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LETTER

Guidelines for Practical Application of the EUROPE Model to Improve Production Units' Resource Efficiency

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Abstract:

Introduction & Objective:

This paper describes the practical usage of the EUROPE (Efficient Use of Resources for Optimal Production Economy) model based on the equality principle to improve the resource efficiency of production units.

Methodology:

The EUROPE model is a tool to monitor, manage and evaluate how the economic, technological and environmental performance of a firm or other production unit changes over time.

Results & Discussion:

A manual for daily use was provided to industrial managers and practical operators in a municipal solid waste firm. The company was able to improve its economic, environmental and technological standards by employing the EUROPE model, which combines relevant aspects of all three standards in a single key performance indicator. The method involves allocating shadow costs to residuals and the technique is demonstrated in the case of a medium-sized Swedish municipal solid waste management firm.

Conclusion:

The case study indicates that the manual accompanying the model is useful for companies applying the model to industrial activities and solid waste management schemes.

Keywords: EUROPE model, Practical application, Production units, Manual, Environmental performance, Solid waste.

1. INTRODUCTION

The main hypothesis in this paper is that the resource efficiency of production units can be enhanced by applying the EUROPE (Efficient Use of Resources for Optimal Production Economy) model [1 - 5]. The main goal is to facilitate the daily use of the EUROPE model by managers and practical operators. Medium-sized Municipal Solid Waste (MSW) management firms were chosen as the object of a case study for two main reasons; first, there are good data available on waste management companies and second, these companies offer an environmentally friendly alternative to incineration. More broadly, we hope that this study will contribute to improving the economic, environmental and technological standards for firms, which in turn may also improve the living conditions for communities located near MSW plants. The research gap that this study aims to fill is the need to develop new economic instruments to manage MSW. The case study concerns the application of the EUROPE model to industrial activities and Solid Waste Management (SWM) schemes. The research questions that we address are: (i) how can we use the EUROPE model to

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improve the resource efficiency of production units, such as MSW management facilities? (ii) how can a versatile economic tool be developed for this purpose? (iii) for whom is this tool important? and (iv) who are the other potential end users (apart from MSW facilities)? More broadly, based on the results from the case study, we explore how the EUROPE model can be applied in practice to promote economic, environmental and technological improvements, and who would benefit from such an endeavour. The answers to these questions will guide the managers and financiers.

The research contributions of this paper are that it provides a better understanding of how natural resource management can be facilitated by the application of economic instruments and the development of a practical manual to help managers and practical operators who employ the EUROPE model. This paper introduces a novel method for reducing industrial spillages and wastes. As noted, managers are provided with a single key factor to simultaneously monitor, manage and evaluate their projects.

The EUROPE model is a tool to monitor, manage and evaluate how the economic, technological and environmental performance of a firm or an activity changes over time. The method involves allocating so-called shadow costs to unwanted residuals. A shadow cost or a shadow price is commonly referred to as a monetary value assigned to currently unknowable or difficult-to-calculate costs [6]. These shadow costs are inserted into the budgets and accounting systems of the company using the EUROPE tool. The changes that occur over time in the shadow costs provide a versatile tool that enables companies to reduce the existence of the waste streams that these shadow costs are allocated to, one by one, in order of importance, or to increase corporate efficiency by lowering the cost of the waste stream in question, if it is of commercial interest to industry. In both cases, it is considered that the versatile EUROPE model can be applied to produce robust results, given the inherent logic of the mathematical theories underlying the model and its successful application in the case study of the MSW firm.

2. METHODOLOGY

In this section, we describe the principle for the usage of the EUROPE model, with an emphasis on how it is applied in practice in the case of MSW companies. A usage manual for applying the EUROPE model is developed, with the aim of improving the efficiency of resource usage by production units. Our case study illustrates the application of the model using real data, and its practical usefulness is discussed. We list the benefits of using the model and provide recommendations for doing so. We describe the present status of the model analytically, following over two decades of its successful application to various arenas, such as the study of ocean currents, transferring capital and the solar system. The case study supports the use of the manual developed. Its validity is based on the generally accepted theory of business administration. The reliability of the case study proves the manual's usefulness in practice.

3. THE EUROPE MODEL

3.1. Basic Framework

The EUROPE model is a mathematical formula that determines the degree of shadow costs that should be additionally allocated to wastes to reduce and/or recover them. This creates economic incentives to reduce these targeted waste fractions, which can either be recovered at the source, or the production cost can be lowered if the waste fraction of interest is a utility to be maximized. In the latter case, the extraction of substances of commercial interest can be optimized or improved. The shadow costs are inserted into the profit and loss accounts, budgets and estimations of the relevant actor (in our case study, the MSW firm) according to the following principle.

$$\text{Shadow cost (SC)} = \text{Proportionality factor (PF)} * \text{Total cost (TC)} * \text{Weight factors (W)} \quad \textbf{(1)}$$

$$PF = A / (B + C) = (\text{Value} - \text{Cost}) / (\text{the total goods} + \text{the total bads}) \quad \textbf{(2)}$$

$$A = \text{the fraction to reduce to improve the production unit's resource efficiency} \quad \textbf{(3)}$$

$$B = \text{all the valuable products in the output of the black box producing unit of interest} \quad \textbf{(4)}$$

$$C = \text{all the unwanted residuals that reduce the economic result of the studied organization} \quad \textbf{(5)}$$

$$TC = \text{the total cost mass of the actor in question or the total cost of the current system breaking down} \quad \textbf{(6)}$$

$W = W_{air}, W_{soil}$ and/or W_{water} = the weight factors to consider the impact of A on the air, soil and/or water **(7)**

Sort: monetary currency, kilogram, litre and/or joule

W (the weight factors) are figures without sort expressing the managements' concern for the air, soil and/or water. W_{air}, W_{soil} and/or W_{water} are determined based on the management's perspective or the demands of public authorities.

3.2. Theoretical Foundations

A smaller amount of constructed shadow costs is allocated to A if SC is small. If SC is larger, the incentives to reduce A are greater and consideration of SC results in the environmental and technological standards and the company profits being improved. A is reduced by allocating the SC connected to A to the budget and accounting system of a company. This creates substantial economic incentives for the company to promote source reduction of A. In the industrial context, this corresponds to the desired functionality of the important flow of natural resources from the mines to the final customers. Thus, the EUROPE model is an economic instrument because it involves economic incentives.

The constructed shadow costs in the suggested approach are a very versatile tool that can ultimately improve economic, technological and environmental efficiency when the proposed model is applied to different projects. The shadow cost levels selected must not be the most optimal cost levels in the traditional economic sense but must be set at a level that will give management incentives to improve the activities related to the residual issues. Nevertheless, the term optimization could be relevant because the innovative EUROPE model logically allocates shadow costs to the different waste streams that are to be minimized.

The production units of different domestic branches of industry, a whole nation or an entire trade bloc will be forced to become more efficient by applying source reduction in line with the EUROPE model. In the waste management case, this source reduction will positively affect the flow of MSW to be utilized. Compared with the situation where the EUROPE model is not applied, the economic and environmental performance will be improved, and the technology in use will be advanced when there are fewer residual products or losses being produced.

4. MANUAL FOR PRACTICAL APPLICATION OF THE EUROPE MODEL

The application of the EUROPE model involves the addition of shadow costs to the costs of the entities with greater shadow costs added to those cost streams of greater economic and/or environmental significance. Resource efficiency is improved by a step-by-step reduction or recovery of the various A fractions identified. This procedure reduces the shadow costs if A is a useful fraction that yields revenues. The cost development is studied over time to assist in making the production more cost effective. The manual guiding the practical application of the EUROPE model involves the following key steps.

1. Determine which residuals to pinpoint, step by step, by estimating the values of A.
2. Calculate the PF by estimating B and C using the companies' bookkeeping system.
3. Determine the suitable TC and/or the total breakdown cost from the company ledgers.
4. Determine the weight factors without sorts for the company's impact on air, soil and/or water.
5. Insert the constructed SC into the accounting system and budgets of the current companies.
6. Determine the SC for any additional A fractions that are of commercial interest.
7. Study the development of SC to monitor, manage and evaluate the performance of A.
8. Take actions to make the system more efficient if SC increases over time.

5. CASE STUDY: A MUNICIPAL SOLID WASTE MANAGEMENT COMPANY

The case study concerns a medium-sized Swedish MSW company. An exchange rate of \$1 = SEK8 (September 2017) is used throughout. The numbers in the study are approximated.

The residuals coming to the MSW company are divided into the following flows: (i) the household wastes collected by the citizens themselves in a so called coloured bag that goes to a plant to produce biogas for vehicle fuel and district heating; (ii) the low energy waste that is combusted to power the city; and (iii) the high energy wastes that go to the cement industry. The final, rejected bio manure fraction from the biogas plant may be commercially important as it can be used as fertilizer by farmers to improve the soil structure. This case study shows how the system mainly for production of biogas can be improved by employing the estimated SC value. Using the SC value simultaneously assists the company to make the biogas production more efficient, to increase the extraction of biogas from food wastes and, ultimately, to maximize the recovery of wastes and minimize all the residuals. Note that usually the EUROPE model is used to decrease the amount of the residual A in the numerator. Here, it is shown how the EUROPE model can increase the efficiency of production when A is a utility that increases the revenues. This is accomplished by the EUROPE model optimizing the production cost when A is manufactured. The constructed SC connected to A enables the corporate management to optimize A, while monitoring, managing and evaluating the extraction of food waste-related biogas over time. This is accomplished through the term (value – cost) in the numerator of (2), which simultaneously optimizes the whole scenario.

Note that one tonne of fermented food waste yields 972 kWh of biogas energy [7]. In Sweden, 1 kWh is worth approximately SEK1 ($0.13). Thus, one tonne of fermented food waste is worth approximately SEK1000 ($130). Based on the 2016 data provided by the MSW company in the case study, we obtained the following values as inputs for the EUROPE formula (as shown in (1) above):

A = biogas from food wastes = value – cost (see equation 2);
A = value of the biogas energy per tonne food waste – cost to produce biogas substrate per tonne of food wastes;
A = SEK1000 – SEK450 = SEK550 (ca. $71 per tonne);
B = total value of the company according to the balance sheet;
B = MSEK250;
C = total operational cost according to the profit and loss account here used to approximately represent the total bads;
C = MSEK15;
TC = MSEK150; and
W_{air} = 1.1; W_{soil} =1.3; W_{water} = 0.7, with the weights estimated as subjective judgements based on the authors' and other professionals' personal experiences to obtain reasonable weight-values for the current MSW company.

These values inserted into equation (1) above yield the following shadow cost for food waste.

$$SC_{food\ waste} = [(SEK1000/tonne\ of\ food\ waste - SEK450/tonne\ of\ food\ waste) * 2000\ tonnes\ of\ food\ wastes / (MSEK250 + MSEK15)] * MSEK150 * 1.1 * 1.3 * 0.7 = (MSEK1.1 / MSEK265) * MSEK150 * 1.0 = 0.0042 * MSEK150 = kSEK623\ (ca.\ k\$80) \quad \textbf{(8)}$$

The A term (value – cost) in the numerator considers how efficient the MSW company is in keeping the cost of producing biogas down and, at the same time, increasing the extraction of biogas and hence improving profits. If $SC_{food\ waste}$ decreases from one year to the next, this indicates to management that innovative technical solutions are required to decrease the production cost. If $SC_{food\ waste}$ increases over time, it indicates that management is performing well.

By studying the development of A over time, management is informed about how to manage the first flow of residuals that the households place into coloured bags that are used to produce biogas at their local MSW plant. Therefore, changes in the term (value – cost) in the numerator in equation (2) reflect whether biogas is being produced in a cost-effective manner (cost) and how large the gas exchange (value) from the household waste is. For example, if cost increases and value decreases, then SC decreases, which indicates to management that consultation with the company's technicians is required to determine actions to improve the system to produce biogas.

SC indicates when the company in question should initiate activities to improve and increase the biogas production. Recommended measures to improve the biogas production efficiency could be investing in better machinery or to educate citizens about how to sort waste appropriately. The size of the change in (value – cost) shows to what degree and how quickly these measures should be implemented. In addition, this term in the numerator in equation (2) expresses how effectively the local households use the coloured bag waste system. For example, if the cost term decreases, this indicates a decrease in the various costs involved in the coloured bag system for biogas production, and vice versa. Thus, the model also provides information about the societal resource efficiency. More specifically, in response to a reduction in SC, a company could take measures including: (i) the provision of information to households about how to sort and maximize the amount of wastes sorted by using the coloured bag system; (ii) improving the technology for biogas production to produce more biogas per unit of wastes, such as by investing in new machinery;

and (iii) increasing the number of different production possibilities to enable the sorting of biogas wastes from the high and low energy fractions, which are currently combusted.

By employing currency units in equations 1–6, the model reveals different, relevant technical problems. In practice, for the case study MSW company, the management inserts k$80 into the accounting system and budgets according to the manual in Section 4. The objective is to monitor, manage, evaluate and constantly improve the company's performance of, in this case, the commercialization of biogas from food wastes Table **1**. For a certain amount of received food wastes by the MSW company, a decreased SC $_{\text{food waste}}$ calculated for the next year indicates a need to improve the production apparatus. How efficient the MSW company is at making biogas out of food wastes is expressed by the current cost to produce biogas.

Table 1. Schematic profit and loss account of a medium-sized MSW company employing shadow costs.

Revenues
Costs
SC $_{\text{food waste}}$ (k$80)
Result (k$80)

If the MSW company can produce more biogas from a certain amount of fermented food waste, this is incorporated in equation (8) because the value term in equation (2) will increase over time and, in turn, raise the SC $_{\text{food waste}}$ value in equations (1) and (8). Thus, by using the EUROPE model, the MSW company can observe both how the costs of producing biogas from food waste change and how much biogas is produced from one tonne of fermented food waste. If the MSW company receives more food waste, then SC $_{\text{food waste}}$ increases. However, for a given amount of food waste, equation (1) enables the MSW company to assess its performance.

If the MSW company's economic performance increases over time because SC $_{\text{food waste}}$ increases, in response to management implementing the required reforms, it means that the firm's performance regarding food waste has improved, or vice versa. It should be noted that although the SC $_{\text{food waste}}$ is a constructed variable, it is useful if taken seriously by managers.

6. RESULTS AND DISCUSSION

The key benefit of the EUROPE model is that the shadow cost construct provides the company management with an instant view of the performance of their business in technical, economic and environmental terms. The managers can determine the appropriate interval for analysis of their activities by calculating the SC, which conveys important aspects of how the company performs expressed in economic terms. Thus, better possibilities for CEOs to manage well is the major value of knowledge added by the paper because the EUROPE model provides a versatile economic instrument.

Examination of the SC over time shows the changes in the efficiency of resource usage by the enterprise. SC is a collocating key indicator. If SC suddenly decreases compared with previous years, this calls for actions by the company, such as the implementation of technical measures or information provision to improve company performance. The SC acts as a warning signal, indicating how the production scheme changes over time about the technical, economic and environmental performance.

Examining the SC year by year enables the company to determine the magnitude of any measures required. For example, a substantially decreased SC compared with that of the previous year indicates that major changes are required, whereas a small change may indicate that only small adjustments are required. The changes of the SC over time enable the company to interpret how efficient it is in using its input resources according to the desired principle of source reduction. Management can design its own rules regarding when and how to act, depending on the extent of the changes in SC from time to time. Then, different degrees of SC changes give rise to different actions.

The balance sheets of a company show the size of its total assets, including its properties, land and possessions, plus claims and so on. In contrast to the balance sheet, the SC in the EUROPE model does not directly show the value of the company's machinery and equipment. Nor does the EUROPE model particularly consider the size of the plant assets or how much money the company has in the bank, as shown by the profit and loss account. Instead, SC provides a very comprehensive indicator or measure that, in a collocating manner, indicates how efficiently the company is using its resources over time to produce utilities, with an emphasis on the desired goal of source reduction. The term (value –

cost) in the numerator of the EUROPE model encapsulates—and allows companies to more easily evaluate—their resource usage over time. In the present case study, the cost of producing biogas and the gas extraction from the food wastes are optimized by using the EUROPE model and SC.

Investments in the production machinery decrease production costs. Then, the cost term in the numerator decreases over time. If the SC decreases, measures must be taken. The managers themselves design the policy in response to this occurrence. Thus, the changes occurring in the efficiency of producing biogas over time are reflected in the cost term in the numerator of the EUROPE model.

When applying the EUROPE model, the cost estimation errors are insignificant because direct increases in costs are shown by the cost term. Generally, the changes in the SC indicate whether the resource efficiency of the business has improved.

A company utilizes bookkeeping depreciations to lower the value of its assets and to reduce taxation. When a company's payments and depreciations decrease over time, the cost term also decreases, which makes the SC more substantial. However, it is not possible to determine precisely what actions should be taken merely by studying the changes in the SC. That is, a decreased SC indicates that some actions should be carried out, but not exactly which ones. Determining the appropriate actions is a task for the waste engineers in the technical department in consultation with the Company's Chief Executive Officer (CEO).

The SC increases because of reforms or improvements that decrease the costs of managing the waste fraction of MSW. As noted, such measures include improved information and education of those involved in the waste stream separation process, direct technical improvements and constant improvements in the biogas production process that enable increased extraction of biogases per unit of food waste. Mathematically, this last process is expressed in the term (value – cost) in equation (2), where the value term reflects changes in the extraction of biogases. The (value – cost) term constitutes a development of the EUROPE model.

If the SC for food waste management decreases from one year to the next, the management of the MSW company understands that it must act to address this issue. However, although the EUROPE model alerts management that it must act, it leaves the determination of the potential technical improvements to the production engineers and CEO of the waste management company.

Conversely, if the SC increases from one year to the next, the EUROPE model indicates to management that the business has improved in technical, economic and environmental terms. When the EUROPE model indicates improved company conditions, it is the role of the chief financial officer to suggest to the CEO which investments to undertake and when.

Therefore, the EUROPE model does not make it possible to determine precisely or in detail which technical solutions should be implemented. It indicates in general that when the SC decreases, there is an issue with the waste management system that requires action. That is, the model does not indicate which technical solution the CEO will finally choose. Instead, it provides managers of MSW companies with an overview, based on the single key indicator SC that presents a general picture of the company's situation about the technology used, the environmental impacts and the efficiency of biogas production.

This is how economic instruments, of which the EUROPE model is one, work in general. The development of the EUROPE model includes a manual that covers its practical application. Section 4 exhibits this manual, which was provided to the MSW company as part of the case study and provides step-by-step instructions for application of the model. In this paper, the EUROPE model is based on currency as the dominant unit for the model calculations, rather than, for example, kilograms, litres, joules or other such physical entities.

In the case study, fraction A is a physical waste fraction. The step-by-step list in Section 4 shows how CEOs should use the EUROPE model in practice. As noted, it is not possible to provide detailed suggestions to management about what actions to take as part of the model, but CEOs should examine the manual and learn the principles for applying the EUROPE model in practice. When the CEO observes that the EUROPE model indicates that measures are required to increase the production efficiency of the company, the CEO will approach the production manager to determine the technical solutions required. The EUROPE model does not prescribes these solutions. Instead, it provides the CEO with an economic instrument to monitor, manage and evaluate the company's performance in strictly economic terms. Then, the company's technicians design the innovative, technical solutions required when the CEO determines—based on continuous usage of the EUROPE model—that the engineers need to find creative solutions. In the short run, the

EUROPE model will not result in zero waste goals being met. However, by applying the model and the manual instructions, over time the CEO can decrease the waste arising from the different waste fractions, focusing first on those waste fractions that are of greatest importance in terms of company profitability and environmental impact.

Further, this method will have a positive impact on private households' behaviour in minimizing waste produced. The cost term in equation (2) decreases over time when the local households become more resource effective. Thus, when corporate management tries to increase its SC using the EUROPE model, its actions will include encouragement and incentives for reducing waste and improve the resource efficiency behaviour exhibited by the local citizens.

The EUROPE model can be used to assist in achieving a certain waste management objective, such as increasing the amount of a certain waste stream collected by MSW companies from households, rather than divert the waste stream to landfill. The coloured bag discussed in the case study in this paper was designed to increase the collection of food waste from households, as food waste can be used to produce biogas and related products. In this case, the EUROPE model is useful because it can guide the company in making the collection of a desired waste fraction more efficient, by assisting it to lower operational costs in this area. In this case, the model provides corporate management with a good understanding of the cost situation for A, as well as the extraction of biogas. The methodology can be applied to both these possibilities.

The case study presented here shows the viability of the EUROPE model when applied to a medium-sized MSW company to improve its environmental, economic and technological performance. The case study results in the calculation of a reasonable SC of k$80, which the company's managers and those of other MSW companies can utilize to guide management decisions. Thus, the SC provides a comprehensive key indicator, which, at a quick glance, summarizes the economic, environmental and technological performance of most medium-sized MSW companies. The tool can also be used to guide managers in other industries than the MSW industry.

The SC is a purely constructed cost that is added to the total costs of the MSW companies that use it. However, the addition of the SC to the total company costs results in a powerful economic incentive for management to start reducing the residual A or to decrease the total costs connected to fraction A, if A is a commercially useful fraction. These issues were the focus of the present descriptive study.

The manual associated with the EUROPE tool is applicable to MSW schemes and other industries. Thus, the practical application of the EUROPE model is likely to be useful in business in general. It may also be possible to apply the model to industries in developing countries, subject to the provision of training concerning its usage. The EUROPE model and the accompanying manual can assist in moving towards achievement of the circular economy, a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing energy and material loops [8]. The tool facilitates the reduction of residuals at the source by providing economic incentives to achieve that goal.

7. CONCLUSION

The main hypothesis in this paper is that the resource efficiency of production units can be enhanced by applying the EUROPE model. The hypothesis is verified because the logics of the theory designed support this conclusion and because the introduced theorems are mathematically correct. Moreover, the results from the case study support the main goal of facilitating the daily use of the EUROPE model by managers and practical operators. Ultimately, as more companies adopt the EUROPE model, the broader goals of improving economic, technological and environmental conditions near MSW plants will be supported. The gap is filled in the existing research regarding novel economic instruments to help industry manage MSW.

The results of the study and the discussion provide answers to the research questions posed, regarding how to use the EUROPE model to improve the resource efficiency of production units such as MSW management facilities, and how an economic instrument can be designed and modified for this purpose. Our research contribution involves the development of a versatile economic tool that enables managers to better understand how their companies can become more economically, environmentally and technically efficient. In this study, this tool has been shown to be of use to small and medium-sized enterprises, particularly MSW companies, and to help them improve the well-being of their municipalities. Our work contributes to the literature by providing novel solutions to promote the optimization of resource efficiency and to assist MSW managers, and potentially managers in other industries, to improve their company's performance. This improved management situation in industry is the major value of knowledge added by the paper.

The pioneering EUROPE model represents a versatile theory for waste management. The novelty of the approach is the innovative usage of the shadow cost construct to create economic incentives for improvement of the functionality of waste management systems. The introduction of a single key indicator to simultaneously monitor most aspects of interest for a waste management system is a highlight. The most interesting findings in this study are the method to facilitate industrial managers' policy decisions and the positive impact on the economic, environment and technological development. The method aids managers to reduce spillages and waste in industrial systems and improve resource efficiency. The main conclusions based on our model and the case study are as follows.

1. The research is of practical use for managers aiming to reduce residuals from industry and MSW firms.
2. Cost-effectiveness and equity increase because of the reduced risk of industrial spillages.
3. The economic incentives harnessed through the shadow cost construct improve the utilization of natural and regained resources.
4. Industrial managers can apply economic instruments to prevent people from abandoning polluted areas.
5. Managers obtain a versatile economic instrument in the EUROPE model to monitor, manage and evaluate their company.

8. BENEFITS OF USING THE MODEL MANUAL FOR MSW FIRMS AND OTHER INDUSTRIES

The EUROPE model and the application method in the manual provide industrial managers with a versatile tool for economic management. The method provides a comprehensive single indicator that is easy to estimate and assists companies to simultaneously assess and then improve their environmental, economic and technological performance. As confirmed in our case study, the model is applicable to the MSW industry, and to other industrial activities. The method is robust in that it is based on generally accepted economic theories from recognized studies.

9. SUGGESTIONS FOR FUTURE RESEARCH

In future research, studies could be conducted to determine how the EUROPE model could be implemented to monitor, manage and evaluate major flows of cargo and necessities. There is potential to apply the model in these ways to mainland China.

10. RECOMMENDATIONS

The EUROPE model should be applied in practice based on the general manual presented in this study; the model can be applied to medium-sized MSW firms to improve their performance.

LIST OF ABBREVIATIONS

CEO	=	Chief Executive Officer
The EUROPE Model	=	The Efficient Use of Resources for Optimal Production Economy (EUROPE) model
MSW	=	Municipal Solid Waste
SC	=	Shadow Cost
SWM	=	Solid Waste Management

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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