

A Circular Economy Indicator for Vehicles

-(Third Report) Examination of Methods for Evaluating Initiatives Aimed at “Promote Longer Use”-

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In the context of the circular economy (CE), reducing resource consumption and maintaining resource value are essential for achieving a sustainable society. In previous studies, we proposed a circular economy indicator for vehicles that evaluates resource circulation by considering material type differences and the quality of recycling, mainly focusing on narrowing and closing resource loops. However, extending product lifetime, referred to as slowing the loop, is also a key CE strategy.

Existing CE indicators often rely on output-based indicators, such as actual product lifetime or total mileage of products, assuming that lifetime extension always leads to environmental benefits. However, this assumption does not always hold true, especially when technological advancements in new vehicles significantly improve environmental performance. Moreover, accurately measuring or predicting vehicle lifetime for a product fleet is difficult due to limited data availability, vehicle exports, and variations in user behavior. These challenges indicate that direct lifetime-based indicators are not suitable for evaluating slowing strategies in the automotive sector.

To address these challenges, this study proposes an input-based evaluation approach that focuses on initiatives designed to enable longer vehicle use, rather than directly measuring actual lifetime. This approach is consistent with existing practices in other sectors, such as the French Repairability Index for electrical appliances and the Long-Life Quality Housing certification system in Japan. These frameworks evaluate design and system features that are expected to contribute to longer use, instead of measuring actual service life.

The scope of evaluation considers three perspectives: vehicle functions, the systems for maintaining those functions, and product attractiveness. Furthermore, these three perspectives can be broadly classified into two categories: attributes of individual vehicles, and systems such as repair and maintenance frameworks that are provided across multiple vehicle models. In this study, the evaluation focuses on vehicle functions and product attractiveness, which can be incorporated by manufacturers at the vehicle development stage.

As shown in Table 1, category of evaluation is defined as the fundamental functions of vehicles and their product attractiveness. Evaluation items are selected by focusing on those with significant influence, and durability, maintainability and replaceability are to be assessed. However, in this study, the specific selection of evaluation items has not been conducted yet. Evaluation is conducted in a relative manner, comparing new vehicle models with currently marketed ones. Durability improvements are assessed using existing durability test standards, while maintainability and replaceability are evaluated based on reductions in working time and improved accessibility. Each evaluation item is assessed stepwise: first by checking compliance with predefined criteria, then by scoring the degree of improvement, and finally by aggregating weighted scores to obtain an overall indicator.

This study organized key concepts and challenges related to evaluating initiatives aimed at promoting longer vehicle use as part of circular economy strategies. By focusing on input-based indicators, the proposed approach avoids uncertainties associated with direct lifetime measurement and enables practical evaluation during vehicle development. Future work will refine evaluation categories, define detailed criteria and weighting factors, and examine consistency with other circular economy indicators to establish a comprehensive framework for assessing automotive circularity.

Table 1 Evaluation Items of Slowing for Vehicles

| Category | | Evaluation items |
|----------------|---------------------|---|
| Function | Driving | Durability, Maintainability, and Replaceability |
| | Braking | |
| | Steering | |
| | Structural strength | |
| | Safety | |
| | Handling stability | |
| | Noise and vibration | |
| Attractiveness | Advanced functions | |
| | Interior | |
| | Exterior | |