Impact of the interaction between motor vehicles and bicycles on route selection, traffic performance, emissions and safety

Ph.D. Mechanical Engineering – Transportation

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***Abstract*— Individual benefits of bicycles along with positive effects on pollutants and environmental issues have led to the increase of cycling rate at urban areas [1]. However, different road users have different criteria and it is important to assess our routes based on their preferences. The study of bicycle-motor vehicle (MV) interaction might be more important than interaction between MVs since cyclists are more vulnerable and potentially exposed to damage of a collision than MVs' drivers [2]. Regarding the probable safety concerns associated with the number of conflicts and impact of volatility driving (hard accelerations/decelerations and aggressive manoeuvres) between MVs and cyclists, roundabouts and intersections with traffic lights and stop-controlled junctions are the critical traffic points [3]. There were several studies focused on impacts of cycling regarding safety concerns, traffic performance and emissions at intersections (about traffic performance-safety: [4], about traffic performance-emissions: [5] and about MVs volatility driving impacts in urban areas [6]). However, there is a lack of research focused on the impacts of cycling in an integrated way. In this thesis the transportation impacts as a result of bicycle-MV interactions selected with route choices modeled using an integrated three-dimensional multi-objective model to achieve all identified goals simultaneously. Minimizing delay, traffic queue and emissions and maximizing the safety are the main objectives of this work at different roads. The thesis main questions are: (i) What are the main criteria in urban transportation network for passengers who are using a motor vehicle or a bicycle? (ii) What are the main factors of driving volatility as a result of bicycle-motor vehicle interactions and their impacts on traffic performance, emissions, and safety? All the necessary traffic data were extracted from the network, then a modeling platform of traffic (VISSIM), emissions (VSP) and safety (SSAM & PC-Crash) were used to evaluate the impacts of volatility on above outputs. The main findings are: (I) The presence of bicycles may dictate a trade-off in the network (II) Dedicated lane for cyclists improves traffic performance, safety and emissions at urban areas (III) bicycle demand variation (9-270 bph) can increase energy impacts up to 7% in the network (IV) Instantaneous decisions can result in volatility driving with impact on cyclist safety.**

Keywords*— *Traffic Performance; Safety; emissions; Bicycle-vehicle interaction; Volatility driving

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TOPIC

2.b.Technologies for the Wellbeing. Innovative technologies for Smart Cities.

REFERENCES

[1] Twaddle, H., Schendzielorz, T. and Fakler, O., 2014. Bicycles in urban areas: Review of existing methods for modeling behavior. Transportation Research Record: Journal of the Transportation Research Board, (2434), pp.140-146.

[2] Götschi, T., Garrard, J. and Giles-Corti, B., 2016. Cycling as a part of daily life: a review of health perspectives. Transport Reviews, 36(1), pp.45-71.

[3] Van Hout, K., 2008. Annex I: Literature search bicycle use and influencing factors in Europe, BYPAD. EIE-programme, 5, p.016.

[4] Kaplan, S., Nielsen, T.A.S. and Prato, C.G., 2016. Youth walking and cycling: the relationship between active travel and urban form, 95th Transportation Research Board Annual Meeting, Washington D.C., US (No. 16-1809).

[5] Zhang, Y., Xumei, C.H.E.N., Zhang, X., Guohua, S.O.N.G., Yanzhao, H.A.O. and Lei, Y.U., 2009. Assessing effect of traffic signal control strategies on vehicle emissions. Journal of Transportation Systems Engineering and Information Technology, 9(1), pp.150-155.

[6] Kamrani, M., Arvin, R. and Khattak, A.J., 2018. Analyzing Highly Volatile Driving Trips Taken by Alternative Fuel Vehicles, 97th Transportation Research Board Annual Meeting, Washington D.C., US (No.18-00980).