are simultaneously flexible and beneficial for stakeholders. (EI1, EI7 и EI8) (Fig. 4).

TABLE 3 DISTRIBUTION OF THE NUMBER OF RESPONSES WITH REGARD TO THE SOCIAL INDICATORS FOR DIAGNOSTIC AND ASSESSMENT SUSTAINABILITY IN CHEMICAL ENTERPRISES IN BULGARIA

SI	1	2	3	4	5	TRS	R
SI1	14	3	2	6	3	-19	VIII
SI2	1	5	1	8	13	27	I
SI3	2	5	5	6	10	17	III
SI4	5	4	9	4	6	2	VI
SI5	2	5	4	6	11	19	II
SI6	4	5	3	8	8	11	V
SI7	1	6	5	9	7	15	IV
SI8	5	15	1	4	3	-15	VII

(Source: authors' own research)

TABLE 4 DISTRIBUTION OF THE NUMBER OF RESPONSES WITH REGARD TO THE ECOLOGICAL INDICATORS FOR DIAGNOSTIC AND ASSESSMENT SUSTAINABILITY IN CHEMICAL ENTERPRISES IN BULGARIA

EL	1	2	3	4	5	TRS	R
EL1	11	4	3	6	4	-12	VI
EL2	2	4	2	12	8	20	I
EL3	4	3	1	14	6	15	III
EL4	6	4	0	11	7	9	V
EL5	2	5	3	10	8	17	II
EL6	2	6	1	8	11	20	I
EL7	6	1	4	9	8	14	IV
EL8	1	7	0	14	6	17	II

(Source: authors' own research)

Second, regarding the social impact, companies assess and consciously plan their socially responsible actions (SI2 и SI5), but the innovation activity of chemical companies is still low, leading to a lower alignment of their social vision and strategy with global best practices for sustainability (SI1 и SI8) (Fig. 5).

Third, concerning the environmental aspect of sustainability, companies highly acknowledge their environmental impact on the environment. They develop environmental plans, committing to environmental initiatives and innovations (EL2, EL5, EL6 и EL8). Companies have not yet reached the global best practices for ecological products and sustainable activities (EL1 и EL4) (Fig. 6).

E. Roles and Professions in the Context of Sustainability

Emerging careers of the future (resp. new sustainability-related professions / careers) is viewed as an extremely positive development. Nowadays, some of them belonging to the National Classification of Professions and Positions in Bulgaria (NCP 2011) are: sustainability manager, sustainability coordinator, sustainability specialist, internal sustainability auditor [23]. Based on the study about the need for new types of knowledge, skills and competences in the context of

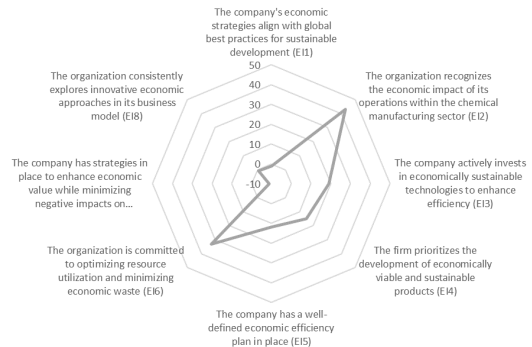


Fig. 4. Ranking of economic indicators for diagnosing and assessing sustainability in chemical companies in Bulgaria.

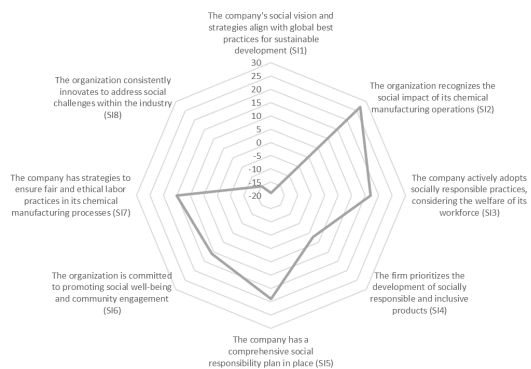


Fig. 5. Ranking of the social indicators for diagnosis and assessment of sustainability in the chemical companies in Bulgaria.

the researched issues, we can also propose some future professions:

- **Sustainable Management Specialist** (responsible for developing and implementing strategies for sustainable management of the company, assessing the impact of activities on the environment and developing practices to optimize sustainability).
- **Environmental Auditor** (will assess the environmental efficiency of business processes and assist the company in identifying areas for improvement while adhering to sustainable standards and regulations).
- **Green Innovator** (will implement new technologies and innovations that support sustainable practices; development of green products, processes, systems).

- **Social Responsibility and Sustainability Specialist** (will be involved in the social responsibility of the company, including interacting with the community and building sustainable values within the company).
- **Climate Analyst** (will research and analyze the impact of climate change on the enterprise and provide recommendations for reducing the carbon footprint).
- **Energy Manager** (responsible for using green energy sources and optimizing energy efficiency in all aspects of the business).
- **Circular Economy Specialist** (will develop and manage economic models that support the transformation of waste into resources and promote sustainable use of materials).

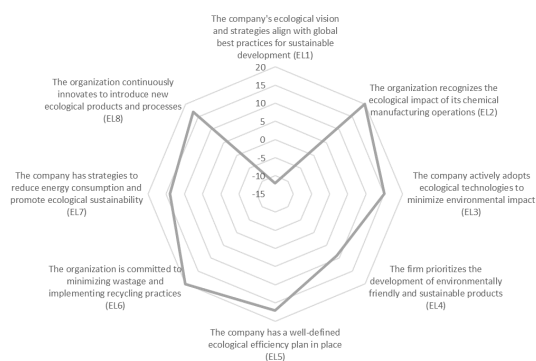


Fig. 6. Ranking of the environmental indicators for diagnosis and assessment of sustainability in the chemical companies in Bulgaria.

- *Green Public Relations Manager* (will coordinate the company's communication with the public regarding sustainable initiatives and will be responsible for building a positive business image in the environmental field).
- *Ethical Manager* (will create and maintain ethical standards and procedures in the company, including environmental care and social responsibility).
- *Environmental and Legislative Advisor* (will inform the company about current environmental laws and standards, as well as advise on compliance with them).

These new roles and professions will be of crucial importance for companies. They will play a key role in integrating sustainable practices into all aspects of business and in creating successful environmental management strategies.

IV. CONCLUSIONS

The future of the chemical industry in Bulgaria is associated with modern technologies, digitalization of working processes, innovative software solutions and ways to protect the Environment. It is green and sustainable. The empirical research, that was carried out in the companies of the chemical industry from the sample, confirms that: 1. Environmental management and Sustainable Business are successfully integrated becoming an important part of the sustainable business strategy; 2. the connection between Environmental Management and Sustainable Business lies in rethinking and applying business models that strive not only for economic success but also for environmental sustainability; 3. the business of the future in chemical industry (including in Bulgaria) should adopt a broad approach to sustainability by integrating not only economic but also social and environmental responsibility into business activities. This includes care for people, the planet and profit. It promotes innovation and constant adaptation, including in connection with sustainability principles and demonstrates social responsibility.

The results of our research visualize the perspectives for the development of Environmental management for Sustainable Business with an emphasis on the companies of the chemical industry in the short and long term. It has the potential for strategic impact as well as to become catalysts for change and take on leadership roles in developing sustainable practices in chemical industry.

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