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The strategy of sustainable development and waste management: Case study: Commercial power industry

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ABSTRACT

In this study, the relationships between two variables: the strategy of sustainable development and the efficiency of waste management in the commercial power industry company have been subjected to discussion. The basis for the explanation of the aforementioned relationships is the assumption that the level of implementation of the strategy of sustainable development is expressed through capital expenditures incurred on the implementation of modern tools of waste management. On the other hand, the efficiency of waste management in the commercial power industry company is reflected by the level of costs incurred on the storage, transport and sales of this waste. The whole of the presented considerations has been divided into two basic parts, theoretical and empirical. The first part of the paper exposes the strategic dimension of the concept of sustainable development taking into account the economic and environmental efficiency of waste management achieved due to the use of modern management tools. The considerations presented in the second part constitute the response to the research question. The empirical part includes the identification of waste in the commercial power industry company in Poland and the research aiming at the cognition and assessment of relationships between the efficiency of waste management and the implementation of the strategy of sustainable development in the surveyed company. The publication increases the understanding of the coexistence of the strategy of sustainable development and the efficiency of waste management in the company of the commercial power industry operating in Poland, with particular emphasis on waste reduction and the possibility of its redevelopment. The research methods applied to accomplish the objective are literature studies, case study, descriptive analysis, trend analysis and the Pearson correlation coefficient.

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INTRODUCTION

Competing in variable business conditions requires the selection of appropriate strategies by enterprises. However, the complexity of the competitive environment of enterprises and uncertainty of business makes it difficult to create effective strategies. In this context, the strategy of sustainable development, which integrates economic, social and environmental objectives of the enterprise and its environment, is emerging. Therefore, enterprises operating in the turbulent environment, in order to satisfy customers' needs, should adapt to changing conditions of the environment, using the advantages of the strategy of sustainable development. These changes are reflected in the process of changes of business strategies, which should evolve taking into account the assumptions of sustainable development. The above arguments led to the research question – does the strategy of sustainable development positively influence the efficiency of waste management in the company? As a consequence of this question, the objective of the study has been the cognition and assessment of the relationships between the efficiency of waste management and the implementation of the strategy of sustainable development of the commercial power industry company in Poland. The research methods applied in order to accomplish the objective are literature studies, case study, descriptive analysis, trend analysis and the Pearson correlation coefficient. The study has been carried out in Poland in 2018.

The strategic dimension of the concept of sustainable development

The strategy defines and formalizes the way in which the objectives of the enterprise are accomplished (Stabryła, 2002). At the same time, the strategy is the pattern of the operation of the company which dynamically overcomes difficulties which enterprises come across on the way of their development (Romanowska, 2005). The properly developed strategy should allow for creating a competitive advantage in the market, perceived as the activities of the company including all its operation areas along with the entire value chain (Porter, 2006). Building the strategy based on the potential of sustainable development may constitute the source of competitive advantage of the company if it takes into account the use of resources and skills. The reaction to the threats to development of enterprises, both in the developed market economies and in the economies of developing countries (Grant, 2003), has become the emergence of the concept of sustainable development. The strategic dimension of the assumptions of the concept of sustainable development is pinpointed byKrameret *al.* (2007). The cited authors postulate conscious taking into account the problem of sustainable development in the overall strategy of enterprises (Krameret *al.*, 2007). For the implementation of strategic goals, some practical tools used for creating a positive image and strong brand of the company will be helpful, which will translate into building a sustainable competitive advantage. The implementation of the strategy of sustainable development in these terms should generate value added from the actions taken for the benefit of the environment and the society (Orsato, 2009). In this context, the strategy of sustainable development is understood as the strategic response of the company, oriented to profit and environmental and social issues, triggered by the type of the conducted activity, both primary and secondary (Salzmann *et al.*, 2005). The essence of the strategy of sustainable development is therefore balancing economic, social and environmental dimensions (Lozano, 2012) and generating positive effects in its all listed dimensions (Krechovská*et al.*, 2014).Summing up, it is worth noting that the strategic dimension of the concept of sustainable development is the element combining the strategy of competitiveness with social and environmental areas (Engert*et al.*, 2016). This means that managers applying the solutions of sustainable development may develop the strategy which allows for the identification and use of the potential of the company (Valor *et al.*, 2014), satisfying both the expectations of shareholders in the field of generating profits and other stakeholders in the business environment in the field of the accomplishment of environmental and social objectives.

Strategy of sustainable development as the basis for the economic and environmental efficiency of waste management

The implementation of the strategy of sustainable development in the company is closely linked to waste management. The process of waste management in the enterprise is associated with acquiring, planning

of the appropriate level of financing and control (Hilson*et al.*, 2000). Production waste is qualified as inventories of intracellular work in progress. It arises periodically while conducting operating activities of the company and it is cycle stock which is subjected to relocation at individual stages of the logistics process. The type of the conducted activity determines the type of arising waste (Arend*et al.*, 2005). Therefore, the organization of work in progress must take into account the stages of the production process, which is associated with the need to establish the moment of arising production waste. Production waste is transferred to interface warehouses, which requires the development of the plan for the flow of waste streams. In the process of waste management, it should be remembered that it is subjected to constant reproduction, which causes its periodicity (Baumgartner *et al.*, 2017). Among the methods of waste production management, one can distinguish: statistical, dynamic, optimizing (Haan*et al.*, 2007). Statistical methods are based on the determination of the regular level of waste, informing on the basic parameters shaping its size and structure. The standards for the level of waste can be developed on the basis of the data achieved from previous periods, taking into account technological changes, changes in consumption and procurement. The simplest method to determine the standards for the level of waste from production processes is using the weighted average method in order to determine the average amount of waste in a period and a daily consumption of waste. When using the statistical-analytical methods, the level of variable waste is determined. In order to determine it, one can apply the analysis of the weighted average supply cycle and the average positive deviation from the average supply cycle. The level of production waste should be optimized. The process of production waste management can be optimized by setting standards and limits and the planning and control of both their levels and structure. The selection of waste management methods depends on the type of the production process and the structure, amount and type of arising waste (Kates *et al.*, 2012).In conclusion, it should be pinpointed that management of production waste obliges to the development of the system of distribution and customer service. The effective management of production waste requires the development of the strategy of its distribution and end-users of waste taking into account the assumptions of sustainable development and the selection of appropriate tools of the strategy implementation.

Modern tools of waste management in the context of the strategy of sustainable development

The efficiency of the process of waste management depends on the efficiency of the decisions taken and the efficiency of the tools applied. Therefore, the efficiency ought to expose the achievement of the intended objectives while maintaining the proper relationship between the effects and the incurred expenditures in statistical and dynamic terms (Pentland, 2014). The commercial power industry companies which implement the strategy of sustainable development refer to the assumptions of the concept of lean management. This is due to the fact that the commercial power industry companies in Poland are interested not only in reduction in operating costs but also the achievement of better environmental and social effects. The implementation of the strategy of sustainable development in the commercial power industry companies in Poland is achieved using different lean management tools. For example, Total Quality Management (TQM) in the commercial power industry companies in Poland amounts to the minimization of the number of complaints filed by customers, which affects reduction in the amount of waste generated by faulty processes, like in the case of using the Six Sigma method. Continuous improvement in production processes in the companies of the commercial power industry in Poland is carried out in accordance with the kaizen philosophy, which allows for systematic reduction in the amount of generated waste and its more effective management. The application of cost accounting in the companies of the commercial power industry in Poland enables planning the level of costs of waste management in the area of its storage, transportation and distribution (Holweg, 2007). The companies of the commercial power industry in Poland manage the structure and composition of waste according to the requirements of individual customers while using target costing. Moreover, the conducted systematic training of employees, taking into account the assumptions of the 5S methods are favorable for an increase in environmental awareness, which leads to reduction in the amount of generated waste. In accordance with the principles

of TPM, the companies of the commercial power industry in Poland reduce the level whereas the application of the SMED method leads to the more effective use of the possessed resources, both human and environmental (Schiederiget *al.*, 2012). Summing up, it is worth pinpointing that the tools of waste management in the companies of the commercial power industry in Poland require taking into account the strategy of sustainable development. The system of waste management in the companies of the commercial power industry focuses not only on reduction in negative effects of the flow of waste. The actions taken by the commercial power industry companies in Poland concentrate on management of the processes of collection, processing, storage and recycling of waste. In this context, the strategy of sustainable development affects the improvement in the organization of the process of waste management and influences an increase in the environmental awareness of its employees and entrepreneurs.

Identification of waste in the companies of the commercial power industry in poland

The empirical research was conducted on the basis of the data shared by the company of the commercial power industry operating in Poland. The research period refers to the years 2009-2017. The surveyed company deals with the production and distribution of electric power. During the production processes some waste inventories arise, among which an important group is combustion by-products. Waste disposal in the Polish legislation is determined by the provisions of the Law on waste (The Act of 27 April 2001) and a range of implementing acts in this field. The Law on waste takes into account the standards of protection of human life and health and environmental protection in accordance with the concept of sustainable development. Therefore, management of waste from the energy sector must take into account legal regulations in the field of reduction in pollution, greenhouse gas emissions and the application of the best available techniques to improve the efficiency of power generation. In the rank of regulation there was specified the catalogue of waste which distinguishes twenty groups of waste classified by its source (Waste from power stations and other combustion plants (Regulatory Information, 2001). The catalogue of waste of the energy sector is really extensive, therefore, in the paper, the attention is drawn to the waste from thermal processes arising in the production process. Waste in the companies of the commercial power industry arise as a result of burning coal in the process of power generation. In the process of power generation, there is a large amount of air pollution and solid by-products. Coal, both hard coal and brown coal, is the most abundant fossil fuel in the world. For this reason, it has become the main carrier of the primary energy. In the course of coal burning, during power generation, combustion by-products arise, such as slag and ash, i.e. furnace waste and flue gas desulphurization materials. This waste is generated regardless of the applied combustion technology. Therefore, the implementation of modern combustion technologies is so important. It contributes to an increase in the economic utility of combustion by-products in various industries and brings about reduction in nuisance of the companies of the commercial power industry for the natural environment. While analyzing management of waste from the companies of the commercial power industry, it should be pinpointed that, in the last decade, there has been a clear decline in the level of generated waste with a simultaneous increase in its management in various industries. It is the result of the implementation of the strategy of sustainable development in the companies of the commercial power industry in Poland. This is due to the fact that waste from coal-fired power generation is broadly used in industry. The main recipient of waste from coal-fired power generation is the cement industry which uses volatile ashes and gypsums as additives to production of various cements, concretes and aggregates. The recipient of waste from coal-fired power generation is also the construction industry, in which waste from coal-fired power generation is used for production of bricks, special ceramics, hydro-insulating and thermo-insulating materials. Ashes have specific applications in the economy; they are used in agriculture for soil remediation or in mining, for sealing and backfilling workings. Summing up, it should be noted that the companies of the commercial power industry in Poland are interested in the implementation of the strategy of sustainable development. This strategy is implemented through the use of modern technologies and the implementation of the tools of waste management enables an increase in the efficiency of the operation of the companies of the commercial power industry, among others, contributing to

reduction in pollution. Another consequence of the modernization of the power generation technology is increasing the industrial utility of waste. An important role in reduction in the amount of waste generated in the companies of commercial power generation is also played by quality and environmental systems, which allow for effective development of the flow of waste from the producer, through subsequent landfills, to the recipient, providing information essential for decision-making in the field of rational waste management by all stakeholders.

MATERIALS AND METHODS

The research problem, undertaken in the study, is the impact of the sustainable development strategy on the efficiency of waste management in the enterprise. The accomplishment of the adopted objective, which was to recognize and assess the relationships between the efficiency of waste management and the implementation of the strategy of sustainable development in the company of commercial power generation in Poland, began with the analysis of the strength and direction of the linear relationship between the analyzed factors using the Pearson correlation coefficient (Table 1). The basis of the research process was the adoption of the methodological assumptions. It was assumed that the level of implementation of the strategy of sustainable development was expressed through capital expenditures incurred on the implementation of modern tools of waste management. On the other hand, the efficiency of waste management in the companies of the commercial power industry reflects the level of costs incurred on waste management. The research method used to achieve the objective is the case study (Gibbert *et al.*, 2008) conducted on the basis of purposive sampling, which was determined by the availability of data necessary for carrying out the research in the company of commercial power generation operating in Poland.

RESULTS AND DISCUSSION

While, analyzing the strength and direction of the relationship between capital expenditures incurred on the implementation of modern tools of waste management and the costs of waste management in the surveyed company, a very strong negative correlation between the analyzed parameters can be observed (Table 1).

At the same time, along with an increase in capital expenditures incurred on the implementation of modern tools of waste management there is a decrease in the costs of waste management. The research results of the correlation are statistically significant (the significance at the level of α= 0.01). This means that the impact of the strategy of sustainable development is reflected in an increase in the efficiency of waste management in the surveyed company of the commercial power industry. In order to confirm the research results calculated with the Pearson correlation coefficient, there were specified the assessment criteria of the model quality using coefficient of determination R^2, which describes the part of the dependent variable which results from its dependence on independent variables taken into account in the model. The results of the fitting of the R^2 regression model to the empirical data calculated for the company are presented in Table 1. When analysing the results of the conducted research, it should be noted that the surveyed company of the commercial power industry included in the research is interested in the information concerning the opportunities for the implementation of modern tools of waste management and the creation and use of the technical and technological basis in the field of the construction of installation to increase the recycling of waste from combustion processes. The specificity of combustion by-products from coal-fired power generation subjected to recycling is presented in Fig. 1.

Table 1: The relationship between capital expenditures incurred on the implementation of the assumptions of the concept of sustainable development and the costs of waste management

Specification	Values	Permissible discharge limits for industrial effluents
The relationship between capital expenditures incurred on the implementation of the assumptions of the concept of sustainable development and the costs of waste management	-0.9989	Y=1.581x-1.5118 0.9994

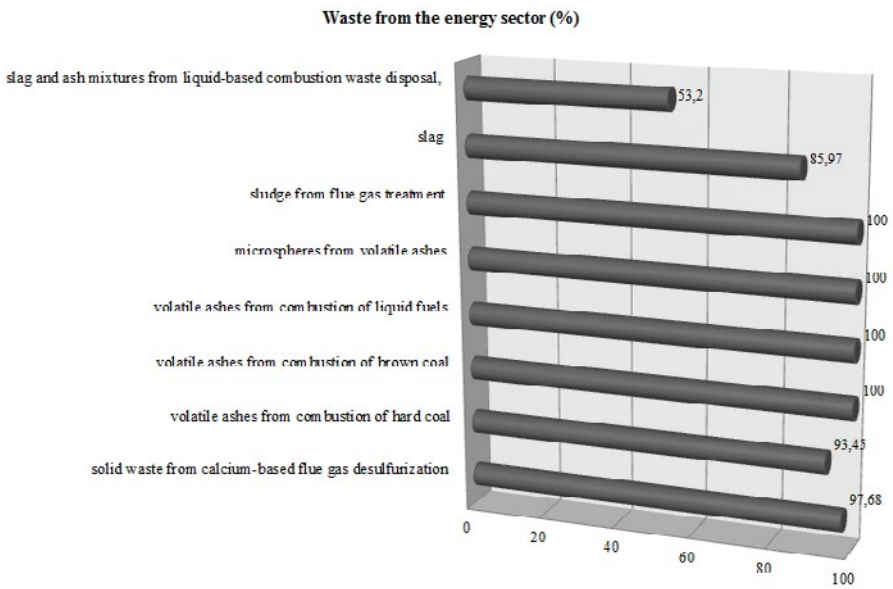


Fig. 1: The level of waste from the power industry subjected to recycling source

The information obtained in the area of the storage of waste relates to the time, amount and the way of storage. When examining the development costs of modern waste management tools in the overall production cost structure of the surveyed enterprise, it is noticed that the share of costs incurred for the implementation of modern waste management tools increases by 14% in the production cost structure in the analyzed period. The research also shows that in the same research period there was a decrease in the amount of waste generated by 12%, which leads to the conclusion that the expenditure on the implementation of modern waste management tools results in a reduction in the amount of waste generated. In the current year, the surveyed company intends to incur expenditures of 16% of the production budget for the implementation of further improvements in the field of waste management.

The first stage of the planned improvements will be training employees for the methods of landfilling. In the second stage, the construction of deducting installations worth 300,000 EUR will be implemented. The estimated duration of the investment is 5 years. The expected effects of this investment are waste reduction by 68% in relation to their current level and a reduction of energy consumption by 35% compared to its current consumption. As a result of this investment, the company expects a 12% drop in water consumption and an increase in the use of alternative fuels in the production process by 34%. In addition, the positive effect of construction of deducting installations will be a reduction of fees for environmental pollution by 38%. Measures taken by the surveyed enterprise are reflected in the calculated correlations. It should be pinpointed that such information is also the focus of interest of recipients of waste from the companies of commercial power generation, who are interested not only in cost-effectiveness resulting from the use of waste but also social and environmental effects resulting from this process. Similar conclusions are drawn by other researchers dealing with the impact of the sustainable development strategy on management efficiency, who also indicate the benefits, risks and consequences of new solutions for society (Hein *et al.*, 2017). While, taking into account the complex nature of the analyzed phenomenon and evolving theories in the area of sustainable development, it should be pinpointed that sustainable development plays an important role in the processes of reduction in the amount of waste arising in the companies of commercial power generation in Poland. The implementation of solutions resulting from the assumptions of the concept of sustainable development using modern tools of management in the companies of the commercial power industry

allows for effective development of the flow of waste through individual links of the supply chain, from the producer, through subsequent landfills, to the recipient, simultaneously supplying information essential for decision-making in the field of rational waste management by all interested parties. What is more, the solutions proposed in the study may also be applied in the power industry enterprises in other countries and other areas of activity. It is worth noting that despite the fact that scientific research into management of waste from enterprises has been carried out on a large scale, there is not much research concerning its dynamics, in particular, there are no studies on the environmental approach to waste management of the companies of commercial power generation.

CONCLUSION

The objective of the study has been to recognize and assess the relationships between the efficiency of waste management and the implementation of the strategy of sustainable development in the company of the commercial power industry in Poland. The conducted research indicates that the effective waste management requires the possession of the up-to-date information on diversity, structure, level and demand for waste from the companies of commercial power generation and the abilities to implement modern tools of waste management in accordance with the assumptions of the concept of sustainable development. The main contribution of the paper is the in-depth understanding of the coexistence of the strategy of sustainable development and waste management in the company of the commercial power industry operating in Poland, with particular emphasis on reduction in this waste and the possibility of its redevelopment. A clear implication from the theoretical and empirical assumptions of the conducted research is the fact that the strategy of sustainable development may be of great significance for the efficiency of waste management in the company of commercial power generation in Poland. However, it should be emphasized that conducting the research process on the basis of the case study indeed allows for the presentation of a more accurate and in-depth image of the analyzed phenomena and relationships, however, it also has some constraints in the form of the limited possibility of scientific cognition. The constraints of the case study are: time-consuming nature, low representativeness of the results, intuitiveness and subjectivity of judgements and high costs of conducted research. The study supports the current view that the rapidity and quality of the implementation of the strategy of sustainable development determines the efficiency of waste management in the companies of commercial power generation in Poland, however, the direction of further research in this area should aim at increasing the efficiency of decisions taken in the area of waste management. In order to accomplish the objective of the paper, literature studies and descriptive analysis, trend analysis and the Pearson correlation coefficient were applied. The problem of sustainable development and waste management is not new but really up-to-date due to the economic and legal conditions in which the companies of commercial power generation in Poland operate.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

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