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ASSESSMENT OF ENVIRONMENTAL COSTS ECO-EFFICIENCY: THE CASE OF A FILLING-STATION

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Abstract

Assessment of eco-efficiency for environmental costs is specific in that majority of the costs provide social rather financial benefit, and only some of the costs could be viewed from both social and financial perspectives. The model for assessment of environmental costs of a filling-station and the methodology for its application developed, with the methodology verified by analysis of analytical data of an actual enterprise is presented in this research. Application of the model to filling-station N proved that filling-station operations are associated with high environmental risk and should therefore be subject to respective management with particular focus on preventive measures. This has revealed the specific aspect of assessment of eco-efficiency of environmental costs of filling-stations: assessing financial efficiency of these costs is simply impossible in many cases

Key words: eco-efficiency, environmental costs, filling-station, social benefit

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1. Introduction

Environmental issues could be mitigated with the help of environmental costs, which are characterized by high uncertainty. It would be difficult to identify the share of environmental costs incurred specifically for environmental purposes and the share to cover other needs of the enterprise (Myers, 2015). It is exactly the indirect impact of environmental costs on performance of the enterprise and their financial effect that boost the motivation of business to strengthen environmental performance. The particular focus has been put on the analysis of environmental cost management (Steen, 2005; Jasch et al., 2010; Munir, 2013; Garcia et al., 2017; Senent-Aparicio et al., 2018; Song et al., 2017). However, there is no ready-to-use model for assessment of eco-efficiency as well as social and financial benefit of the environmental costs.

Filling-stations are subject to diverse and specific environmental costs in implementation of various environmental activities. It would be important to analyze the environmental costs incurred by a filling-station and verify efficiency of the environmental costs, i.e. whether they have provided or will provide any return benefit.

The research aim is to develop and perform empirical verification of eco-efficiency of environmental costs of a filling-station. In order to achieve the aim, the following steps shall be performed: 1) analyze the classification of environmental costs and practice in determination of their eco-efficiency; 2) identify the formation of environmental costs of filling-stations; 3) develop the model for assessment of eco-efficiency of environmental costs of the filling-station; 4) develop and empirically verify the methodology of application of these model. Research limitation is non-inclusion of the costs incurred by an enterprise in relation to the losses of fuel and other products used at the filling-station into the analysis, although these costs also cause negative environmental impact.

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The methodology for assessment of eco-efficiency of environmental costs has been developed by employing scientific literature analysis, generalization, and graphic visualization. For the purpose of objectivity in assessment of environmental costs, the financial and social approaches towards assessment of these costs have been adopted. The method of case analysis has been applied to empirical verification of the methodology. Analysis of primary analytical data has been conducted and logical insights have been generated for adaptation of the methodology for assessment of eco-efficiency of environmental costs.

2. Material and methods

2.1. Environmental costs and their eco-efficiency

Environmental policy of the European Union places particular importance on the polluter-pays principle (PPP). The idea behind this principle is that the social and economic damages caused by pollution and use of resources shall be covered by the polluters or consumers (Meškys, 2014). In explanation of what the PPP actually implies, it is emphasized that an entity causing damage to the environment is required to remunerate not only the costs of restoration of the environment, but also the costs of the damage prevention measures.

Public interest implies living in a safe and healthy environment, meaning that environmental taxes are essentially in line with the PPP (Munir, 2013). Ekins (1999), West and Williams (2004), have come to the conclusion that environmental taxes tend to be regressive, as the amount of environmental taxes paid tends to decrease relatively with an increasing tax base.

Besides environmental taxes, there is a range of other environmental costs incurred by an enterprise. They are costs which are incurred in the process of compliance with environmental requirements or environmental welfare (Boros et al., 2017; Bracci and Maran, 2013; Coles et al., 2017; Jasch, 2003; Jasch et al., 2010; Kallbekken and Sælen, 2011; Parry, 1997; Steen, 2005). Myers (2015) has suggested the following definition of environmental costs: costs incurred by an enterprise in relation to pollution control and treatment, waste disposal, and social responsibility. In general, the scientific literature studied suggests that environmental costs are the costs of an organization intended for limitation of the harmful environmental impact related to its operations.

Environmental costs are related to environmental liability and often come with a high degree of uncertainty, i.e. every enterprise incurs different environmental costs that depend on the nature of its operations. In many cases environmental costs are registered as such by the accounting systems only partially (Joshi et al., 2001) or are allocated to the respective production processes by simply being viewed generally as operating costs or administrative expenses (Jasch, 2003; Xiaomei, 2004). Managers and accountants should put effort into making environmental costs visible to the maximum extent possible (Henri et al., 2014).

Jasch et al. (2010) have emphasized the importance of classification of environmental costs and classified environmental costs into two groups: direct environmental costs and indirect costs related to environmental protection. Bracci and Maran (2013) classify environmental costs into 5 groups: prevention costs intended for the activity integrated into efficient long-term projects; prevention costs intended for non-recurring projects; costs intended for restoration of environmental functions; compensatory costs under the environmental defence approach; compensatory costs intended for recovery of the existing consequences of negative environmental impact. Findings of the research indicate that all socially responsible enterprises are usually forced to incur mandatory environmental costs. Environmental taxes could also be attributed to the mandatory environmental costs (Margerison, 2014).

Entrepreneurs' attitude towards environmental costs does not differ from their attitude towards other expenses incurred by the enterprise, i.e. they believe that any costs should generate benefit. Nonetheless, scientific literature focuses predominantly on eco-efficiency rather than eco-effectiveness of environmental costs. This method for assessment of environmental costs has its concept based on the idea that economic activities and activities intended for improvement of environmental protection must be coordinated between the production system, business processes or enterprise. Henri et al. (2016) have expanded the concept of eco-efficiency stating that environmental activities should not only reduce environmental losses, but also simultaneously reduce environmental costs. According to Xiaomei (2004), Huppes and Ishikawa (2005), Cullen and Whelan (2011), eco-efficiency is a set goal to create benefit while reducing the environmental losses. According to Hellweg et al. (2005), such indicators usually represent eco-efficiency as the ratio of economic value added and the environmental benefit.

Scientific literature analyses efficiency of costs incurred by business upon change of technology or resources used, when this also contributes to environmental protection. Construction enterprises aim at achieving environmental benefit by replacing building materials, introducing new technologies (Bribián et al., 2011; Ferrández-García et al., 2016). Logistic companies view environmental activity as reduction of costs, where waste is avoided and use of resources is reduced (Karagülle, 2012).

However, the economic benefit-only approach towards the analysis of environmental costs is not appropriate for all businesses. Hellweg et al. (2005) has proposed end-of-pipe technology businesses using the ratio of eco-efficiency of environmental costs calculated as the ratio between benefit for environmental protection and change of costs. This indicator is specific in the way that one of its

components - benefit - may have financial expression or reflect reduced pollution and other social benefit, while another component - costs - may refer to financial expenses or environmental losses only.

Such an approach towards assessment of environmental costs is appropriate for the business - filling-stations - chosen for this study. Environmental impact is inherent to this business, and as many costs as possible must be turned into environmental benefit. Primary area of operations of filling-stations is trade, where technologies change by adding or replacing individual elements. On the other hand, social benefit of the costs incurred must be considered, in particular, where financial burden and financial benefit of environmental costs are not assessed. Social benefit of environmental activities of filling-stations is generated in the form of customer loyalty, goodwill, clean and socially friendly environment.

2.2. Environmental costs of filling-stations and model for their assessment

For assessment of the filling-station activities that cause risk and very significant impact to the environment and public, the costs incurred in implementation of these activities must be analysed and assessed. Filling-stations, aimed at effective reduction of the environmental costs incurred, calculating the burden of environmental costs, and verifying how efficient and economically justified the incurred environmental costs are, are proposed the model for assessment of eco-efficiency of environmental costs (Fig. 1) and the methodology for its application.

The model is implemented in 5 stages ensuring consistent assessment of the environmental impact of a filling station and eco-efficiency of the environmental costs incurred. Assessment of environmental costs starts with stage 1 of the model - identification of the filling-station operations. Parry and Bento (2000), Gale (2006), Rocha et al. (2011), Azevedo and Bias (2011) have named the following types of filling-station operations: retail and wholesale of oil products and liquefied petroleum gas, lubricants, automotive products, car wash services. Parking site services, sales of food products and beverages, hygiene services, cafeteria - fast food services could also be classified as filling-station operations. All the operations of a filling-station have strong impact on environmental pollution that manifests itself through damage to human and environment: harmful impact on human health, soil contamination, risk of fire, accumulation of hazardous waste (Fig. 2). This naturally leads to stage 2 of the model - Identification of risk for mitigation of impact and risk of the operations.

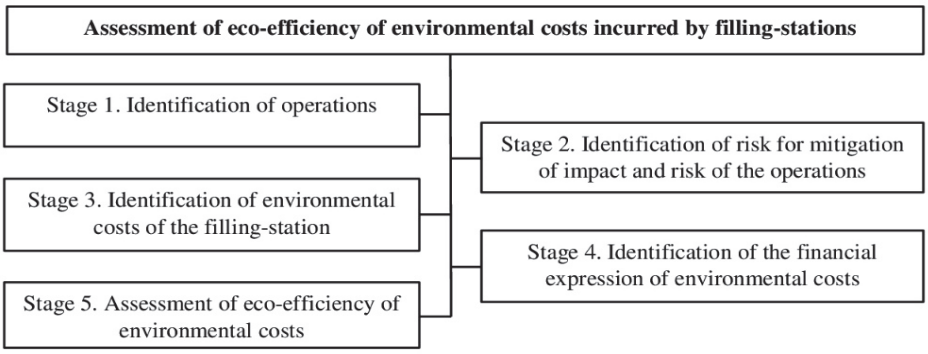

Fig. 1. Model for assessment of eco-efficiency of environmental costs incurred by filling-stations: logical scheme (designed according to Jasch (2003), Jasch et al. (2010); Rocha et al. (2011), Bracci and Maran (2013), Plessis and Oberholzer (2014), Myers (2015))

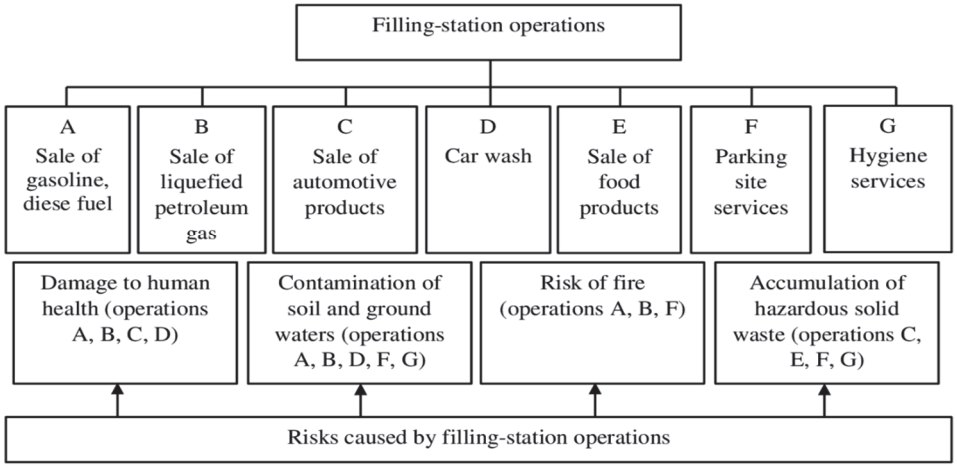

Fig. 2. Filling-station operations and the associated risks (designed according to Parry and Bento (2000), Rocha et al. (2011), Azevedo and Bias (2011))

Identification of environmental risk of a filling-station is then followed by assessment of the environmental activities the filling-station will or shall implement in line with social responsibility and estimation of the environmental costs that would be incurred by the filling-station. According to Rocha et al. (2011), environmental risks, hazards and necessary actions for their elimination can be identified in details (Fig. 3). Filling-stations are recommended to apply the following measures for improvement of environmental protection: control of timeliness of inspection of fuel-station equipment; monitoring of effective period of the facilities during the service life; installation of warning signs at the locations of fire hazard and other unsafe locations (e.g. vehicle fuel filling sites); use of fuel additives leading to reduction of the concentration of exhaust pollution.

Stage 3 of the model - identification of the environmental costs incurred by the filling-station - is based on the classification and grouping of environmental costs discussed by Jasch (2003), Jasch et al. (2010), Rocha (2011), Plessis and Oberholzer (2014). Classifying the environmental costs into four groups is recommended: mandatory environmental costs; social costs; preventive environmental costs; contingent costs (Fig. 4). Every enterprise should diligently perform identification of the costs it incurs, i.e. identify all costs that it has incurred for environmental purposes during the period analyzed. It is important that the enterprise takes into account the costs that are necessary in order to perform operations and the costs incurred on a voluntary basis. This kind of cost classification is usually determined by the nature of business.

Damage to human health		
Risk	Impact	Activities
Inhalation of fuel vapour; contact with oil and fuel	Skin, respiratory and digestive diseases and disorders	Preventive education about environmental protection; training in accident prevention and confinement
Contamination of soil and ground waters		
Risk	Impact	Activities
Accumulation of deposits of oil products	Deposits of oil products destruct fauna and flora	Compliance with the standards during installation of reservoirs (distance to water bodies, flammable substances, etc.); strict monitoring of the service time of reservoirs, reservoir treatment control
Risk of fire		
Risk	Impact	Activities
Risk of fire emerges in case of missing safety and inadequate maintenance of electrical equipment, inadequate maintenance of fire extinguishers	Direct destruction of fauna and flora	Strict control of electrical installations and equipment, periodical inspection of fire extinguishers; preventive, educational training in accident confinement
Accumulation of hazardous solid waste		
Risk	Impact	Activities
Risk is caused by improper waste sorting and disposal practices	Indirect destruction of fauna and flora	Training and education about improper waste treatment: improper waste storage, disposal; waste sorting prevention, education about hygiene

Fig. 3. Risks, hazards emerging from filling-station operations and the mitigating actions (according to Rocha et al. (2011))

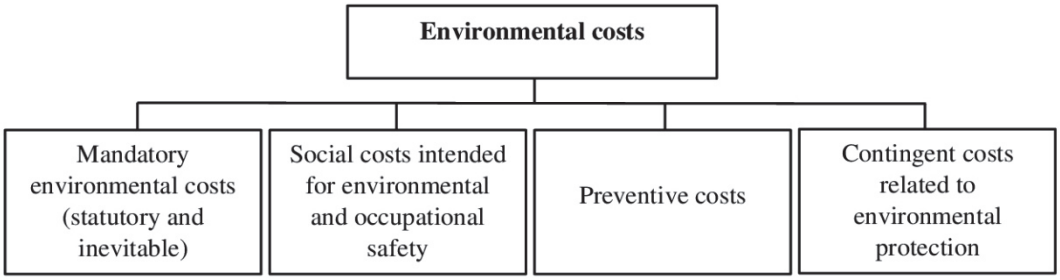

Fig. 4. Classification of environmental costs (designed according to Jasch et al. (2010); Rocha (2011), Bracci and Maran (2013))

In view of the conclusion by Myers (2015), that environmental commitments are comprised of statutory environmental taxes and other environmental costs, it is necessary to identify the costs that the filling-station incurred on a mandatory basis and the costs incurred on a voluntary basis. The costs that had to be incurred for environmental purposes should be identified in the overall cost structure of the enterprise, and the total of all annual environmental costs should be calculated. Thereby, the total amount of environmental costs incurred during a year is assessed, i.e. financial expression of environmental costs is determined (stage 4 of the model).

Stage 5 of the model involves assessment of eco-efficiency of environmental costs. Environmental costs could be compared to investment into better corporate image, public benefit, occupational health, sustainability of equipment, etc. For verification of payback of the environmental costs and assessment of the payback period, the enterprise should calculate eco-efficiency of environmental costs upon identification and analysis of the required information about the operations (stages 1-4 of the model). Creative approach towards assessment of eco-efficiency of environmental costs is required (Kallbekken and Sælen, 2011; Kamruzzaman, 2012), i.e. it is important to consider whether the environmental costs have had any financial and/or social benefit. Direct financial benefit is calculated by employing financial indicators, while social benefit is received in the form of future benefit, goodwill, image of a responsible, orderly, caring enterprise. Eco-efficiency of environmental costs can be simultaneously expressed by reduced environmental losses and environmental costs (Henri et al., 2016). It would be reasonable to assess the investments into environmental protection by calculating the payback time (for assessment of long-term investments) or burden of other costs (usually taxes) reduced by the environmental costs incurred (for assessment of both long-and short-term investments). Criteria and indicators proposed for assessment of eco-efficiency of the costs are presented in Table 1.

Long-term environmental investments of filling-stations are usually related to purchase of new facilities or a piece of equipment that will be used for environmental purposes. Operation of the piece of equipment or facility purchased leads to improvement of other operating conditions of the enterprises or the operations that, with this investment are not implemented, would entail environmental taxes. The amount saved on taxes as a result of the reduced environmental taxes respectively covers the share of the long-term investment, and its eco-efficiency is expressed by calculating the payback period (in years) of the costs incurred. Costs incurred for the purpose of a short-term environmental investment are usually intended for implementation of certain environmental activities. By investing into short-term environmental measures, a filling-station incurs certain costs, but these costs, in turn, lead to reduction of other environmental costs. Reduction of other costs may be expressed as a percentage or an actual amount. In this case, the filling-station would be capable of assessing the benefit of environmental costs that are mandatory for its operations in relation to other environmental costs by calculations and analysis.

The developed methodology for assessment of eco-efficiency of environmental costs of a filling-station is adapted at the enterprise by taking consistent steps of its application: filling-station operations are assessed; their hazards and projected environmental actions are determined in order to reduce or fully avoid any impact of the damage caused. Environmental costs can be mandatory, voluntary, preventive, or contingent. Following identification of the environmental costs incurred, their eco-efficiency, or return of the costs incurred, is assessed. Assessment of eco-efficiency of environmental costs of filling-stations should be performed taking into account not only the financial, but also social benefit of each investment into environmental protection.

In case of a socially responsible enterprise, the costs incurred often come back as a benefit from other perspective: customer loyalty, greater demand, and labour efficiency.

Table 1. Criteria and indicators for assessment of environmental costs

<table>
<tr><th>Assessment criteria for environmental costs</th><th colspan="3">Indicators for assessment of environmental costs</th></tr>
<tr><td rowspan="3">• whether the environmental costs incurred are intended for long-term or short-term investment;
• whether the analysed environmental costs have been incurred on a voluntary basis or are mandatory costs;
• whether the costs return in the form of direct financial benefit or indirect social-financial benefit</td><td>Nature of investments into environmental protection</td><td>Projected opportunities</td><td>Calculation of eco-efficiency of the costs</td></tr>
<tr><td>Long-term environmental investments</td><td rowspan="2">The annual financial benefit of investment operation in relation to other environmental costs, including environmental taxes, is identified and assessed in view of the criteria and indicators for assessment of eco-efficiency of the costs</td><td>Amount of investments / opportunity = investment payback period
Investment amount – opportunity = cost payback amount</td></tr>
<tr><td>Short-term environmental investments</td><td>Investment amount – opportunity = cost payback amount</td></tr>
</table>

3. Results and discussion

Filling-station N has been chosen for practical verification of the model for assessment of eco-efficiency of environmental costs. As a result of implementation of stage 1 of the model, the following businesses of filling-station N have been identified: sale of oil products, liquefied petroleum gas, lubricants; sale of automotive products; sale of fast food, beverages, coffee; provision of free of charge parking, hygiene, car window washing services. Some of these activities are harmful and pose hazard to humans and environment, which means that the potential damage should be described (stage 2 of the model). Damage to human health is posed by sale of gasoline, diesel fuel, liquefied petroleum gas, automotive products, and car wash services. These activities also cause soil contamination. Hazardous solid waste accumulates from sale of automotive, industrial, food products. Risk of fire is caused by sale of gasoline, diesel fuel, liquefied petroleum gas.

Following assessment of the operations at filling-station N, the associated risks, potential hazards and damage to the public and environment, the environmental activities that need to be undertaken for mitigation of these risks and hazards are identified. The identified environmental activities also help identify the costs incurred by the filling-station in implementation of these activities. According to stage 3 of the methodology, environmental costs of filling-station N have been classified into 4 groups by their nature: mandatory environmental costs, necessary for operations; social costs intended for environmental and occupational safety; preventive environmental costs; contingent costs related to environmental protection. The first group of costs is mandatory costs, while the remaining three cost groups are voluntary costs (Fig. 5).

Stage 4 of the model for assessment of eco-efficiency of the costs is implemented, summing up of all the environmental costs incurred by the enterprise. As a result, the financial expression of environmental costs incurred by the filling-station is determined. Fig. 6 provides information about the environmental costs incurred by filling-station N in 2012-2016. The smallest amounts of environmental costs of filling-station N were the contingent environmental costs. Compared to other types of costs, environmental prevention also required smaller amounts of costs, except for the year 2012, when preventive costs increased as a result of setting up of new waste sorting containers.

Voluntary environmental costs are the second by the size of costs. The amounts of voluntary costs tend to vary considerable with each year. The size of these costs is determined by the extent of social responsibility that the owners and management of the filling-station have decided to assume and the amount of funds allocated to implementation of the environmental activities.

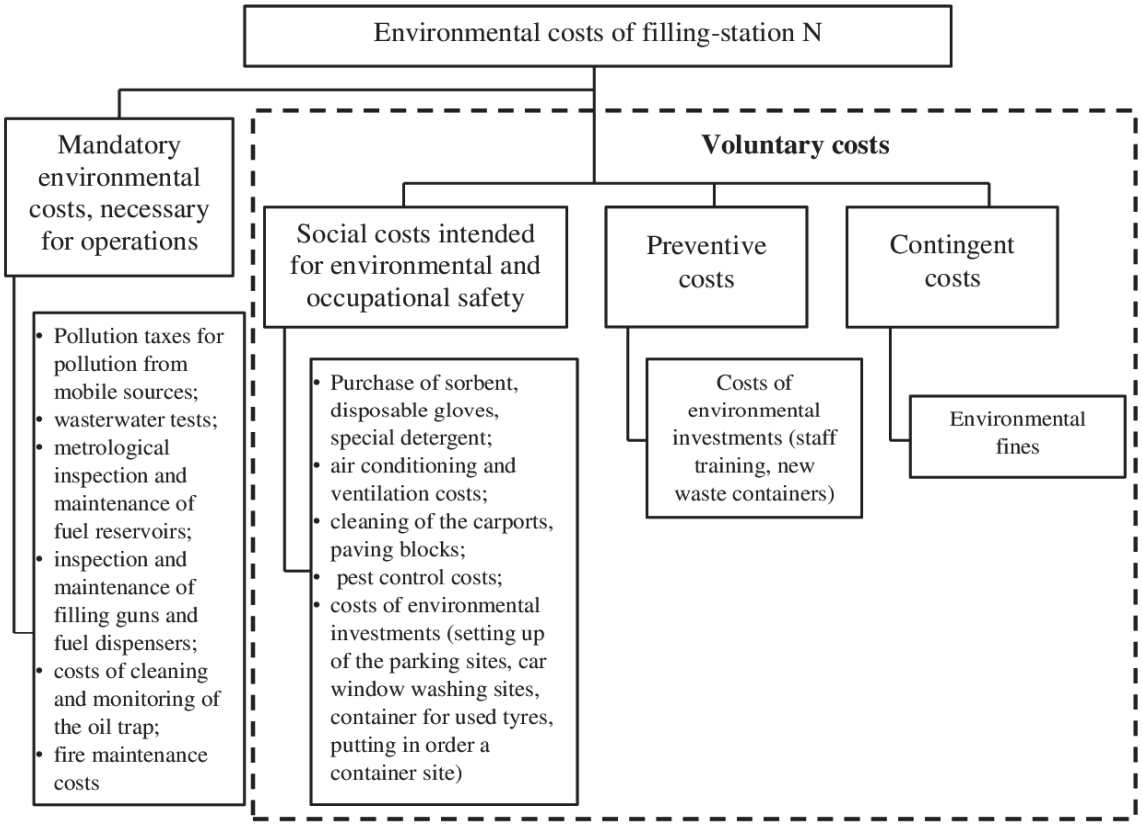

Fig. 5. Classification of environmental costs of filling-station N

The largest amount of costs incurred by filling-station N are mandatory costs that are necessary in order to conduct operations. The upward trend of mandatory costs has been clearly noticed during analysis of the information on environmental costs incurred by filling-station N. Their major share is comprised of the costs of maintenance and inspection of the equipment, which suggests that their amount is determined by environmental taxes and service prices of the servicing companies, and that contingent costs, i.e. fines, are avoided where mandatory costs are incurred. Staff training costs account for the major share in the structure of preventive costs. Unfortunately, the amount of these costs and their share in filling-station N tend to reduce. Following identification of the financial expression of environmental costs incurred by filling-station N, assessment of the necessity of environmental costs, eco-efficiency of the environmental costs is determined (stage 5). Eco-efficiency of costs is assessed by calculating the payback time (in years) of the mandatory and voluntary environmental costs, analyzing whether certain environmental costs have led to reduction of amounts of the environmental taxes or not, and assessing the return social benefit of the environmental costs incurred.

Mandatory environmental costs are necessary and related to the specifics of filling-station operations. They are expected to help avoid contingent costs and reduce certain mandatory costs. Hence, the opportunity of their application in relation to other environmental costs is projected and eco-efficiency of the costs incurred is calculated by using the analytical information (Table 2). Majority of mandatory environmental costs incurred by filling-station N do not imply direct payback and financial efficiency.

Mandatory environmental costs encourage filling-stations to follow strict environmental control and incur the mandatory environmental commitments that put financial burden upon a filling-station. This once again proves that these costs are necessary in order to conduct operations. Costs of fuel reservoir washing are financially efficient. Fuel deposits cover the walls of fuel reservoirs over time, causing additional contamination of the fuel. Spills usually occurring in the course of fuel filling by consumers enter the wastewater and oil residue collector 0 oil trap - together with rainwater. Oil traps must be cleaned on an annual basis. Standard price on cleaning of oil trap is approximately 1000 EUR. The price depends on the level of contamination of the wastewater, as highly contaminated wastewater usually leaves difficult to remove stains in the oil trap.

With cleaner wastewater, these stains do not accumulate in the oil trap, and the company providing oil trap cleaning services offers 20 % discount for the service. Hence, cleaner fuel from clean reservoir, cleaner wastewater and oil trap walls lead to reduction of oil trap cleaning costs by 200 EUR. In this case, however, it is necessary to account for not only smaller price on oil trap cleaning, but also for the social benefit - cleaner fuel vapors are less harmful and friendlier to the environment.

Voluntary costs of filling-station N are related to environmental investments that can be long- and short-term. Long-term investments are the investments which provide the product which will be used by an enterprise and its clients in the long run. Examples of voluntary long-term environmental investments incurred by filling-station N and assessment of their eco-efficiency are presented in Table 3.

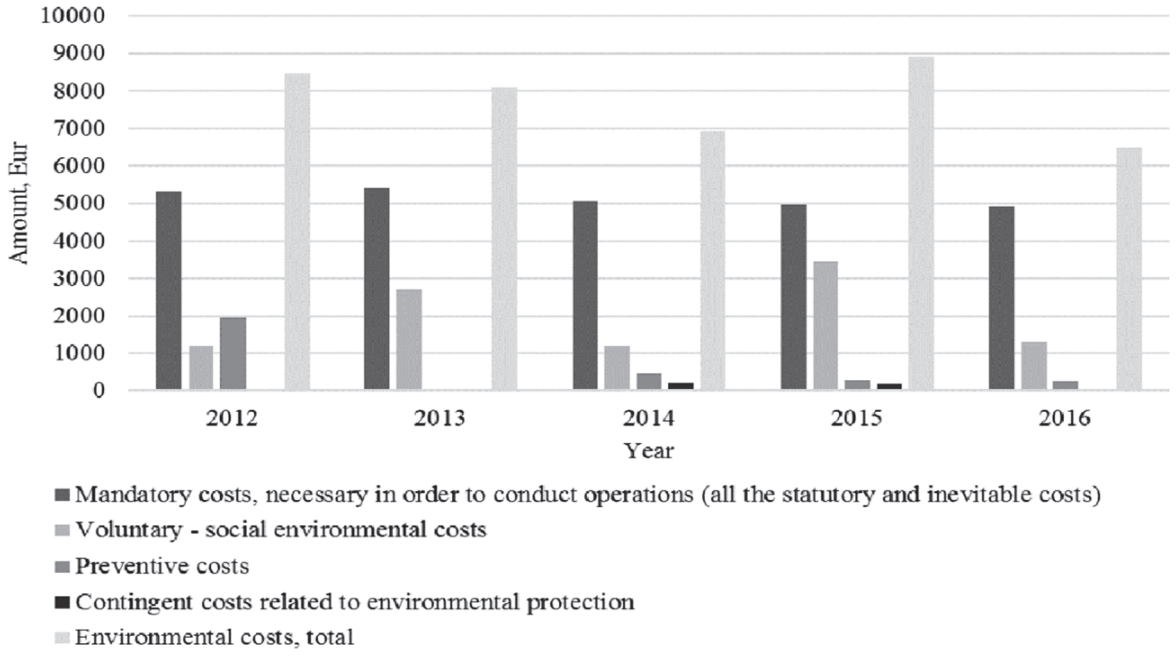

Fig. 6. Environmental costs of filling-station N in 2012-2016

Table 2. Assessment of eco-efficiency of mandatory environmental costs of filling-station N

Mandatory environmental costs	*Amount of costs, EUR*	*Projected opportunities*	*Eco-efficiency of costs*
Pollution taxes for pollution from mobile sources	50	Mandatory tax does not provide for any prospects of financial efficiency in relation to other environmental costs.	No
Fuel reservoir washing costs	2 500	Fuel is cleaner, leading to cleaner wastewater and, in turn, cleaner walls of the oil trap. Reduction in the annual amount of costs of cleaning of oil trap is approximately 20 %.	Standard annual fee for petroleum trap cleaning ≈1 000 EUR. After washing of the fuel reservoirs, the price on oil trap cleaning reduces by approximately: 1 000 EUR x 20 % = 200 EUR.
Wastewater tests	200	The costs are mandatory and do not provide for any prospects of financial efficiency in relation to other environmental costs.	No
Costs of cleaning and monitoring of the oil trap	1 110		
Metrological inspection and maintenance of fuel reservoirs	720		
Inspection and maintenance of filling guns and fuel dispensers	520		

Table 3. Assessment of eco-efficiency of voluntary environmental costs of filling-station N incurred as long-term investments

Costs incurred as investments	*Amount, EUR*	*Projected opportunities*	*Eco-efficiency of costs*
Car window washing site set up	1 400	Social benefit: dust, dirt are removed from the windows and sides of client cars. Cleaner cars mean cleaner rain water running off their surfaces. This leads to conservation of soil, water, flora and fauna, air, improvement of citizens' quality of life.	These costs do not provide any direct financial benefit. Social benefit comes back in the form of goodwill, corporate image, convenience for customers, customer loyalty and abundance. However, filling-station wastewater which has accumulated in the oil trap is characterized by higher degree of contamination, meaning that the filling-station will incur higher taxes for the wastewater.
Carport, paving block cleaning costs	280	Social benefit: dust accumulated on the carport and petroleum fuel residues retained in the paving blocks are washed off mean cleaner wastewater running off the filling-station surfaces after rain. This leads to conservation of soil, water, flora and fauna, air, improvement of citizens' quality of life.	
Parking site set up	2 890	Social benefit: vehicles are no longer parked at the kerb and the lawn is no longer trampled. This leads to conservation of soil, flora and fauna, improvement of citizens' quality of life.	These costs do not provide any direct financial benefit. Social benefit comes back in the form of goodwill, corporate image, convenience for customers, customer loyalty and abundance.
Container site put in order	550	Social benefit: reduced pollution of the filling-station territory. Conservation of soil, water, flora and fauna, air, improvement of citizens' quality of life, health.	
Container for used tyres set up	400		

All voluntary costs incurred as long-term investments bring social benefit to the filling-station, i.e. the image of a neat, clean, environmentally friendly filling-station improves the goodwill, customer loyalty and abundance. Customers who are satisfied with the caring attitude of the filling-station towards them tend to visit the filling-station more often, generating greater profit. Hence, the long-term environmental investments do not come back in a direct financial form, but rather come back in other aspects: higher ratings of the filling-station, more fuel and other products sold. This points at the specific aspect of assessment of eco-efficiency of environmental costs - it is often simply impossible to assess exact eco-efficiency of environmental costs. The data presented suggest that, in provision of car wash service and performing carport, paving block cleaning works, the filling-station incurred not only

the costs pertaining to investment, but additional costs as well - higher fees related to wastewater testing. However, these services are provided for the purpose of and by prioritizing the social benefit brought by the environmental investment mentioned above. Short-term environmental investments are related to day-to-day improvement of customer service, more convenience services, clean surroundings, conservation of nature. Examples of voluntary costs in relation to the short-term investments of filling-station N and assessment of their eco-efficiency are presented in Table 4.

Preventive costs at filling-station N are usually related to environmental staff training and preventive environmental protection. In assessment of these costs, their social benefit is the first to be noticed; however, some of them have financial expression as well (Table 5).

Analysis of environmental costs incurred by filling-station N voluntarily as short-term investments reveals that the financial effect is generated from the costs incurred in relation to sorbent and special detergent. Potential financial efficiency, i.e. wastewater related fees lower by approximately 48 EUR or 20 %, is the result of two factors (use of sorbent and special detergent). The amount of potential financial efficiency should be divided by the number of its factors, thus assessing contribution of a single factor into potential financial efficiency. It is absolutely not important whether only sorbent or sorbent together with special detergent is used, as the standard amount of fees would reduce by 20 % in any of the cases as long as the wastewater does not exceed the maximum permissible value of harmful particles. Considering that, in this case, two types of additional costs, which have effect on the lower amount of fees, are incurred, the amount of potential financial efficiency is divided by two (48/2= 24 EUR). In this case, application of sorbent and special detergent has led to reduction of wastewater related fees by approximately 24 EUR each. Other filling-station costs incurred as short-term environmental investments do not imply any direct financial-efficiency. Social benefit is generated and, as mentioned above, the costs incurred come back in another aspect: goodwill, customer abundance and loyalty. Financial expression of these aspects is impossible. Filling-station N invested into preventive environmental activity - cleaning of the environment - by purchasing the containers, i.e. facilities for cleaning of the environment. Use of the containers led to lower annual environmental taxes paid, i.e. the amount saved on taxes during the year respectively covered the share of the cost of equipment. The amount invested by filling-station N into setting up of the containers is estimated to pay back in 8-9 years. Assuming that the annual waste collection fee would not change in future, this measure will bring the financial benefit of 200 EUR of savings on annual environmental taxes in the ninth year of use of the containers and in the subsequent years. Investment into staff training does not imply any direct financial payback, but the costs incurred come back in the form of social benefit.

The interest of filling-stations in implementing environmental measures along with the respective costs is usually related to payment of fines for inadequate implementation of environmental protection. Filling-station N analyzed is not an exception, even though the share of contingent costs in the total amount of environmental costs is not large (Table 6).

Table 4. Assessment of eco-efficiency of voluntary environmental costs of filling-station N in relation to short-term investments

Costs incurred as investments	***Amount, EUR***	***Projected opportunities***	***Eco-efficiency of costs***
Purchase of disposable gloves	120	Social benefit: customers keep their hands clean during fuel filling. Improvement of humans' quality of life, health.	These costs do not provide any direct financial benefit. Social benefit comes back in the form of goodwill, corporate image, convenience for customers, customer loyalty and abundance.
Pest extermination and prevention	110	Social benefit: extermination of pests, i.e. carriers of dangerous diseases and agents of unsanitary conditions. Improvement of humans' quality of life, health.	
Air-conditioning and ventilation of filling-station premises	580	Social benefit: air-conditioning and ventilation equipment installed in the filling-station premises ventilate the premises, protecting customers and staff against hazardous vapors. Improvement of humans' quality of life, health.	These costs do not provide any direct financial benefit. Social benefit comes back in the form of goodwill, corporate image, convenience for customers, customer loyalty and abundance, labor efficiency.
Purchase of sorbent	51	Sorbent and special detergents are used for absorption of spilt fuel and lubricants, cleaning of the remaining fuel stains. Cleaner territory of the filling-station means cleaner wastewater of the filling station. With the degree of contamination of wastewater not exceeding the permissible limit, the price on wastewater tests is lower by approximately 20 %.	Standard total annual wastewater related fee is approximately 240 EUR. In case the degree of contamination of wastewater does not reach the maximum value, the approximate saving on wastewater related fee is: 240 EUR x 20 % = 48 EUR
Purchase of special detergent	61		

Table 5. Assessment of eco-efficiency of preventive environmental costs at filling-station N

Preventive costs	*Amount, EUR*	*Projected opportunities*	*Eco-efficiency of costs*
Staff training	450	The accumulated knowledge in environmental protection is applied to containment in case of accidents, promotion of maintenance of the environment, conservation of soil, water, flora and fauna, air, improvement of humans' quality of life, health.	These costs do not provide any direct financial benefit. Social benefit: environmental prevention of accidents, protection of the environment. Social benefit comes back in the form of goodwill, corporate image, convenience for customers, customer loyalty and greater abundance, labour efficiency.
New waste sorting containers set up	1640	Sorting of household waste reduces the annual costs of waste collection by 200 EUR.	Investment amount / opportunity = investment payback period: 1640 EUR / 200 EUR = 8.2 years

Table 6. Assessment of eco-efficiency of contingent environmental costs at filling-station N

Contingent costs	*Amount, EUR*	*Projected opportunities*	*Eco-efficiency of costs*
Environmental fines	170	Payment of environmental fines does not imply any opportunities of eco-efficiency in relation to other environmental costs.	None

Contingent environmental costs do not have any direct social or financial effect; however, they encourage investments into environmental measures for future reduction of the amounts of fines or their elimination from the environmental costs. Analysis of environmental costs of filling-station N has shown that certain mandatory environmental costs (fuel reservoir cleaning) and certain voluntary costs incurred as short-term investments (purchase of sorbent and special detergent, setting up of waste sorting containers) are characterised by direct financial eco-efficiency. Major part of the costs analysed are socially effective – the costs incurred come back in the form of social benefit.

Practical application of the proposed model for assessment of eco-efficiency of environmental costs of filling-stations has revealed main characteristic aspects of the recommended methodology: easy to apply in practice, simple, designed according to results of scientific research works and practice of filling-station operations. It is not time-intensive and helps identify plenty of useful information by consistently adapting stages of the model and does not involve any complex calculations. As suggested by the conducted analysis of environmental costs and the assessed eco-efficiency of environmental costs, only a small part of costs intended for environmental protection imply financial payback. The voluntary environmental costs incurred come back in the form of social benefit. The corporate goodwill and customer loyalty promote sales.

4. Conclusions

The necessity and role of environmental commitments are doubtlessly indispensable from the modern economy. In general, the scientific literature studied has suggested the conclusion that environmental costs are the costs of an enterprise or organisation intended to limit the harmful environmental impact emerging from its operations. At the same time, the following two interrelated facts should be acknowledged: environmental activities require certain costs; however, the benefit provided by them is often not expressed financially, i.e. the benefit is social rather than financial. Certain environmental costs are visible and acknowledged. These are primarily the environmental taxes, which, however, account for only a part of environmental costs. The research conducted at the enterprise that actually incurs environmental costs has supported opinion, that environmental costs are comprised of statutory environmental taxes and other environmental costs pertaining to environmental liability.

Environmental costs must be grouped and classified, where deeper analysis is sought. They are classified into hidden vs. visible, related to environmental protection directly vs. indirectly, mandatory and voluntary, preventive vs. compensatory. The more detailed is the classification of costs, the more accurate is the assessment of their social and financial returns. On the other hand, the nature and significance of environmental costs is determined by the nature of operations of the analyzed organisation.

Main result of the research: the model for assessment of environmental costs of a filling-station and the methodology for its application developed, with the methodology verified by analysis of analytical data of an actual enterprise. The proposed model is comprised of five interrelated stages involving identification of filling-station operations and their potential harmful impact; identification and classification of the costs incurred in relation to the harmful impact, and assessment of the social and/or financial benefit of the costs. N filling-station operations are associated with high environmental risk that was proven while applying the model for assessment of environmental costs. Therefore, it should be the subject of respective management with particular focus on preventive measures in practice.

Main risks posed by filling-station operations are related to damages to human health, contamination of soil and ground waters, risk of fire, accumulation of hazardous solid waste. Environmental costs incurred by filling-stations are directed towards mitigation of the risks mentioned above, and are therefore mixed, providing different return. Two approaches have been followed in conduction of the research, and the following classification of environmental costs of filling-stations has been used: 1) mandatory vs. voluntary in view of their statutory basis, 2) environmental costs related to operations, social costs, preventive environmental costs, and contingent costs in view of their nature.

Financial management of business entities requires taking into account efficiency of all costs incurred, including those related to environmental protection. Conventionally, assessment of costs is expected to show financial benefit of the costs. Assessment of eco-efficiency of environmental costs, however, is specific in that majority of the costs provide social rather financial benefit, and only some of the costs could be viewed from both social and financial perspectives. In this research, direct financial benefit has been calculated by employing economic indicators: calculation of investment payback time, reduced burden of other costs (taxes usually) as a result of the environmental costs incurred. Social benefit is received in the form of future benefit, goodwill, image of a responsible, orderly, caring enterprise, and cannot be expressed financially in any way. Social benefit in the filling-station analysed is provided by the filling-station costs that are intended for environmental and occupational safety and by the prevention costs. Certain mandatory environmental costs and contingent costs (fines) incurred by the filling-station provide neither financial nor social benefit. The research has revealed the specific assessment aspects of eco-efficiency of filling-stations environmental costs. Assessing financial efficiency of filling-stations environmental costs is simply impossible in many cases.

The research could be resumed by extending the field of costs analysed, i.e. by analysing the costs that are incurred by an enterprise in relation to fuel and other material loss, where the loss has environmental impact. Further research aimed at more comprehensive improvement of the methodology provided could be related to exploration of the link between increasing amount of environmental costs incurred and scopes of operations conducted by an enterprise, as well as to development of generic model for assessment of environmental costs that would be applicable to all enterprises incurring environmental costs and of the methodology for its application.

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