Economics and Organization of Logistics
5 (2), 2020, 97–104

DOI: 10.22630/EIOL.2020.5.2.16

Marcin Rabe
University of Szczecin

The impact of waste quality on a sustainable waste management model

Wpływu jakości odpadów na zrównoważony model gospodarki odpadami

Abstract. The growing interest of enterprises in development in the directions of the concept of sustainable development or corporate social responsibility somehow forced market participants to be more flexible in their actions. Entities from the waste industry must quickly adapt to changing, dynamic realities in order to maintain an appropriate position on the market. The aim and subject of the publication is to present the impact of waste quality on the construction of a sustainable waste management model. The quality of waste determines whether a given waste processing product meets the expectations and standards of the final recipient, as well as the costs of its final management or recycling. The article also presents waste in the light of the applicable national and European Union regulations as well as sustainable development in the aspect of industrial waste management.

Key words: sustainable development, waste management model, waste

Synopsis. Wzrost zainteresowania przedsiębiorstw rozwojem w kierunkach koncepcji zrównoważonego rozwoju czy społecznej odpowiedzialności biznesu niejako wymusiły na uczestnikach rynku większą elastyczność w działaniu. Podmioty branży odpadowej muszą bardzo szybko dostosować się do zmiennych i dynamicznych realiów, chcąc utrzymać odpowiednią pozycję na rynku. Celem i przedmiotem publikacji jest przedstawienie wpływu jakości odpadów na budowę zrównoważonego modelu gospodarki odpadami. Jakość odpadów decyduje o tym, czy dany wyrób z przetwarzania odpadów spełnia oczekiwania i normy odbiorcy końcowego, a także o kosztach jego ostatecznego zagospodarowania czy recyklingu. W artykule także przedstawiono odpad w świetle obowiązujących przepisów krajowych i unijnych oraz rozwój zrównoważony w aspekcie gospodarki odpadami przemysłowymi.

Słowa kluczowe: zrównoważony rozwój , model gospodarki odpadami, odpady

Introduction

The growing interest of enterprises in the development of the concept of sustainable development or corporate social responsibility somehow forced market participants to be more flexible in their actions. This situation only confirmed that the main task of modern management is to observe the business environment and search for answers to emerging questions and problems [Nogalski 2008]. Waste industry entities had to adapt very quickly to the changing, dynamic realities in order to maintain an appropriate position on the market. It turned out to be important to create the image and value of the company through the time criterion – the speed of action on the existing situations, cooperative and network connections. A single installation will not manage all waste from a given producer and will not be able to react quickly enough. With such defined cooperation, there are much greater opportunities to create cooperation while starting the waste processing process at the producer's.

When analysing the currently available publications related to waste management, one can notice a clear interest in the issues of municipal waste management with particular emphasis on packaging waste and, to a much lesser extent, broadly understood post-mining waste. Such a state of affairs may result from the pressure of the European Union and pro-ecological organizations in the last decade to reduce the amount of municipal waste deposited, reduce the consumption of natural resources and increase the use of secondary raw materials.

All these activities are related to the growing consumption and use of plastic packaging in almost every area of the economy. The legal basis for the functioning of the European Union and domestic waste market is also focused on municipal waste, treating post-production waste extremely superficially.

The aim and subject of the publication is to present the impact of waste quality on the construction of a sustainable waste management model. The quality of the waste in the model also determines the costs that their producer must incur when transferring the waste to the final installation and what costs will be incurred by the installation during the treatment process. The quality of waste determines whether a given waste processing product meets the expectations and standards of the final recipient, as well as the costs of its final management or recycling. The article focuses on sustainable development in terms of industrial waste management and analyses waste in the light of the applicable national and European Union regulations. The research method used in the publication is the analysis of existing data and literary criticism. The literature, netography and statistical data show that industrial waste management can be an effective management system that allows to achieve high-quality final products obtained from processed post-production waste by means of marginal installations and allows enterprises to function in a circular economy. However, you should be aware of both its advantages and disadvantages.

Waste in the light of applicable national and European Union regulations

Waste, understood as all useless and thrown things or substances, both in European and national regulations, does not have a single general definition. It should be noted that we are dealing with a number of wastes that are defined depending on many factors and criteria classifying them as waste. European and national legislation is identical in this respect due to the implementation of European Union regulations into national legislation.

The basic definition of waste in European regulations was included in the Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain directives in Article 3 [Directive 2008/98/EC…] and defines waste as "any substance or object which the holder discards or intends or is required to discard". Also included is the definition of hazardous waste, meaning waste showing at least one of the hazardous properties listed in Annex III to the Directive. These properties include materials and substances: explosive, oxidizing, highly flammable, flammable, irritating, harmful, toxic, carcinogenic, corrosive, infectious, harmful to reproduction, mutagenic, waste which in contact with water, air or acid releases toxic or highly toxic gases, sensitizing, ecotoxic, waste which, after disposal, can by any means yield another substance, for example in the form of a leachate, which has at least one of the characteristics listed above.

Bio-waste was defined as "biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail outlets and comparable waste from food processing plants". Municipal waste should also be mentioned, the definition of which was developed for statistical purposes by Eurostat and the Organization for Economic Co-operation and Development in order to harmonize the data provided by the Member States. Municipal waste is defined as "household waste and waste from other sources, such as retail, administration, education, healthcare, housing and catering services and other services and activities, similar in nature and composition to household waste".

As stated above, in terms of the definition and conception of waste, national regulations are in line with community regulations. Regardless of the adjective describing the type of waste (liquid, industrial, etc.), one should focus, as Jerzmański [2013] notes, on the basic definition of waste, which is based on three actions of the waste producer – disposal, intention to dispose of and the obligation to dispose of the waste. Therefore, we can talk about a cause-and-effect relationship that occurs in deliberate and planned waste management. With such a definition of waste, in principle, everything or substance that the user has at his disposal at a given moment will be waste at an indefinite time. However, the decision about the situation in which an item or substance will change its status to waste is made by the so-called producer of this waste [Radecki 2008]. However, in the literature on the subject, one can find many doubts as to whether the mere fact of disposing of an item or substance by a waste producer, for example in the production process, actually gives it the status of waste.

The end-of-waste regulation has been implemented into national legislation on the basis of Article 6 of Directive 2008/98/EC of the European Parliament and of the Council. Poland did not make use of the possibility of taking a national decision on the possibility of determining criteria whether certain waste may cease to be waste as a result of technical regulations, administrative regulations or voluntary agreements [Mazurek 2019]. The implemented provision was included in Article 14 of the Waste Act of 2012 [Ustawa z dnia 14 grudnia 2012 r…]. Certain types of waste cease to be waste if, as a result of their recovery, including recycling, they meet the following conditions:

– the object or substance is used for specific purposes;
– there is a market or demand for such items or substances;

– the given object or substance meets the technical requirements for use for specific purposes and meets the requirements set out in the regulations and standards applicable to the product;
– the use of the object or substance does not lead to negative effects on life, health or the environment.

By recovery referred to in Art. 1.3 clause 1 point 14 of the Waste Act should be understood as any process the main result of which is that the waste serves a useful purpose by replacing other materials that would otherwise be used to perform a given function, or as a result of which the waste is prepared to perform such a function in a given plant or in the economy in general. However, in Art. 3 clause 1 point 23 of the Act on waste, one of the types of recovery is recycling, which is understood as recovery, where waste is reprocessed into products, materials or substances used for the original purpose or other purposes.

Sustainable development in terms of industrial waste management

The present concept of sustainable development was popularized by the Brundtland Commission (World Commission on Environment and Development), which in its report presented this definition: "sustainable development is development that meets the needs of the present without endangering the possibility of meeting the needs of future generations" [Misztal 2017]. However, in order for the concept of sustainable development to exist more broadly in the production dimension, manufacturing plants must adapt to it.

In terms of waste management, sustainable development is perhaps the most desirable and visible activity from all sectors of the economy. Both the applicable legal regulations and the efforts of global organizations to take measures to reduce the generation of waste and any harmful emissions while maintaining the natural environment in its present shape, force the shaping of systems based on three balancing pillars: social, economic and environmental development [Biegańska and Ciuła 2011]. Social and economic development can be assessed through the prism of the amount of waste, both municipal and packaging waste. All waste is considered a source of pollution, and when stored it is dangerous to soil, water and air.

Properly prepared, processed and recovered waste can be a valuable source of raw materials. Sustainable development of waste management is primarily waste management without the need to landfill it, with maximum recovery of input materials. This is particularly evident in the management of industrial waste. The activities of the industry are interfering more and more deeply with the waste policy of production companies, not limiting their role only to waste recipients. More and more often, the waste producer expects as much waste as possible to be recycled, and the recipient takes steps to enable this process. The joint cooperation is aimed at optimizing the waste management process from the place of production, through sorting, logistic preparation, to final management. This approach allows for the development of methods and schemes of action that take into account pro-environmental processes. The responsibility of the waste producer for its management gives another tool to supervise the waste management process, taking into account all environmental standards. It also eliminates to a large extent unfair practices of waste recipients, which contributes to the observance and improvement of environmental protection standards.

A properly designed waste management system allows to reduce both emissions related to transport, limits energy consumption to the necessary amounts supporting the process of waste disposal from the plant, but also allows to increase the amount of waste intended for recycling. Properly prepared waste, transferred to the terminal installation, allows to disable one or more processes related to waste preparation for further processing. This allows for further reductions in emissions and resource consumption for the purposes of own operation and/or the recovery of materials for further processing, including in the form of raw materials.

Assumptions and construction of a waste management model

Shifting the waste processing process involves the producer of the waste to be jointly responsible for its quality, thus giving a real impact on the costs borne by the producer for waste management. The problem is both the delivered waste and the end product for each type of installation. Reclassification of the final product, price change for processed waste and raw materials, returns or inclusions deducted from the product weight result in a decrease in both the effectiveness of the entire waste processing system and the profitability of individual types of installations [Szweda 2017].

Each of the installations is characterized by a certain specificity of operation, whether it be the types of processed waste or the final product produced, which will have a different recipient. It also includes the waste processing technology of a given installation as well as the technological and production line. Installations also differ in terms of recipients or the number of deliveries and production capacity specified in the environmental permit, but for each installation, one of the most important performance indicators is the number of widely understood complaints [Rosik-Dulewska 2020].

Complaints may relate to virtually any aspect of the processed waste. Each processed waste may be subject to a complaint, as well as untimely deliveries. The waste management model must take into account those factors that are directly responsible for the elimination of existing non-conformities and have an impact on the costs of the entire process. At the same time, it should be borne in mind that not all changes, although they will bring measurable benefits to each of the participants in the industrial waste management system process, will be acceptable to everyone.

In accordance with the currently operating industrial waste management system, waste is transferred to terminal installations that prepare it for further management. To simplify the model, an intermediate element in the form of waste transport logistics has been omitted due to the fact that it has no significant impact on the quality of waste [Frąś 2017]. The waste is transported both by end installations and external carriers. The external carrier, on the basis of European Union (CMR convention) and national regulations, is responsible for the entrusted cargo and in the event of its damage as a result of improper securing, transportation, storage, e.g. in modal transport, it covers any damage due to the quality of the delivered waste [Gil and Ignaciuk 2014].

Only the producer has a direct impact on the quality of the waste, the recipient, who determines the quality requirements for the received products, and the terminal installation that determines the parameters of the received waste, have an indirect impact. However, it is not always possible to check whether a given batch of waste meets the assumed requirements. Therefore, it is important that waste producers incur costs related to the transferred waste that do not meet the established criteria, on the same basis as terminal installations.

The industrial waste management model was built on the assumption that there is a correlation between the quality of the delivered waste, regardless of its type, and the quality of the final product obtained. For this purpose, two additional quality groups were designated:

- waste requiring cleaning and better, constituting the sum of waste requiring cleaning and clean,
- contaminated and better waste constituting the sum of contaminated waste, requiring cleaning and clean waste.

In the next stages in building the model, the Pearson's linear correlation can be used and the following data can be adopted:

$$y = \frac{\sum i\left(x - \vec{x}\right) \cdot \left(p - \vec{p}\right)}{\sqrt{\sum\left(x - \vec{x}\right)^2} \cdot \sqrt{\sum\left(p - \vec{p}\right)^2}}$$

- input – share of received waste of a certain quality, average number of complaints (x, p),
- initial – correlation coefficient of the number of complaints to the share of waste of a certain quality (y).

Using the Pearson's linear correlation, we obtain an analysis of the results in three intervals

- result close to 0 – no correlation, changing one of the tested data does not change the other,
- result close to –1 – negative correlation, a change in one value from the tested data causes an opposite change in the other (e.g. increasing the value of x causes a decrease in the value of p),
- result close to +1 – positive correlation, a change in the value of one of the data causes the same change in the other (e.g. increasing the value of x increases the value of p).

As the absolute value of the coefficient increases, the strength of the correlation increases (the data is more related). So the closer to the value of –1 or 1, the more we can assume that changing one data will change the other.

Table 1 Correlation coefficients for individual waste quality groups
Tabela 1 Współczynniki korelacji dla poszczególnych grup jakościowych odpadów

	Waste unsuitable for processing	Waste very heavily conta-minated	Conta-minated waste	Waste that requires cleaning	Clean waste	Waste that needs cleaning and better	Waste polluted and better	
Y	from –1 to +1	from –1 to +1	from –1 to +1	from –1 to +1	from –1 to +1	from –1 to +1	from –1 to +1	Average number of complaints

Source: own study.

Summary and conclusions

This paper presents a theoretical model of waste management, which does not cover the entire industrial waste management system, but focuses on its most important element – waste quality. The quality of the waste determines the extent to which a given waste will be utilized, and to what extent it will be stored in a landfill. Therefore, quality has a direct impact on the achieved recycling and recovery levels. The quality of the waste also determines the costs that must be borne by the producer when transferring the waste to the final installation and what costs will be incurred by the installation during the treatment process. The quality of waste determines whether a given waste treatment product meets the expectations and standards of the final recipient, as well as the costs of its final management or recycling.

The effectiveness of industrial waste management depends on both legal regulations and solutions implemented by individual installations. As shown in the model, the quality aspect of the delivered waste is extremely important. In the current waste management system, only a few waste or groups of waste have a normative classification, which is the same as determining the class and quality of a given waste. One example of such standardization will be the classification of scrap and waste paper.

References

Biegańska J., Ciuła J., 2011: Zintegrowana gospodarka odpadami komunalnymi w Polsce jako element zrównoważonego rozwoju [Integrated municipal waste management in Poland as an element of sustainable development], Archiwum Gospodarki Odpadami i Ochrony Środowiska 13(1), 51–60 [in Polish].

Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain directives.

Frąś J., 2017: Metody badawcze – rodzaje i istota, materiał dydaktyczny [Research methods – types and essence, didactic material], Politechnika Poznańska, Poznań [in Polish].

Gil L., Ignaciuk P., 2014: Odpowiedzialność za ładunek w transporcie drogowym [Responsibility for cargo in road transport], Logistyka 3, 1977–1980 (CD) [in Polish].

Jerzmański J., 2013: Ustawa z 14 grudnia 2012 r. – nowe zasady gospodarowania odpadami [The Act of 14 December 2012 – new rules for waste management], Przegląd Komunalny 2, 47–66 [in Polish].

Mazurek S., 2019: Informacja Ministra Środowiska na temat spalarni odpadów komunalnych i ich miejscu w systemie gospodarki odpadami [Information of the Minister of the Environment on municipal waste incineration plants and their place in the waste management system], Departament Gospodarki Odpadami w Ministerstwie Środowiska, Warszawa [in Polish].

Misztal A., 2017: Logistics processes and sustainable development of an enterprise, Organizacja i Zarządzanie 75, 201–212.

Nogalski B., 2008: Kierunki badań i rozwój w naukach o zarządzaniu – kontekst strategiczny [Directions of research and development in management sciences – strategic context], [in]: Zarządzanie strategiczne – podstawowe problemy [Strategic management – basic problems], R. Krupski (ed.), Wałbrzyska Wyższa Szkoła Zarządzania i Przedsiębiorczości, Wałbrzych [in Polish].

Radecki W., 2008: Ustawa o odpadach. Komentarz [Waste Act. Commentary], Wolters Kluwer Polska, Warsaw [in Polish].
Rosik-Dulewska Cz., 2020: Podstawy gospodarki odpadami [Fundamentals of waste management], PWN, Warsaw [in Polish].
Szweda M., 2017: Rynek paliw alternatywnych 2016/2017 [Alternative Fuels Market 2016/2017], [electronic source]: https://ibdo.pl/?page_id=771 [access: 15.11.2018] [in Polish].
Ustawa z dnia 14 grudnia 2012 r. o odpadach [Act of 14 December 2012 on waste, as amended], Dz.U. 2013 poz. 21 z późn. zm. [in Polish].

Correspondence address:

Marcin Rabe, PhD
University of Szczecin
Management Institute
Department of Logistics
Cukrowa St. 8, 71-004 Szczecin, Poland
e-mail: marcin.rabe@wzieu.pl