Modeling grocery shopping-related urban transport – the case of E-Food

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How will urban transport change in the light of increasing e-grocery purchases? In order to answer this question, we introduce a framework of several interlinked models of store location and passenger and freight transport demand and assignment.

Grocery shopping induces a considerable share of urban transport, either by logistic companies, retailers or consumers.[1] With potentially very influential technological and social trends arising in the first decade of the 21st century, urban transport is about to change considerably. Thus we need to understand the system and predict changes due to these trends. How will urban transport change in the light of increasing e-grocery purchases? In order to answer this question, we introduce a framework of several interlinked models and apply these to a scenario of population growth and increasing e-grocery retailing.

The framework's initial step is a lean location model that predicts the number of small and large grocery stores by zone based on population size, number of transit stops and other explanatory variables (Heldt et al., 2017). In order to add further information to the stores, a second model (SYNTHESIZER, von Schmidt et al. (2017)) applies iterative proportional fitting taking into account the original distribution on the one hand and on the other new marginal sums for two floorspace categories coming from the location model. The additional attributes include further size categories (<= 399 m², 400-799 m², 800-1,499 m², >= 1,500 m²) and the type of format (discount store, full assortment store, organic store). The model also generates new stores if the number of predicted stores in an area exceeds the number of locations in the input dataset. The next step involves models that calculate passenger and freight transport demand. We apply the agent-based travel demand model TAPAS (Heinrichs et al., 2016; Hertkorn, 2005) for generating passenger transport demand taking into account the changed location pattern. Tours of freight vehicles to either supply grocery stores or households are planned with jsprit (https://github.com/graphhopper/jsprit). The vehicle flows of both models are jointly assigned by using SUMO (Krajzewicz et al., 2012, www.sumo.dlr.de).

The proposed framework is applied to the city of Berlin, Germany. Berlin's population is estimated to grow to 3.8 million inhabitants by 2030 with an annual growth of over 40,000 persons from 2017 onwards (Senatsverwaltung, 2016). At the same time, the market share of e-grocery retail is expected to grow tremendously, however from a very low level. In 2016, e-food in Germany accounted for 1 % of total sales but growing at a rate of over 20 % (HDE 2017). In our study, we consider the city of 2030 with population growth rates for 60 zones as input to the location model. As a result the model predicts an increasing number of locations where population grows. Assuming that 10 % of stores will close down due to the increasing market share of e-grocery shopping, we then randomly remove locations. Travel demand of passengers is expected to change in the light of increasing online-shopping. Hence, we assume that a percentage of initial trips to grocery shopping destinations is replaced by either staying at home,

[1] According to Durand and Gonzalez-Feliu (2012), grocery shopping accounts for 9 % of urban goods movement trips in terms of freight transport while shopping trips by consumers make up nearly half of all urban goods movement. About 14 % of all trips in Germany's cities in 2013 had the purpose of shopping for daily needs (Ahrens, 2014).

i.e. making no trip or by going home instead of grocery shopping. Private households are now supplied by retail companies with smaller vehicles.

Preliminary results show for location patterns that applying the spatial distribution of floorspace categories and retail format in 2015 to an increasing number of grocery stores changes the initial distribution. In some zones, the numbers of stores of all format types increase. This becomes particularly obvious in the case of organic stores which in reality grew considerably during the last few years opening new locations across the whole city. In our simulation this trend remains underestimated – new organic stores emerge mainly where their density is already high. However, overall, the resulting location pattern is plausible.

In our presentation, we will show what implications the changing grocery store pattern has for urban transport. We expect that the number of shopping trips performed by consumers will decrease as they stay at home instead. However, the time-savings from the trip itself are assumed to translate into slightly longer trips for other purposes such as leisure. Furthermore, we expect that freight transport increases. The final question that we will answer in this presentation is whether decreased passenger traffic or increased freight traffic prevails.

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