Relating accessibility and trip frequency

Exploring the theory about induced trips

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23 September 2004

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The British as well as the Dutch government changed their policy towards solving congestion problems radically in recent years. The British policy of “predict and provide”, which refers to a policy of constructing road capacity to meet the predicted growth in travel demand, was followed by the management of traffic volumes by using the existing road capacity in a more efficient way. The Dutch government followed the inverse way. This shows that the solutions for congestion problems are not clear. It might amongst others be caused by the failure of transport models to adequately predict growth in travel demand because of infrastructure supply changes. This effect is known as induced travel. The theory of induced travel is an economic interpretation because it argues that generalized costs influence travel demand. This interpretation has been doubted because the demand for travel has always been seen as a demand, derived from the demand to carry out activities, which leaves the travel costs irrelevant.

The theory of induced travel is based on the economic theory of travel markets distinguishing markets for travel demand and infrastructure supply [Manheim [2]). A change in a transport condition that reduces the generalized costs of travel leads to an increase in the quantity demanded for travel. However, there are other factors that drive growth in travel demand. These exogenous factors are factors like population growth, increase in car ownership, labour force participation, income etc. It is difficult to distinguish growth due to inducement from growth due to the exogenous factors.

When the generalized costs of travel are reduced, people have different ways to respond to it in the short run. They can change their route, time and mode of travel to their preferred one, they can make longer trips or they can perform new trips. Route, time and mode changes can be either counted as induced or diverted travel. This reveals that the definition of induced travel must be stated clearly.

The constant travel time budget is an important theory supporting evidence for induced travel as it considers time allocation to travel as completely inelastic. When transport conditions improve travel speeds increase and journeys of longer distances or extra journeys will be undertaken as individuals allocate a fixed amount of time to travelling. This is in accordance with the maximum utility theory as the individual’s utility of performing a trip increases when the generalized costs of travel decrease. Then the possibility of people making trips is larger.

When a review is made of relevant literature it appears that induced travel was already recognized in 1938. In 1994 the SACTRA report [19] provided strong evidence for the existence of induced travel. It was concluded that the induced travel effect matters most under conditions where the network is operating close to capacity, where demand elasticity is high and where the changes in travel costs are large. Evidence from econometric models, comparisons of forecast and observed traffic growth on improved roads, traffic counts before and after the improvement of roads and evidence from travel time budget studies reveal traffic growth rates are not easy to be explained only by exogenous factors. This implies that the induced travel effect exists.
Although induced travel has been motivated through theory as well as observed in reality, its existence and size remain uncertain. Problems are that classical transport models fail to include the phenomenon, it is difficult to separate the many effects that occur statistically and the definition is not clear. Therefore this research focuses on one single effect of a transport condition improvement, the increase in trip frequency. A clear-cut definition can be stated. The aim of this research is to study the theory on induced travel by providing insight in the relationship between accessibility (reflecting transport condition improvements) and trip frequency. Because socio-economic characteristics together with the accessibility level, determine trip frequency, these variables are kept constant. Thus socio-economically homogeneous households are analyzed in a case study area.

As numerous definitions for accessibility have been proposed in literature, various proxies are used in this research. Overall, four components of the accessibility measure are recognized by Geurts [52]. The transport component (reflecting the generalized costs of travel), the spatial component (reflecting the possibility to perform the desired activities) and the individual component (reflecting the different preferences of individuals) are all included in one or more proxies. The time component is not taken into account. The proxies used are travel time from home to work of the head of household, travel cost from home to work of the household members, travel distance from home to work of the household members, travel speed from home to work of the household members, average travel time cost per trip per household, travel time for mandatory trips per household, number of mode transfers per captive trip per household and generalized costs of travel regarding activity possibilities per household member. For this last proxy centre zones of activity possibilities are defined by considering land uses per zone. As not every centre zone will be of equal importance for every individual, a zone attractiveness per individual is composed. The accessibility of an individual is determined by the inverse of the generalized costs of travelling from the home zone to each of the selected centre zones multiplied by a weigh factor for the relative importance in activity possibilities of each zone for that individual (defined by the zone attractiveness).

From literature it appears that household's car ownership level, household income and household size are proper classification variables to define socio-economic homogeneous groups of households. A cross-sectional survey database is selected to analyse the relationship between accessibility and trip frequency. The exogenous factors are kept constant as one point in time is studied. The SACTRA conditions [19] determine the geographic area of study. It is preferable to choose an area in a developing country in a densely populated urban area.

After the definition of the methodology the research hypothesis is stated derived from the theory. For socio-economically homogeneous households, a higher level of accessibility of the household or household members is expected to lead to an increased trip frequency.

A database of the Metro Manila Urban Transport Integration Study (MMUTIS) of Manila in The Philippines appeared to be available. The SACTRA conditions [19] are present in the MMUTIS study area. The information, which has to be collected to analyse the relationship between accessibility and trip frequency with the described methodology, is included in the database. The quality of the database is good as it was conducted to have a reliable, comprehensive and coherent database that can be used as a firm basis for planning. A study by Gonzaga [55] revealed that Metro Manila travel behaviour is indeed determined by physical constraints (the accessibility level) and socio-economic characteristics. Age is considered as an important socio-economic determinant of travel patterns. It will be used as a classification variable next to the already defined ones. The household interview survey of about 57.900 households is studied to collect data on accessibility proxies, trip frequencies and socio-economic characteristics of households or household members, as well as the willingness-to-pay survey to collect data on values-of-time of individuals and data on land use to compose the accessibility proxy generalized costs of travel regarding activity possibilities.

The results of relating different proxies of accessibility to trip frequency are presented by diagrams, curve fit analyses, box plots, descriptive statistics and histograms. In the diagrams relating accessibility to trip frequency, often no clear pattern is seen, especially after erasing the outlier values. The goodness-of-fit values (R^2) are low when linear, logarithmic and exponential relationships are estimated, although most of the times the b-values in the regression curves are according to the expectation with an inclining function for the relationship between accessibility and trip frequency. The histograms give useful information on the used variables and how they relate to each other. It is found that people with a higher income have higher travel times to work, whereas their trip frequency is the same as for people with a lower income.

Next to this, the total time spent travelling is analysed per individual. It can be observed that the travel time budget is not constant. The results for relating travel time to work and extra time travelled indicate an inclining function. This implies that a higher travel time to work leads to an increasing amount of extra time travelled. This is remarkable as it was expected that a lower accessibility level leads to less travel.

An analysis of variances is made to test the hypothesis statistically that for groups of data classified by a certain variable, the mean value for another variable is equal for the groups. If the hypothesis is rejected, it means the variance between groups is larger than the variance within groups. This gives an indication of the appropriateness of using a certain socio-economic classification variable in this study. The analysis of variance indicates that the two, supposedly independent, variables (accessibility and socio-economic characteristics) depend much more on each other than the assumed dependent variable (trip frequency) depends on these two variables. This correlation is caused by the fact that most people reported they only made 2 (mandatory) trips during the day of measurement for the MMUTIS.

Small geographic areas are selected to see if the results are clearer than for analysing the entire study area. For the Makati municipality as well as the Taguig municipality (two extremes in the dependent variables) the results are rather similar to the results found for the entire study area.

As it appeared difficult to estimate the relationship between accessibility and trip frequency for the MMUTIS database because of the almost constant trip frequency rate, another survey database is studied to see whether the results are different. The Dutch OVG survey is chosen because people in a developed country are expected to have a wider range of trip frequencies. Although this wider range of trip frequencies is indeed found for the selected Twente study area, the results presented in diagrams, curve fit analyses, box plots, descriptive statistics and histograms are rather similar to the results found for Metro Manila.

For Metro Manila, the surprising result that most people make 2 trips during a day is verified by interviewing (former) residents of the study area. It appeared their travel pattern is such that it is easy to underreport some trips. Small walking trips and trips that result from trip chaining are probably not always seen as trips by the MMUTIS respondents. This is caused amongst others by the fact that the MMUTIS study did not give a clear definition of a trip. For the OVG study it was stated more clearly.

Looking at similar empirical work it is seen that most of the studies used the frequency of non-mandatory trips related to accessibility measures. Not many of these trips are reported for the MMUTIS database. This indicates the MMUTIS is probably less suitable for the purpose of the used research methodology. However, although in the OVG Twente area these non-mandatory trips are found, the results for relating accessibility and trip frequency are rather similar to the results found for Metro Manila. This implies the results are not influenced by the choice for a certain study area. The research methodology is probably more decisive.

For both study areas, the research hypothesis, where a higher level of accessibility is expected to lead to a greater amount of trips performed, is rejected. The findings of no clear pattern in the results and contradiction to the research hypothesis are caused by correlation between accessibility and socio-economic variables.

Travel behaviour is a very complex phenomenon and depends on many different factors. The research methodology attempts to explain certain travel behaviour by certain variables but probably other variables play an important role too. The different perceptions of utility by individuals, life stage of individuals and geographical composition of cities amongst others influence travel behaviour next to the accessibility, socio-economic and trip frequency variables. For the chosen research methodology the existence of induced travel is not found. Therefore a cross-sectional database should be reconsidered for the purpose of this type of research. Although this database type has been chosen because of the major advantage that the exogenous factors influencing trip frequency can be kept constant, a longitudinal database is able to recognize the influence in time of the studied factors. This might produce better results, although it is far more complex.