LUTDMM: an operational prototype of a microsimulation travel demand system

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1   Introduction

The activity-based approach as the second generation of travel demand forecasting models attracted attention in the 1970s, resulting from the fundamental changes in urban, environmental and energy policy. This approach is based on the notion that travel is a derived demand from the need to pursue activities that are scattered in time and space, and focuses on the analysis of the individual's travel behaviour which results from his/her participation in a sequence of activities and is possibly influenced by interactions with other people, such as fellow members of a household. The advantages of an activity-based modelling approach for analysing complex travel behaviour and forecasting travel demand have been stated by many researchers (e.g. Goulias, 1997; Kitamura, 1997; Pas, 1997). The primary objective in the development of activity-based models is to gain a fundamental understanding of travel behaviour. Consequently, the activity-based model has the ability to be able to answer different questions, in particular offering the potential for effective and practical tools for conducting policy analysis.

In general, there are two main approaches - the econometric model system and the microsimulation model system - in the application of activity-based models. Extensive literature on econometric modelling (e.g. Ben-Akiva *et al*, 1996; Golob, 1998; Mannering et al, 1994; Hensher and Johnson, 1981; Louviere, Hensher and Swait, 2000) has appeared for some time, although the intense data needs of these models may have restricted their widespread use. These models are normally based on random utility theory to analyse and predict individual choice behaviour. Microsimulation models have also been postulated for some time, but are only now becoming feasible with the advent of readily available high capacity computers (Kitamura et al, 2000; Nagel and Axhausen, 2001). Miller (1997) and Miller and Salvini (2001) have discussed the reasons for and merits of adopting a microsimulation approach for travel demand forecasting.

This paper describes the development of an operational prototype of a microsimulation model of household travel, responsive to alternative transport networks, land use patterns and densities, and socio-economic characteristics of individuals, with the focus on a detailed discussion on the key sub-model of an 'Activity Travel Simulator'. The model is being tailored for use in multimodal urban transport corridors, with the study area focusing on the north-west metropolitan corridor of Adelaide in South Australia. The primary objective of the model is to be able to provide estimates of the likely usage of different travel modes, with an emphasis on including features that can determine the likelihood of people using public transport and non-motorised modes, in particular where the incorporation of alternative land use patterns supportive of such modes is envisaged. A small example of an application is given to demonstrate the capability and flexibility of the model.

The model system is being implemented in the object-oriented software design paradigm. Four sub-models – socio-demographic, synthetic population generator, activity-travel simulator, and network – are formulated into the model system. All of the sub-models are loosely connected with each other and can be used independently. The activity-travel simulator, which is the key component of the model system, generates activity-travel patterns and forecasts travel demand, as well as scheduling activity and travel demonstrated

by individuals and households in time and space. The activity-travel simulator is based on the concept of decomposition of a daily activity-travel pattern into segments to which certain aspects of observed activity-travel behaviour are matched. The activity-travel pattern can be deconstructed into various segments, in terms of activity type, activity duration, activity location, and mode choice and transition. The activity-travel simulator assigns a 24-hour activity-travel pattern for each member of a household by using a set of representative activity-travel patterns. The representative activity-travel patterns are derived from the observed activity-travel behaviour of the individual and household, and are categorised into different groups according to the socio-demographic characteristics of the household. Monte Carlo simulation is employed to generate the daily travel patterns. In addition to the activity-travel simulator, another major component of the microsimulation model system is the synthetic population generator. The basic platform for the approach is a GIS model of the corridor, which includes dwelling types and locations, land uses, road network and public transport network. The generated synthetic households have their associated dwelling and similar socio-demographic characteristics in the study area. Again, Monte Carlo simulation is used for this approach. The detailed introduction and discussion to the synthetic population generator can be found in Xu and Taylor (2004).

2 LUTDMM development

Proper consideration of both short and longer term traveller behaviour requires integrated models that reflect a number of choices by individuals and households, including household location, vehicle ownership, destination, mode and route choice. An integrated activity-based Land Use, Travel Demand Microsimulaton Model (LUTDMM) system is a desirable model system to describe these variables. The fundamental aspect of the model system is that it is an object-oriented paradigm (OOP), developed within the model system, which provides a user-friendly interface for modellers. A Geographic Information System (GIS) is incorporated into the model system and is used as a platform to manipulate all spatial elements without zonal aggregation. It allows for the joint layering of a study area's land uses, transportation, vacant land, household locations and household activity patterns. It can predict people's responses to their travel behaviour by applying different transport and land use policies. To date, the model has been designed to forecast the participation of households in activities/travel on a typical weekday in a study area, and it is planned to further develop the model to forecast travel demand on several continuing days.

2.1 The model structure

Figure 1 shows the general structure of the model system. Four sub-models are included in the model system: *socio-demographic* model, *synthetic population* generator, *activity-travel simulator* and *network* model. In our earlier work (Taylor *et al*, 2002) a separate land use sub-model was included in the model system. The current version of the model uses the land use data as an exogenous input only. The future incorporation of land use data is available in the form of alternative scenarios for the study area, provided by the South Australian state planning agency, Planning SA. All these sub-models are loosely connected with each other and can be used independently. The functions of the sub-models are:

- the *socio-demographic model* forecasts the evolution of individuals and households over time from an assumed base year
- the *synthetic population generator* creates a synthetic population as an input representative population for the activity-travel simulator to predict travel demand in a specific study area
- the *activity-travel simulator* generates activity-travel patterns and forecasts travel demand, as well as scheduling activity and travel demonstrated by individuals and households in time and space, and

- the *network model* estimates travel movements (including public transport) in corridor networks
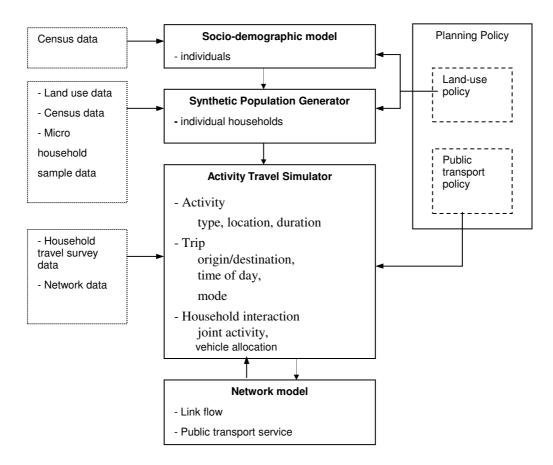

Figure 1   General structure of the microsimulation model system

2.2   The model process

The basic process of the model system is to forecast travel demand within a study area using a base year population. The steps required are as follows:

- Step 1: generate a synthetic population for a study area; the census data, census household sample data and current land use data are input into the synthetic population generator
- Step 2: input the synthetic population data, together with the household travel survey data and road network data into the activity travel simulator to forecast a schedule of activities and travel for each member of a household within the whole synthetic population and thus to obtain a forecast travel demand pattern, and
- Step 3: incorporate the travel demand data into the network model to estimate the link flow and public transport service requirements

The impacts of changes in planning policies can then be tested by using the model to examine resulting changes in travel behaviour. A change in land use patterns can be included directly into the model, as described in step 1, while travel behaviour affected by any changes in public transport policy would be part of the process outlined in step 2.

2.3   The software package and the parent interface

Based on established theoretical foundations of travel behaviour and travel demand, as well as modelling techniques, the LUTDMM was developed in a PC based software package which provides the user with an effective and practical tool for analysing travel behaviour in the most detailed level. The LUTDMM in its computer software configuration has the ability to accept descriptive data concerning traveller, land use and road network characteristics belonging to a study area. Delphi (version five) computer software was selected as a programming platform for the model development that was well suited to the defined task. The size of the analysis region for LUTDMM modelling is only limited by the memory capacity of the computer in which the LUTDMM is installed. There is no limit set on the number of zones of a study region.

The LUTDMM user interfaces allow the user to carry out various tasks in an easy way. Within these interfaces, the user can specify a certain task to be carried out, and can assess the operation and view a variety of critical outcomes during the modelling process. The interface of the main control window of LUTDMM was designed as a parent interface, which can be brought up with a mouse click on the LUTDMM icon. It is the essential interface that guides the user with the operation of the program sub-models, and it also allows the user to display multiple windows at the same time. The parent interface is illustrated in Figure 2.

Figure 2   The LUTDMM parent interface

3   Data requirement

A number of data sets are required for implementation of the model for the study area. These are:

- 1996 Census data
- 1996 Census Sample File data
- 1999 Metropolitan Adelaide Household Travel Survey data (99MAHTS)
- Digital Cadastral Database

- land use scenario data
- Adelaide Road Network data
- Traffic Analysis Zone data
- Traffic flow data

The ABS 1996 census data is a complete data set, incorporating information on a wide range of socio-demographic characteristics and a variety of geographical areas. Aggregated socio-demographic information is required for generating the synthetic population, as well as providing a base year population from which to forecast future population, based on death, birth and migration rates. The geographic data available from the census were used to derive the boundaries of the study area, as well as for use as background layers on maps. They can also be edited or updated according to the needs of the study.

The 1996 ABS census household sample file data for the Adelaide Statistical Division, a disaggregated data set containing information on the socio-demographic characteristics of households, consists of a one per cent sample of private dwellings from the Census, with their associated family and person records, and a one per cent sample of persons from all non-private dwellings of the Census, together with a record for the non-private dwellings. This one per cent sample data for the ASD is the most detailed household data available from the ABS. The procedure of creating the synthetic population that was developed for this study requires basic sample households as input data for the model. Therefore, this is the most important data set necessary for obtaining characteristics of households (with their members) in order to formulate sample data for the creation of the synthetic population for a study area.

The 99MAHTS data is the latest available travel survey data for Adelaide, comprising 5886 households, with 14 004 person records containing all person travel activities and information, and the associated personal information. After an initial data check, households with complete person records missing (one or more than one family member) were eliminated. Using inference methods, some missing or incorrect data in the person records was successfully repaired. A total number of 5415 households remained in the data set after further missing data repairing procedures were carried out using imputation methods to obtain approximately 20 per cent of the income data which were missing (see Xu *et al* (2002)). In the 99MAHTS data set, 858 of the households are part of the study area. As the activity travel simulator is currently only used for simulating the activity-travel of households occurring in a typical weekday day, the activity-travel records in weekends and public holidays were removed into another file. According to the household types categorised in the census data and census household sample file data, the households were grouped into small classes, and representative activities/travel patterns were then generated by the number of persons and number of cars in each small group.

Zones are necessary and important elements in a microsimulation model's spatial data management system (Miller and Salvini, 2001). One main reason is that input data, such as individual households, firms and activity places are all easily accessible at the zone level. The second reason is that the output results can be more easily explained at the zone level and displayed within a GIS system. In this study, two basic zones, the traffic analysis zone (TAZ) and census collection district (CCD), are required for the analysis of travel behaviour. The TAZ zones are used to identify trip origins and destinations and the CCD zones are used to recognise the zones where households reside.

Lastly, the digital cadastral data base (DCBD) comprises legal land parcels, their identification, the geographic position of their boundaries relative to the national map grid and the dwelling count in that parcel. Each household whose travel behaviour is analysed in the model can be identified with its dwelling location in the dwellings table that is produced based on the DCBD. However, as each dwelling in the dwellings table was only allocated to a CCD and not a TAZ, data processing was required to link each dwelling to its TAZ. The

CCD data, along with the dwelling table, were processed in the ArcView GIS package for each dwelling to obtain its associated TAZ.

4   Activity Travel Simulator

The activity travel simulator is an activity-based microsimulation of daily household activity and travel over time and space. It may be seen as an analytical tool for policy makers to assist their planning policy decision-making. Travel behaviour can be best understood by such a model through exploring the decisions made in engaging in optional activities, the allocation of flexible times to activities, the choice of location for activities to be participated in and the interaction between household members in undertaking their activities and travel, as well as the decision to trade off in-home and out-of-home activities. The model procedure is based on the notion of decomposition of a daily activity-travel pattern into segments to which certain aspects of observed activity-travel behaviour are matched. Key features of the simulator are as follows:

- the simulator schedules each member of the household's daily activities and travel within a study area, with a consideration of the possible interactions between the members of a household in the choice of their activity, duration and mode. Trip chains are also modelled at the same time
- it supports decision-making with issues of public transport provision and level of service. For example, it can simulate changes of travel behaviour when a policy scenario is applied
- the output of the model is flexible with respect to the level of aggregation or disaggregation. The output can be a selected socio-demographic group, a selected CCD or a whole study area. The output result includes the type of activity, trip frequencies by purpose by mode, trips frequencies by purpose by time of day, household trip rates, etc.

As the household is used as a primary entity in the analysis of travel behaviour within the context of this study, several elements that could influence household members' participation in activities and travel have been taken into account in modelling the activities/travel patterns. These elements include the resources that may be shared by household members (for example, income, vehicle), constraints and conditions that may be imposed on other household members in participating in activities and travel, as well as modal choice. The constraints include coupling constraints, spatial-temporal constraints, modal constraints and activity constraints. For example, usually a full time worker would only participate in a social recreation activity after an 'eight-hour' work activity or during the lunch time period of work. Alternatively, a parent may have a trip chain involving dropping off a child at school on the way to work, and that child then has a travel mode as a car passenger. Monte Carlo simulation is employed in the travel-activity simulator. The flow chart in Figure 3 shows the modelling procedure, which involves the following steps:

- Step 1: the simulator reads the socio-demographic information of each household from the input data of a synthetic population to recognise the family type
- Step 2: according to the family type, the simulator looks for a suitable representative activity-travel pattern in the processed 99MAHTS database, and schedules a 24 hour activity-travel pattern to a member of the household. This process usually starts with one of the parents, if it is an adult couple family household or a single parent family household, until all the members receive a daily activity-travel pattern, including trip chains
- Step 3: the simulator then checks each person's activity-travel pattern, including the spatial continuity of trips, the consistency of trip starting and ending times, the travel time against the network travel time, and the availability of vehicles in the household

against the mode being used
- Step 4: the simulator then corrects or supplements data if required
- Step 5: if a public transport policy scenario is not being considered, the simulator calculates the statistical output
- Step 6: if a public transport policy scenario is being considered, the simulator reschedules activity-travel patterns for each individual within the whole synthetic population, and Steps 3 to 5 are then repeated

The mode choice decision results from the simulator are based on rules and observed data. In addition, a nested logit modal choice model has been incorporated into the model system as an alternative procedure for mode choice simulation. This is useful in the study of the possible impacts of alternative transport policies on modal choice.
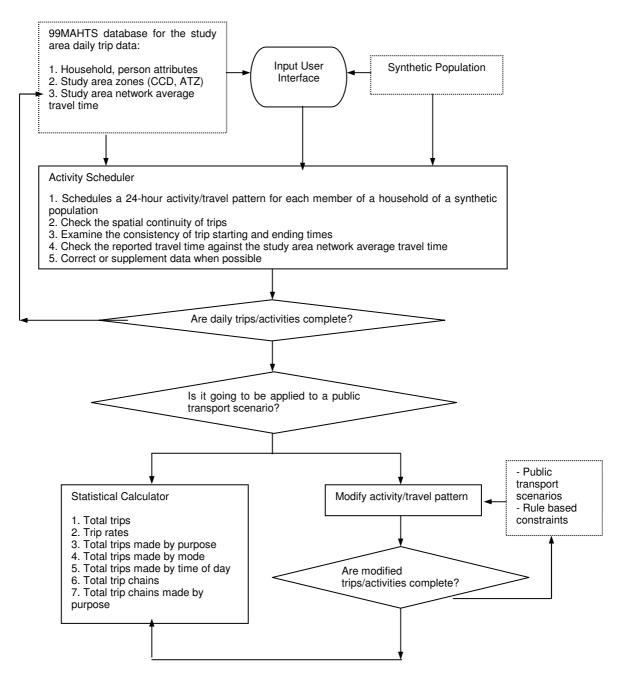
Figure 3   Flow chart of the modelling process in the travel activity simulator

4.1 Testing the activity travel simulator

Tests of the activity travel simulator have been conducted on the basis of its ability to reproduce the travel parameters available from the 99MAHTS database for the study area, noting that the 99MAHTS data are themselves only a sample of the population. Comparisons have been made using the main attributes of travel, in terms of trip rates, trip purpose, modal choice, departure times and trip chaining behaviour. Table 1 provides a comparison of trip rates for some socio-demographic groups and the full study area. Note that in this study a trip is defined as a movement between an origin and a destination where the individual involved then partakes in an activity at the destination. A stop involving a change of mode, drop off/pick up of someone and the accompaniment of someone is not regarded as a single trip, but rather as a trip chain. The sample households are synthetic households from the synthetic population generator for the study area. The simulated data in Table 1 shows the mean values obtained from four sample runs of the model. This allows confidence intervals to be estimated for each trip rate. Note that sample size for 99MAHTS data is the number of households in that database residing in the study area, whereas the sample size for the simulated data is the total number of synthetic households generated as residing in the study area for the five household types (adult couple family with children aged 0-14 years, adult couple family with children (including all children), adult couple only, adult single parent with children and person living alone). The 1996 ABS census found 58 562 households residing in the area by these household types.

Table: 1: Comparison of observed and simulated trip rates

	CF with C0-14		CF with children		Couple only	
	99MAHTS	Simulated	99MAHTS	Simulated	99MAHTS	Simulated
Sample size	158	8779	413	17 691	353	15 566
Persons/hhld	3.85	3.97	3.92	3.91	2	2
Trips/hhld/day	13.38	13.55	11.11	13.29	6.11	6.13
Trips/person/day	3.48	3.41	2.84	3.40	3.06	3.06

	SP with children		Person living alone		Whole study area	
	99MAHTS	Simulated	99MAHTS	Simulated	99MAHTS	Simulated
Sample size	97	7128	321	18 177	1184	58 562
Persons/hhld	2.69	2.65	1	1	2.40	2.39
Trips/hhld/day	8.39	7.91	2.78	2.79	8.10	7.53
Trips/person/day	3.12	2.98	2.78	2.79	2.95	3.06

Note: CF with C0-14 = adult couple family with children aged 0-14 years, CF with children = adult couple family with children (in, SP with children = adult single parent with children

By way of further illustration of the activity travel simulator, Figure 4 and Figure 5 show a comparison of trip purposes and mode choice between the 99MAHTS data and the simulated trips respectively. In these cases, the trips/modes are those made/used by couple family with children 0-14 years old, couple family with children (including all children) and couple only households. Similar plots are available for other household types and for trip timing and trip chaining behaviour. These results suggest that the activity travel simulator can reproduce observed travel behaviour in the corridor.
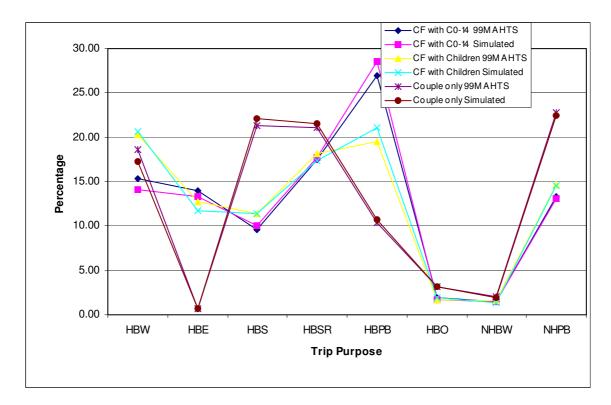
Figure 4   Comparison of trip purposes for couple family with children 0-14 years old, couple family with children (one or more over 14 years old) and couple only households
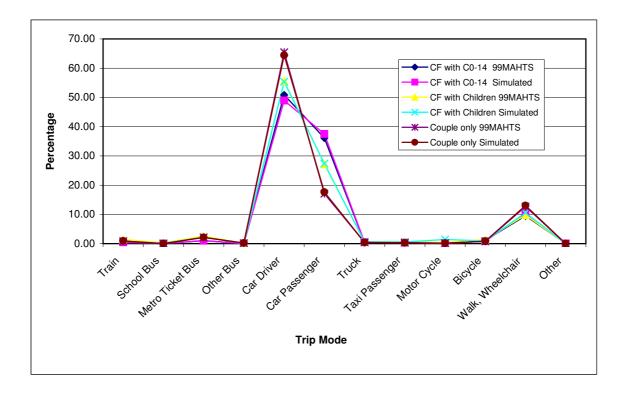

Figure 5   Comparison of trip modes for couple family with children 0-14 years old, couple family with children and couple only households

A summary of trip chaining from the activity simulator and its comparison with the 99MAHTS data for the study region is given in Table 2, which shows the percentages of trip chains having a given number of stops.

Table 2: Comparison of trip chains by number of stops (percentages) in the study area

No of stops	1-stop	2-stop	3-stop	4-stop	5-stop	6-stop	7-stop
99MAHTS	62.01	30.04	4.69	2.51	0.25	0.25	0.25
Simulated	63.61	28.99	5.21	1.69	0.20	0.07	0.23

5   Example of application

As an example application of the model, it was applied to a test scenario concerning a proposed land use development of a small area in the northern part of the study area, comprising the ten Census Collector District (CCD) zones shown in Figure 6. A total of 549 new dwelling would result from the redevelopment. The plan is for these to be detached houses with at least three bedrooms each, thus suitable for adult couple families with or without children. Under current housing market conditions, the price for purchasing one of these houses with associated land will be more than $364,000. This suggests that households who have a weekly income of less than $700 will generally not be able to afford such a house. Based on this assumption, households with a weekly income of less than $700 are also not considered for these dwellings
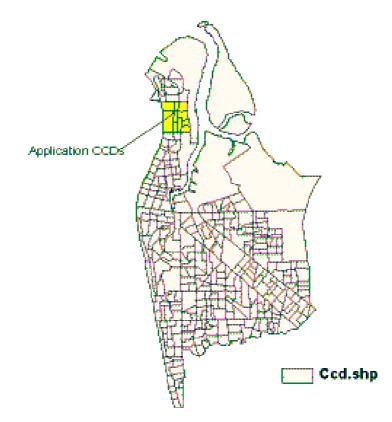

Figure 6   Example application of the model – CCDs for residential redevelopment

Table 3 shows summary trip generation results for the redeveloped area with synthetic households residing in the new dwellings. This table compares the existing base case with the future redevelopment scenario.

Table 3   Trip rates for existing base case and future redevelopment scenario for the ten CCDs shown in Figure 6.

	Sample size	Persons/hhld	Trips/hhld/day	Trips/person/day
Existing base case	1957	2.44	7.60	3.11
Future redevelopment scenario	2506	2.62	8.43	3.22

The average number of persons per household in the base case is nearly the same as in the results from the study area in Table 1, though slightly higher in the scenario. This result is expected as households comprising persons living alone – 31.03 per cent of the current population - are not assigned to the proposed new dwellings. The trip rates are slightly higher in the scenario households and this can be explained on the same basis, since households comprising persons living alone usually make fewer trips than other socio-demographic groups.

The outcomes of travel and trip characteristics, in terms of the percentage of total trips by purposes, percentage of total trips by modes, trips by purposes by modes, and percentage of trip chains by purposes for both the base case and scenario are displayed from Table 4 to Table 7. The results of the percentage of total trips by departure time indicate that there is not much difference in trip departures by different time periods between the two cases.

Table 4   Percentage of total trips by trip purposes

Trip Purpose	Base Case (%)	Scenario (%)
Home based work	15.30	19.49
Home based education	8.41	8.53
Home based shopping	14.46	13.68
Home based social recreation	21.79	20.22
Home based personal business	17.40	16.53
Home based other	2.51	2.38
Non-home based work	1.31	1.40
Non-home based personal business	18.83	17.79
Total	100	100

It is not surprising to find that the scenario households would make slightly more work and education trips than the base case households (4.19 per cent more home-based work trips, 0.09 per cent more non-work-base work trips and 0.12 per cent more education trips). This result matches up with the assumptions for the scenario. The household weekly income being equal to or more than $700 for the new households indicates that more workers would be in the households in these new dwellings, and the larger houses in the new development suggest that the percentage of adult couple family with children households would be increased in the area.

Table 5   Percentage of trips by trip modes

Trip Mode	Base Case (%)	Scenario (%)
Train	0.89	0.76
School Bus	0.13	0.15
Metro Ticket Bus	2.76	2.48
Other Bus	0.24	0.17
Car Driver	55.75	57.26
Car Passenger	25.39	24.61
Truck	0.35	0.53
Taxi Passenger	1.10	0.93
Motor Cycle	0.86	1.15
Bicycle	1.25	1.21
Walk, Wheelchair	11.17	10.71
Other	0.11	0.05
Total	100	100

Car driver and car passenger are the dominant modes for journeys. The results from Table 5 suggest that the new households are households likely to make more use of car modes and less use of walking and public transport without changes to the public transport service.

Table 6 gives additional detail with the modes used for different trip purposes. The scenario households use the car driver mode slightly more than the base case households for journeys for home-base education, home-based shopping, home-based personal business, home-based other and non-home-based business (0.71, 3.1, 1.33, 1.08 and 4.01 per cent respectively), but slightly less for trips for home-based work, home-based social and recreation and non-home-based personal business (0.51, 0.22 and 0.06 per cent respectively). The car passenger mode is the favoured mode for home-based work, home-based education and home-based other by the scenario households (0.75, 1.41 and 0.4 per cent higher respectively) when compared to the base case households.

The scenario households use less public transport modes than the base case households for all trip purposes except for home-based social recreation (0.83 per cent more using bus mode), but use more of the motorcycle mode for all journey purposes except for the home-based personal trip,. Walk mode is used by the scenario households slightly more than by the base case households for home-based work and non-home based personal business by 1.05 and 0.35 per cent respectively, but the walk mode is used less by the scenario households for all other travel purpose when compared to the base case households.

The scenario households make more one-stop trip chains, but less three-stop trip chains than the base case households. Base case households make 2.1 per cent more stops in trip chains for the purpose of changing mode of travel/vehicle, but 1.87 per cent fewer stops in trip chains for the purpose of dropping off/picking up someone, when compared with the scenario households (Table 7). This indicates that the change of social demographic markets would bring in a change of activity and travel behaviour in the area, as the percentage of adult couple family households increases (these types of households make more one-stop trip chains and more stops for the purpose of dropping-off/picking up someone) and the percentage of person living alone households decreases (these households make more three-stop chains and more stops for the purpose of changing mode of travel/vehicle) in the scenario.

Table 6 **Trip modes for each purpose between base case and the scenario**
(percentage)

Trip Mode	HBW		HBE		HBS		HBSR	
	Base Case	Scenario	Base Case	Scenario	Base Case	Scenario	Base Case	Scenario
Train	1.54	1.41	3.2	2.66	1.12	0.45	0.22	0.19
School Bus	0.00	0.00	0.16	0.17	0.00	0.00	0.06	0.05
Metro Ticket Bus	3.61	3.28	7.44	6.10	4.42	3.15	1.33	2.15
Other Bus	0.00	0.00	0.00	0.00	0.28	0.45	0.49	0.28
Car Driver	77.66	77.15	8.00	8.71	63.61	66.71	48.84	48.62
Car Passenger	7.17	7.92	53.92	55.33	16.29	15.64	32.32	32.26
Truck	0.79	1.00	0.00	0.00	0.00	0.00	0.00	0.19
Taxi Passenger	1.19	0.75	1.28	1.00	2.19	1.42	0.09	0.02
Motor Cycle	2.29	2.38	3.36	4.66	0.65	1.18	0.00	0.00
Bicycle	1.76	1.07	3.60	2.77	1.30	1.52	1.85	2.20
Walk, Wheelchair	4.00	5.05	19.04	18.59	10.14	9.48	14.79	14.04
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100	100	100	100	100	100	100	100

Trip Mode	HBPB		HBO		NHBW		NHBPB	
	Base Case	Scenario	Base Case	Scenario	Base Case	Scenario	Base Case	Scenario
Train	0	0	2.68	1.99	2.58	1.69	0.43	0.48
School Bus	0	0	0.00	0.00	0.00	0.00	0.57	0.69
Metro Ticket Bus	1.39	0.95	1.07	0.60	0.00	0.00	2.04	1.57
Other Bus	0	0	0.00	0.00	0.00	0.00	0.46	0.29
Car Driver	53.36	54.70	55.50	56.57	79.38	83.39	61.81	61.75
Car Passenger	34.69	34.11	27.88	28.29	2.06	1.36	19.11	18.91
Truck	0.04	0	0.00	0.00	7.73	9.15	0.64	0.98
Taxi Passenger	1.24	1.37	6.43	8.37	0.00	0.00	0.50	0.43
Motor Cycle	0.46	0.11	0.00	0.00	0.00	0.00	0.29	0.59
Bicycle	0.08	0.29	0.00	0.00	0.00	0.00	0.39	0.35
Walk, Wheelchair	8.74	8.48	4.83	3.59	4.12	2.71	13.68	13.91
Other	0	0	1.61	0.60	4.12	1.69	0.07	0.05
Total	100	100	100	100	100	100	100	100

Table 7 **Trip chains made by purposes between base case and the scenario**
(percentage)

Change mode of travel/vehicle	54.55	52.45
Dropped-off/picked-up someone	21.05	22.92
Accompanied someone	24.40	24.63
Total	100	100

6 Conclusion and further development

This paper describes the development of a comprehensive microsimulation model for studying household activity and travel behaviour based on the notion that travel is derived from participation in activities. The data used, along with the processing procedures are discussed and demonstrated. One of the main components of the model, the activity-travel simulator, is explained in detail. The results from the model testing indicated that the simulator is fairly accurate in replicating the observed activity travel behaviour in general. Ideally, an independent data source from survey data is desired for validation. However, with independent data sources unavailable, the intuitive verification indicates that modelling procedures operate as anticipated. For the practical use of the model, the validation of the activity travel simulator is important and the exploration of a suitable method would be a major challenge in future research.

The model is designed to assist policy makers with their planning policy decisions, enabling activity and travel patterns to be modified when different transport or land use scenarios are applied to a region. The results from the application of the model clearly showed that change of land-use pattern would have an impact on activity and travel patterns in an area, which again confirms the reliability of the model, and shows its power and flexibility. Users could choose alternative scenarios with, for example, different housing types and therefore different demographic markets for residents, and test the outcomes. Here is part of the potential power and versatility of LUTDMM.

Further development and testing of the integrated model and its sub-model components continues. Current research activities contributing to the development of the model system include:

- development of the full functionality of the activity travel simulator.
- collection of stated preference survey data with the particular purpose of investigating travel behaviour changes related to public transport policy options. This will enable the development of the nested logit modal choice model, with the application of public transport policy scenarios to estimate and analyse the possible changes in travel behaviour within the activity travel simulator.
- completion of the transport network model
- testing of the transport impacts of different land use scenarios, and
- further research on the development of the model to extend the HIS data sets and to model the impacts of VTBC programs.

7 Acknowledgements

8 References

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