The effect of household size and structure on travel/activity patterns: 
Exploration of household travel time budget

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Abstract
There have been number of studies that investigated the individual travel time budget. Most of these studies came to a conclusion that, on average, individual would spend about 1-1.5 hours per day for travelling (Robinson & Converse, 1972; Zahavi & Talvitie, 1980; Newman & Kenworthy, 1999; Schafer & Victor, 2000). However, although sharing household responsibilities among household members has become a common practice in modern societies, the role of the household structure and the intra-household interactions between household members in generating (or reducing) travel time of individuals and households is largely unknown.

Recently, more attention is given to the study of social-psychological aspects of travel behaviour, such as social interaction between household members, and pro-social orientation of household members, have a strong effect on their travel patterns (Bhat & Pendyala, 2005; Timmermans, 2006). Sharing household responsibilities among household members has become a common practice in western societies. For example, many dual-earner households share their household-obligation trips, such as drop-off and pick-up children, with other household members.

Much of the findings on time allocation, reported in the travel behaviour literature, can be generally explained by social exchange theory. Social exchange theory explains social change and stability as a process of negotiated exchanges between parties, where all relationships have give and take (although the balance of this exchange is not always equal). It states that social behaviour can be seen as an exchange of goods (material or non-material) in a process of influence that tends to work out at equilibrium to a balance in the exchanges (Homans, 1958). In the context of travel time use it can be argued that patterns of time allocation of household members are the outcome of a process in which they try to maximize utilities or minimise costs, based on the available resources of the household. This argument is supported by recent works that explored activity time allocation of the male household head and the female household head (Chang et al., 2005; Cao & Chai, 2007).

Social exchange theory roots are in economic theory that studies how people make choices about how to best use their scarce resources. In this work, social exchange theory is revisited and the concept of (dis)economies of scale is incorporated in its application to travel budgets. It is argued that one of the limited resources the household is faced with is the aggregated time budget of its members. A new concept is introduced in this work: the household travel time budget (HHTTB). While all members of the household can be regarded as travel 'consumers', regardless of their age, the main 'producers' of travel are typically the adult members of the household, who commonly have a driving licence, own a car or have access to one. It is specifically hypothesized, that due to economies of scale, it is likely that a household as an entity will be able to use its overall travel time budget in a more efficient way as the number of household members who 'consume' travel increases. This can be expected due to the similarity of activity and travel patterns some of the 'consumers' in the same household might have - typically siblings who are close by age. On the other hand, when the number of travel 'producers' increases, it is not guaranteed that the travel costs in the household will be reduced. We might see internal arrangements made between household members to reduce the costs, but on the other hand, the social activities couples have might be larger by size and complexity than the activities held by single
adults. Moreover, travel time of couples might be larger than travel time of singles not only as a result of the increased demand for social activities, but as the result of inefficient use of their time budgets, where activity and travel time are shared even if not 'necessary' (or 'diseconomies of scale'). It is therefore important to distinguish between household not only by their size (number of members) but also by their structures (number of adults and number of children).

Using the 2004 UK National Travel Survey, the daily use of travel time was analysed in the household level and the individual level. Household size and structure were used as variables to explain the amount of travel time, trips and travel distance done by household members.

It was observed that the proportion between the household size and the amount of travel time among household member is not a fixed one. The marginal increase in the household's travel time budget decreases with the number of children. This may be explained by 'economies of scale' due to the increased number of activity and travel 'consumers' in the household.

It was also observed that the average travel time of individuals in households headed by two adults is larger than the average travel time of individuals in households headed by one adult - a findings that can be explained by 'diseconomies of scale' due to the increased number of 'producers' in the household. Revisiting the hypothesis of fixed travel time budgets, and following the empirical evidence described in this work, it is therefore argued that although it is not completely rejected, a better explanation of travel patterns is provided by HHTTB.

Realizing that we live in a period of rapid and significant economic and social change, its effect on household travel/activity patterns and social interactions among household members cannot be ignored. Analysing travellers' HHTTB could provide informed behavioural insights about future travel patterns of individuals and households. Obvious applications are in residential location, car ownership, and various travel demand analyses. We identify the potential for utilizing the HHTTB concept to plan and design more efficient and more sustainable communities, and conclude with suggestions for further research.