

## WASTE MANAGEMENT IN POLISH ORGANISATIONS PARTICIPATING IN EMAS

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**Purpose:** The purpose of this paper was to present the activities undertaken in the area of waste management by Polish enterprises participating in the EMAS system, operating in the water supply, sewage and waste management and remediation branches.

**Design/methodology/approach:** The grounds for the assumed research method was the analysis of secondary sources in form of environmental statements. The selection of sample was targeted, the research was complete and included 19 companies participating in EMAS, dealing with water supply, sewage and waste management and remediation. Based on the analysis, groups of most frequent activities in the area of waste management have been determined and specific solutions implemented in each group have been presented.

**Findings:** Polish enterprises mostly performed activities relating to: public educational campaigns, use of a system of measurable indicators, waste treatment or disposal and modification of waste treatment installations. It has been found, despite the fact that research has been made among organisations whose activity mainly involves positive environmental impact, that presented solutions could be implemented or inspire not only businesses with a similar profile, but also those whose operations entail producing and introducing waste to the environment.

**Research limitations/implications:** A certain limitation of the research is the fact that information in environmental reports is not uniform, which makes it difficult to analyse. Not every organisation includes data on specific implemented activities in their environmental reports. The areas of further research may include analysis of solutions implemented by Polish manufacturing companies participating in EMAS, relating to waste or energy efficiency.

**Practical implications:** The key input of the described research includes examples of specific actions that could be implemented by organisations dealing with various types of activity in order to prevent production of waste or reduce the volume of waste.

**Social implications:** This paper describes exemplary solutions that could help organisations in improving their environmental performance relating to waste.

**Originality/value:** The results of conducted research may supplement the previous research concerning the EMAS system. This paper contains guidelines and examples of specific activities that organisations could implement in the field of waste management.

**Keywords:** EMAS, waste management, waste hierarchy.

**Category of the paper:** Research paper.

## 1. Introduction

Over the last few years, waste management has become a key issue on the EU agenda, discussed in all member countries, including Poland. According to Directive 2008/98/EC, that is a primary legal act in the EU concerning waste management, a shift towards the "recycling society" is expected, in which the starting point for any activity would be preventing the generation of waste and using waste as a resource (Directive 2008/98/EC, 2008). In order to reach this goal, adopting a systemic approach will be essential, including development of relevant legal regulations, both on the EU level and in individual member states (e.g. national programmes to prevent waste production).

Considering the waste hierarchy, preventing the generation of waste is a priority (Directive 2008/98/EC, 2008; Dz.U. poz. 21, 2012). Taking specific preventive actions depends on the type of waste and the type of operations. These activities may include implementation of the eco-management and audit scheme (EMAS), which currently is the most credible and transparent environmental management system. The basic goal of this system is to support organisations in achieving continuous improvement of their environmental performance in various environmental areas, including waste management. The significance of this tool in preventing waste production has been emphasised both on the EU level (Directive 2008/98/EC, 2008) and also in key legal documents relating to waste management in Poland (Dz.U. poz. 1688, 2015; Dz.U. poz. 21, 2012; Dz. U. poz. 888, 2013; M.P. poz. 784, 2016).

This paper is an attempt to fill the cognitive gap in the knowledge concerning the activities undertaken by Polish organisations participating in EMAS to reduce the negative impact or increase the positive impact of their operations in different environmental areas (e.g. related to waste). Eliminating this gap will allow to present solutions to be implemented in enterprises in order to meet high EMAS requirements, present environmental practices that may be implemented in organisations with different profiles (participating and not participating in EMAS) in order to improve their environmental performance, and also to present specific activities in waste management, performed by organisations in practice.

## 2. EMAS significance in waste management hierarchy

Waste is defined as any substance or object which the holder discards or intends or is required to discard (Directive 2008/98/EC, 2008). Directive 2008/98/EC defines the following waste hierarchy, including: prevention, preparing for re-use, recycling, other recovery (e.g. energy recovery) and disposal. This hierarchy is also valid in Poland, since the obligation of each EU member state is the transposition of Community legislation into national law.

According to the defined hierarchy, the key method of waste management should be reduction or total prevention of waste production, as possible. This principle implies that every organisation whose activity causes or can cause production of waste, should properly plan, design and conduct these activities. In order to achieve that, adequate forms of service, production or use of resources and materials should be considered, to prevent generation of waste or reduce its volume, and also to reduce the negative environmental impact (in manufacturing operations, entire product life cycle must be considered). Waste that cannot be avoided, should undergo recovery processes. Here, the possibility to prepare for re-use should be considered in the first place. If not possible, recycling is the following method in the hierarchy. If this waste management method is not possible as well, other means of recovery should be considered. Waste streams for which recovery is not possible due to technological or economic reasons, should undergo disposal processes. Disposal methods are used when all recyclable waste components are separated (Dz.U. poz. 21, 2012).

It must be noted that the purpose of the waste hierarchy mentioned above is reaching the best overall outcome in terms of environmental protection by all member states. It means that for specific waste streams, departing from these priorities is possible, when justified for reasons of possibilities technical feasibility, economic viability and environmental protection (Directive 2008/98/EC, 2008).

Beside the waste hierarchy on the EU level and in individual member states, also exemplary actions that could be implemented in each mentioned waste treatment area are presented. For preventing the generation of waste, which is the priority, significance of implementation of credible environmental management systems has been emphasised, in particular EMAS (Directive 2008/98/EC, 2008; Dz.U. poz. 21, 2012). The importance of this instrument in reducing the volume of waste or preventing its generation results mainly from very strict requirements, imposed by EMAS on organisations intending to participate or maintain their participation in the scheme. It particularly concerns the requirement to achieve continuous improvement of environmental performance in six areas indicated in the EMAS Regulation, one of which relates to waste (Regulation (EC) No. 1221/2009, 2009). This requirement somehow forces organisations whose activity contributes to the generation of waste to seek solutions to eliminate or reduce waste. It also applies to organisations whose activity involves positive environmental impact (e.g. treatment of waste received from other entities). In order to improve their environmental performance, they seek solutions that allow increasing the volume of received waste or conducting more efficient waste treatment processes.

Improvement of environmental performance is assessed using environmental efficiency indicators (Commission Regulation (EU) 2018/2026, 2018). For organisations whose activity entails generation of waste, an indicator representing the "total annual generation of waste" in the given area is applicable, broken down by type (Commission Regulation (EU) 2018/2026, 2018). The organisation should focus on reducing the value of that indicator. Organisations whose activity has a positive environmental impact (e.g. dealing with waste treatment) can use

other or additional indicators. These may concern the scale of recycling processes, increase in the number of clients who transfer the recycling and recovery obligations, and also the number of conducted training activities, etc. It should be mentioned that the EMAS requirement to use indicators is consistent with the assumptions of Directive 2008/98/EC, where the measures to prevent waste production include, among others, development of indicators of the environmental pressures associated with the generation of waste (Directive 2008/98/EC, 2008).

In the context of waste management, also significant is the EMAS requirement to maintain conformity with legal regulations. It means that organisations are obliged to monitor and implement on time any changes in all relevant legal acts, including those relating to waste. It is important both for organisations whose activity is associated with the generation of waste (helps them maintain conformity e.g. with permits) and also organisations conducting activity associated with waste management (helps them maintain conformity with relevant EU and national regulations).

### **3. Review of previous research concerning EMAS**

The requirement to improve environmental performance on a regular basis stimulates organisations registered under EMAS to seek solutions that help fulfil this condition. Specific solutions implemented by companies can be perceived a positive effect of EMAS implementation. The research has indicated that some of them can be considered environmental product innovations (Hoffmann et al., 2003; Salomone, 2008; Nycz-Wróbel, 2016) or technological innovations (Braun, Grotz, 2002; Rennings et al., 2006; Nycz-Wróbel, 2016). It needs to be emphasised that the previous research concerning the effects of EMAS implementation focused mainly on determining whether and what general environmental effects were achieved by the companies after participating in the system. The research shows that most frequently indicated benefits concerned systematisation and arrangement of previous environmental activities (Freimann, Schwaderlapp, 1996; Hillary, 1998; Bohne, 2000; Steger, 2000; Umweltbundesamt, 2000; Kossler et al., 2002; Morrow, Rondinelli, 2002; Hyršlova, Hajek, 2005, 2006; Abeliotis, 2006; Ministerio De Medio Ambiente, 2006; Nycz-Wróbel, 2016a), limiting the negative environmental impact mainly through the reduction of generated waste and the usage of resources and energy (Bültmann, Wätzold, 2000; Schucht, 2000; Umweltbundesamt, 2000; Braun, Grotz, 2002; Wenk, 2004; Hyršlova, Hajek, 2006; Vernon et al., 2009; Nycz-Wróbel, 2016a) and also improvement of environmental performance (Hillary, 1998; Morrow, Rondinelli, 2002; Hillary, 2004; Daddi et al., 2011; Merli et al., 2014; Nycz-Wróbel, 2016a). More specific activities planned or implemented in order to improve environmental performance have been indicated in the research conducted among German and French companies. These included introduction of technical upgrades in existing facilities and

installations, optimising or implementing new technological processes, replacement of problematic materials or introducing environmental product improvements (Bültmann, Wätzold, 2000; Schucht, 2000). Other available studies indicate enterprises reporting financial outcomes through savings as a result of improvements introduced in the area of waste management. In a study conducted among German companies, savings in this area have been reported by the majority of participants (Umweltbundesamt, 2000). In other studies, enterprises indicated waste management among a few areas in which most savings were achieved. These were the result of a reduction in the quantity of generated waste, or occurred by re-using and recycling of resources (Iraldo et al., 2005) or materials recovery and packaging management improvement (Strachan et al., 1997; Strachan, 1999). The study concerning French enterprises also indicated reduction of costs related to waste removal (Schucht, 2000).

Based on the listed studies, it can be concluded that environmental benefits are among the most frequently reported results achieved through EMAS implementation. Popularisation of such research results may contribute to the promotion of the EMAS scheme, which is recommended e.g. in the key European and Polish legal acts, relating to waste management (Directive 2008/98/EC, 2008; Dz.U. poz. 21, 2012). No studies are available, however, to provide specific activities initiated to achieve improvement in various environmental areas, including those associated with waste. This paper is an attempt to fill this gap. Presenting the outcome of such research will be important for wider promotion of EMAS and will also complement the previous studies, providing examples of specific solutions to be adopted in organisations from different countries, dealing with various types of activity, to improve their environmental performance and maintain conformity with the scheme requirements.

#### **4. Aim and method**

The aim of this paper was to present the activities in the area of waste management, performed by Polish enterprises registered under EMAS, dealing with water supply, sewage and waste management and remediation. The theoretical part presents the waste hierarchy introduced in the European Union, valid in all member states. It also lists EMAS requirements important for improvement of organisations' environmental performance in the waste area. The results of previous desk-research analysis regarding the EMAS system have also been presented, indicating a cognitive gap in the knowledge on particular activities implemented by the analysed companies in order to improve their environmental performance.

The empirical part presents the results of author's own research conducted among Polish enterprises registered under EMAS, dealing with water supply, sewage and waste management and remediation. The grounds for the assumed research method was the analysis of secondary sources in form of environmental statements. It should be noted that the analysis of environmental statements had been used as the grounds for the research in previous studies concerning the EMAS scheme, among others in the study on the effect of EMAS implementation on the improvement of environmental performance (Daddi et al., 2011; Matuszak-Flejszman, 2019; Heras-Saizarbitoria, 2020; Nycz-Wróbel, 2020). Environmental statements can provide valuable information on technical innovations. Enterprises can use statements of other organisations to collect ideas for innovative technical solutions feasible at their facilities (Rennings et al., 2006).

Environmental statement is a type of an environmental impact report that is obligatory for organisations participating in EMAS and must be regularly published and updated. The EMAS Regulation defines it as exhaustive information provided to the society and other interested parties, concerning the type of activity, implemented programmes, environmental goals and tasks, environmental effects, etc. (Regulation (EC) no 1221/2009, 2009). It is worth mentioning that environmental statements are credible sources of information as the data provided in those documents are regularly verified in terms of correctness, reliability, credibility and conformity with the EMAS Regulation requirements by an independent third party, that is the environmental verifier (Regulation (EC) no 1221/2009, 2009).

Environmental statements were downloaded from the Polish EMAS website. The basis was the EMAS listing dated 18 Feb 2021. The selection of sample was targeted, the research was complete and included 19 companies participating in EMAS, dealing with water supply, sewage and waste management and remediation.

The characteristics of individual enterprises in terms of size and type of activity is presented in Table 1.

**Table 1.**  
*Characteristics of individual enterprises participating in the study*

No.	Designation for study purposes*	Size of organisations	NACE code
1	A	Large	36; 37
2	B	Medium	35.11; 35.21; 38.1; 38.2; 38.32; 39.0; 81
3	C	Medium	36; 37
4	D	Medium	38.32, 70
5	E	Large	36; 37
6	F	Small	38.1; 38.3; 39.0; 71.2; 81.3
7	G	Micro	38.32; 70
8	H	Micro	38.32; 70
9	I	Medium	38.1; 38.2; 38.3; 81
10	J	Small	38.1; 38.2; 39.0
11	K	Small	69.20; 38.32
12	L	Medium	38.1; 38.3; 39.0; 71.2; 81.3
13	M	Medium	38

cont. Table 1.

14	N	Micro	38.32; 70
15	O	Large	38.1; 38.3; 39.0
16	P	Large	37; 38; 81
17	R	Small	38.22
18	S	Small	37; 38.2; 46.9; 47.9; 49.5
19	T	Medium	38.1; 38.3

\* In order to present the results of the study, companies participating in the study have been coded with letters A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, R, S, T.

Source: individual research based on analysis of environmental statements.

Considering the size of organisations, the structure of the analysed population included 4 large, 7 medium, 5 small and 3 micro enterprises. The type of activity has been presented using the statistical classification of economic activities in the European Community (NACE codes). The NACE code indicates the basic scope of activity for which an independent environmental verifier evaluates the implemented EMAS scheme.

Table 2 presents detailed characteristics of NACE codes, with the number of organisations performing each type of activity.

**Table 2.**

*Detailed characteristics of activity performed by the analysed enterprises*

NACE code	Characteristics	Number of enterprises
35.11	Production of electricity	1
35.21	Manufacture of gas	1
36	Water collection, treatment and supply	3
37	Sewerage	5
38	Waste collection, treatment and disposal activities; materials recovery	2
38.1	Waste collection, treatment and disposal activities; materials recovery Waste collection	7
38.2	Waste treatment and disposal	4
38.22	Treatment and disposal of hazardous waste	1
38.3	Materials recovery	5
38.32	Recovery of sorted materials	6
39.0	Remediation activities and other waste management services	5
46.9	Non-specialised wholesale trade	1
47.9	Retail trade not in stores, stalls or markets	1
49.5	Transport via pipeline	1
69.20	Accounting, bookkeeping and auditing activities; tax consultancy	1
70	Activities of head offices; management consultancy activities	4
71.2	Technical testing and analysis	2
81	Services to buildings and landscape activities	3
81.3	Landscape service activities	2

Source: individual research based on analysis of environmental statements.

The majority of the analysed enterprises dealt with waste management (NACE codes: 38, 38.1, 38.2, 38.22, 38.3, 38.32, 39.0). The other three types of activity conducted by a larger group of research participants were categorised with NACE codes 70, 81 and 37. The activity defined with NACE code 37 involved sewage collection and treatment (A, C, E, S), water supply and sewage infrastructure management (A) and sewage disposal services (P).

The research was conducted between 01 March 2022 and 30 April 2022. An in-depth analysis of entire environmental statements of individual companies participating in the study has been conducted. The analysis allowed identification of all activities performed by the analysed enterprises in the field of waste management. Next, the identified activities have been arranged and grouped. The results have been presented in a table form. Table 3 presents the most frequent activities. Tables 4 to 7 list specific solutions used by the analysed enterprises as part of individual forms of activity.

## 5. Results

Table 3 presents the types of the most frequent activities in the field of waste management, undertaken by Polish enterprises dealing with water supply, sewage and waste management and remediation.

**Table 3.**

*Most frequent activities in the field of waste management, undertaken by Polish enterprises*

Activities	Number of enterprises
Ecological education of society	12
Waste treatment or disposal	9
Modernisation of installations used for waste treatment	5
Other	13

Source: individual research based on analysis of environmental statements.

Most enterprises performed activities related to ecological education of society (12). Waste treatment or disposal was performed by 9 enterprises, while 5 organisations modernised their installations used for waste treatment. A group of "Other" activities has also been distinguished, including any other activities relating to waste reported by the analysed companies (13).

Table 4 presents the forms of educational activities undertaken by Polish enterprises.

**Table 4.**

*Forms of educational activities concerning waste management, undertaken by Polish enterprises*

Public educational activities	Enterprise	Number of enterprises
Educational actions for the society (for kindergartens, schools and adults)	B, D, F, G, H, M, N, P, S, T	10
Ecological actions and projects	D, F, H, K, P, R, S	7
Trainings, conferences, seminars	D, G, H, K, N, S	6
Educational social campaigns	D, G, K, N, S	5
Ecological and educational workshops	B, G, K, N	4
Eco open-air events	F, G, K, N	4
Ecological contests	B, H, R	3
Press articles, publications, website or own educational materials	B, K, N	3
Ecological advisory	K	1

Source: individual research based on analysis of environmental statements.



The analysis of environmental statements leads to a conclusion that the analysed enterprises organised various forms of ecological education for the society, relating to waste management. One of the most preferred forms were educational and informative actions (10). In this area, three companies (D, F, M) educated the adults and kindergarten/school children, four enterprises performed activities dedicated for kindergarten and school children (H, N, P, S), while the other three (B, G, T) reported educational actions without a specified age group. The organised forms of education also included ecological actions and projects (7). Among them were waste packaging collection in enterprises, schools, institutions and municipalities, collection of renewable resources, hazardous waste or used electric and electronic equipment, cleaning illegal dump sites, rivers, forests and also introduction of sorted waste bags marking in municipalities where waste collection services were provided. One of the most interesting projects encompassed production of educational materials (in form of press articles, educational video materials broadcast in media, printed folders and booklets), workshops for children, youth and adults, design and placement of information boards on educational paths and installation of sorted waste bins and crushers in school buildings. The group of analysed enterprises also included those involved in organising and conducting free or paid training events, conferences or seminars (6). These concerned the environmental protection legal system (in particular waste management). Beside that, a training cycle for farmers was organised in order to promote compost products obtained in the processes of waste treatment. Among the most popular events were also educational campaigns (5). They accompanied mass events in towns, municipalities or educational facilities. Environmental statements also provide examples of specific organisations or social groups collaborating with the analysed companies in the field of education, including: educational facilities, universities, ecological organisations, enterprises, representatives of local administration, municipalities, municipal services companies, church organisations, residential area administration, district council representatives and town councils, etc. The group of research participants also included organisations partially transferring their educational activities to municipal operators, based on partnership agreements (K).

Since the majority of the analysed enterprises operated in the area of waste management, their activity also included waste treatment or disposal. Nine of them provided examples of specific solutions applied in this area in their environmental reports (Table 5).

**Table 5.***Waste treatment and disposal operations performed by Polish enterprises*

Waste treatment and disposal processes	Enterprise	Number of enterprises
Mechanical and biological waste treatment	B, F, L	3
Using biodegradable waste from gardens to produce compost	B	3
Waste composting (sewage, green collected from residents, biodegradable from the food, paper and wood industry and from agriculture)	S	
Production of high quality, certified fertilisers based on organic refuse		
Municipal waste recovery to produce compost	J	
Plan to classify compost from kitchen refuse as a product		3
Mechanical treatment of non-recyclable waste – production of alternative fuel (RDF)	B	
Recovery of municipal waste to obtain an RDF component	J	
Production of alternative fuel from waste remaining after sorting of recyclable materials	O	2
Disposal of waste 17 05 04 by means of recovery for backfilling and terrain levelling	A	
Disposal of waste generated in the sewage treatment process by using it for reclamation of degraded post-industrial land (e.g. heaps)		
Disposal of non-hazardous waste by using it for slope construction or as insulation layers	B	2
Returning post-processing refuse from mechanical and biological treatment of municipal waste for further processing to obtain a product or recyclable material	B	
Municipal waste recovery processes to separate recyclable materials	J	1
Recycling of non-hazardous waste generated at the technical and office facilities (e.g. steel scrap, non-ferrous scrap, packaging waste)	A	
R5 treatment of waste 20 03 06 – "recycling or recovery of other non-organic materials"		1
Using fermentation biogas generated in the methanogenesis of biodegradable waste and kitchen refuse, to be used as a fuel in co-generation processes	B	
Recovery of waste by transferring waste to other entities	I	1
Use of modern technologies to recover multiple material fractions	J	1
Municipal waste recovery to separate biostabiliser		
Operating multiple waste recovery plants (e.g. installation with the status of a Municipal Plant, construction and industrial waste sorting station, waste shredding plant)	L	1
Waste recovery and recycling	D	1

Source: individual research based on analysis of environmental statements.

Research participants mostly reported the following waste treatment processes: mechanical and biological waste treatment (3), composting processes (3) or RDF fuel production processes (3). Other processes included waste disposal (2) and recovery to provide recyclable materials (2). Some solutions reported by the analysed enterprises were innovative. One of them, implemented by enterprise B, consisted in using an organic fraction dry fermentation system in the biological part of the mechanical and biological treatment process and a biodegradable fraction preparation unit for the methanogenesis processes. Another innovative solution has been implemented by enterprise S. It consisted in using refuse sewage sludge as a raw material for production of high quality fertilisers. This company has developed an aerobic/anaerobic composting method with artificial aeration. It is a patented technology, already popularised in Poland. Certain solutions applied by the research participants were consistent with the “circular economy” idea. As an example, enterprise L

operated several waste recovery installations. Recovered paper, glass or plastics are transferred to recyclable materials distributors, to be used in manufacturing of paper, glass or plastic products. This company also recycles PET containers (e.g. for production of clothes). Other waste (so-called ballast) is recycled as alternative fuel, further used at industrial plants, mainly cement producers.

The described analysis also allowed to identify certain improvements of the previously used systems (Table 6).

**Table 6.**

*Solutions used by Polish enterprises in modernisation of waste treatment installations*

Modernisation activities	Enterprise	Number of enterprises
Expanding an existing anaerobic fermentation plant with a sorted biodegradable waste preparation unit	B	1
Construction of a water trap sludge desanding station	E	1
A plan to build a construction debris storage and cleaning yard and boxes for sorted waste	I	1
Modernisation of sorting line	J	1
Expansion of waste shredding plant (production of alternative fuel)	L	1

Source: individual research based on analysis of environmental statements.

Examples of specific solutions in modernisation of waste treatment installations were reported by 5 enterprises. The aim of the improvements was: increasing the share of processed biodegradable waste in production of power and thermal energy through intensification of methanogenesis (B); reducing the volume of sludge accumulated in water traps through sludge treatment and changing the refuse management method with the possibility of reuse (E); more efficient sorted waste collection with focus on cleanness required by recipients at glassworks, metal plants, paper mills and plastics processing plants (I); achieving required recycling efficiency (J) and improving the quality of produced alternative fuel (L). The reported modernisation activities consisted in installing an additional pneumatic optical sorting machine as well as new technological solutions to improve the system throughput (J), or additional conveyors, NIR sorter, another end shredder and boxes (L).

Other activities in the field of waste management, performed by the analysed enterprises, are listed in Table 7.

**Table 7.**

*Other activities in the field of waste management, performed by Polish enterprises*

Other activities	Enterprise	Number of enterprises
System of measurable indicators	D, F, G, H, J, K, L, N, O, S, T	11
Obligation for employees to sort waste in the workplace	B, K	2
Launching an application with a free waste collection schedule for the area operated by the company	B	1
Introducing a waste catalogue for residents, containing information on how to sort waste properly and providing location of waste collection points		

cont. Table 7.

Using technologies that do not generate hazardous waste	R	1
Systematic supervision of recipients authorised to receive non-recyclable waste		
Establishing a Research and Development Centre, dealing with new technologies of waste treatment and recycling		

Source: individual research based on analysis of environmental statements.

Among other activities, the most frequently used solution was the introduction of a system of measurable indicators, allowing the evaluation of environmental performance. The indexes used by the analysed organisations can be divided into two major groups. One group concerned educational actions. This type of indicators has been used by 8 enterprises (F, G, H, J, L, N, O, T). The other group, introduced in 11 enterprises (Table 7), concerned waste treatment processes. Among the used indicators were: mass of collected waste, waste package recycling, increase in the number of clients transferring the recovery and recycling obligations and mass of compost produced from the stream of municipal waste. Other activities concerned waste sorting obligation in the workplace (B, K) and implementation of a systematic supervision of waste recipients, using both legally required documents (waste transfer sheet/BDO register) and operating measures consisted in controlling the recipient's loading procedures (R).

## 6. Discussion

First, it should be mentioned that the research has been conducted among enterprises whose activity mainly involves positive environmental impact. These were companies dealing with water supply, sewage and waste management and remediation, with the majority involved in waste management. As regards the last of these groups, its activities are focused on reducing the volume of waste transferred to landfills and increasing the amount of recycled waste. Thus, the operations performed by this type of enterprises, as identified on the basis of this research, can differ from the activities undertaken by companies whose operations entail generating waste and introducing waste to the environment. The research indicates that activities undertaken by its participants to improve waste management most frequently consisted in: ecological education of the society, waste treatment and disposal processes, modernisation of waste treatment plants and use of measurable indicators to evaluate their environmental performance. Considering the small scale of previous research indicating specific solutions implemented by enterprises registered under EMAS, it is difficult to compare particular activities. However, we can identify two types of activities most frequently implemented to improve environmental performance. These include implementing or optimising modern technological processes and technical improvements of the existing plants or installations. This type of activity has been performed by the Polish enterprises participating in this research, as well as French and German companies, participating in previous research.

Two enterprises participating in the research applied innovative solutions in the performed waste treatment processes, which also confirms the conclusions of the previous studies, indicating that EMAS stimulates organisations to seek innovative solutions relating to already used technologies.

As it has been mentioned above, waste management should basically involve preventing the generation of waste or reducing the volume of waste. In this regard, research participants were involved in public education of the society. Although in organisations dealing with recycling of packaging materials or electric and electronic equipment this type of activity is enforced as a statutory obligation, related with funding and conducting public educational campaigns (Dz.U. poz. 1688, 2015; Dz.U. poz. 888, 2013), these activities can be undertaken by any organisation, even at a smaller scale, e.g. addressed to its own employees. As regards preventing the generation of waste and reducing its volume, another activity introduced by the research participants should be mentioned, namely the system of measurable indicators. The obligation to use environmental indicators is also enforced under EMAS. However, only one indicator relating to waste is proposed in the Regulation (what is significant, it concerns organisations that generate waste). The analysis of environmental statements enabled listing other indicators that could be used not only by organisations dealing with waste management.

This research allowed to formulate the following recommendations, worth considering by managers seeking specific solutions in the waste management field to be possibly implemented in an organisation:

- First, waste hierarchy is essential, which says that preventing the generation of waste or reduction of waste volume is a priority. In this particular area, organisations (both releasing waste and dealing with waste treatment) should primarily seek feasible solutions. One of the activities that might be helpful, is the education of various social groups, and also using a system of indicators for evaluation of organisations' progress in reducing the negative impact (of operations involving the release of waste) or the positive impact (of waste management). Already used technological processes are also worth a closer look. If possible, improvements should be made in order to reduce the amount of generated waste or to increase the efficiency of waste treatment.
- Indicators listed as a result of the described research, used mainly by organisations dealing with waste management, can be introduced also in other enterprises. This paper presents examples of specific indicators concerning waste treatment processes that can also be used, without changes or after modification, by other organisations dealing with waste management (e.g. from other countries) or any organisation dealing with waste treatment, intending to improve their performance. Another indicator used by the analysed organisations concerned educational campaigns. It can also be used in enterprises whose operations entail the generation of waste. However, in that case, this indicator may refer to the number of training sessions, or the number of employees trained in waste management.

- Specific solutions presented herein, concerning waste treatment or disposal processes and modernisation of plants, can be introduced in other organisations with a similar profile (e.g. from other countries). A valuable suggestion for enterprises whose operations entail the generation of waste is that as they move towards the reduction in the volume of waste, they should seek solutions to improve their existing technological processes or related installations and equipment.
- Furthermore, it is worth mentioning that the entities with whom enterprises releasing waste to the environment cooperate must be authorised to receive and manage waste.

As it has already been mentioned, the outcomes of this research may supplement the results of the previous studies concerning environmental performance of enterprises registered under EMAS and provide examples of specific solutions implemented by the analysed organisations. A certain limitation of the research is the fact that information in environmental reports is not uniform, which makes it difficult to analyse. Not every organisation includes data on specific implemented activities in their environmental reports. However, the described analysis enabled identification of activities that could exemplify or be implemented also in other organisations intending to improve their performance in waste management.

## 7. Summary

The purpose of this paper was to present the activities in the area of waste management, performed by Polish enterprises registered under EMAS, dealing with water supply, sewage and waste management and remediation. The described research allowed to identify examples of specific activities most frequently undertaken in the field of waste management. These included: various forms of public educational campaigns, using a system of measurable indicators to evaluate the effects of educational campaigns and waste management, waste treatment and disposal processes and modification of waste processing plants. The key input of the described research are examples of specific actions that could be implemented or inspire organisations in their activity to prevent generation of waste or reduce the volume of waste. It is particularly important in the context of the EU and national policy on waste management. Despite the fact that research has been made among organisations whose activity mainly involves positive environmental impact, presented solutions can be implemented or inspire not only businesses with a similar profile, but also those whose operations entail generation and introducing waste to the environment. This paper supplements the previous studies concerning the EMAS scheme, providing examples of specific solutions allowing to improve environmental performance among the analysed enterprises.

It should be noted that the described research is not sufficient to fill the gap in the knowledge concerning the activities undertaken by Polish organisations participating in EMAS to reduce the negative impact or increase the positive impact of operations in different environmental areas. Consequently, another research areas should be identified in this field, e.g. relating to activities performed by Polish manufacturing enterprises to reduce the volume of produced waste or to improve their energy efficiency.

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