Comparison of the environmental impact of the replacement of an automatic transaxle by a new one or a remanufactured one

Moroncini, G.*,1, Equeter, L.*,1, Sénéchal, O.2, and Dehombreux, P.1

*Corresponding authors

1. Machine Design and Production Engineering Lab, Research Institute for the Science and Management of Risks, University of Mons, Belgium, Gerome.MORONCINI@umons.ac.be, Lucas.EQUETER@umons.ac.be

2. Université Polytechnique Hauts-de-France, CNRS UMR 8201, LAMIH, Valenciennes, France

Cite this contribution as: Moroncini, G., Equeter, L., Sénéchal, O., & Dehombreux, P. (2026). Comparison of the environmental impact of the replacement of an automatic transaxle by a new one or a remanufactured one. In L. Equeter (Ed.), *Proceedings of the Collaborative Research and Education for Asset Management 5.0 International Conference* (pp. 26–27). Éditions universitaires de l'UMONS.

Introduction

Sustainability is a major challenge and necessity for industry. Composed by three dimensions, which are economy, society and environment, it is a main component of Industry 5.0, which stands as a sustainable, resilient and human-centric approach of the industry. The transition towards Industry 5.0 requires the implementation of tools able to evaluate these three pillars, for all the missions performed within a company. Due to its key role in asset management, equipment maintenance is a key entry point for integrating sustainability in company's considerations. Indeed, when a part composing a machine fails, the management of this failed part remains a critical aspect. Several options can be considered, as the repair of the failed part, its replacement by a new part or a used one, etc. These options strongly refer to circular economy [1], whose main purpose is to extend the use duration of natural resources as much as possible before discarding them, and avoid it when possible. Ten words starting with the letter 'R' usually summarize the possible actions that can be performed on a machine to reduce its impact on the environment [1]. Among them, remanufacturing has a growing importance. In fact, its principle is to gather the functional parts of a discarded machine to reuse a portion of or all of them in an identical new machine with the same level of quality and performance as a new one composed by only new components. In Belgium, the plant of Aisin Europe located in Baudour is specialized in the remanufacturing of automatic transaxles.

The purpose of this work is to evaluate and compare the environmental impact of two failed automatic transaxles produced by Aisin, one being replaced by a new transaxle, and the other being replaced by a remanufactured one, by performing a life cycle assessment [2,3], in order to check the relevance of their activity on the environmental pillar of sustainability.

Methodology

Life cycle assessment methodology is composed of four stages, which are: (i) the goal and scope definition, (ii) the inventory analysis, (iii) the impact assessment and the (iv) interpretation [2,3].

The studied product system is the automatic transmission of a car that travels 200 000 km (which is the functional unit) in Europe during its whole life cycle, with a failure occurring on the transaxle after 100 000 km. For confidentiality reasons, the specific model of the transaxle is not disclosed in this work. The two available options compared in this work are to replace the failed transaxle by a new one or a remanufactured one, in order to travel the remaining 100 000 km. Four main steps therefore compose the life cycle of the studied product system. The first one is the manufacturing of the new transaxle in Japan. This step groups all the life cycle steps referring to the mining of the ores, extraction and production of the manufacturing materials, assembly of the parts and transport of the transaxle from Japan to Europe. The second step refers to the use phase of the transaxle on a distance of 100 000 km. It is considered that the car is a hybrid model, consuming 4.4 L/100 km of oil and that the mechanical efficiency ratio is equal to 0.95. The third step is the one of interest, as it refers to the replacement of the transaxle by a new one or a remanufactured one. In the case of the replacement by a new transaxle with only new parts, this step is considered as the same as the first one. In the case of the replacement by a remanufactured transaxle, the proportion of new parts and reused parts is defined thanks to the data provided by the company, which specify the probability of replacement depending on the considered part. All the data related to the mass of the parts have been supplied by the company, as well as the plans of the transaxles. The fourth step is identical to the second one. As a remanufactured transaxle has the same level of performance as a new one, it is considered that there is no difference in their mechanical efficiency ratio.

Thanks to these assumptions and considerations, a complete inventory of the materials composing the transaxle is obtained. This stage concludes that the most used materials in terms of mass were steel alloys (47.0 %), aluminium alloys (28.10 %), cast iron alloys (12.76 %) and stainless steel alloys (5.31 %), which corresponds to 93.2 % of the total mass of the transaxle. The unit processes related to these materials are defined by using the ecoinvent database. For the impact assessment, the computation method ReCiPe 2016 is used [4] and all the category indicators are kept in the analysis.

Results and discussion

The results show that for all the environmental category indicators, replacing a transaxle by a remanufactured one allows to reduce the impact by 20 %-30 %. By considering that the steps 1, 2 and 4 are the same for the two cases, it is shown that the impact of the remanufacturing process is approximately 4 to 5 times lower than the one of the manufacturing of a new transaxle. In both cases, the highest impact is due to the manufacturing processes, followed by the mining and extraction of the manufacturing materials.

Conclusion and perspectives

Thanks to the application of the LCA methodology, this work shows that replacing a defective transaxle by a remanufactured one has environmentally from 20 % to 30 % less impact than replacing it by a new one, for all the impact categories considered in the ReCiPe 2016. This result confirms the interest of investigating the implementation of circular economy in current industrial processes and products life cycle.

References

[1] P. Morseletto, “Targets for a circular economy,” *Resour. Conserv. Recycl.*, vol. 153, art. no. 104553, 2020, doi: `10.1016/j.resconrec.2019.104553`.

[2] *Environmental Management — Life Cycle Assessment — Principles and Framework*, ISO 14040:2006, 2006.

[3] *Environmental Management — Life Cycle Assessment — Requirements and Guidelines*, ISO 14044:2006, 2006.

[4] M. A. J. Huijbregts, Z. J. N. Steinmann, P. M. F. Elshout, G. Stam, F. Verones, M. D. M. Vieira, A. Hollander, M. Zijp, and R. van Zeim, *ReCiPe 2016 v1.1 — A Harmonized Life Cycle Impact Assessment Method Midpoint and Endpoint Level — Report I: Characterization*, National Institute for Public Health and the Environment, Ministry of Health, Welfare and Sport, RIVM Report 2016-0104a, 2017.