Summary

Economic analysis of measures for improved operation and maintenance for cycling and walking

TØI Report 1690/2019
Authors: Knut Veisten, Nils Fearnley, Rune Elvik
Oslo 2019 53 pages Norwegian

The level of operation and maintenance of areas for cycling and walking, along with the infrastructure standard as such, will signal what importance society attaches to these modes of transport. Cycling and, in particular, walking, are also important in relation to public transport. Operation and maintenance may impact on the choice of cycling or walking, including cycling/walking to a stop/station/terminal. If cycling or walking is the chosen mode of transport, the operation/maintenance regime could affect accident risk, travel time, travel comfort, or other welfare-related elements. For economic analysis there is a sparse base of quantified impacts, as well as a lack of quantified associations between impacts and operation/maintenance levels. Example calculations indicate that lighting on cycle/walking infrastructure and reduction of the extent of slippery surfaces in winter conditions may be economically viable measures, depending on the effects on travel time, the number of cyclists/pedestrians at the outset, and diverted travel from other transport modes. Knowledge gaps need to be filled before more complete economic analyses can be carried out. Primarily there is a need for establishing links between quantified levels of operation and maintenance levels, road conditions, and consequences for cycling/walking.

Missing links – few quantified consequences from different levels of operation and maintenance

In relation to an ongoing research and development project, “Improved operation and maintenance for more pedestrians and cyclists” (BEVEGELSE), the Norwegian Public Roads Administration has commissioned an assessment of the economic consequences of altered operation and maintenance of the cycling and walking network. Literature on consequences that can be related to operation and maintenance does exists. For injury risk, studies associate large part of cyclists’ and pedestrians’ injuries with road conditions, such as ice, gravel (strewed on asphalt in winter), leaves, holes in the road, or a stone or other object. For other impacts that can be related to road conditions, such as travel time and travel comfort, some studies indicate connections with operation and maintenance, but without quantifying the potential consequences . In general, there is hardly any quantified relationship between road conditions and specified operation and maintenance regime on the one hand and accident/injury risk, speed, comfort and other user effects on the other hand. In this report we thus had to limit ourselves to indicating some directions ahead: providing some analyses of pedestrian and cyclist injuries, presenting a framework for cost-benefit analysis, and listing knowledge gaps.

Significantly increased injury risk when surface is slippery - the winter operation challenge

At the outset we lack data that link levels of operation and maintenance of the cycling and walking infrastructure with effects on pedestrians and cyclists. However, regarding injury data, particularly for pedestrians, the challenge for winter operation of cycling and walking infrastructure is obvious. Two data sets from the Oslo emergency ward, one comprising injured cyclists, in 2014, and the other injured pedestrians, in 2016, included variables for accident causes that could be associated with operation and maintenance. During the five months from November to March, a large proportion of the injured pedestrians reported to have fallen on slippery roads (on ice), nearly 85% in some months. It is estimated that halving the extent of icy road conditions could reduce the annual number of pedestrian injuries in Oslo of about 20%.

The predominant winter operation regime in Norway is been ploughing/shuffling and strewing sand or gravel (referred to as “GsB standard”); a type of winter operation that can have different execution rules (response times, on snowfall and/or ice formation, and qualities of execution). The injury data for pedestrians from the Oslo emergency ward actually indicate that shuffling the snow without strewing can increase accident risk – it was the third most dangerous operation combination, after icy road conditions (without snowfall and shuffling) with no strewing of sand/gravel or with “too limited” strewing of sand/gravel. A winter operation regime that has been applied in recent years, in particular on cycling routes in the larger cities, is to sweep the snow and then add a mixture of salt and water (referred to as a bare roads or “GsA standard”).

Few of the remaining possible consequences are quantified

The injury data from Oslo emergency ward cannot be linked to any existing, unambiguously defined operation regime (say, ploughing and strewing of sand/gravel, GsB). Nevertheless, we can assume that sweeping and salting (GsA) was less prevalent on cycling roads in 2014, and used very sparsely on the part of the network for pedestrians, in 2016.

We lack other quantified relationships between operation/maintenance regimes and accident risk or other consequences. We may make assumptions about the direction of the effects, e.g., that travel time is expected to increase, and travel comfort decreases, for cyclists and pedestrians when the surface is slippery, when there is sand or gravel on the asphalt, and when there are holes and cracks in the road surface. From an assessment of generalized travel costs it is also expected that the level of operation and maintenance will affect the decision to travel and the transport mode choice.

There are other reported road conditions in the Oslo emergency ward datasets that can have some association with operation and maintenance, particularly in the dataset of injured cyclists, like slipping on sand or gravel (gravel often remains on the asphalt for a considerable time after the snow has melted) or leaves from trees, or having hit a hole in the road or a stone on the road. However, we lack quantified and located specifications of operation and maintenance regimes for state/county cycling and walking infrastructure and for municipal cycling and walking infrastructure. Such a specification would comprise the degree of monitoring and control of the infrastructure, what triggers measures (other than winter operation) and response times. Such quantified and located descriptions of the operation and maintenance regimes, for all types of cycling and walking infrastructure, represent one of the necessary inputs for assessing measures and the expected impacts from their implementation. In general, given a known variety of operation and maintenance regimes over a geographical area (Norway, or Norway/Sweden/Finland), quantified road standards, and measures of their associated consequences for cyclists and pedestrians (injuries, travel times, and other potential welfare-affecting consequences) could answer the questions that have been posed by our client:

a. How much does the accident risk increases on pavements and cycling and walking infrastructure in winter, and how much can it be reduced by improved friction?

b. How much does the travel time increase for pedestrians and cyclists due to snow and ice on cycling and walking infrastructure, and how much can the delays be reduced by improved by better operation standards, e.g. free of snow and ice standard?

c. How much does the accident risk increases on pavements and cycling and walking infrastructure due to leaves, gravel, and sand?

d. What are the positive consequences for pedestrians and cyclists resulting from the installation of LED lighting and SMART lighting on cycling and walking infrastructure?

e. What would be the consequence for accidents and mobility of repairing bad road surfaces on pavements and cycling and walking infrastructure?

f. How much increase in cycling and walking can be achieved by a standard upgrading of operation and maintenance, summer and winter? What would be the consequences of downgrading the standard?

As indicated, these questions can only partly be answered based on existing data and established relationships. An elaborate answer is given to question a, applying injury data from Oslo. The same data are applied for partial answers to questions c and e. However, estimating effects on travel time and mobility, related to questions b and e, have not been possible based on existing sources / data. The same applies, at least to some extent, to effects from lighting of separate cycle/walk sections, question d, and demand effects, question f.

Data that could shed light on some of these issues exist, such as the effects on travel time, mobility, and demand. E.g., travel survey data or mobile phone app data could be merged with other geographical data, such as descriptions of the road standards for cycling and walking infrastructure and operation and maintenance regimes, as well as weather data (affecting road conditions and affecting the decisions to walk and, especially, to cycle). However, there is also a need for new studies that can establish the links between operation and maintenance levels, conditions of the cycling and walking infrastructure, and consequences for cycling and walking.

Economic analysis examples - cycling and walking calculator

The fundament for economic analysis of operation and maintenance measures on the cycling and walking infrastructure is scarce. Neither the costs of the operation and maintenance measures nor their consequences are known. However, a framework for cost-benefit analysis is described and various inputs are discussed. Example calculations are provided for a change of winter operation regime from ploughing and strewing of sand/gravel (GsB) to sweeping and salting (GsA), as well as for the installation of LED lighting. These are preliminary analyses that can indicate knowledge gaps and illustrate how to proceed further. For instance, at the outset we set no effects on travel time or travel comfort from these measures, lacking the fundament for proposing any value. We test the assumption of demand effects, the transfer from other transport modes to walking and cycling, as a consequence of the measures.

The results of the analyses illustrate the importance of the demand effect – if only current cyclists and pedestrians are affected, with no diverted travel or induced demand, the measure cannot be supported by the cost-benefit analysis. This applies to both installing LED lighting and winter operation. Diverted travel from motorized transport provide benefits in terms of reductions of congestion, air pollution, CO2 emissions, and noise, as well as a positive health benefit from increased active transport. However, if current cyclists and pedestrians are assumed to travel at 1 km/h higher speeds as a result of the measures, there is a considerable rise in benefits. Regarding the cost of the measures, the net benefit of the winter operation measure (GsA) is more sensitive to cost increases than the LED lighting measure. The winter operation has recurrent costs, while the lighting measure has considerable investment costs but relatively low operation and maintenance costs.

Knowledge gaps – and the possibilities of filling them

As already pointed out, there is a lack of quantified relationships between operation and maintenance regimes and consequences for cyclists and pedestrians. Investigating the injury data from Oslo, causes of injury can be identified that are clearly related to operation and maintenance, especially winter operation. Yet, we do not have data showing combinations of operation and maintenance regimes and consequences, whether for injury, travel time, or other impacts. A list of knowledge gaps would comprise the following:

1. Quantified descriptions of operating and maintenance regimes/levels for different types of cycling and walking infrastructure in different geographic areas (having different infrastructure owners), which also include descriptions of the institutional features, as well as measurements of road conditions (surface conditions etc.).

2. The relationship between (operation and maintenance-related) road conditions and mobility, comfortable speed and travel time for cycling/walking (which could combine objective measurements *in situ* with questionnaires – travel survey questions, possibly also including mobile phone apps for travel registration).

3. The relationship between (operation and maintenance-related) road conditions and travel comfort (and security) for cycling/walking, which could also include valuation of changes in various road condition elements and the cycling and walking infrastructure.

4. Information about the amount of walking and cycling at specific locations. An increased number of pedestrian an cyclist counting stations would provide better information about annual average daily traffic of cyclists and pedestrians along various road sections. Some of these new count locations ought to be installed prior to changes of operation regime or prior to infrastructure maintenance, upgrade or infrastructure development. Counts could also be combined with pre-post surveys.

5. Before-and-after studies related to operation, maintenance and other infrastructure measures, applying objective counts combined with surveys (and, possibly, cellular phone apps) may also be applied in estimating the demand effect of such measures.

6. Detailed information about injured pedestrians and cyclists. Cyclist and pedestrian injury data from the Norwegian Patient Registry (NPR), from all over the country, ought to be made available for analysis, possibly with similar additional registrations as carried out by the Oslo Emergency Ward. Injury registrations should be geographically located.

7. Economic analysis examples of more measures are needed, e.g., the repair of cracks and potholes. Moreover, the measures addressed in our example analyses might be differentiated further, e.g., improving lighting on cycling and walking infrastructure versus installing lighting in places where there is none, as well as differentiating between combined measures for pedestrians and cyclists, on one hand, and separate measures, on the other.

Some knowledge gaps may possibly be filled with existing data, if these are connected in new ways. Existing travel survey data and mobile phone app data include registrations of time and location. Then it is possible to merge various geographic variables to these data sets, such as road standards, operation and maintenance regimes, other built environment data, and, preferably, weather data. This would allow for analyses of the choice of cycling/walking as transport mode and cycling/walking travel speeds, where infrastructure standard and the type and level of operation/maintenance are included as variables in the analysis.

If it is desired that a larger proportion will choose to walk or cycle for different travel purposes, then more measurable connections should be established between the operation and maintenance of the cycling and walking infrastructure and the consequences for cycling and walking. In order to be able to assess operation and maintenance measures economically, such quantified relationships are crucial.