EasyChair Preprint

№ 10158

Approach Towards Model-Based Implementation of Remanufacturing Using the Example of Automated Guided Vehicle Industry

Manfred Strasser, Fabian Holly, Barna Gal and Sebastian Schlund

May 14, 2023

4th Symposium on Circular Economy and Sustainability
Heraklion, Greece 19-21 June, 2023

Approach towards model-based implementation of remanufacturing using the example of automated guided vehicle industry

Manfred Strasser[1], Fabian Holly[1,2], Barna Gal[2] and Sebastian Schlund[1,2]

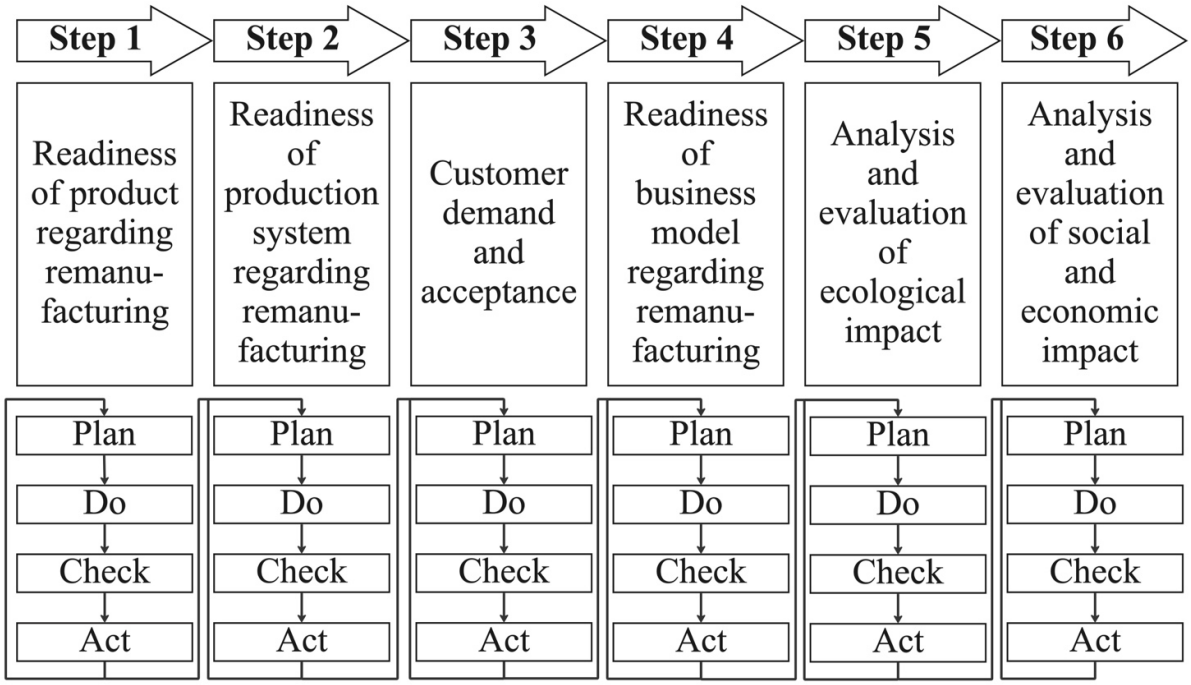
[1] *Institute of Management Science, Vienna University of Technology, Vienna, Austria*
[2] *Fraunhofer Austria Research GmbH, Vienna, Austria*

Our planet has a finite number of natural resources and the steadily increased consumption of these threatens our very existence in the climate crisis that prevails today. There are different strategies for the implementation of circular economy, where one of these possibilities is called remanufacturing. In the paper, a procedure model is developed, which supports companies during the introduction of remanufacturing processes. The result is a method for manufacturing companies and the implementation process of this model takes place step by step. The tool covers the critical areas for remanufacturing like product, production system, customer, business model as well as ecological, economic, and social impacts. The systematic application of the six-step process model is based on methods and tools that are well known in the industry. An excerpt of the tools mentioned is: PDCA cycle, value stream analysis, life cycle assessment, evaluation matrices, business model canvas and profit margin calculation.

OEMs are challenged in implementing remanufacturing using an existing procedure model, but only few implementation models for remanufacturing can be found [1] and confirms the weak link between scientific publications and industrial implementations. The main research objective of the paper focuses on the actions needed to implementing remanufacturing processes. From this research aim, 4 sub-questions are derived and formulated as follows: (1) What criteria does the product have to meet to introduce remanufacturing for the product? (2) What framework conditions in the company must be ensured to successfully bring the remanufacturing process into the company? (3) What economic, environmental, and social impact does the introduction of remanufacturing have on the company (finances, resource efficiency, CO2 footprint)? (4) What process steps does the company have to perform to establish remanufacturing for the product?

The requirements for the process model elicited in the requirements analysis play an essential role in the conceptual design. The requirements (i) analysis and evaluation of ecological impacts, (ii) analysis and evaluation of social and economic impacts, (iii) maturity of the product with respect to remanufacturing, (iv) maturity of the production system with respect to remanufacturing, (v) customer demand and acceptance by the customer and (vi) maturity of the business model with respect to remanufacturing, must be directly incorporated into the architecture of the process model. The clear sequence of the steps and simple comprehensibility determine the characteristics, which the architecture of the procedure model must ensure. Based on the requirements, the conceptual design provides a process model for the introduction of remanufacturing processes that can be implemented step by step. The completion of each step is based on the proven method of the PDCA cycle. PDCA is an iterative four-phase problem solving process [2]. Each of the steps within the procedure model (see figure 1) is a problem to be solved. PDCA provides an appropriate method to solve these problems for implementing remanufacturing processes. The cycle consists of the activities Plan, Do, Check and Act [2]. If Check does not return the desired result, the cycle is repeated till Check return an appropriate result.

Figure 1. General procedure model for the implementation of remanufacturing processes



The result of conceptual design and implementation is a process model that supports companies in the introduction of remanufacturing. The effectiveness of the procedure model has been evaluated based on a company that develops and produces intelligent, driverless transport systems. In general, under critical evaluation the developed procedure model fulfills the defined objectives. The demonstration using the example of an automated guided vehicle has shown that the procedure model for the introduction of remanufacturing completely covers the points determined from the objectives. These are as follows (i) detailed description of the individual steps of the procedure model, (ii) presentation of tools and methods for the successful implementation of the steps, (iii) expected results in each step, (iv) presentation of the actions, of the company, for the successful completion of a step. In case of successful implementation of the procedure model, positive effects in the areas of ecology, social and economic efficiency result for the company. Critically, the focus of the process model is to provide a good initial plan for implementing remanufacturing and is not to establish an optimal remanufacturing process in the company right from the start. After successful implementation of this initial endeavor, it may well make sense from the company's point of view to examine the individual steps of the remanufacturing process in detail and to optimize them subsequently.

Key words: procedure model, framework, remanufacturing, circular economy, resource efficiency

JEL: Q56; O32; M11

References:

[1] Kurilova-Palisaitiene, J. (2021). On Remanufacturing Readiness Level – An introduction to a Remometer™. Procedia CIRP, 98, 91–96.
[2] VDI 2870-2 Verein Deutscher Ingenieure e.V. (2013). Ganzheitliche Produktionssysteme – Methodenkatalog.