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Grey Decision Making as a tool for the classification of the sustainability level of remanufacturing companies

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ABSTRACT

Remanufacturing facilitates multiple usages of products by providing several life cycles and contributes to more sustainable societies by the reduction of raw materials and energy consumption. Previous studies on sustainability assessment in remanufacturing focus predominantly on the life cycle design and the life cycle engineering approach. There is a research gap regarding the assessment of remanufacturing operational excellence as far as sustainability issues are concerned. The problem in the application of the principles of sustainable development in everyday business operations is the lack of clearly defined sustainability indicators, which might be used in the assessment of remanufacturing activities. In this paper authors present a set of indicators which are used as the criteria for sustainability assessment and to address company classification. Authors define three classes of companies, which respond to the different sustainability levels. The aim of this paper is to provide a new tool for decision making based on Grey Decisions Making. This tool helps in classifying the current state of remanufacturing operations, and then identifying and prioritizing operations in the company which need improvement actions. The authors present the numerical example in order to explain the decision making process and indicate how the application of Grey Decision Making (GDM) can contribute towards more sustainable societies.

1. Introduction

In a competitive environment the companies have to improve their performance systematically. With the increasing importance of sustainability, companies are forced to enter two new elements into their competitive strategy (besides Profitability) namely People and Planet (the 3Ps). Application of the sustainability policy in companies can be defined as the better utilization of resources in a way which does not interfere with the natural environment and the surrounding communities.

In order to better identify the current situation of companies and to find the optimization potential, there is a need for a matrix of performance measures. The sustainability measures should allow for the assessment of the company performance in the three dimensions as proposed by Brundtland Commission (WCED, 1987): economic, ecological, social.

The main reason for using performance measures is that they create possibilities for decision-makers to gain knowledge about what happens in the company at present and to direct future actions (Elg, 2007). Strong measures help to make decision making towards more sustainable societies and should be (Feng and Joung, 2009): understandable, relevant, comparable, reliable/usable, data accessible, with logic structure/simple.

In the remanufacturing sector many companies fall under the category of small and medium enterprises (SMEs). They have limited resources (both human and financial) to implement complex performance measurement systems. SMEs need some guidelines for decision making on how to identify optimization potentials and how to derive and implement them based on sustainability indicators (e.g. resource consumption, impact on climate/health/environment) (VDI, 2006). It is important for SMEs to have effective decision support tools for a goal-oriented analysis and then the implementation of appropriate measures for increasing their sustainability.

The research questions are defined as:

Q1) Which indicators can be used in SMEs for the assessment of the sustainability level, without adding additional reporting workload?

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Q2) How can we classify the sustainability level of the companies?
Q3) Which actions should be taken first in the SME in order to improve the sustainability of the company?

In order to answer the 1st research question the authors propose 15 indicators to assess the operational excellence of the remanufacturing process with regards to the dimensions of sustainability (Section 2). The Authors focus is placed on the remanufacturing process itself. Most of the previous research refers to the sustainability of remanufacturing in a closed loop framework with regards to life cycle engineering. In this SIRO[1] research project the emphasis is placed on the assumption that remanufacturers (SMEs) want to perform their operations to the best possible standards in the economic, environmental and social dimensions. Based on the previous studies it was assumed that the SMEs in remanufacturing sector have very limited resources and will not perform complex assessments.

In order to answer the second research question the concept of sustainability levels classification is developed. The sustainability level class is the overall assessment of the company resulting from summarizing the values of the individual indicators. In the paper three sustainability levels of the remanufacturing company were defined (analogy to the traffic lights system):

- class $k = 1$ (in green) in web version – there non immediate improvement actions are needed;
- class $k = 2$ (in yellow) in web version – there is a conditionally acceptable level of sustainability, which requires corrective actions as soon as it is economically and organizationally possible;
- class $k = 3$ (in red) in web version – there is an unacceptable level of sustainability of remanufacturing operations, which requires corrective actions immediately.

It this research the assumption is made that the scope of the corrective actions is bigger than the scope of the improvement actions (e.g. improvement action does not required investments, when corrective action requires some investment and significant additional workload for managers).

In this research the assumption is made that the indicators might be qualitative or quantitative, so the tool for the assessment must be capable in dealing with such conditions. The indicators are used also as the criteria for the overall assessment of the company's current state as regards the sustainability of remanufacturing operations. In order to classify companies into one of three classification groups the method of Grey Decision Making (GDM) is used, which allows for the carrying out of the classification process in a quantifiable way (see Fig. 1).

This paper presents the concept of decision-making procedures for assessing the level of sustainability in the remanufacturing process (Sections 3–4). The originality of the procedure relies on the use of GDM, one of the methods of the Grey Systems Theory in remanufacturing research. Moreover the paper meets the research gap regarding the assessment of remanufacturing operational excellence as far as sustainability issues are concerned. The aim of this paper is to present how GDM tool can be used to assess the current state of the sustainability of the remanufacturing operations. Authors explain how to compare different companies in a suitable framework (the proposed classification) and how to improve the remanufacturing operations as regards sustainability dimensions. The GDM approach is chosen because the data in the remanufacturing process is very often uncertain and incomplete, and the mechanisms governing the modeled phenomena are only partially known. The GDM tool is also used for the prioritizing of improvement actions (3rd research question). Authors show how the decision making process in remanufacturing companies can benefit from the application of GDM in order to achieve a higher level of sustainability of their operations.

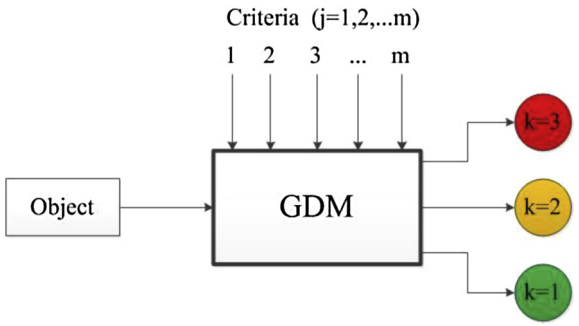

Fig. 1. The classification process using GDM.

2. Assessment criteria suitable for remanufacturing

2.1. Remanufacturing characteristics

Remanufacturing is an industrial process whereby used/broken down products (or components), referred to as "cores" are restored to useful life (Östlin et al., 2009). The main drivers for remanufacturing in automotive sector are: ethical responsibility, product take-back and recovery legislation, profitability of remanufacturing, brand protection and warranties management, spare parts supply securing and customer orientation (Seitz, 2007).

Remanufacturing facilitates multiple usages of the value-added in the primary production process. It helps to avoid labor and energy consumption and has a big potential for cost savings. The previous studies reported to the strategic planning decision making for automotive aftermarket remanufacturing (Subramoniam et al., 2009, 2010). In this paper we focus on the remanufacturing process execution. The remanufacturing is multi-operations, multi-variants process (Golinska, 2013b). Remanufacturing covers a number of operations which are needed to restore worn out or obsolete products for the next useful life cycle. Sundin (2004) stated that it is not possible to present generic remanufacturing process that is valid for different remanufacturing facilities. The logic of operations can vary and is industry and parts/products specific. The typical process in the automotive remanufacturing commences with the disassembly of cores (returned products), which are than cleaned, sorted and reprocessed. The restored elements and the new ones (if needed) are then joined together during reassembly. After testing, these remanufactured products can be delivered to the customers. The availability of cores influences the logic of the remanufacturing process in cases such as the below:

- If demand is lower than the amount of cores available then a number of sorting activities take place in order to eliminate the cores that are below par,
- If demand is higher than the amount of cores available then no additional sorting activities are needed but the scope of components reprocessing might be extended in order to achieve a recovery rate up to 100%.

[1] The German-Polish cooperation for sustainable development, project "Sustainability in remanufacturing operations (SIRO)", grant of the National Centre of Research and Development (Narodowe Centrum Badan i Rozwoju NCBR) number: WPN/2/2012.