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C2: E-Bikes in Transport Models: A Review of Current Practice and Literature

Leonard Arning

Introduction

Due to their higher speeds and lower physical effort required, electrically-power assisted cycles (EPAC, also known as e-bikes) make cycling a more attractive mode of transport for different user groups, trip purposes, trip lengths or topographically challenging areas. When changes in the transportation system affect the choices its users can make, it is necessary to consider including such new modal options in transport models to ensure that their outcomes continue to be accurate. The share of e-bikes is rising, most prominently in Europe and Asia, however it is unclear whether and how e-bike use should be included in macroscopic transport models. Modelling e-bikes in more detail might also create new analytical possibilities in model application, for example evaluating the impact of e-bike subsidies or dedicated infrastructure. Only bicycle-style e-bikes are considered in this review, despite scooter-style e-bikes powered by a gas handle being particularly popular in Asia. This is because in the context of transport modelling, scooter-style e-bikes are more akin to motorized private transport.

In current transport modelling practice, e-bikes are often neglected or treated as an afterthought. We demonstrate this by investigating exemplary existing models from contexts where e-bike modelling techniques would be expected to be the most advanced. Exploring new ways of representing e-bikes in transport models will shed light on appropriate model structures and their usefulness. Because there is very little research explicitly into differentiating conventional bicycles and e-bikes in transport models, we consider evidence from related research fields.

Systematic Literature Review

The systematic literature review is structured along five fields of research that can provide input into formulating and estimating e-bike purchase, mode and route choice models. Namely, they are:

1. The impacts of infrastructure on e-bike use
2. The impacts of topography and user demographics on e-bike use
3. The impacts of rebates and other incentives on e-bike use
4. The impacts of e-bikes on mode choice
5. The impacts of e-bikes on route choice.

We queried three databases for peer-reviewed publications from 2015 or later in June 2022 with five search strings, which together with three additional sources from a preliminary literature review result in a total of 30 relevant sources. Most studies take place in a Dutch or Northern European context and either evaluate various types of e-bike trial schemes or analyse data from national mobility surveys.

Results

The results of the review inform future research about how to represent e-bikes in transport models. Regarding research field 1, differences in the utility of e-bikes by different kinds of infrastructure and person groups highlight that travel costs, such as travel time and comfort, should be differentiated not just by bicycle type but also infrastructure and person group. Evidence for the relevance of differentiating between person groups is further strengthened in research field 2, where avoiding physical extortion is identified as the main motivation for purchasing and using e-bikes. While some demographic attributes appear to always have either a positive or negative correlation with e-bike use, others (such as prior cycling habits, gender and education) do so differently in North America and Europe. Exploring possible reasons for these differences provides further insights into factors that should be considered in modelling approaches that aim to be applicable in different regional contexts.

Research field 3 highlights the importance of both the purchasing price (and hence subsidies), but also of an initial stimulus for behaviour change. Modelling e-bike purchase choice will have to face the issue that e-bike acquisition is, especially during the stage of early-adopters, not a purely utilitarian decision. We outline possible modelling approaches. Research field 4 yields the largest number of relevant sources. E-bikes lead to a mode shift predominantly from conventional bicycles and private cars. The degree to which those two modes are substituted by e-bikes – a question highly relevant for modelling their environmental impact – strongly depends on the previous travel behaviour of the person group they are introduced to. Pointedly, introducing e-bikes to car users decreases car usage, while people who already cycle tend to substitute their conventional bicycle travel. We highlight strengths and shortcomings of reviewed study designs that inform mode and purchase choice models. Lastly, sources reviewed in research field 5 point towards speed characteristics of e-bikes, infrastructure and ambient factors and once again the segmentation of person groups being relevant to cyclists' route choice.

Overall, this systematic literature review demonstrates that while there are only few scientific publications explicitly about e-bikes in transport models, there is a large body of research that investigates factors influencing e-bike ownership and how e-bikes affect travel behaviour. These findings can be used as a starting point for developing dedicated modelling approaches.

Future Research

Modelling approaches that could be informed by findings from this systematic literature review include modelling cycling as two separate modes for conventional bicycle and e-bike as well as an e-bike purchase choice model. These modelling approaches could be applied to different modelling techniques, such as agent-based, mesoscopic or four-step-models. Overall, representing e-bikes in transport models might not only enhance model quality: their application to practical transportation planning tasks, such as evaluating cycle superhighways or subsidy measures, could reveal new analytical possibilities brought about by differentiating between different types of bicycles.