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How Can Traffic Engineering Assist Bicycle Movement in Urban Areas?

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Yuchu Liu

Department of Civil and Environmental Engineering, Imperial College London, UK.

Abstract

As cities get more and more congested with vehicles, people start to realise the negative effects this creates, and many start to examine cycling, which did not get much attention in the past, as a choice for travelling within a city. Major problems faced by cyclists and those who wish to cycle is safety risks and undesirable experience. A Separated cycle lane is a widely applied approach for decreasing the risk of cycles colliding with motorised traffic, and it has been shown that such a practice reduces both perceived and actual risk of cyclists getting injured. Traffic signal systems, which were developed to promote efficient flow of traffic, has the side effect of reducing pollution, which creates a friendly environment for cyclists. Implementing cycling infrastructures at public transportation hubs can encourage cycling for commuting. If such practices are applied properly, cycling can become a more attractive transportation mode.

Keywords

Traffic engineering, sustainable travel, public transport, signal control, urban infrastructure, cycling

1. Introduction

1.1 General Background

For 2019, cycling accounts for 2% of all trips and 1% of the distance travelled among all transport modes in England [1]. While the percentage is considerably smaller than other modes, its participation in making transport more environmental-friendly is necessary. Its physical nature gives this transport mode an incomparable advantage over driving and buses in urban areas where traffic congestion has become a norm, despite its limitations as being man-powered and vulnerable to weather conditions. The majority of cyclists cycle for either commuting or leisure [2].

1.2 Research aim and scope

This report aims to examine how traffic engineering may help to encourage cycling in urban area. The approach taken will be first identifying issues discouraging cycling. Then relevant engineering interventions will be discussed to address these issues. Limitations or drawbacks of the proposed interventions will also be briefly discussed. It should be noted that the problems vary largely from case to case especially in the context of traffic engineering, therefore the proposed interventions should not be treated as a panacea.

1.3 Outline of thesis

There are two issues identified which prevent people from cycling in urban area. In section 2, A widely used practice will be proposed to address people's concern about safety when cycling, and then briefly discuss its effects. Section 3 will focus on how to improve cyclists' experience and potentially attract more people to choose cycling.

2. Improving safety for cyclists

2.1 Problem statement

Safety is of primary concern of traffic engineering. In the case of cycling, due to the fact that a cyclist is much less protected by external equipment unlike cars equipped with numerous safety measures, injury and death are still likely to occur even if the speed at which it travels is much lower than other mechanised vehicles. Statistic results have shown that more than half of respondents across groups categorised by age, gender, cycle/drive or not, feel dangerous to cycle on road over 2011 - 2020, with special attention that 70% of non-cyclists feel so [3]. It is, therefore, reasonable to speculate that creating a safe perception of cycling may significantly encourage cycling.

2.2 Separated cycle lane from carriageway

Separating the cycling traffic from other motorised traffic is a common practice. Though it comes with the cost of taking space away from other vehicles, it is still implemented widely to encourage cycling and discourage private driving. Separation is achieved either by a physical barrier or road markings. It does not necessarily inhibit other vehicles from driving into the dedicated cycle lanes, but it does reduce conflict since it conveys the message to the road users that the lane is for cyclists specifically.

The effect of separated cycle lanes can be reflected by people's perception of whether it is safe to cycle. A survey conducted in Toronto and Vancouver shows that major streets with shared lanes were perceived as the most dangerous for cyclists, whereas paved multi-use path ranked the safest among the responses of interviewees [4]. This survey also finds that actual safety risk ranking also largely conforms to the result for perceived risk ranking. Thus having separated cycle lanes from other high-speed traffic should be able to attract those who are willing to cycle instead of choosing other modes but are worried about cycling safety.

However, depending on how the separation is done, sometimes the actual effect may not be consistent with how the users perceive it. Marshall and Ferenchak proposed an opinion that sometimes these measures 'provide a false sense of safety,' whereas other unconsidered factors actually prohibit the risk from being mitigated [5]. Moreover, the design of separation should foresee the effect of increased number of users. When a large number of cyclists use the infrastructure whose capacity is exceeded, a safety measure may turn out to be hazardous.

In general, separation is a practice that is easy to implement and can have a positive effect on addressing safety risk for cyclists. However, adverse effects may also occur if it is not done appropriately and therefore this should be carried out with careful consideration. Decision makers may have to consider the balance of the needs of cyclists and other road users when the space is limited and separation requires taking space originally for other uses.

3. Improving cycling experience

3.1 Urban cycling experience overview

People's will to cycle is subject to a variety of factors. It should be admitted that cycling is not always as convenient compared to other transport modes in a motorised age. While there's barely anything that could be done regarding issues like weather, improving the experience when people do cycle, will motivate people to cycle. It is worth examining how cyclists can interact with other traffic modes as well as participants.

3.2 Air quality

Cyclists are directly exposed to open air, therefore subject to bad air quality, but unlike pedestrians who can use face covering to protect themselves to some extent, cycling is a relatively intense physical exercise and face coverings may not be applicable to mitigate the issue. Therefore, clean air and good visibility is a desirable environment for cyclists. As motorised traffic contributes significantly in urban air pollution, mitigating this problem may encourage people to choose cycling.

Traffic signal control systems such as Split, Cycle and Offset Optimisation Technique (SCOOT) have been widely applied to help traffic flow in an efficient manner. These practices reduce the total time vehicles spent on road and therefore the amount of emission. A computational study has shown that such systems are capable to lower emission of pollutants including CO_2, NO_x, and PM_{10} by 10% - 40% for an urban scenario [6]. PM_{10} specifically worsens visibility when the concentration is high and is harmful when people breathe in air with it, causing respiratory problems. By reducing the emission of these pollutants, an ideal situation for cyclists is achieved, and a higher number of cycling can be expected.

On the other hand, such systems are not specifically developed for encouraging cycling but for enhancing efficient traffic flow, suggesting that reducing pollution is only a side effect. There is not a conclusive answer for whether that encourage cycling or private driving more depending on different situation, where the problem may not ease if the latter one is the case. The emerging electric vehicle (EV) market and industry may relieve the situation but it may still take quite long to substitute fossil fuel powered cars completely.

3.3 Easier connection with public transportation modes

Cycling is appealing for relatively short journeys where driving may actually be slower due to congestion, but for a longer journey this advantage vanishes and the cyclists' stamina determines the maximum distance that one may decide to cycle as well. A potential way to encourage cycling is to make the transition between cycling and other public transportation modes easier, specifically, encourage people to choose cycling for their first and last-mile travel.

A smoother transition can be achieved in two ways. First, public transport can be modified so that bicycles can be carried on board. Currently existing practices include but not limited to bike racks on buses and admitting bikes that can be folded up. It should be noted that these implementations, while providing convenience indeed, also have significant limitations like limited capacity.

Second potential way is providing bicycle parking/renting at transition hubs. With such infrastructure, one can cycle, for example, to a metro station, and rent another bike cycling to the destination after the metro trip. However, such infrastructure requires space, and it is not always possible for the hubs with the highest number of passengers, which are generally located in central urban area, to find a space suitable for this purpose.

Overall, it is often difficult to accommodate the needs of cyclists to existing transportation modes to an extent that will largely increase the use of cycling. Therefore, future renovation and development should bear these in mind if intended to promote cycling.

4. Limitations and implications

In the context of traffic engineering, it is important to note that people's behaviour is not always predictable overall, and the population itself is not homogeneous. When we categorise cyclists based on purposes (cycle for leisure or commuting), different implementations may not apply to all the groups. For example, *Section 3.3* may not be as relevant for leisure cyclists as for commuting cyclists as they may do it for exercise so there is no point in taking another transportation mode. The routes that these two groups use can be different, and the same cyclist may choose different routes every day to the same destination. Thus it might be hard to make a decision where a separation cycle lane should be constructed.

When the number of cyclists increases, many new problems can arise. A city may end up having congestions with bicycles just like cars if the capacity of cycling infrastructure cannot catch up with demand. By that time, more sophisticated regulations, which is currently lacking, might be necessary to make people cycle safely and properly, such as having speed limitations. Emerging new technology is also important. Electrically powered bicycles are not rare these days and classification of these may influence the design specifications of the interventions.

Finally, it should be recognised that it is unlikely that cycling will take over private driving unless there is some revolutionary improvement of this transportation mode. While a decision could be intentionally made to discourage driving, to what extent this is to be done is worth discussing. People are sometimes reluctant to change so taking space from carriageway and allocating it to cycle lane may have adverse effects like worsening traffic congestion, which is

undesirable.

5. Conclusion

In conclusion, traffic engineering in an urban context can help cyclists by increasing safety and providing a more desirable travel experience. Having a separated cycle lane from carriageway decreases the both the perceived and actual risk of collision if applied properly. Traffic signal control systems that decrease pollution and therefore improve air quality can create a friendly setting for cyclists. Cycling infrastructure at major transportation hubs and special arrangements for bicycles on public transportation creates more convenience for cyclists. These should be able to make cycling an attractive choice for travelling in a city.

The proposals above are indeed subject to different limitations, which either confine the situation where those can be applied or the effect those can lead to. Therefore, comprehensive analysis of both feasibility and expected outcome is necessary if any intervention is to be conducted.

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