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Influence of Sustainable Strategic Management on Methane Projects as Exemplified by the Jastrzębska Spółka Węglowa S.A. Mining Company

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Abstract: This article presents research conducted in one of the largest mining companies in the EU—Jastrzębska Spółka Węglowa S.A. It relates to how the implementation of sustainable strategic management has affected methane projects. In the study, a literature analysis was first conducted, establishing the existence and significance of the research gap. Then, a group of experts from JSW S.A., during moderated workshops, prepared a multidimensional model describing the structure of the implementation of sustainable strategic management. The model was constructed and verified using the AHP method. As a result of the study, it was found that the implementation of sustainable strategic management resulted in a change of the company's strategic priorities. Significant professionalization of management in the course of these projects was also observed. The most important and beneficial element of the implementation was the adoption of strategic goals related to the production of their very own energy based on methane emitted by mines. Other noteworthy elements of the change concern the introduction of continuous business case assurance during projects and the standardization of the project phase model.

Keywords: mining industry; methane projects; strategic management; sustainable management; project management; analytic hierarchy process; balanced scorecard; scenario methods

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1. Introduction

The aim of the article is to present the impact of organizational change consisting in the implementation of sustainable strategic management on the management of methane projects in Jastrzębska Spółka Węglowa S.A. (JSW S.A. or JSW) [1]. The audited company is the largest producer of high-quality coking coal and a significant producer of coke in the European Union. JSW, like the entire coal sector, or more broadly the mining sector, faces many challenges of various types. One of the keys, also constituting the justification of the research presented in this article, is the response to climate threats and the resulting need to implement solutions based on the assumptions of sustainable development [2,3]. Increasingly, these challenges are also reflected in the concepts, approaches, and tools used in management [4–6].

The issue of management in mining sector enterprises, especially in the context of building a sustainable economy, should be considered extremely important. This is due to the fact that such entities, through a large scale of operations and the specificity of the mining process and products, have a significant impact on the natural, social, and economic environment [7–10]. Even a small improvement in the efficiency of mining enterprises can cause not only economic effects, but also significant, beneficial environmental and social effects. Despite its importance, the issue of managing enterprises in the mining sector is rather a niche field of research exploration.

Below, in Table 1, selected bibliometric information based on the analysis of the Scopus and Web of Science (WoS) databases is presented. The subject of sustainable strategic management, to which this article refers, appeared in the Scopus database in 97 publications, and in the WoS database in 87. Only some of them refer to social sciences and management. Earth sciences, environmental sciences, and engineering are the most numerous. It is worth emphasizing that the first publications on the subject in question appeared at the beginning of the 20th century. In recent years, an increase in research activity has been observed, although the number of publications is still small.

Table 1. Basic bibliographic analysis of the issue of sustainable strategic management in the mining industry.

Key Words	Scopus	WoS
management & mining & company	6020	8653
sustainable & management & mining & company	648	932
sustainable & strategic & management & mining & company	97	87

Source: own elaboration.

At the next stage of the initial literature research, a review of the separate publication databases in Scopus and WoS was carried out. On this basis, the main directions of ongoing research have been identified. They concern the relationship between mining companies and stakeholders and the impact these companies have on the environment. It is dominated by the presentation of case studies from developing countries, e.g., [9,11–14].

Few studies concern an improvement to the management process in mining companies, or even more narrowly, coal companies. One of the few publications on this issue, by F. Doulati Ardejani et al., presents a conceptual framework of green mining strategy [15] (p. 113). The model proposed there is aimed at minimizing the negative environmental and social effects of investments by carrying out structured impact analyses and remedial action plans. Although this concept is based on a process approach, it draws attention to the special role of the strategic justification phase of investment projects. It is part of the investment project related to the launch of the mine. Thus, a component resulting from the design approach can be seen here.

An interesting supplement to these studies was proposed in the article by C. Le Guill and F. Poupeau [16], in which the framework of the social-economic system developed by E. Ostrom was verified, which also allows for the evaluation of new mining processes. The presented analysis of cases from Peru and the USA led to the identification of structural factors for these types of projects. The main part of this analysis is related to the activity of stakeholders [16] (p. 6). On the other hand, the factor defined by researchers as "strategic development of the company" was verified as a sub-structuring factor.

Both models presented above indicate the need to improve the initiation process as well as investment preparation in terms of a better understanding of the social and environmental context. In terms of the dimensions of sustainable development, however, the economic aspect and the resulting need to ensure the efficiency of the actions taken are also taken into account. This point of view is presented in the article by D.N. Moldashi, which indicates methods (e.g., SWOT or EVA) supporting the implementation of the strategy of mining companies by improving the efficiency of investment projects resulting from these strategies [17].

Summing up the conducted analysis of the literature, it can be stated that:

- research on management in mining sector organizations is of a niche nature,
- the existing research is dominated by a perspective based on the stakeholder approach and the concept of sustainable development,
- the perspective of improving the management methodology is presented individually, e.g., in the context of financial methods or decision-making methods.

- no publications presenting a holistic approach to improving the management process in the mining sector enterprises were identified.

It can therefore be concluded that there is a research gap regarding the presentation of the use of management instruments for the implementation of the concept of sustainable development in the business activity of mining enterprises. The need for research in this direction is highlighted by Lazarenko Y. et. al. [18] (p. 1). In order to provide a partial answer to the identified research gap, the research presented in this article on the effects of implementing sustainable strategic management was initiated at JSW S.A.

Methane occurs in coal seams in the form of free or adsorbed gas. [19] Below, on Figure 1 there is presented an information about methae emissions in Polish coal mining. Coal seams in the area of JSW S.A. operations are characterized by a relatively high methane content in coal seams, amounting to approximately 10m^3/t Dry Ash Free (daf) coal, and in some places even up to 20 m^3/t daf coal [20]. Such a high content of methane necessitates taking actions aimed at methane drainage of the deposits, and thus improving the safety of the work crews. The issue of occupational safety is extremely important to JSW, also as a result of tragic events related to methane that have occurred in JSW's mines. At the same time, methane as a gas is characterized by a very high greenhouse effect; its impact on the greenhouse effect is estimated as 25 times higher than CO_2 [21].

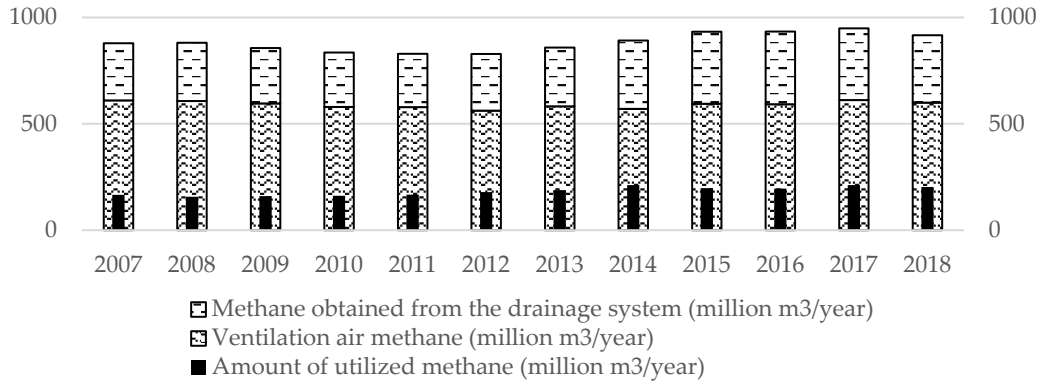


Figure 1. Methane emissions in Polish coal mining. Source: own elaboration based on [20].

Therefore, regardless of external factors, JSW, aiming both at the safety of mine crews, strives to drain methane deposits and reduce methane emissions in the air coming from the mine, mainly through exhaust shafts. Initiatives related to methane drainage and/or management of extracted methane are important from the point of view of the strategy due to both the economic dimension (downtime in the event of a hazard or explosion) and the social dimension (work safety, methane emission, environmental hazard).

2. The Issue of Implementing Sustainable Strategic Management in the JSW S.A. Mining Company

2.1. JSW. S.A.—Historical Context of Functioning and Characteristics

The first use of hard coal by man was documented in China's Fushun province in 1000 BC. In Europe, we owe the first mention of hard coal to Aristotle, who in the 4th century BC wrote about the occurrence of combustible stones in Thrace [22]. Such a long history of hard coal concerns coal used as a source of heat or as one of the fuels used in the production of electricity. In the case of JSW S.A., the key product is not thermal coal, but one of only 30 critical raw materials of the European Union, coking coal [23]. It currently accounts for approximately 80% of JSW S.A.'s total coal production.

The history of humans using coking coal is much shorter. The dynamic development of the world economy, especially during the industrial revolution, rapidly increased the demand for iron products, which led to the mass logging of forests for the production of charcoal, which is necessary in metallurgy. According to Frużyński, in 1785 there were 44 blast furnaces operating solely in Upper Silesia, consuming 60 thousand tons of

charcoal, for the production of which it was necessary to secure 240 thousand tons of wood. The breakthrough came in Great Britain in 1735, when Abraham Darby's Coalbrookdale ironworks was first to develop pig iron by using coke to smelt iron ore. In Poland, the first attempts to move away from charcoal in metallurgy took place in 1788, but they ended in failure because of the inappropriate type of coal. It was not until 1790 that Salomon Isaac of Brabant discovered coal deposits suitable for coke production in the region of Zabrze and Chorzów [23]. Since then, there has been dynamic development in metallurgical coal mining and coking in Upper Silesia, and therefore a departure from charcoal and, consequently, the felling of trees being replaced with coking coal mining.

Understanding the difference between steam coal and coking coal is important because, on the wave of decarbonization of the global economy, restrictions on access to capital enabling development and transformation apply to both the steam coal mining industry (partly replaceable by renewable energy sources (RES) and coking coal, which is still the basic raw material necessary in the steel production process. Although research and development projects are being carried out aimed at eliminating coke from the steel production process, it is still necessary for the production of steel on an industrial scale [24]. In the 21st century, the demand for steel increased 2.4 times, reaching an annual production level of 1.88 Gt worldwide. This means a demand for coking coal in the amount of approximately 1.1 Gt [25]. It is estimated that by 2050 the consumption of steel will increase by about 20% compared to the current consumption [25]. However, these estimates seem to be extremely cautious in view of the dynamically increasing annual consumption of steel per person in the 21st century from 150 kg in 2001 to 230 kg in 2022 [26], i.e., by 53%, and the increase in the world population in this period by 28% [27] and the expected further growth of the world's population by 2050 by another 21% compared to 2021.

The increase in demand for steel postulated by the World Steel Association probably takes into account only the increase in population [26], ignoring the increase in demand per capita. In the perspective of 2050 rather, an increase in the demand for steel at the level of at least 45% should be expected, without taking into account the dynamic increase in the demand for armaments that began as a result of the war in Ukraine, and thus another demand impulse for steel. Given the current lack of an alternative to coking coal in the production of steel, and, at the same time, the expected further increase in demand for steel, the issues of strategic management in the company, which is the largest producer of one of the thirty critical raw materials in the EU, should be included among the issues of particular importance both at the level of the enterprise itself, Poland, and the European Union.

Jastrzębska Spółka Węglowa S.A. was established on 1 April 1993. It consisted of seven independently operating mining enterprises, which were transformed into a company wholly owned by the State Treasury. On 6 July 2011, JSW S.A. debuted on the Warsaw Stock Exchange. The company is the parent company of the JSW Capital Group. The majority shareholder of JSW S.A. is the State Treasury.

In the years 2003–2005, a decision was made to produce coke as an element of diversification in the value chain, also by increasing the capital share in Koksownia Przyjaźń. In 2014, Koksownia Przyjaźń S.A. merged with Kombinat Koksochemiczne Zabrze S.A., as a result of which JSW KOKS S.A. was established, a subsidiary of JSW S.A. The company is a leading European producer of high-quality coke. As a result of organizational changes in the corporate structure of the JSW Capital Group, four coal mines and three coking plants are currently in operation.

JSW S.A. is the largest producer of hard coking coal and for years has held a key position on the Polish and European markets, thanks to the production of high-quality coking coal and the location of its operations in the vicinity of its main customers. JSW S.A. it is also a sales center for coke and all coal-derived products produced by coking plants belonging to JSW KOKS S.A. Over the last 30 years, a thorough technical, economic, organizational, and technological restructuring, as well as creating the basis for increasing work efficiency and reducing costs, have contributed to the creation of one of the most modern hard coal companies in Europe.

The development of entities operating on such a large scale and with a large impact on the socio-economic environment and the natural environment requires the use of systemic strategic management. This necessity is also noticed in the literature [28–30]. Researchers emphasize challenges resulting from the dissonance between dynamically changing price conditions and their impact on the situation of mining companies [31]. They also draw attention to the need for a long-term view of investments carried out by mining companies [32]. The currently adopted strategy of JSW S.A., taking into account subsidiaries for the years 2022–2030, sets the directions for development for the entire capital group and indicates key strategic areas enabling long-term development and creating added value for stakeholders. It is a response to the challenges arising from the dynamically changing global market environment, economic situation, and changes in the capital structure of the group, as well as those related to maintaining stable, long-term growth along with meeting the expectations of stakeholders and adapting to the challenges resulting from climate change.

2.2. Integration of Strategic Management and Sustainable Management at JSW S.A.

An extremely important element for the functioning of the JSW S.A. capital group is to adapt its activities to regulatory and legal changes in the field of climate issues. This was reflected in the adopted Environmental Strategy of the JSW Capital Group until 2030 with an outlook until 2050. The development of this document resulted from the guidelines of the Paris Agreement and the assumptions of the European Green Deal and the FIT FOR 55 package. It mainly refers to changes in the reduction of greenhouse gas emissions. Based on the above assumptions, the JSW S.A. capital group has planned to take action to reduce greenhouse gas emissions in its activities. It includes the implementation of projects to reduce the main sources of emissions by 2030, including the development of innovative emission reduction technologies for further neutralization by 2050 (Net Zero). An element of the strategy is also the diversification of activities based on low-emission and taxonomic products and services. As environmental protection priorities at JSW S.A. and its subsidiaries, measures were adopted in the fields of protection of water resources, waste management, and protection of biodiversity, taking into account the needs of local stakeholders and the local community.

Another action in the field of sustainable development was the start of climate change reporting in the renowned CDP (Carbon Disclosure Project) rating. The international rating organization classified JSW S.A. as high in the categories of climate action, obtaining a high "C" rating. Thus, the surveyed company was ahead of other companies in the mining industry. It should be emphasized that the implementation of a dedicated project and program management methodology (PPMM) and a dedicated IT tool with a strategy module is undoubtedly an innovative approach in the industry, not only on a national scale.

From the point of view of the conducted study, it is important that the aforementioned environmental strategy assumes the reduction of GHG emissions, i.e., the organization's carbon footprint (in scopes 1 and 2), by 30% by 2030 compared to 2018, in accordance with the path <2 °C, as well as achieving climate neutrality in 2050. It is worth emphasizing that over 70% of the carbon footprint of the JSW S.A. group is methane. Figure 2 above presents the volume of CH4 emissions at JSW S.A. mines during the period 2018–2022. For the years 2023–2025 a predictive analysis was performed based on a three-period moving average. It indicates that without taking extreme measures to reduce methane emissions, this may remain at a similar level in subsequent years.

The main assumptions of the REM Program assume an increase in the effectiveness of methane drainage in mines and the use of captured methane through the modernization and construction of methane drainage stations, cogeneration systems and a network of pipelines enabling the transmission of gas between individual mines. This will allow capturing a greater amount of methane emitted by methane drainage systems, while reducing ventilation methane emissions to the atmosphere. Implementation of the program will be carried out in the individual plants of the company, mines, with the designation

of a project manager. Including individual projects in a structured program will allow for the centralization of directional decisions within one steering committee. The indicated method of implementation will allow for more effective management of a group of projects, bearing in mind the objectives of the entire REM Program.

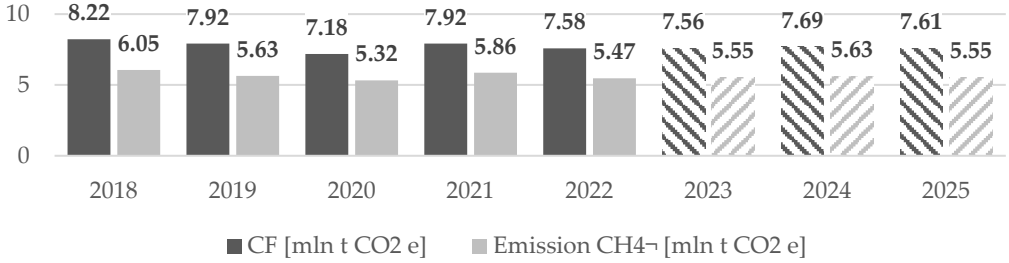


Figure 2. Methane emissions at JSW S.A. mines in the years 2018–2022. Source: own elaboration based on internal documents of JSW S.A.

Reducing ventilation air methane emissions into the atmosphere is an extremely important aspect due to the fact that in Poland and in Europe there are no installations operating on an industrial scale for the utilization of methane directly from ventilation air (VAM system). According to the assumptions in the Environmental Strategy, the adopted emission goals should be achieved by the end of 2025. Taking into account the current forecasts for 2026 regarding the total amount of methane emitted in the process of coal mining, it can be concluded that the implementation of the REM Program will allow reducing its amount by about 17%.

The actual reduction in the amount of methane emitted to the atmosphere will be a key measure of the project's success in the light of the upcoming legislative changes related to proposed regulation of the European Parliament and the Council on the reduction of methane emissions in the energy sector. The objectives of the MERP are in line with expectations regarding the reduction of methane emissions presented in the proposed regulation. The use of captured methane at a level above 95% is a direct response to the ban on methane emissions from methane drainage stations. On the other hand, increasing the efficiency of methane drainage in mines is connected with the ban on methane emissions from ventilation shafts. The use of captured methane is also a vehicle for real benefits for the company, taking into account the uncertainty prevailing on global markets related to energy production. Gas managed and converted into electricity in their very own installations, and thus the diversification of supplies, is a very favourable situation. Taking into account the environmental aspect (methane disposal) and energy prices, this action is justified in virtually every aspect.

2.3. Integration of Strategic Management and Project Management at JSW S.A.

Although the implementation of projects is not the core activity of mining companies such as JSW S.A., projects are a very important element of the implementation of the strategy. Ensuring the availability of the deposit requires the implementation of many projects, while the exploitation of the coal seam itself is an example of process activity. The importance of projects at JSW is evidenced not only by the construction in 2017 and further successive strengthening of the role of project portfolio management, but also by the annual investment budget comparable to the investment budget of the Polish Ministry of Health.

The first step in integrating strategic management and project management was the appointment in 2017 by the Management Board of JSW S.A. of Project Management and Standardization Team, operating in the Investment, Strategy and Development Office. The task of the team was to develop a dedicated project and program management methodology (PPMM) in the JSW S.A. capital group, together with mines and subsidiaries, based on their experience. The methodology created was not only to implement a new approach to implemented investments/initiatives/projects, but it was also to include the best practices

applicable so far (informally) throughout the JSW Capital Group and to be the primary tool for the implementation and monitoring of individual strategic goals of the Company.

In 2019, an attempt was made to link the company's strategy with the project portfolio. The BSC and AHP methods were used for this purpose. The first of these methods draws attention to the need for a four-dimensional assessment of development through perspectives: financial, customer, internal processes and development [33,34], and the possibility of using the BSC method in hard coal mining companies both globally [35,36] and in Poland [37]. One example is the combination of the BSC model and the fuzzy analytical hierarchy process presented by Indian researchers for assessing the performance of Indian mining enterprises [35]. It should be emphasized here that even the latest publications on the implementation of BSC in companies from the hard coal sector are based on the BSC model, which is over forty years old. The issues of corporate social responsibility (CSR) were radically less important in business then than they are today [38]; especially when it concerns mining companies, which, due to the specificity of their operations, have a very wide impact on the local community and the natural environment [39]. Moreover, in Poland, it was only in the last decade that the issues of CSR in the mining sector resounded more and more strongly in subsequent publications [40–42]. Enterprises such as JSW cannot be climate neutral [43], but they can and should take environmental aspects into account in their strategy, and thus in their portfolio of projects. Therefore, at JSW S.A., the analysis was extended to include a fifth dimension: man and the environment.

The team developing the rules for the operationalization of the strategy realized that not all of the initially identified 12 and currently 14 strategic goals are equally important, and what is more, their weight may change depending on the prevailing market conditions and the company's situation. For example, projects diversifying sources of income are very desirable in the case where the financial condition of a company is very good, while at the same time it is necessary to limit them in the conditions of threatened financial liquidity of the company that fights for survival, even at the expense of very prospective investments. Therefore, it was decided that extensive scenarios of the environment be implemented: base, development, and crisis, and using the AHP method to prioritize strategic goals. This made it possible to establish a hierarchy of strategic goals in the context of a given scenario of the environment. The article by M. Ortiz-Barrios et al. concerns the application of the multi-criteria decision-making model for selecting a sustainable supplier [44]. The authors, descending to the level of tools, i.e., methods, such as FAHP, TOPSIS, and FDMATEL, verify the conditions and effects of their use in the mining sector. One of the world's best-known multi-criteria methods, the AHP method, is the method used at JSW S.A. [45]. The next step was to assign each of the projects to previously defined and hierarchised strategic goals by determining to what extent a given goal is supported directly or indirectly by a given project. The percentage of the project budget that supports a given strategic goal was also determined using the expert assessment method. In this way, the following information was obtained:

- Which strategic goals are supported by the projects?
- What is the number of projects per strategic objective?
- What is the project budget for each strategic objective?

This made it possible to determine the strategic value of each project. It results from both the level of support for a given strategic goal by the project and the importance of this goal. The sum of the strategic values of all projects in the strategic portfolio is always 100%. It is worth noting that the strategic value of a given project may change over time, depending on the number of projects or as a result of a change in the applicable scenario.

2.4. Change in the Importance of Methane Projects at JSW S.A.

In 2019, when the strategic value for all projects was calculated for the first time, the high position of methane projects in the hierarchy of the entire portfolio was a big surprise. Compared to some other projects, they did not have the largest budgets, nor were they directly related to coal mining. It was even more surprising that these projects

maintained their very high position regardless of the adopted scenario of the environment: baseline, crisis, or development, while a number of other projects radically changed their position. This was primarily due to their strong impact on the strategic perspectives identified within the BSC, in particular: the perspective of internal processes (reduction of unit mining costs), the perspective of man and the environment (reduction of electricity consumption, reduction of methane emissions), and the financial perspective (reduction of electricity costs):

- As a result of the COVID-19 epidemic, the prices of coking coal reached long-term lows and any savings, including in electricity costs, became very valuable for JSW (2020)
- As a result of the outbreak of war in Ukraine, electricity prices increased dramatically and each MWh produced at JSW also increased its importance (2022)
- Environmental awareness in society is becoming more and more important and the fact of reducing methane emissions into the atmosphere also builds a positive image for JSW
- In the EU, the need to reduce methane emissions and to introduce levies on emissions is getting louder and louder—JSW has already introduced a solution that significantly reduces methane emissions.

The observed change in the perception of methane projects as a result of the integration of strategic management with sustainable management and project management was, apart from the research gap identified in world literature, the basic inspiration for research conducted at JSW S.A. Particularly interesting from the point of view of both the theory of management science and the practice of implementing changes in the management process was the determination of which elements of the implemented sustainable project management had a particular impact on the situation of methane projects in the audited company. Of course, this required the identification of the implementation structure and the adoption of an appropriate methodology for evaluating its individual components. In the further part of the article, both the adopted methodological assumptions in this regard and the results of empirical research are presented.

3. Research Course and Methodology

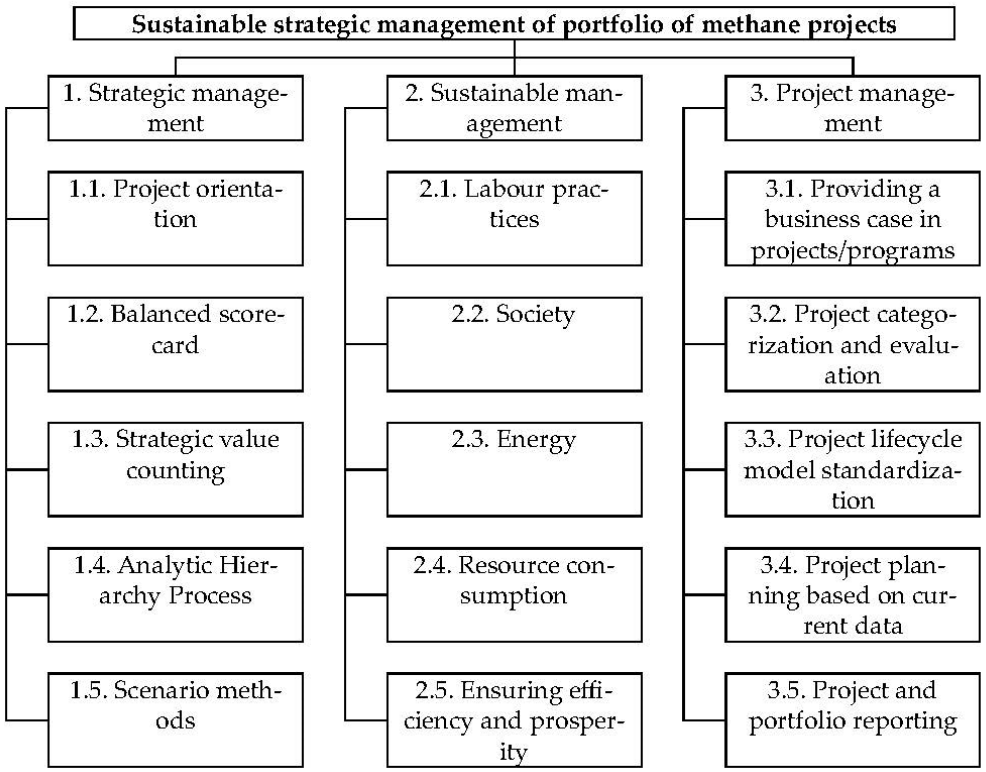
The research presented here uses a qualitative approach and the case study method. This methodological solution is the most optimal from the point of view of identification and description of phenomena in specific organizations [46,47]. The research was inspired by the assessment of the project submitted by JSW S.A. for the PPEA competition. It was carried out in the period July–October 2022. Project evaluation under the PPEA uses the international IPMA PEB standard. The procedure of the study conducted as part of the assessment is in line with the qualitative approach and the case study method. During the study, several FGIs (focus group interviews), document examinations, and desk research were conducted. The main result of the study was the evaluation of the submitted project in terms of PPEA. However, it was also noticed that JSW in the years 2017–2022 made a profound change in their strategic management process. It was pointed out that the introduction of new management solutions had a particular impact on methane projects realized in MERP. This observation was an inspiration for further research presented in this article. In particular, it allowed defining the research problem, research questions, as well as preparing assumptions for the next stages of the study.

It was therefore assumed that the research problem concerns how the implementation of sustainable strategic management affected methane projects implemented by JSW. The operationalization of the problem allowed the formulation of the following detailed research questions:

- RQ1. What was the implementation of sustainable strategic management at JSW?
- RQ2. How has the implementation of sustainable strategic management influenced the importance of the methane projects for JSW?
- RQ3. How did the implementation of sustainable strategic management affect the management and course of the methane projects?

The research problem posed was verified during preliminary literature research. It was found that the undertaken problem responds to the existing research gap in the literature. What is more, it is important because the identification of the effects of implementing sustainable strategic management at JSW in the context of methane projects can support transformation processes in other mining sector enterprises, especially in economies that, similar to the Polish economy, are based on fossil fuels. It was assumed that both the lack of publications presenting similar research and the importance of the research problem justify the continuation of research and the publication of the obtained results. On this basis, in the next stage, lasting from November to December 2022, the conceptualization and operationalization of sustainable strategic management at JSW S.A. was made into a multidimensional model (hereinafter called SSM model).

Work on the structure of the model included both literature research and empirical research, including focus group interview (FGI) workshops, conducted with the participation of experts representing JSW involved in the implementation of sustainable strategic management. Its proposed structure (Scheme 1) is the answer to the first of the research questions posed. Therefore, the model distinguishes three main dimensions (criteria): strategic management, sustainable management, and project management. Each of these dimensions was additionally divided into five sub-dimensions (subcriteria), relating to the applied management tools/solutions. Their detailed description is presented in Table 2.



Scheme 1. Structure of the model of sustainable strategic management (the SSM model) at JSW S.A. Source: own elaboration.

Table 2. Description of subcriteria of the SSM model at JSW.

	Subcriteria	Description
1. Strategic management	1.1. Project orientation	Taking into account the project approach (projects, programs, portfolios) as a formula for implementing the strategy by adapting the standards: ISO21500, PMBOK, IPMA ICB, PRINCE2 to the form of a dedicated methodology (PPMM).
	1.2 Balanced scorecard	Introduction of a system of goals defined on the basis of the Balanced scorecard as a strategy building and monitoring tool. Separating an additional perspective within the BSC—Man and the Environment.
	1.3. Strategic value counting	Introduction of the rules for calculating the strategic value of the project based on the assessment of the level of support for individual strategic goals by the project and the importance of a given strategic goal.
	1.4. Analytic Hierarchy Process	Assessment of the weights of individual strategic goals in the context of environmental scenarios obtained on the basis of expert knowledge in the procedure of pairwise comparisons using the Saaty's scale.
	1.5. Scenario methods	Isolation of three scenarios of the environment: base, crisis, development and identification of the currently applicable scenario as the basis for planning and updating the strategy.
2. Sustainable management	2.1. Labour practices	Inclusion of a strong representation of the social side in the form of over 100 trade union organizations in decision-making processes. Employees' demands (including wage demands) are actively recognized and implemented in the company's operations.
	2.2. Society	Continued cooperation with local governments in the area of agreeing consulting. The activities of social institutions and local governments are actively supported (support for kindergartens, hospitals, schools, etc.).
	2.3. Energy	Opportunities to reduce energy consumption are actively sought; CO_2 emissions are limited and the possibility of using the side-effects of methane emissions to produce energy for the needs of mine operations.
	2.4. Resource consumption	Processes are optimized and modern technologies are introduced to reduce resource consumption, recycle and reduce waste.
	2.5. Ensuring efficiency and prosperity	The benefits and costs of investments are identified and the effectiveness of projects is assessed, including in the long-term perspective. The effects of the actions taken on the local economy are taken into account.
3. Project management	3.1. Providing a business case in projects	The decision to start a project is made on the basis of a business case. The business justification of the project is subject to continuous verification during its implementation.
	3.2. Project categorization and evaluation	Project decisions based on initial prioritization based on the Eisenhower matrix, and then A–C categorization based on the assessment of: the strategic value of the project, its economic effects, the level of risk and the size of the budget.
	3.3. Project lifecycle model standardization	Introduction of project management standards by specifying the four phases of the project: initiation, planning, implementation, closing, specifying the procedures in each phase and management documents.
	3.4. Project planning based on current data	Introduction of the principle of project planning (scope, schedules, and costs) based on updated data and ongoing modification of plans during project implementation.
	3.5. Project and portfolio reporting	Introduction of monthly reports for the Management Board/Steering Committee on the implementation of projects and portfolios with additional PMO information, as well as reports at the end of the project, including lessons learned.

Source: own elaboration.

The last stage of the empirical research, conducted in January–February 2023, consisted in verifying the SSM model presented above in terms of RQ2 and RQ3 questions. It consisted in verifying the impact of the model presented above on:

- importance of the methane projects for JSW,
- change in the method of managing the methane projects.

Four experts representing JSW S.A. participated in the last stage of the empirical study and were selected on the bases of the following criteria:

- knowledge of the implementation of sustainable strategic management at JSW,
- ongoing involvement in the implementation of the strategy and program of methane projects (MERP),
- ensuring different perspectives resulting from the organizational roles/positions held,
- time availability of experts.

The experts selected represented all key organizational roles from the point of view of the implementation being investigated. Therefore, they were people employed in the following positions:

- strategy director (expert 1),
- deputy director of the strategy office (expert 2),
- project management team leader (expert 3),
- methane project manager (expert 4).

The AHP (analytic hierarchy process) method was used for verification, supplemented with an assessment of the impact direction. The choice of the AHP method results from its several basic advantages. First of all, among many methods of decision support, it is the most popular, and thus verified not only in research, but also in real economic processes. The method allows describing a complex problem and then evaluating its elements using pairwise comparisons [45,48,49]. The method also uses a complex verification of the consistency of expert assessments, which increases the likelihood of obtaining valuable assessment results. An additional argument in favor of using the AHP method is the fact that it has been implemented at JSW S.A. as part of sustainable strategic management, as a tool supporting decisions regarding the prioritization of strategic goals. As a result, the experts selected to verify the SSM model from among JSW S.A. employees were already familiar with this method, which significantly increased the probability of the correctness of the conducted study. The AHP method was used to assess the significance of the impact of sustainable strategic management on methane projects. A pairwise comparison survey using T.L. Saaty's scale was used here [50]. However, a six-point scale from −3 to +3 was used to assess the direction of impact of sustainable strategic management implementation on methane projects.

In the analysis of the significance of SSM model elements, judgments meeting the CR $\leq$ 0.20 were used [50,51]. In the case of clusters in which the CR indicator was higher, the experts were asked to re-verify their assessments. For each element of the SSM model weights were calculated, using the procedure of AHP analysis. The weights show which elements of the SSM model are more and which are less important from the point of view of the role of methane projects in the organization or the way they are managed. On the level of subcriteria, two types of weights are calculated, local and global; see [45]. The experts participating in the study assessed independently of each other. The AIP (aggregating individual priorities) approach was used to obtain the overall score [52]. This procedure allows the use of the geometric, arithmetic mean or median in the process of aggregating multiple opinions [53] (p. 224). The study used the arithmetic mean. Detailed information about judgements and the consistency is presented in Appendices A and B, while the results of the analysis (weights) are presented in Figures 3 and 4.

The same group of experts was asked to assess if the direction of influence of any element of the SSM model was positive or negative in relation to methane projects. Here, the assessment of the impact direction of the criteria was calculated on the basis of the weighted average of aggregated expert assessments for the subcriteria of a given criterion

and the local weights of these subcriteria. However, the arithmetic mean was used to aggregate individual opinions to obtain the overall score in a group of experts.

The research was supplemented by an individual interview conducted with a representative of the supervisory board of JSW S.A.

4. Results of Empirical Research

This part of the article presents the results of the last stage of empirical research. They made it possible to determine the significance and direction of the impact of individual components of the implementation of sustainable strategic management at JSW S.A. for the program of methane projects (MERP) run by this company. On this basis, answers to research questions RQ2 and RQ3 were formulated.

4.1. Assessment of the Significance of the Impact of Sustainable Strategic Management on Methane Projects

The study using the AHP method made it possible to determine the weights of the criteria (Figure 3) and subcriteria (Figure 4) of the SSM model. In the opinion of the surveyed experts, the key to changing the perception of the role of meta-new projects at JSW was the emphasis on the principles of sustainable management in the strategy (the importance of this element is close to 50%). This made it possible to see the possibility of limiting the negative impact of mining processes on the environment by reducing methane. The policy of the European Union, as well as national legal solutions consistent with it, supports the transformation of the mining industry towards sustainable development. It is worth noting that in over 30% of cases, the increase in the role of methane projects in the organization was also influenced by the implementation of the project approach to the implementation of the strategy. The project management methodology (PPMM) has launched, among others, additional processes of project analysis in pre-investment phases and more clear linking of projects with strategic priorities.

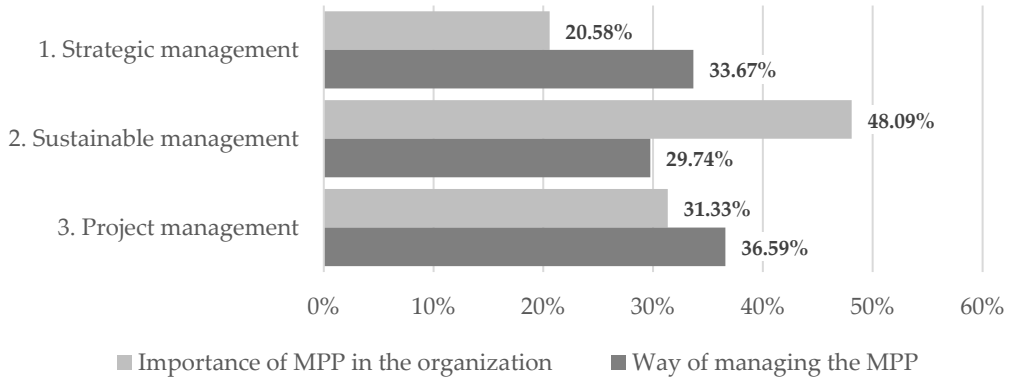


Figure 3. The influence of the SSM model's criteria on projects realized in MERP. Source: own elaboration (see: Appendices A and B).

When it comes to the method of project management, the analyzed dimensions received quite similar significance scores, with little indication of the importance of project management implementation (weighting nearly 37%). The introduced methodology (PPMM) systematized and streamlined the management of projects, programs, and portfolios, and therefore was also of significant importance for the course of the methane projects.

The assessment of the significance of the subcriteria of sustainable strategic management is based on the calculated values of global weights. According to experts, the most important factor contributing to the increased importance of the methane projects was JSW's strategic decision to reduce greenhouse gas emissions by reducing methane emissions by capturing it in mines and using it to produce their very own energy. In addition to the environmental effect, it also allows achieving economic effects in the form of reducing resource consumption and improving the efficiency of the mining process in

the long term (subcriterion 2.1). Energy generates nearly 20% of the impact on changing the role of methane projects in the organization. According to experts, an important factor supporting an increase in the role of methane projects was the implementation of business justification in projects (global weight over 12%). It is on this basis that strategic decisions regarding the project are made, starting from the pre-design phase and throughout the project's implementation. Ensuring the continuity of the assessment of the business case of the projects made it possible to maintain consistency between the strategic priorities and the current activities of JSW.

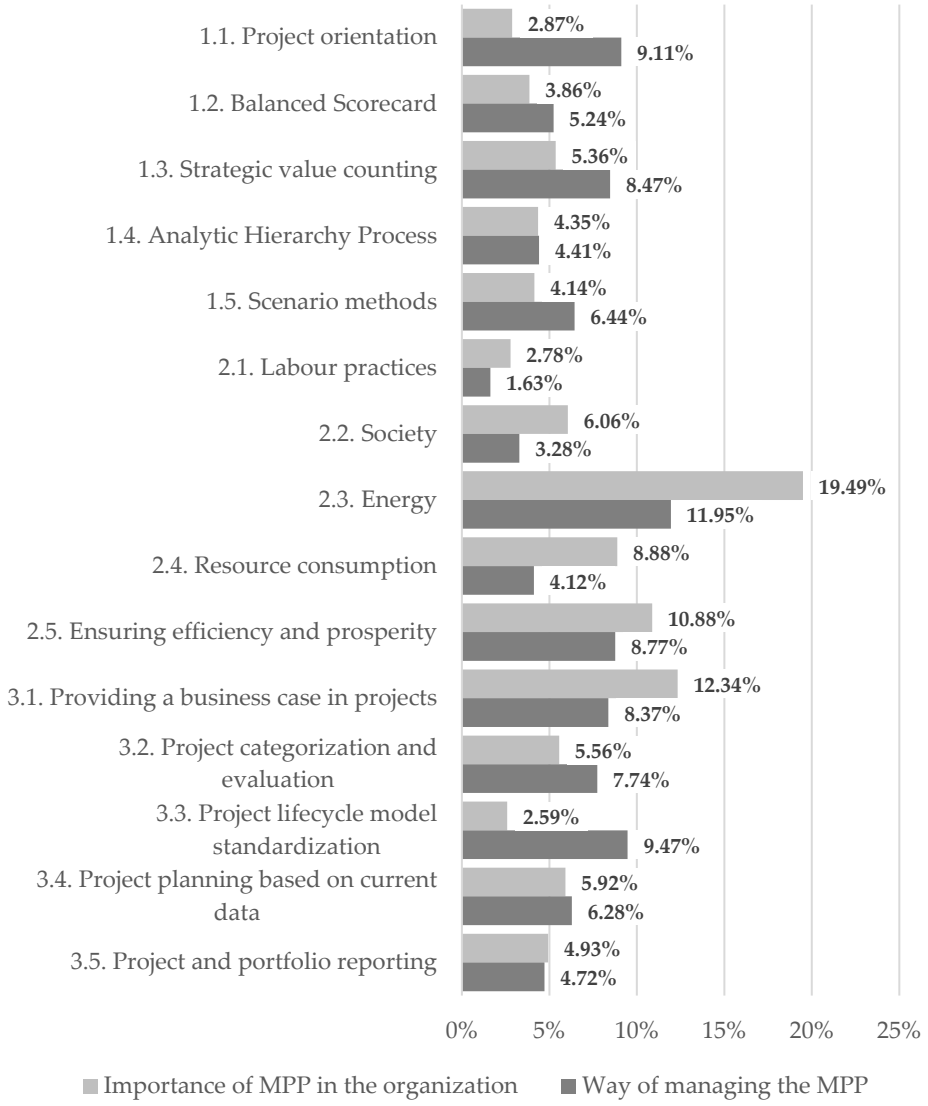


Figure 4. The influence of the SSM model's subcriteria on projects realized in MERP. Source: own elaboration (see: Appendices A and B).

The impact assessment on the management of the methane projects also points to the important role of energy production decisions. In the field of sustainable management, issues related to ensuring efficiency and development (subcriterion 2.5) also turned out to be important. Experts also noticed the role of introducing a project approach, including, above all, the standardization of the project lifecycle model (subcriterion 3.3.) and continuous assertion of the business case for the project (subcriterion 3.1.).

4.2. Assesment of the Direction of Impact of Sustainable Strategic Management Implementation on Methane Projects

The second dimension of the assessment of the implementation of sustainable project management concerned the direction of impact. Experts indicated which elements of the implemented change were beneficial and which were unfavorable from the perspective of the methane projects. The results in the form of aggregated assessments are presented in Figure 5, and the assessments of individual tools in Figure 6.

Figure 5. Direction of influence of the SSM model's criteria on projects realized in MERP. Source: own elaboration (see: Appendices A and B).

The conducted research shows that the overall assessment of the impact of the implemented change on methane projects is favorable. Sustainable strategic management allowed increasing the role of the methane projects in the strategy (starting the MERP) and improving the efficiency of their management. The first effect results primarily from the inclusion of the principles of sustainable development in strategic priorities, thanks to which methane projects have been perceived as supporting many of JSW's strategic goals. The implemented strategic management tools had a particularly positive impact on the management of the methane projects.

Moving on to assessing the direction of the impact of management tools implemented as part of individual dimensions of sustainable strategic management, it is worth paying attention to the following issues. Firstly, from the point of view of methane projects, the factor related to the inclusion of energy production among the strategic priorities turned out to be the most advantageous. It is worth noting that it was also indicated as the most important. From the point of view of managing methane projects, the most beneficial factor turned out to be the decision to use the project approach to implement the strategy. According to the experts surveyed, however, not all elements of sustainable strategic management were beneficial for the management of the methane projects. It was pointed out that the implementation of the principles of sustainable development requires taking into account the expectations of many different stakeholder groups, including local communities and employees. This may increase the difficulty in integrating the project and building a coherent set of operational objectives.

It is worth emphasizing here that from the group of implemented tools for sustainable strategic management, experts consider those that allow increasing operational efficiency, reducing resource consumption and, consequently, increasing the efficiency of the organization as crucial and beneficial. From this perspective, the social factor may be a kind of ballast that makes it difficult to achieve the full efficiency of projects. However, according to experts, the elements assessed negatively are not of significant importance from the perspective of methane projects.

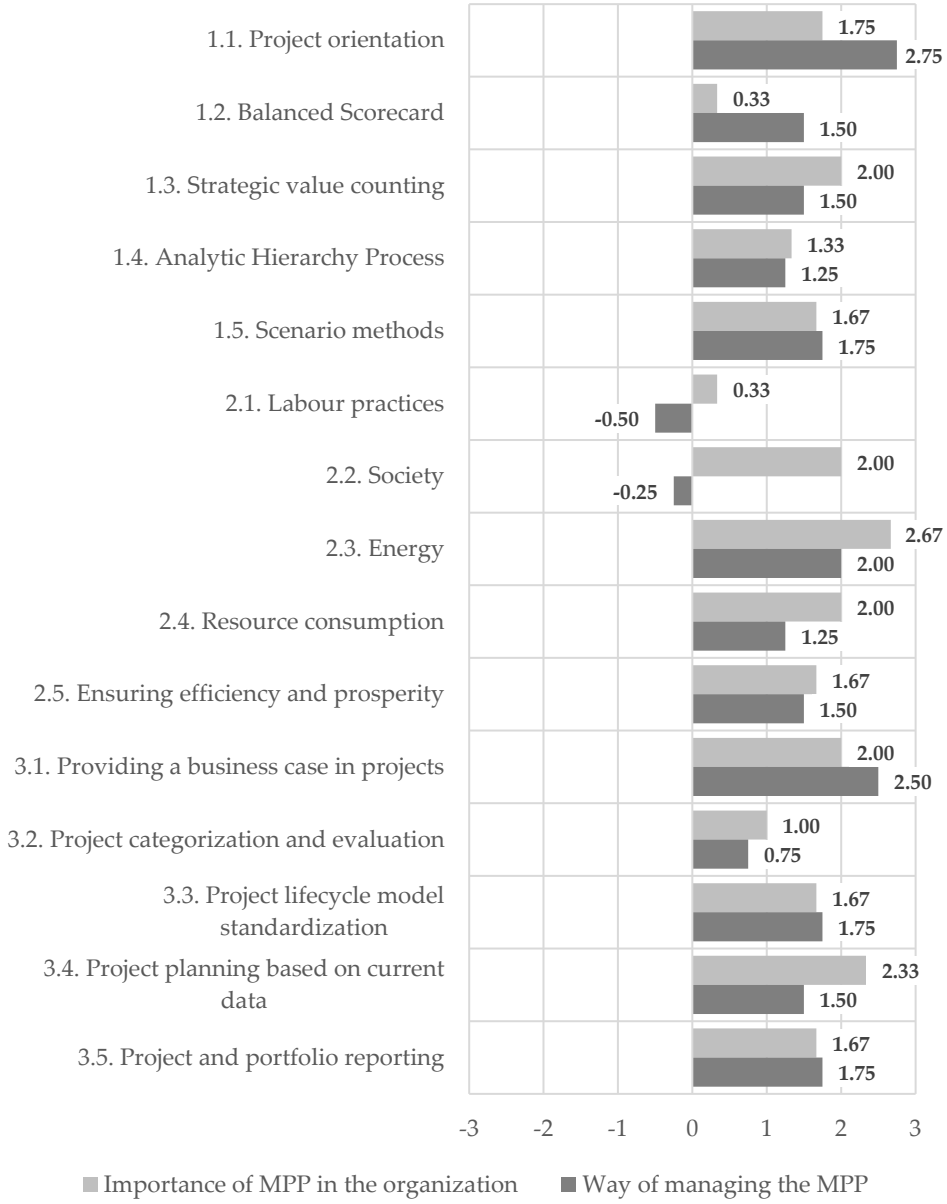


Figure 6. The direction of influence of the SSM model's subcriteria on projects realized in MERP. Source: own elaboration (see: Appendices A and B).

4.3. Assessment of the Implementation of the Sustainable Strategic Management Model at JSW S.A. in the Context of Projects Realized in MERP, from the Perspective of a Member of the Supervisory Board

The research was supplemented by an interview with a member of the Supervisory Board. He was asked for his opinion on the effects of implementing sustainable project management. He pointed out that JSW defines strategic goals related to the capture and use of methane in its environmental strategy until 2030. Projects under the methane program (MERP) are defined on this basis. Both the strategic goals of the company in the area of sustainable development and their consistency in the form of, for example its methane program, result from two sources. The first are European and national policies to combat the climate crisis, and the second are the values that are the foundation of the company's operation and development. Thanks to the implementation of the balanced scorecard, enriched with the "human and environment" dimension, the company was able to clearly operationalize its strategic goals by referring to the principles of sustainable

development. Currently, 24 projects are being implemented that support strategic goals from this dimension.

The representative of the Supervisory Board emphasized the importance of the implemented project approach. The basic effects achieved, in his opinion, are a clear assignment of responsibility in all dimensions of the decision-making process—from the strategic to the operational level. It is particularly important to increase the ability to manage individual projects by separating the dedicated role of the project manager. The person in this role is solely responsible for the project or projects. There are no assigned tasks resulting from other areas, e.g., process ones. Systematizing the project management process by defining the methodology PPMM turned out to be an important issue. Thanks to it, projects are implemented according to a similar scheme; decisions are prepared by collecting and delivering an appropriate set of management information. It is important to introduce continuous project monitoring, thanks to which managers get the opportunity to introduce changes and verify the business legitimacy of their implementation. In the opinion of a member of the Supervisory Board, however, the above-mentioned effects apply equally to all types of projects, including methane ones.

5. Conclusions

The conducted study allowed gathering the experience of a large mining company—JSW S.A., resulting from the implementation of sustainable project management. The structure of this implementation was identified by identifying and grouping the applied management tools. They were assessed in terms of their impact on a specific set of methane projects, important for the organization, realized in MERP. This complements the existing scientific output. At the same time, it is also offers guidelines for similar transformations in other companies in the sector, allowing to find those elements of implementation that are particularly important or particularly beneficial for the methane program. It is worth noting that, at JSW S.A., the implementation program of sustainable strategic management allowed achieving considerable maturity. Further improvement activities are being undertaken, including further updates of the strategy and changes in defining the responsibility of project roles. The introduced innovation has already been consolidated in the organizational culture, which reduces the likelihood of its limitation in the future. This is important for the ongoing methane projects, which should ultimately allow the achievement of the adopted strategic goals in the field of methane reduction. Summarizing the study, reference is made below to the formulated research problem and the questions asked.

As a hint to the research problem, it should be stated that the implementation of sustainable project management had a positive impact on methane projects. It made it possible to supplement the strategy with social and environmental goals. The mechanisms of calculating the strategic value allowed to observe that methane projects support many different strategic goals. As a result, their role in the organization has changed in relation to previous practices, where attention was paid mainly to investment projects with large budgets. A short list of answers to the research questions is also presented below in Table 3.

Several challenges were encountered during the implementation of the study. The first resulted from the lack of description of similar studies in world literature. This required building an original approach to the description of the implementation by identifying a multidimensional model of sustainable strategic management. The second challenge related to the choice of the method of evaluating the effects of implementation. Due to the use of a multi-dimensional model, it turned out to be natural to search for solutions among multi-criteria methods. The selected AHP method allowed, however, to determine only the importance of individual elements of the model, and not the direction of their impact of implementation. This required the construction of an additional questionnaire with a two-way scale. The third challenge concerned the selection of experts and the aggregation of their opinions. People involved in making decisions on methane projects at various levels were selected for the study, from the supervisory board to the person directly responsible for the implementation of one of the projects. The arithmetic mean

was chosen for the aggregation of opinions, mainly because of difficulty in determining the significance of the opinions of individual decision-makers. An additional limitation here was the limited availability of the person representing the supervisory board, which prevented her from participating in the assessment using the AHP method and the scale of assessing the direction of influence.

Table 3. Research questions and answers.

Questions	Answers
1. RQ1. What was the implementation of sustainable strategic management at JSW?	The answer to this question is the multidimensional model of sustainable strategic management (SSM model), comprising three main dimensions and five sub-dimensions each relating to the implemented management tools.
2. RQ2. How did the implementation of sustainable strategic management affect the importance of the methane projects for JSW?	The introduction of sustainable project management increased the importance of projects in the methane program. Elements resulting from sustainable management were of key importance here, in particular the drive to generate their very own energy based on methane released in the mining process.
3. RQ3. How did the implementation of sustainable strategic management affect the management and course of the methane projects?	The introduction of sustainable strategic management systematized project management, including methane projects, allowing for a clear assignment of responsibility to specific organizational roles. The introduction of the principle of continuous monitoring and ensuring the business justification of the project was of key importance.

Source: own elaboration.

The conducted study concerns an extremely interesting issue, which is the study of the effects of innovations implemented in the management process. The undertaken attempt to assess not only the change as a whole, but also its individual components, has not only a cognitive, but also a utilitarian dimension. According to the authors, this direction of research in management sciences is still poorly exploited and requires further research. In addition, it seems necessary to further develop research on management in the mining sector. The justification is the importance of this sector for the economy and the natural environment. Contemporary challenges require the introduction of many, often quite radical, changes in the rules of organizations functioning in this sector. They require optimization not only in terms of economic efficiency parameters, but also because of their impact on the social and natural environment.

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Data Availability Statement: The data are placed in The data are placed in Appendices A and B.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Model	Importance of MPP in the Organization										
	Strategy Director		Dep. Dir. of the Strategy Office		Project Management Team Leader		Manager of Methane Project		General Evaluation		
	D *	W **	D *	W **	D *	W **	D *	W **	D *	W **	GW ***
Sustainable strategic management	2.22	100.00%	1.61	100.00%	2.65	100.00%	1.54	100.00%	1.87	100.00%	100.00%
CR		14.64%		17.80%		15.70%		0.25%			
1. Strategic management	1.90	24.49%	0.85	18.43%	2.03	18.81%	1.75	45.23%	1.44	20.58%	
2. Sustainable management	2.44	66.48%	1.82	72.15%	2.08	5.62%	2.81	7.16%	2.10	48.09%	
3. Project management	1.41	9.02%	1.48	9.42%	2.84	75.57%	1.14	47.61%	1.81	31.33%	
CR		**12.55%**		**12.77%**		**7.52%**		**15.76%**			
1.1. Project orientation	2.00	15.64%	1.00	4.39%	1.00	17.18%	3.00	18.55%	1.75	13.94%	2.87%
1.2. Balanced Scorecard	2.00	55.49%	−2.00	5.16%	1.00	2.50%	1.00	11.85%	0.33	18.75%	3.86%
1.3. Strategic value counting	2.00	9.67%	1.00	17.66%	3.00	22.48%	2.00	54.36%	2.00	26.04%	5.36%
1.4. Analytic Hierarchy Process	1.00	10.46%	1.00	44.76%	2.00	22.48%	1.00	6.89%	1.33	21.15%	4.35%
1.5. Scenario methods	2.00	8.74%	1.00	28.03%	2.00	35.36%	−1.00	8.35%	1.67	20.12%	4.14%
CR		**15.77%**		**18.98%**		**18.57%**		**15.66%**			
2.1. Labour practices	1.00	9.95%	−1.00	4.48%	1.00	6.24%	1.00	2.44%	0.33	5.78%	2.78%
2.2. Society	3.00	25.21%	1.00	5.00%	2.00	13.25%	1.00	6.95%	2.00	12.60%	6.06%
2.3. Energy	3.00	29.12%	2.00	48.52%	3.00	42.80%	3.00	41.71%	2.67	40.54%	19.49%
2.4. Resource consumption	2.00	14.72%	2.00	17.63%	2.00	9.33%	3.00	32.19%	2.00	18.47%	8.88%
2.5. Ensuring efficiency and prosperity	2.00	21.01%	2.00	24.37%	1.00	28.38%	3.00	16.72%	1.67	22.62%	10.88%
CR		**3.37%**		**6.26%**		**17.40%**		**4.41%**			
3.1. Providing a business case in projects	1.00	53.70%	2.00	15.40%	3.00	63.80%	2.00	24.56%	2.00	39.37%	12.34%
3.2. Project categorization and evaluation	1.00	4.92%	1.00	8.41%	1.00	3.41%	1.00	54.22%	1.00	17.74%	5.56%
3.3. Project lifecycle model standardization	1.00	13.94%	1.00	4.91%	3.00	7.43%	1.00	6.77%	1.67	8.26%	2.59%
3.4. Project planning based on current data	2.00	13.94%	2.00	32.51%	3.00	20.89%	-1.00	8.27%	2.33	18.90%	5.92%
3.5. Project and portfolio reporting	3.00	13.50%	1.00	38.76%	1.00	4.48%	2.00	6.19%	1.67	15.73%	4.93%

* direction, ** weight, *** global weight. Source: own elaboration. Bold: CR indicators.

Appendix B

Model	Way of Managing the MPP										
	Strategy Director		Dep. Dir. of the Strategy Office		Project Management Team Leader		Manager of Methane Project		General Evaluation		
	D *	W **	D *	W **	D *	W **	D *	W **	D *	W **	GW ***
Sustainable strategic management	2.39	100.00%	2.05	100.00%	1.30	100.00%	−0.12	100.00%	1.64	100.00%	100.00%
CR		**1.76%**		**14.64%**		**13.04%**		**6.85%**			
1. Strategic management	2.34	48.44%	2.37	24.49%	2.09	28.08%	1.34	23.11%	1.85	33.67%	
2. Sustainable management	2.68	9.24%	1.88	66.48%	−0.06	13.50%	1.30	6.03%	1.36	29.74%	
3. Project management	2.40	42.32%	2.41	9.02%	1.22	58.42%	−0.72	70.85%	1.67	36.59%	
CR		**1.09%**		**10.28%**		**5.74%**		**14.03%**			
1.1. Project orientation	3.00	5.81%	3.00	13.71%	3.00	54.62%	2.00	34.14%	2.75	27.07%	9.11%
1.2. Balanced Scorecard	3.00	33.35%	1.00	6.20%	1.00	6.27%	1.00	16.46%	1.50	15.57%	5.24%
1.3. Strategic value counting	2.00	27.65%	2.00	22.13%	1.00	12.75%	1.00	38.07%	1.50	25.15%	8.47%
1.4. Analytic Hierarchy Process	1.00	5.54%	2.00	28.50%	1.00	13.61%	1.00	4.72%	1.25	13.09%	4.41%
1.5. Scenario methods	2.00	27.65%	3.00	29.45%	1.00	12.75%	1.00	6.62%	1.75	19.12%	6.44%
CR		**14.53%**		**11.77%**		**7.69%**		**16.29%**			
2.1. Labour practices	1.00	10.00%	−1.00	5.29%	−1.00	3.25%	−1.00	3.35%	−0.50	5.47%	1.63%
2.2. Society	3.00	24.73%	−1.00	4.77%	−2.00	3.81%	−1.00	10.84%	−0.25	11.03%	3.28%
2.3. Energy	3.00	27.63%	2.00	46.73%	1.00	27.85%	2.00	58.50%	2.00	40.18%	11.95%
2.4. Resource consumption	2.00	12.12%	1.00	12.31%	1.00	21.30%	1.00	9.64%	1.25	13.84%	4.12%
2.5. Ensuring efficiency and prosperity	3.00	25.52%	3.00	30.91%	−1.00	43.79%	1.00	17.67%	1.50	29.47%	8.77%
CR		**5.20%**		**13.74%**		**12.96%**		**14.28%**			
3.1. Providing a business case in projects	3.00	55.05%	2.00	7.16%	3.00	14.41%	2.00	14.87%	2.50	22.87%	8.37%
3.2. Project categorization and evaluation	1.00	8.24%	3.00	3.64%	1.00	8.41%	−2.00	64.33%	0.75	21.16%	7.74%
3.3. Project lifecycle model standardization	1.00	6.90%	2.00	52.01%	3.00	34.12%	1.00	10.53%	1.75	25.89%	9.47%
3.4. Project planning based on current data	2.00	16.48%	3.00	8.75%	−1.00	37.35%	2.00	6.12%	1.50	17.17%	6.28%
3.5. Project and portfolio reporting	2.00	13.33%	3.00	28.45%	1.00	5.71%	1.00	4.15%	1.75	12.91%	4.72%

* direction, ** weight, *** global weight. Source: own elaboration. Bold: CR indicators.

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