ESREL 2025 – Abstract

Title: Choosing the Optimal Maintenance Policy Considering Cost, Quality of Service and Environmental impact. Application to a bike and a fleet of bikes

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Selecting the optimal maintenance policy requires balancing multiple criteria, such as cost, quality of service and environmental impact. This work applies a structured approach to determining the best maintenance strategy, focusing on a single bike and a fleet of bikes, using quantitative methods and decision-making tools.

This approach consists of 8 steps: system definition, needs analysis, criteria selection, maintenance options identification and evaluation based on the selected criteria, selection of the most appropriate multicriteria decision-aid method, application of the method and discussion of the results.

In the cases of the bike and the fleet of bikes, the model focuses on the evaluation of the quality of service, environmental and economic impacts of several components of the bike, which are: the tyres, the battery, the engine and the brakes. It is assumed that the reliability of these components follows a Weibull distribution, while their environmental and economic impacts are respectively evaluated in $kg_{eq}CO_2$ and euros (€).

A Monte Carlo simulation is run on Python, evaluating the performances of 4 maintenance policies for a single bike and 24 for a fleet of bikes generated from 4 parameters: number of weeks between two maintenance sessions (2, 4 or 8 weeks), proportion of the fleet maintained per maintenance session (one quarter, one eighth or one sixteenth), tyre repairing by the user or not and replacement of the bike every five years or not. The results obtained from the simulations are analysed with two multicriteria decision-aid methods, ELECTRE and AHP, permitting the comparison of an outranking and an aggregation method.

Finally, this framework allows to choose the optimal maintenance strategy considering quality of service, economic and environmental impacts for each considered case. This work also shows the interest of simulation in the generation of non-trivial maintenance policies from a restricted number of parameters.