Department for Transport

Motorcycles and Congestion: The Effect of Modal Shift

Phase 3 - Policy Testing

WSP Civils
66-68 Hills Road
Cambridge
CB2 1LA
Tel: +44 (0)1223 558050
Fax: +44 (0)1223 558051
http://www.wspgroup.com

Policy & Research

Department for Transport

Motorcycles and Congestion: The Effect of Modal Shift

Phase 3 - Policy Testing

Issue/revision	Issue 1	Revision 1	Revision 2	Revision 3
Remarks	Draft	Final Draft	Final	
Date	27 May 2004	7 July 2004	August 2004	
Prepared by	Clare Lindsay	Clare Lindsay	Clare Lindsay	
Signature			***C L F Lindsay***	
Checked by	Ian Williams		Ian Williams	
Signature			***I N Williams***	
Authorised by	Clare Lindsay	Clare Lindsay	Clare Lindsay	
Signature			***C L F Lindsay***	
Project number	10551164	10551164	10551164	
File reference	orignls\Phase3 \PolicyTest_v1.doc	Orignls\Phase3\ Policytest_v2.doc	Orignls\Phase3\ Policytest.doc	

MOTORCYCLES AND CONGESTION: THE EFFECT OF MODAL SHIFT

Phase 3 - Policy Testing

CONTENTS **PAGE**

List of Tables

List of Figures

MOTORCYCLES AND CONGESTION: THE EFFECT OF MODAL SHIFT

Phase 3 - Policy Testing

EXECUTIVE SUMMARY

In May 1999 an Advisory Group on Motorcycling was set up by the Government after the White Paper "A New Deal for Transport" recognised that motorcycling had the potential to act as a viable alternative to car travel in certain circumstances. The Advisory Group had three primary terms of reference:

- To look at the safety record of motorcyclists and agree measures that would improve safety
- To look at the environment impact of motorcycles and if necessary agree measures to be taken
- To look at the role of motorcycles in integrated transport policy and to assess the scope for further enhancing their benefits through traffic management.

This study builds on earlier research carried out for the Department for Transport on the potential for increasing motorcycle use and reducing congestion and follows on from the study "Motorcycling and Congestion" completed by Halcrow. The first phases of this study collected data and developed improved methods to quantify the extent of motorcycle ownership and the propensity to transfer mode. The ownership and usage models developed during the earlier phases of the study were then incorporated into two test transport models for London and the South East Region (LASER) and the Cambridge Sub Region (MENCAM). Trips by motorcycle owners and non-owners were differentiated and the use of the motorcycle as a mode of travel considered.

This phase of work reports on model runs using the modified transport models. As in the survey, the Cambridge model shows that motorcycle owners are less likely to use bus than other travellers, although other modes (walking, cycling and rail) retain a significant mode share. From the model, motorcycle owners tend to travel slightly more quickly and spend slightly less per kilometre travelled than others. The differences are however small.

The pattern of motorcycle trip origins and destinations in the AM peak period is not so different from that for cars. It has a dispersed pattern of origins from home and a more concentrated pattern of destinations. The most noticeable difference is that a greater proportion of motorcycle trips is contained wholly within urban areas.

A range of potential model runs were considered including the effects of:

- Trip end related policies affecting the end (normally the destination) of the journey – eg parking costs / times, security and capacity;
- Road / Route relate policies affecting particular links in the network and thus the journey time / choice of route etc – eg Congestion charging, bus lanes, cycle lanes, advanced stop lines;
- Ownership related – different ownership patterns or levels and how these impact on travel;
- Other issues which can be investigated through sensitivity testing - eg weather.

Five tests were selected and carried out using the Cambridge model as follows:

1. Permitting motorcycles to use the limited number of bus lanes on the radial routes approaching Cambridge

2. Increasing the cost of car parking by 50% for the motorcycle owners – these have the opportunity to consider motorcycle or other modes as an alternative

3. Introducing a global road user charge of 10p per mile (in 2003 prices) for car travel by motorcycle owners – as again this group have the potential to change mode to reduce travel costs

4. Increasing the level of motorcycle ownership by 50%. The existing patterns of owners are retained so the areas with low numbers of resident motorcyclists will continue to be lower than average

5. Combining the introduction of road user charging as in test 3 with the increased motorcycle ownership investigated in test 4. Increasing the cost of car travel is expected to lead to an increase in motorcycle owners as more travellers seek more cost effective means of travel.

The change in trips by mode *for motorcycle owners* are shown in the Table below. The first two tests were found to have very limited impacts on the choice of mode. Both policies are focused on a very limited number of trips and thus the impact is, not surprisingly, limited. The unexpected small decrease in motorcycle trips in the Bus lanes policy test was due to the decrease in time being unbeneficial for short trips of less than 20 minutes, where the fixed hassle factors associated with parking and dressing appropriately outweigh time savings. Similarly increasing the ownership levels does little to affect the travel conditions and the movement between modes is thus limited. The road user charging is the one policy that produces a significant movement from car on to other modes. Motorcycle is the main beneficiary in terms of volumes of trips, although the percentage increase on the small number of rail trips by this group of travellers is large. Combining road user charging and increased ownership reinforces the usefulness of motorcycle as an alternative mode of travel and produces the greatest reduction in car trips of all policies tested.

Percentage change from 2001 Base run in trips by mode for motorcycle owners

Mode	**M/Cs in Bus Lanes**	**Parking costs (car + 50%)**	**RUC (car 10p/mile)**	**Ownership +50%**	**Ownership & RUC**	**Ownership & RUC** *relative to Ownership only*
Car	0.3%	-0.5%	-10.8%	52.1%	34.8%	-11.8%
Cycle	0.6%	0.6%	0.4%	50.7%	50.1%	0.3%
Walk	0.5%	0.7%	0.4%	50.6%	50.1%	0.3%
Bus	0.6%	0.3%	4.9%	52.5%	57.2%	3.4%
Rail	-0.8%	0.4%	10.9%	48.9%	57.1%	5.9%
M/C	-0.3%	0.2%	6.2%	49.6%	60.4%	7.5%
Total	**0.0%**	**0.0%**	**0.0%**	**50.7%**	**50.7%**	**0.0%**

The impact on the amount of motorcycle travel on different types of road in the highway network was fairly limited as shown in the Table below. Allowing motorcycles access to bus lanes appears to lead to some rerouting in order to make some use of the less congested links. In the table below the bus lanes are included with the urban single carriageway A roads. Parking costs and global increases in ownership have little effect. Road user charging leads to proportionately more motorcycle travel on motorways and dual carriageways, as more of the longer journeys switch to motorcycles.

Percentage change in motorcycle kilometres by road type

Road Type	**M/Cs in Bus Lanes**	**Parking costs (car + 50%)**	**RUC (car 10p/mile)**	**Ownership +50%**	**Ownership & RUC**
Motorways	2%	1%	38%	51%	107%
Dual Carriageways	-1%	1%	22%	51%	83%
Non urban Single Carr. A road	-1%	0%	16%	51%	75%
Non urban B and minor roads	-1%	0%	15%	51%	73%
Urban B and minor roads	-5%	1%	5%	52%	57%
Urban Single Carr. A roads *(including Bus lanes)*	18%	1%	9%	51%	65%
All roads	0%	0%	17%	51%	75%

The congestion benefits of the potential increase in motorcycle use are varied. Access to bus lanes appears to make little difference to the amount of time lost due to congestion. However Cambridge where this case was tested has fairly limited bus lanes. The impacts in larger conurbations and London would be expected to be more significant. The reduction in car travel from the other policies leads to some reduction in time lost to congestion. The most effective policies are: encouraging increased motorcycle ownership (and hence use), and charging car trips. The congestion benefits are however not cumulative with much lower savings from the two measures combined than individually.

Change in lost time for all vehicles (minutes) by road type compared with Base run

	M/Cs in Bus Lanes	**Parking costs (car + 50%)**	**RUC (car 10p/mile)**	**Ownership +50%**	**Ownership & RUC**	**Ownership & RUC** *relative to Ownership only*
Motorway	53	125	494	259	-245	-504
Dual carr.	-140	-9731	-2025	-7963	-8204	-241
Nurb A Sing Carr	1034	-6366	-85909	-62930	-20065	42865
Nurb B & minor	64	1540	9133	8864	-5459	-14322
Urban B & Minor	336	757	7262	-4987	-835	4152
Urb A SingCar	-731	-2151	-3979	-4231	-1081	3150
All road types	**617**	**-15826**	**-75025**	**-70989**	**-35888**	**35101**

In summary the most effective means of increasing motorcycle usage is through increasing the number of motorcycle owners and hence the size of the population that have the option available. Increasing the cost of travel on other modes will encourage owners to make more motorcycle trips and there are likely to be resultant savings in congestion.

The challenge is to bring about sufficient change to produce noticeable effects for the travelling population as a whole, as the number of motorcyclists compared with other travellers is very small. At the margin, changes can bring immediate short term relief to congestion in urban areas. However it is clear from the responses to the surveys undertaken in Phase 1 of the study and the form of the usage model developed, that motorcyclists, like cyclists, are strongly influenced by weather conditions and the effects of a wet wintry day could offset benefits gained through policies promoting motorcycle use.

MOTORCYCLES AND CONGESTION: THE EFFECT OF MODAL SHIFT

Phase 3 - Policy Testing

1 INTRODUCTION

1.1 In May 1999 an Advisory Group on Motorcycling was set up by the Government after the While Paper “A New Deal for Transport” recognised that motorcycling had the potential to act as a viable alternative to car travel in certain circumstances. The Advisory Group had three primary terms of reference:

- To look at the safety record of motorcyclists and agree measures that would improve safety
- To look at the environment impact of motorcycles and if necessary agree measures to be taken
- To look at the role of motorcycles in integrated transport policy and to assess the scope for further enhancing their benefits through traffic management.

1.2 This study builds on earlier research carried out for the Department for Transport on the potential for increasing motorcycle use and reducing congestion and follows on from the study “Motorcycling and Congestion” completed by Halcrow.

1.3 Phase 1 of the study developed a motorcycle ownership model and a motorcycle usage model. The models were developed by analysing existing data sets such as the National Travel Survey, the Family Expenditure Survey, data from the London Area Transportation Study (LATS) and the Census of Population. In addition both revealed preference (RP) and stated preference (SP) surveys were undertaken specifically for the study to obtain additional information on aspects affecting motorcycle owners and users.

1.4 The models developed have then been incorporated into two test transport forecasting models for Cambridge and for London and the South East. Both test models are strategic integrated land use and transport models operating at fairly aggregate levels of spatial detail and with a number of traveller type categories. The land use models incorporate the trip generation and distribution stages of more conventional multi-modal models. These stages of the models have not been modified to carry out any motorcycle policy testing. The trip matrices *totalled across all modes of travel* are therefore taken as fixed for this work.

1.5 The motorcycle ownership models have been implemented by applying the models to detailed zonal population information from the 2001 Census. The output from this stage was the probability of owning a motorcycle for six segments of the population in each zone of the model. These probabilities were applied to the trip matrices within the test models to provide separate matrices of trips for motorcycle owners and non-owners.

1.6 Both test models undertake mode choice and assignment to multi-modal transport networks. The networks are represented as a series of links. They incorporate congestion and its impact on route and mode choice, but do not include any junction modelling / delays. The existing mode choice models in the LASER and MENCAM models have been retained for the non motorcycle owners. This ensures the base year calibration of the modelling system is not undermined. The new mode choice models developed specifically for this study have been incorporated for the motorcycle owners so that a new motorcycle mode of travel is defined for them.

1.7 Both models consider the mode choice and assignment stages of the model for an AM peak period only. All policy tests will be undertaken in the Base year of the models on a “what if” basis rather than forecasting through time.

1.8 Section 2 considers the range of policy impacts that could be investigated using the modified transport models. The remaining sections of the report then present some of the findings from the set of model runs carried out.

1.9 Section 3 considers the impact in the MENCAM Cambridge model of explicitly introducing both motorcycle owners and motorcycle as a mode of travel. The results from the set of policy tests implemented in the Cambridge model are then presented in Section 4.

1.10 Section 5 presents the results from the variant base run carried out using the modified LASER model. There were significant differences in model formulation between the statistical models developed during Phase 1 and the existing structures within the LASER model. The sheer size and complexity of the LASER model relative to the Cambridge made it difficult to produce an operational model that was appropriate for a wide range of policy testing. As a result policy testing was focused on the Cambridge model.

2 SCOPE OF POLICY TESTING

2.1 There are a number of scenarios that could be investigated using the enhanced models as a test-bed. The following list provides the broad groups of policy interventions. Each aspect is then considered in more detail considering how the policy could be implemented within the models and the assumptions that would be required.

2.2 The interventions fall into four main categories from the modelling perspective:

- Trip end related policies affecting the end (normally the destination) of the journey – eg parking costs / times, security
- Road / Route relate policies affecting particular links in the network and thus the journey time / choice of route etc – eg Congestion charging, bus lanes
- Ownership related – different ownership patterns or levels and how these impact on travel
- Other issues which can be investigated through sensitivity testing - eg weather

2.3 In addition some assumptions have been made in the implementation of the mode choice models. The robustness of such assumptions could be checked through carrying out sensitivity tests on the ranges for parameter values.

Trip end policies

2.4 The trip end policies are primarily those associated with parking, namely:

- the cost of parking (car or motorcycle)
- the amount and proximity of parking space (car or motorcycle)
- varying the maximum parking time
- reversing parking policy to offset road user charging
- permitting motorcycle parking on pavements
- providing secure parking for motorcycles

2.5 The first four apply to cars as well as motorcycles and the relative costs and times of the two modes as well as the absolute levels could be investigated. However motorcycles currently very rarely pay for parking. Introducing parking charges for motorcycles could be considered, however the impact on mode choice is more likely to result from significant changes to the costs of car parking than due to charges for motorcycles.

2.6 Both models do include charges for car parking within the central built up areas of Cambridge and in various locations throughout London and the South East. The test models do not currently include explicit measures of the amount of parking space for either motorcycles or cars within the central areas. Instead, within Central London a disutility term was estimated for cars to represent the combined cost and supply of parking spaces. Due to the limited representation of parking supply within the test models, informative results would be more difficult to achieve.

2.7 Adjusting the length of stay permissible in certain locations would be modelled indirectly. To represent this type of policy some assumptions would need to be made on the affect this ultimately has on both the cost of parking and the time taken to find and access a parking space. These latter variables are both available within the model, and the segmentation by trip purpose enables the different requirements for parking duration to be represented.

2.8 Parking security affects the choice of parking location and the surveys in Phase 1 found that in some cases motorcyclists are prepared to walk further after parking their bike to their destination in order to park in a more secure location. Modelling parking security would involve modifying the parking search and walk times at the destination zone combined with a modification to the mode specific constants to reflect improved security.

Route measures

2.9 Route measures are policy interventions that change the conditions on particular stretches of the road network for particular modes of travel. There is a wide range of options that could be investigated including:

- Improving road capacity to increase the potential for motorcycle weaving
- Congestion charging for car and / or motorcycle
- Permitting motorcycles to use bus lanes
- Permitting motorcycles to use cycle lanes
- Permitting motorcycles to use advance stop lines
- Closing roads to cars but allowing motorcycles to use as through routes (eg in historic centres such as Cambridge)

2.10 Within the Cambridge test models the network (coverage) of bus lanes has been added to the highway network. We are in discussions with TfL about the availability of bus lane information for London, but time is running out to incorporate this into the LASER model. In the base run of the model these links may be used by buses and cycles but not by cars or motorcycles. The effect of permitting motorcycles to use these lanes, the resulting changes in link times and any impact on mode choice could be investigated.

2.11 Similarly in the centre of Cambridge and other historic towns there have been a series of street closures that result in virtually no through routes for car traffic (and currently motorcycles). A series of rising bollards have been introduced which lower to allow buses access but ban cars. The effect of permitting motorcycles to use these more direct routes through the city centre could be tested.

Ownership related

2.12 The ownership model has been implemented outside the main test models by applying the model to the population data to determine the probability of a person of a particular type owning a motorcycle and to split the trip matrices by person type into those trips by owners and those by non owners. The levels of ownership are relatively low and are fundamental to the amount of motorcycle use. Given the significance of the ownership levels on future use, we believe it would be informative to test the impact of significantly higher ownership in the future.

2.13 The testing could involve globally increasing ownership levels across the study area due to changing insurance costs / policies or changing car ownership levels (to which motorcycle ownership is clearly linked). Alternatively the rapid growth of owners in particular corridors or areas as a result of another location specific policy invention such as parking policies or road user charging could be considered.

Other

2.14 From the work undertaken to develop the motorcycle usage models it was clear that the variation in the weather conditions does impact in some cases quite significantly on the likelihood of using the motorcycle for a particular journey.

2.15 It has not been possible to incorporate a weather related variable into the test models. They have been implemented using the mode choice model parameters to reflect travel within an AM peak period on a fine warm day when all users including those who only travel by motorcycle for 6 months of the year are likely to choose motorcycle. Since the potential influence of the weather is greater than some of the other variables considered here, it would be interesting to combine one of the more influential policy tests with a change in weather conditions to ascertain whether the policy remains significant. This could be achieved through adjusting the coefficients of the mode choice model to represent a cold winter’s day with heavy rain rather than fine dry conditions. In this case it will be the impacts of the policy test on the all year round cyclists that will be obtained.

3 IMPACT OF INTRODUCING MOTORCYCLES IN MENCAM

3.1 Within the MENCAM model there were nine matrices of travel demand with each segment representing different trip purposes and levels of car availability. To represent the motorcycle owners effectively the matrices were divided into those trips by persons not owning motorcycles (97%) and those who do own motorcycles and can thus choose to use them. The owners were estimated by applying the ownership model derived in Phase 1 of the study to the 2001 Census data for the population. The trip matrices were then sub divided into owners and non owners by applying the set of ownership proportions to the home end of the trip matrices.

3.2 The resulting patterns of motorcycle trip origins and trip destinations in the MENCAM model for the Base year of 2001 are shown in Figure 3.1 and Figure 3.2. As with all trips the majority of the motorcycle trip ends are in the built up areas of Cambridge, St Ives, Huntingdon and St Neots. There are surprisingly few trips to / from Ely (North East of Cambridge), the other main market town within the study area. The pattern of trip destinations is less dispersed than for trip origins, which is to be expected in an AM peak model.

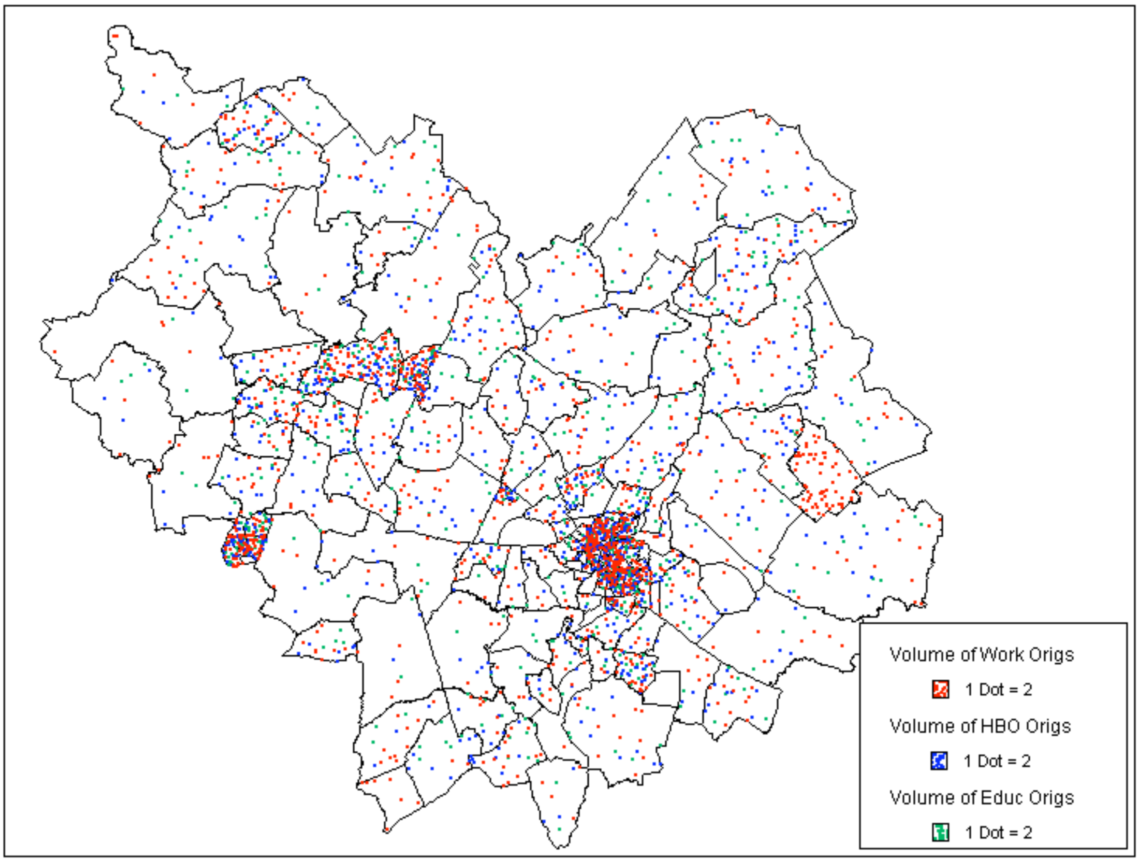

Figure 3.1: Motorcycle trip origins in AM peak – 2001 MENCAM model

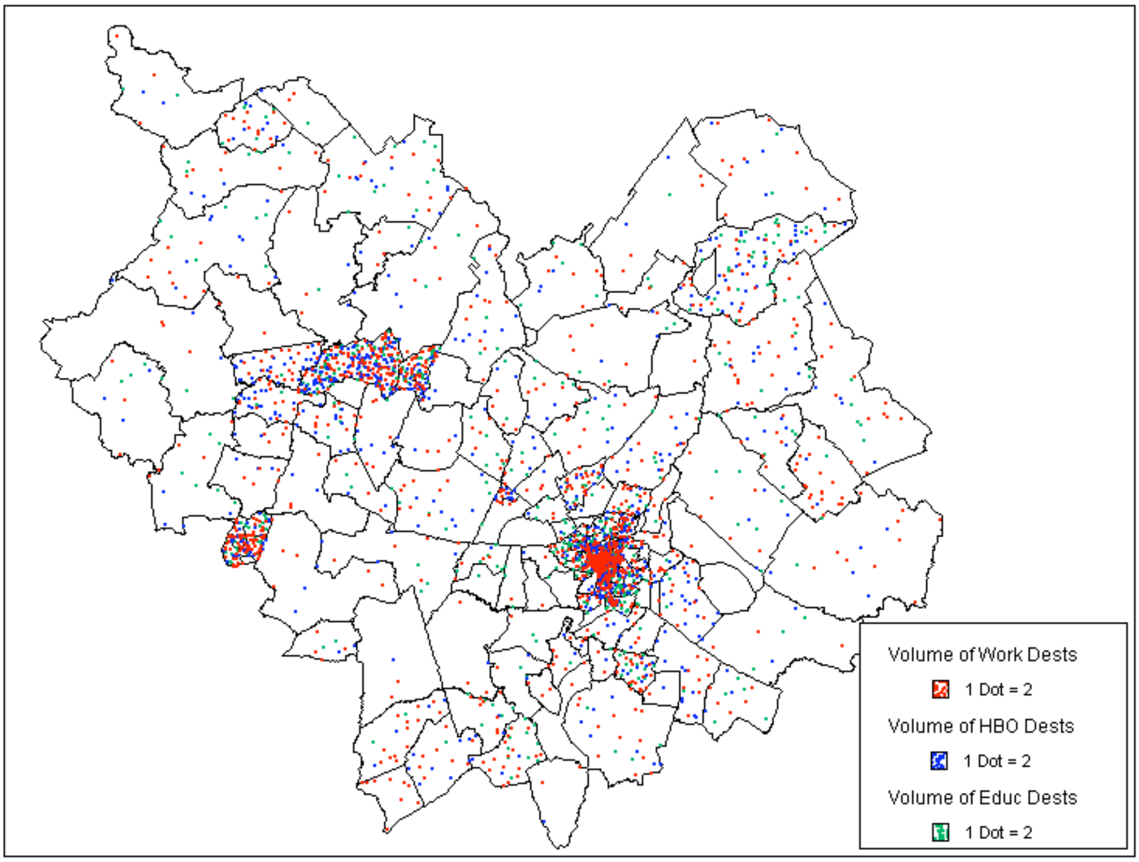

Figure 3.2: Motorcycle trip destinations in AM peak – 2001 MENCAM model

As can be seen in the preceding figures Cambridge City is the largest attractor of motorcycle trip destinations, while Huntingdonshire generates the most trip origins. The district to district pattern of trips is shown in Table 3.1. Trips wholly within a district account for a majority of trips with significant numbers travelling from South Cambs (which surrounds Cambridge City) into the City itself. There are very few motorcycle trips in an outward direction in the AM peak (ie from the City towards Huntingdon and East Cambs) where congestion is relatively low.

Table 3.1: Pattern of motorcycle trips in 2001 MENCAM Base run

	Destination District					
Origin District	City	South Cambs	East Cambs	Huntingdonshire	External	All
City	21%	3%	0%	0%	0%	25%
South Cambs	10%	13%	1%	2%	1%	26%
East Cambs	3%	2%	6%	1%	1%	13%
Huntingdonshire	2%	2%	1%	26%	2%	32%
External	1%	1%	1%	1%	0%	4%
All	**37%**	**20%**	**9%**	**29%**	**4%**	**100%**

Mode choice

3.3 The mode choice models for the trips by persons not owning a motorcycle were retained from the original MENCAM model. For the motorcycle owners the mode choice model developed during Phase 1 of the study was implemented with some minor modifications as outlined in the Phase 2 report. Figure 3.3 shows the resulting overall mode shares for both the owners and non-owners. As seen in the figure, motorcycle is well used by owners although they comprise only 2% of all journeys in the AM peak period. Car remains an attractive alternative mode with 35% of the AM peak journeys by M/C owners using this mode. Bus however becomes significantly less attractive for this group of travellers than the population as a whole. Given the difficulties recruiting public transport users for the surveys during Phase 1 and the difficulty in achieving a significant level of trading for these users, this is not a surprising result.

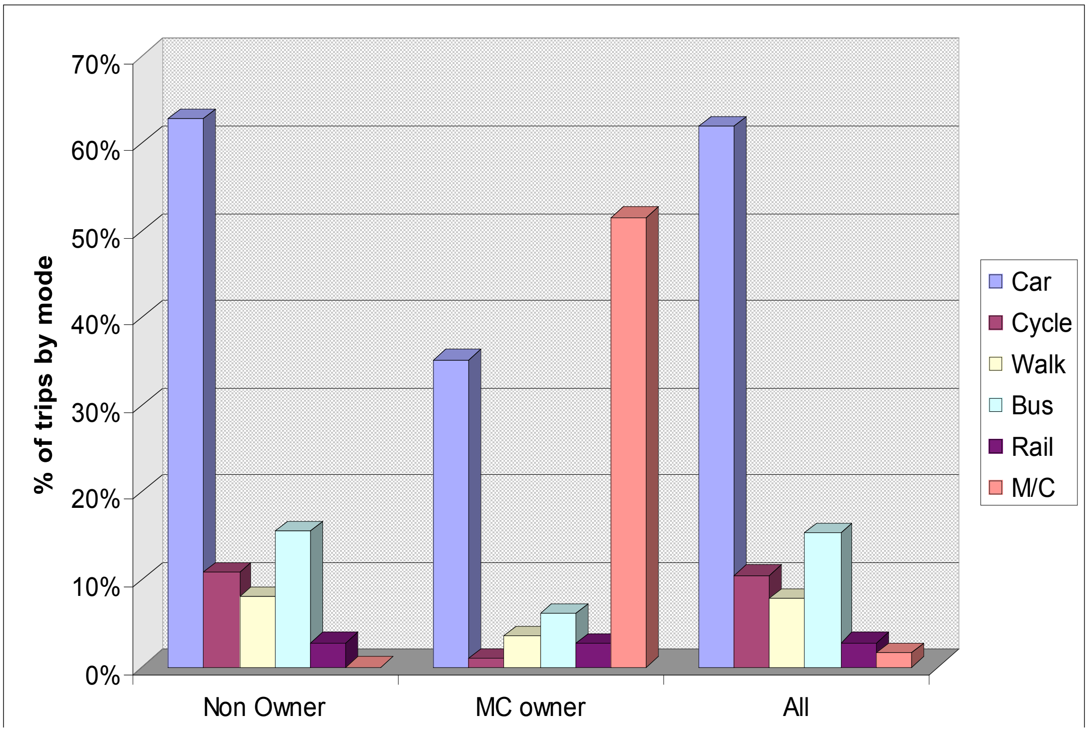

Figure 3.3: Mode choice of trips for all trip purposes – 2001 MENCAM

Journey characteristics

3.4 The average modal journey characteristics for both the motorcycle owners and non-owners are shown in Table 3.2. The mode choice model for the non-owners is unmodified from the original MENCAM model, while that for owners is taken from the Phase 1 work.

Table 3.2: Average journey characteristics for 2001 Base run

	Average trip length (kms)		Cost per trip (£)		Cost per Km (£)		Time per trip (mins)		Speed (km/hr)	
Mode	Owners	Non owners	Owners	Non owners	Owners	Non owners	Owners	Non owners	Owners	Non owners
Car	17.5	17.4	0.71	0.69	0.04	0.04	24.3	24.4	43.2	42.6
Cycle	0.7	3.1					3.6	15.4	12.0	12.0
Walk	0.7	1.0					8.2	11.7	5.0	5.0
Bus	10.4	15.7	0.45	0.47	0.04	0.03	46.5	58.4	13.4	16.1
Rail	42.7	36.7	2.48	2.16	0.06	0.06	74.6	55.3	34.3	39.8
M/C	13.3		0.32		0.02		17.5		45.8	
Total	14.8	14.8	0.53	0.70	0.03	0.04	22.7	28.6	39.2	31.0

3.5 The average trip length for both M/C owners and non-owners is the same (14.8 km). For the owners the length of car journeys increases very slightly while walk and cycle shorten dramatically suggesting these modes are only viable choices for the very shortest journeys. For public transport bus journey lengths shorten slightly while rail increase. This suggests the mid length journeys are those most likely to use motorcycle – sufficiently long to make it worthwhile dressing appropriately and dealing with the parking / security issues, but not so long to be less comfortable / significantly affected by the weather.

3.6 The costs per trip closely reflect the changing lengths while the cost per kilometre is the same for both owners and non-owners alike. The average speed of travel is similar for both groups of travellers with the largest differences being for bus and rail where the fixed waiting and interchanging times will lower the average speed for shorter journeys.

3.7 The following set of figures (Figure 3.5 to Figure 3.6) show the average journey length and average journey time for motorcycle trips to and from each zone within the MENCAM model. The lengths of journeys starting in or close to the urban areas within the model are shorter than those starting in rural areas as indicated by the blue areas in Figure 3.4. However for much of the more rural parts of the study area the journeys are typically more than 15km in length. For trips arriving in each zone the average trip length is typically shorter than that for origins with short trips within urban areas balancing the longer trips arriving from the surrounding villages.

3.8 The pattern of motorcycle journey times by zone are similar to the distances, with a few notable differences. The urban areas are less distinct particularly at the destination end of the journey. Thus even though trips to these areas are typically shorter than average the journey times are not significantly lower due to the levels of congestion encountered.

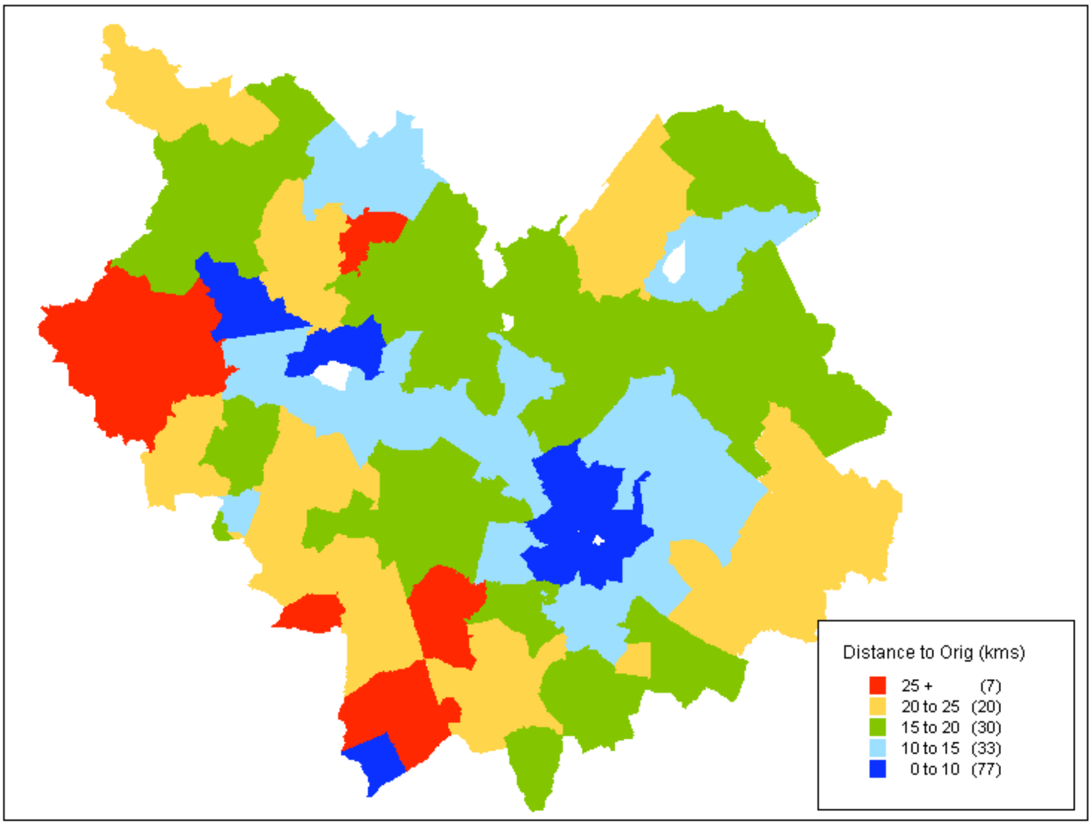

Figure 3.4: Average motorcycle journey distance from each origin zone – 2001 Base run

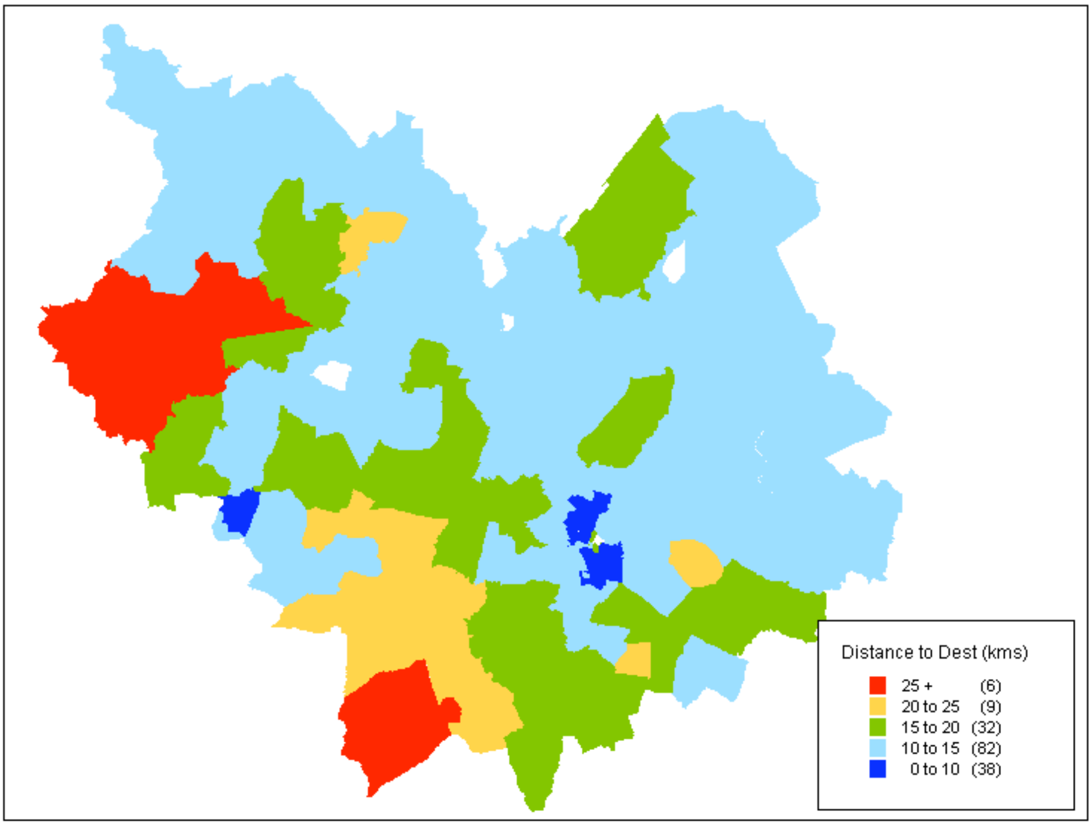

Figure 3.5: Average motorcycle journey distance to each destination zone – 2001 Base run

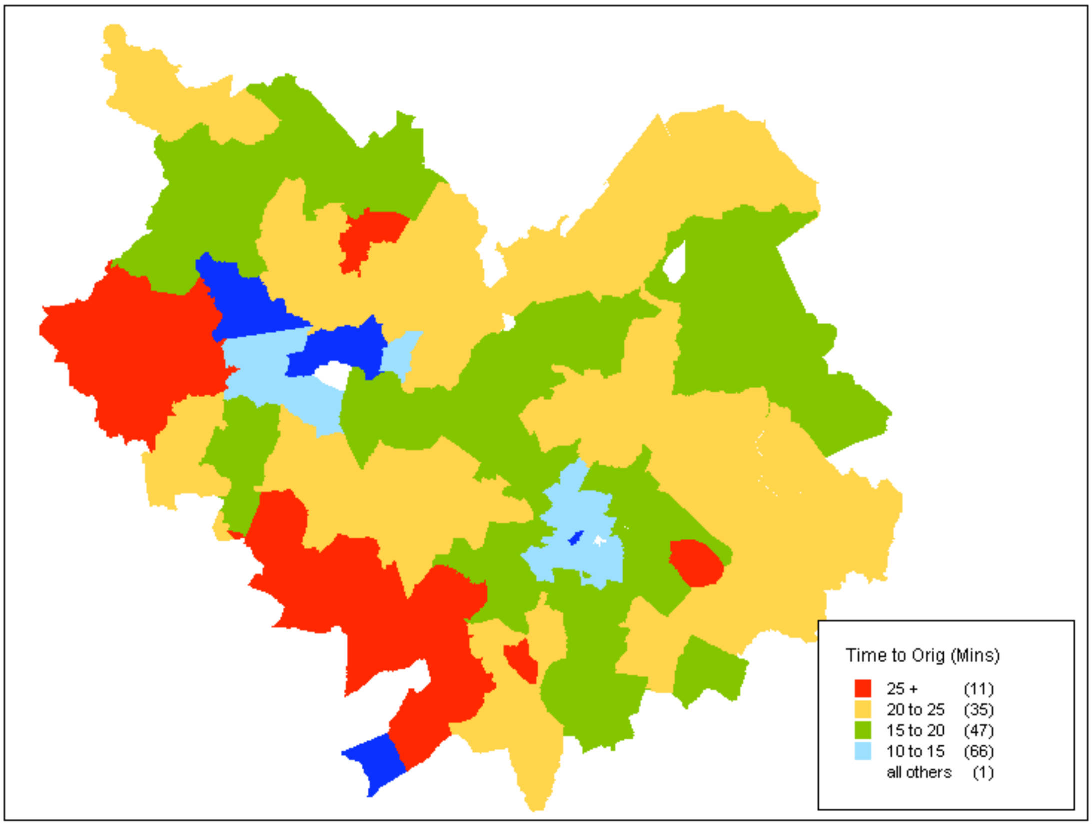

Figure 3.6: Average motorcycle journey time from each origin zone – 2001 Base run

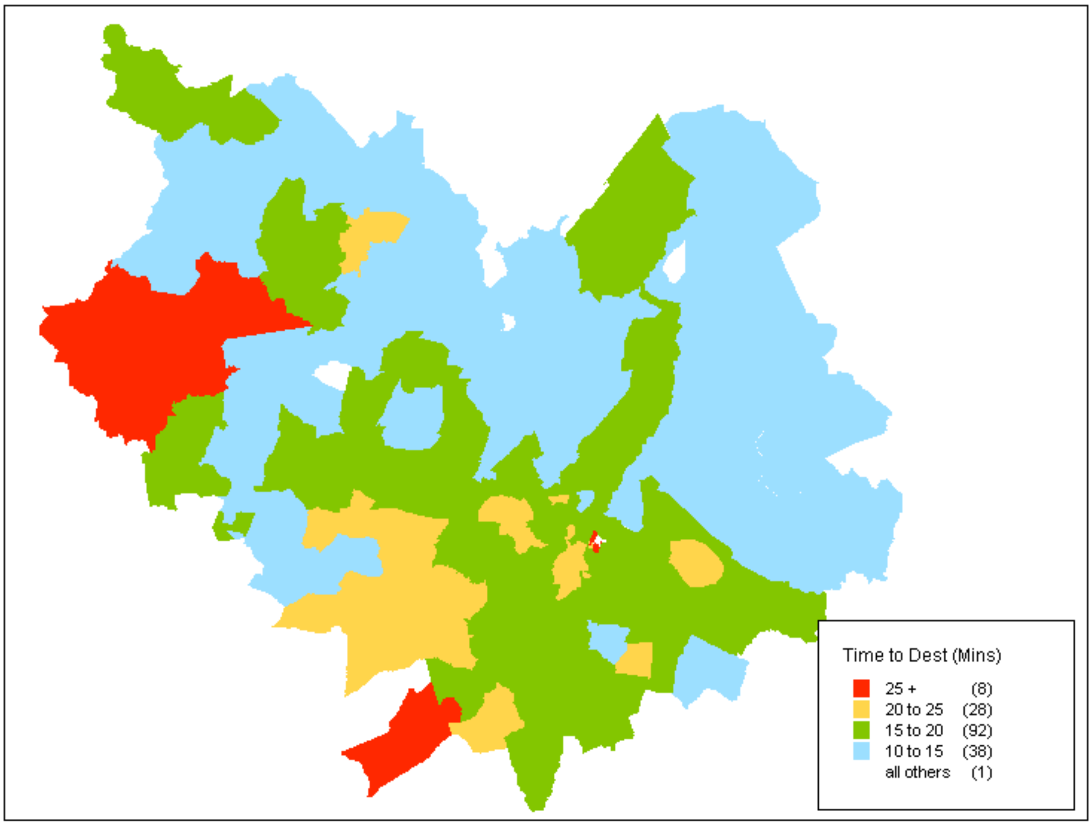

Figure 3.7: Average motorcycle journey time to each destination zone – 2001 Base run

Congestion and lost time

3.9 The highway network in the Cambridge transport model includes the capacity of each link in term of pcus (passenger car units) per hour for each link. As the load on the link increases towards the specified capacity the travel time along the link increases. Loads can exceed the specified capacity but significant delays will be incurred. The ratio of the load to capacity in the 2001 Base run is shown in Figure 3.8. From the figure it can be see that the most congested links are mainly in and around Cambridge city with a few strategic links also operating close to capacity.

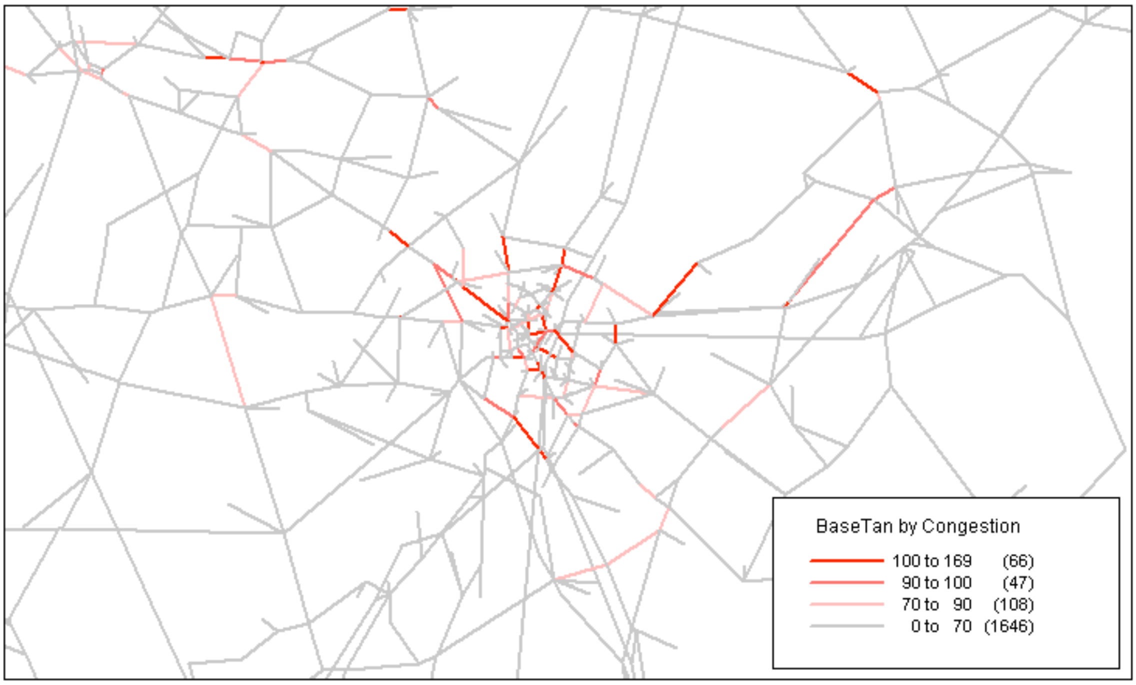

Figure 3.8: Ratio of load to capacity in 2001 Base run

3.10 Another indicator of congestion is the amount of time lost due to delays relative to travelling in uncongested conditions. This "lost time" can be calculated for each link in the highway network as the difference time to travel the length of the link in the modelled congested AM peak and in free-flow conditions. This delay when multiplied by the number of vehicles (or pcus) is the amount of time lost in the system due to congestion.

3.11 Table 3.3 shows the amount of "lost time" for each class of road in the 2001 Base model run and the resulting time lost per kilometre travelled. As already indicated by Figure 3.8, travellers lose more time per kilometre travelled on the urban roads where approximately 1 minute is lost for every kilometre travelled. Significant delays are also experienced on the non urban single carriageway A roads which are the largest contributors of lost time due to the large volumes of traffic they carry. Much lower delays per kilometre travelled are experienced on dual carriageways and motorways.

Table 3.3: Lost time by road type in 2001 Base run

Road type	Lost time (pcu mins)	Lost time (mins) / km
Motorway	11640	0.04
Dual carriageways	157410	0.16
Urban A Single Carriageway	138892	0.99
Non urban A Single Carriageway	706501	0.51
Urban B & Minor roads	194048	1.03
Non urban B & minor roads	170442	0.26
All roads	**1378933**	**0.30**

3.12 Figure 3.9 shows how the overall lost time translates to each link in the Cambridge network weighted by the load (pcus) on the link. Although dual carriageways and motorways experience lower delays than roads within the urban areas, the large volume of traffic on the A14 and A11 trunk roads and the M11 motorway carry mean they contribute significantly to the time lost in the study area as a whole.

Figure 3.9: Lost time on highway by link – 2001 Base run

4 POLICY RESULTS USING MENCAM

4.1 From the statistical analysis carried out in the development of the mode choice models during Phase 1 of the study, it has been established that cost is the best variable for influencing mode choice rather than changes in travel time and security. However the levels of motorcycle usage are relatively low and the scale of change required to make a significant difference to congestion levels is likely to be difficult to achieve.

4.2 Bearing this in mind and considering the policies that can be implemented in sufficient detail to provide informative results a subset of the policy tests described in Section 2 were proposed for the Phase 3 policy testing work. Because the two test models available are very different in scale with the Cambridge model providing significantly faster run times than the LASER model and proving less complex to implement the motorcycle usage model than in LASER. We proposed undertaking the majority of the policy testing work using the Cambridge model.

MENCAM policy tests

4.3 Initial proposals for six policy tests were put forward, with four of the six being agreed for implementation in the Cambridge model. The four policy tests completed as variants on the Base run were defined as follows:

- Permitting motorcycles to use bus lanes
- Increasing car parking costs
- Introducing road user charging for cars
- Increasing levels of motorcycle ownership

4.4 A fifth test was also completed combining the last two in the above list, namely:

- Increased motorcycle ownership combined with road user charging for cars

4.5 A further two tests were initially proposed one considering allowing motorcycles through the historic core of Cambridge on road currently closed to all vehicles except buses and taxis and a final test to investigate the detrimental impact of poor weather on motorcycle usage. Both these tests were considered lower priority than the tests outlined above and run through the Cambridge model. It is worth noting at this stage that like bicycles, the use of motorcycles is heavily influenced by weather conditions. Wet rush hours in Cambridge are noticeably more congested than on fine as a proportion of the large number of cyclists switch to using the car rather than cycling. The effect for motorcycles might be expected to be similar, however the currently levels of motorcycle use make the effect less noticeable to travellers.

4.6 The following sections of this chapter look at each of the policy tests in turn considering first the implementation, then the impacts on travel behaviour – particularly the effects on mode choice and resulting congestion levels.

Test 1 – Permitting motorcycles to use bus lanes

4.7 Where bus lanes are coded as separate links within the Cambridge model, motorcycles will be permitted to use these links. This does not allow them to cut through the Cambridge historic core, but provides uncongested links on sections of a majority of the radial routes entering Cambridge in the morning peak period. The number and length of bus lanes in Cambridge is fairly limited so the expected impact of this policy instrument is limited.

4.8 The motorcycles have been assumed to travel 20% faster than the buses in bus lanes as they will not incur any of the delays due to stopping and picking up passengers in the urban area. The travel times for motorcycles entering the city centre from outside should therefore become slightly faster than in the Base run. This would be expected to make motorcycles very marginally more attractive than previously and could lead to some change in choice of route.

4.9 The change in mode split for the motorcycle owners is shown in

4.10 Table 4.1. This confirms that the impact of the policy is very limited on the choice of mode and unexpectedly makes motorcycle very slightly less attractive than initially.

Table 4.1: Trips by mode for motorcycle owners in Base and Bus lane policy test

Mode	Base	Bus Lanes	Difference	% difference
Car	4498	4511	13	0.3%
Cycle	126	127	1	0.6%
Walk	451	454	2	0.5%
Bus	774	778	4	0.6%
Rail	343	340	-3	-0.8%
M/C	6581	6563	-18	-0.3%
Total	12773	12773	0	0.0%

4.11 This anomalous result was investigated to ensure the usage model was operating as intended and the results were not the result of poor convergence or noise within the system. The reason for the unexpected change in mode share is the inclusion within the usage model of coefficients for each minute of journey time which change sign depending on whether the trips are less than 20 minutes in length or longer. For the shorter journeys a small decrease in time is considered unbeneficial rather than beneficial – this is presumably associated with the fixed hassle factor of dressing appropriately and finding appropriate secure parking locations which become more significant for shorter journeys.

4.12 There are however some small benefits to travellers to be seen from this test. Table 4.2 shows how the average trip characteristics for the motorcycle owners change. As expected the impacts are very small, with motorcycle trips becoming slightly longer on average with small increases in the average speed of travel and no significant change in the cost. Bus travel appears to become marginally slower, with slightly shorter trip lengths. Allowing motorcycles into bus lanes has no impact on the speed of buses on these links so the effect is due to the nature of the passenger trips using bus. Overall there are small gains

Table 4.2: Percentage change in trip characteristics through M/C use of bus lanes

Mode	Trip length	Cost/trip	Cost/km	Time/trip	Speed
Car	-0.1%	0.2%	0.3%	0.1%	-0.2%
Cycle	0.4%			0.4%	0.0%
Walk	0.4%			0.4%	0.0%
Bus	-0.2%	0.0%	0.2%	0.0%	-0.2%
Rail	0.8%	0.9%	0.1%	0.5%	0.4%
M/C	1.2%	0.0%	-1.2%	0.1%	1.1%
All modes	0.5%	0.2%	-0.3%	0.1%	0.4%

4.13 Of more interest is how the permitted use of bus lanes affects the amount of travel on different types of road. Above we can see average trip lengths increase slightly which could be due to more travel around the periphery of Cambridge to enter on one of the radials providing a section of congestion free travel. Table 4.3 shows that there is a significant increase in the kilometres travelled by motorcycles on urban single carriageway roads which include the bus lanes. The modelled increase is in fact entirely due to travel in the bus lanes with a small decrease on the other urban single carriageway A roads. In addition there is a small increase in the use of motorways which in the Cambridge area is solely the M11 with decreases on other types of road.

The largest decrease is from the Urban B and minor roads. This does indicate some re-routeing particularly within the urban area despite the limited impact on mode choice.

Table 4.3: Percentage change in characteristics by road type due to use of bus lanes

Road Type	M/C Kms travelled	Mins travelling by M/C	Avg Speed of M/Cs	Lost time (mins) All modes
1 Motorways	2%	3%	0%	53
2 Dual Carriageways	-1%	-1%	0%	-140
3 Non urban Single Carr A road	-1%	-2%	1%	1034
4 Non urban B and minor roads	-1%	-2%	0%	64
5 Urban B and minor roads	-5%	-8%	4%	336
7 Urban Single Carr. A roads *(including Bus lanes*	18%	10%	7%	-731
All roads	0%	-1%	1%	617

4.14 The overall change in lost time for all modes is shown in the last column of Table 4.3. Here it can be seen that despite the reduction in M/C use on many road types there is an increase in the amount of time lost by all modes. The changes in lost time on each link in the network are shown in Figure 4.1. The blue links are those where the time lost is reduced either through less congestion or lower loads on links. The red links experience increases in lost time – again either through increased loads with unchanging levels of congestion or through increased congestion. From the figure it can be seen the changes are small with most benefits on the more minor routes and within the urban area.

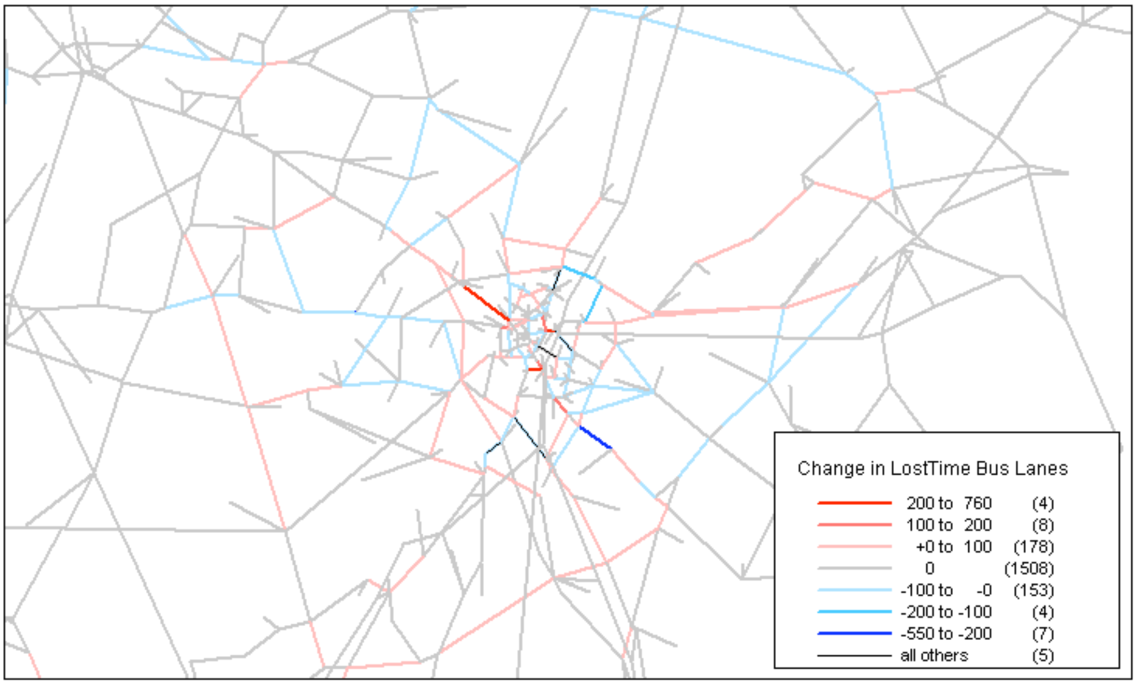

Figure 4.1: Change in lost time (pcu minutes) due to permitting motorcycles in bus lanes

Test 2 – Parking costs

4.15 Two alternative forms of this test were considered – either modifying the car parking charges and considering the impact on motorcycles and other road users or introducing parking charges for motorcycles in the central areas. Motorcycles very rarely pay to park and enforcing such a policy would be complex in an area such as Cambridge. It was therefore considered more appropriate to adjust the parking costs for cars and investigate the impacts on mode choice and congestion.

4.16 For Cambridge this test increased the **car** parking charges by 50% for **motorcycle owners only**. In practice parking policy would increase parking charges for all users which could lead to some significant changes in mode and destination choice for all travellers swamping the effects we wish to analyse on the use of motorcycles and the knock on effects on other modes. The impact of increased car parking costs is also likely to be at least as great on motorcycle ownership as on motorcycle usage. Since the ownership modelling is not explicitly included, understanding the impact on motorcycle usage for the owners was considered the most informative set of results.

4.17 Parking charges only apply for trips with destinations in the built up urban areas of the Cambridge sub region as shown in Figure 4.2. The level of parking charge is greatest within the centre of Cambridge and lower for the outer Cambridge city area and in the surrounding market towns. The increase for the policy test was applied to all zones in the model.

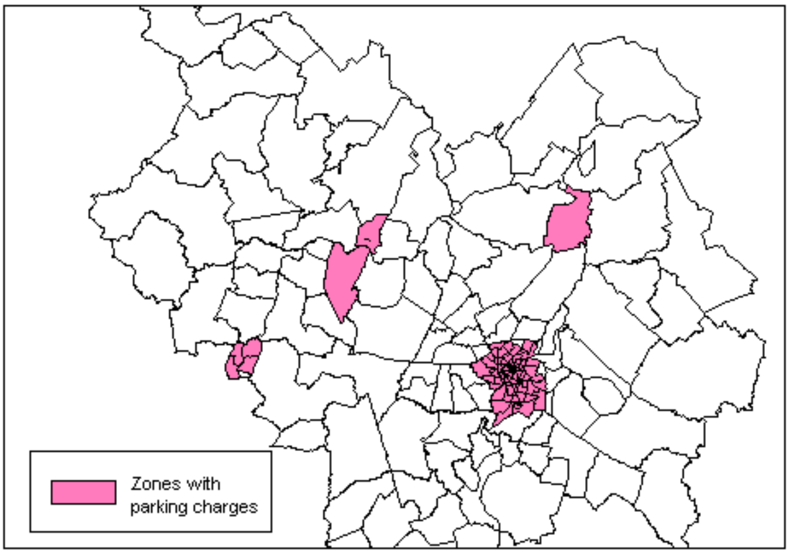

Figure 4.2: Zones with car parking charges within Cambridge model

4.18 The effect of the change in parking cost on the overall modal share of trips within the model is very limited as shown in Table 4.4. Looking at the change in demand on a district to district basis it was found that the only significant impact on car trips was for those travelling from Huntingdonshire to Cambridge which dropped slightly. The compensating small increase for motorcycles is however for travel wholly within Cambridge city.

Table 4.4: Trips by mode for motorcycle owners in Base and Parking cost policy test

Mode	Base	Parking Costs	Difference	% difference
Car	4498	4477	-21	-0.5%
Cycle	126	127	1	0.6%
Walk	451	454	3	0.7%
Bus	774	776	3	0.3%
Rail	343	344	1	0.4%
M/C	6581	6595	14	0.2%
Total	12773	12773	0	0.0%

4.19 The proportion of car trips affected by the parking charge increase is relatively small as charges are only incurred for destinations within the most urban areas and the relatively large proportion of trips for education purposes that take place in the AM peak period are assumed not to park (merely drop off children etc) and thus do not pay a charge. The percentage change in trips by mode for the different trip purposes within the model is shown in Table 4.5. From Table 4.5 it can be seen that the education trips are actually more likely to move to car due to lower congestion due to the displaced commuting trips. The changes are however very small.

Table 4.5: Change in trips by mode for each trip purpose due to increase in parking charges

Mode	HBW	HBO	HBEd	All trips
Car	-0.8%	-0.6%	0.6%	-0.5%
Cycle	0.7%	0.8%	0.0%	0.6%
Walk	0.8%	0.8%	0.0%	0.7%
Bus	0.8%	0.7%	0.1%	0.3%
Rail	0.1%	1.9%	2.7%	0.4%
M/C	0.5%	0.3%	-0.3%	0.2%
Total	0.0%	0.0%	0.0%	0.0%

4.20 The change in average trip characteristics for the motorcycle owners affected by this policy are shown in Table 4.6. Here it can be seen that the 50% increase in parking costs has resulted in the average cost of car travel increasing by around 10%.

Table 4.6: Percentage change in trip characteristics through increased parking costs

Mode	Trip length	Cost/trip	Cost/km	Time/trip	Speed
Car	0.7%	10.9%	10.2%	0.1%	0.6%
Cycle	0.0%			0.0%	0.0%
Walk	-0.1%			-0.1%	0.0%
Bus	-0.2%	0.0%	0.2%	-0.1%	-0.1%
Rail	-0.1%	-0.1%	-0.1%	0.3%	-0.4%
M/C	0.0%	-0.2%	-0.3%	-0.2%	0.3%
Total	0.2%	5.2%	4.9%	-0.1%	0.3%

4.21 The limited impact on mode choice in the Cambridge model demonstrates a low cost elasticity. However the alternative modes available for travellers between many zone pairs within the Cambridge model are limited and non existent in many cases. The bus services focus primarily on travel to / from the city centre thus any trips around Cambridge or between the market towns / villages will have little choice but to drive even with the increased cost. In reality if such a policy were introduced for an area such as Cambridge it would be important to consider the trip redistribution effects that are likely to occur. These have necessarily been omitted from this work as the complexity of introducing motorcycle owners into the trip distribution models was beyond the scope of this study.

Table 4.7: Percentage change in characteristics by road type due to increased parking costs

Road Type	M/C Kms travelled	Mins travelling by M/C	Lost time (mins) All modes
1 Motorways	1%	1%	125
2 Dual Carriageways	1%	1%	-9731
3 Non urban Single Carr A road	0%	0%	-6366
4 Non urban B and minor roads	0%	0%	1540
5 Urban B and minor roads	1%	1%	757
7 Urban Single Carr A roads	1%	1%	-2151
All roads	0%	1%	-15826

4.22 Table 4.7 shows that the small increases in motorcycle trip lengths account for increases on all road types but most noticeably on the urban roads and on the main trunk roads/ motorways. As would be expected there are savings in lost time – with the most pronounced savings being on the A roads both in and around Cambridge. Figure 4.3 shows that the overall small savings are due to some significant savings on a few links combined with losses on a number of other links. Overall the change results in lost time of 0.37 minutes per kilometre travelled on the highway compared with 0.38 minutes per kilometre in the Base run – ie small.

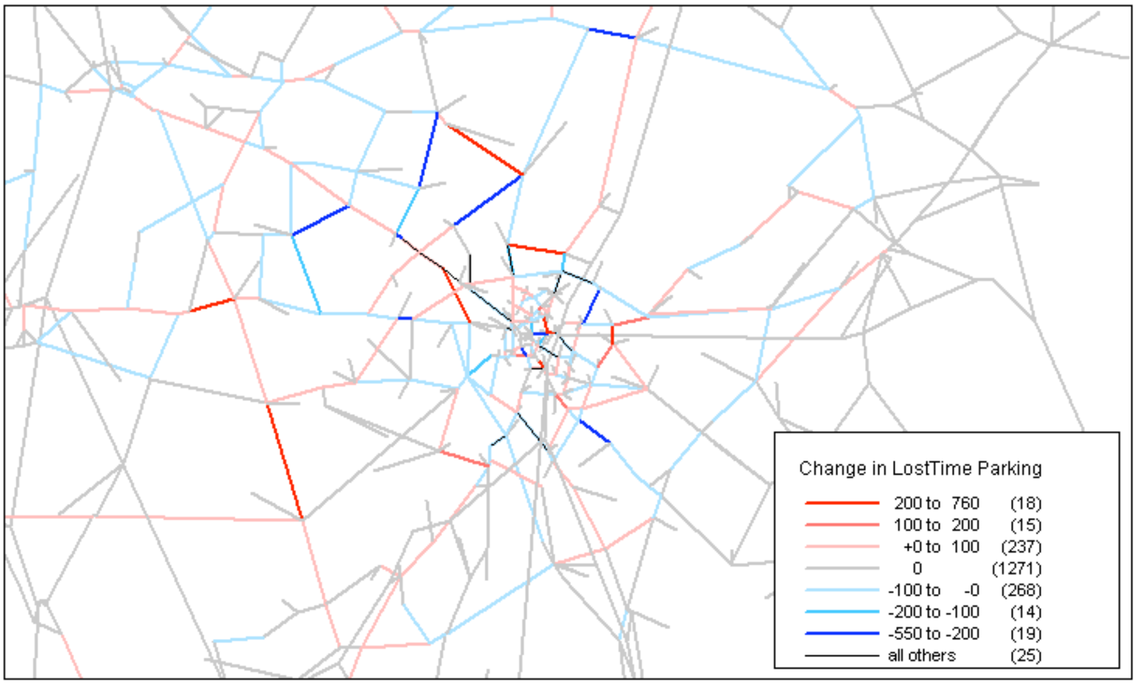

Figure 4.3: Change in lost time (pcu minutes) due to increased parking costs

Test 3 – Road user charging

4.23 Cost was identified in the earlier phases of work as one of the more powerful policy instruments. It was therefore agreed to carry out a test run significantly increasing car costs relative to motorcycle costs through the introduction of road user charging. This would be expected to result in more significant increases in motorcycle use than other policy tests being considered and would thus be an informative test to undertake. To avoid difficulties with the choice of location of road user charging via a cordon or area charging scheme the impacts were tested by applying a global distance based road user charge to car travel.

4.24 As for the parking cost test this charge was only applied to the car trips of motorcycle owners to determine their responses in terms of mode and route choice and the potential for wider benefits through increased ownership. A distance charge of 10 pence per kilometre (in 2003 prices) was introduced in the model.

4.25 The overall change in the average travel characteristics as a result of introducing the road user charges are shown in Table 4.8. The cost per kilometre travelled by car has increased significantly resulting in a reduction in the average length of car trips. Thus some of the longer trips have been displaced from car to other modes such as motorcycle and public transport as seen in

Table 4.9. The average trip lengths for bus and motorcycle both increase as do the average speeds of travel suggesting some reduction in congestion on the highway.

Table 4.8: Percentage change in trip characteristics on introduction of road user charging

Mode	Trip length	Cost/trip	Cost/km	Time/trip	Speed
Car	-8.7%	158.2%	183.0%	-6.3%	-2.7%
Cycle	-0.2%			-0.2%	0.0%
Walk	-0.2%			-0.2%	0.0%
Bus	8.0%	0.9%	-6.5%	4.6%	3.2%
Rail	-3.4%	-4.2%	-0.9%	-0.2%	-3.1%
M/C	8.9%	2.8%	-5.6%	6.4%	2.4%
Total	0.7%	68.1%	66.9%	1.1%	-0.5%

4.26 In this case the change in trips by mode is more significant as was expected from a global charge to so many travellers. As shown in Table 4.9 there is a 10% reduction in the number of trips by car. A majority of these switch to motorcycle which can be used ubiquitously, with smaller increases to bus and rail where the public transport provision opportunities exist. There is no significant impact on the walk and cycle trips which are typically much shorter than those made on motorised modes.

Table 4.9: Trips by mode for motorcycle owners in Base and Road User Charging policy test

Mode	Base	RUC	Difference	% difference
Car	4498	4011	-487	-10.8%
Cycle	126	126	0	0.4%
Walk	451	453	2	0.4%
Bus	774	811	38	4.9%
Rail	343	381	38	10.9%
M/C	6581	6991	410	6.2%
Total	12773	12773	0	0.0%

4.27 With global road user charging the differences by trip purpose are not that great and relate largely to the proportion of trips initially travelling by car. Motorcycle is most likely to be used as an alternative to car for commuting journeys rather than for education and other shopping and recreation purposes.

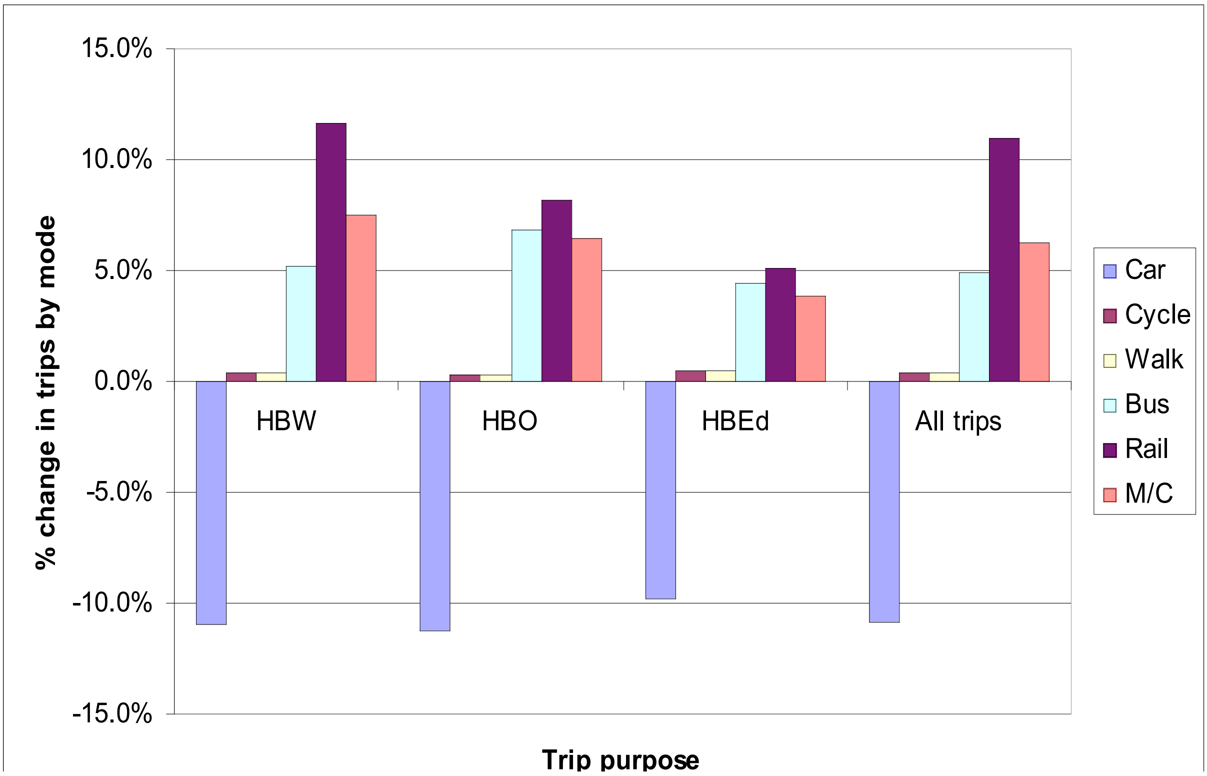

Figure 4.4: Change in mode choice by trip purpose

4.28 Looking at the change in motorcycle trips on a district to district basis as seen in Table 4.10 it can be seen that the largest rate of growth is in trips between districts where there were fewer in the base run. Motorcycle trips to and from the external area also grow significantly. These tend to be the longer distance trips that will incur the greatest road user charge.

Table 4.10: Change in district to district motorcycle trips with road user charging

Origin	Destination district: City	South Cambs	East Cambs	Huntingdonshire	External	All
Absolute change in trips						
City	14	8	2	4	4	32
South Cambs	36	57	6	12	39	151
East Cambs	17	18	17	8	9	69
Huntingdonshire	15	26	8	54	35	138
External	3	13	3	4	0	23
All	85	122	37	82	87	413
Percentage change in trips						
City	1%	5%	10%	14%	42%	2%
South Cambs	5%	7%	16%	12%	44%	9%
East Cambs	9%	15%	4%	20%	16%	8%
Huntingdonshire	14%	17%	21%	3%	28%	6%
External	6%	17%	6%	8%		10%
All	3%	9%	6%	4%	31%	6%

4.29 The increase in kilometres travelled by motorcycle through both increased numbers of trips and longer journeys is spread over the different types of road, but greatest on motorways and lowest on the urban roads. Reduced congestion results in higher average speeds for motorcycles on the non urban roads and the main A roads in urban areas.

Table 4.11: Percentage change in characteristics by road type due to road user charging

Road type	M/C Kms travelled	Mins travelling by M/C	M/C speeds	Total lost time (mins) All modes	Lost time per km All modes
Motorway	38%	38%	0%	494	0.00
Dual carr.	22%	21%	1%	-2025	0.00
Nurb A Sing Carr	16%	14%	1%	-85909	-0.06
Nurb B & minor	15%	14%	1%	9133	0.01
Urban B & Minor	5%	5%	0%	7262	0.04
Urb A SingCar	9%	8%	1%	-3979	-0.03
All road types	17%	13%	2%	-75025	-0.02

4.30 As can be seen from the change in lost time both in total mins saved and minutes per kilometre travelled the greatest congestion relief appears on the non urban single carriageway A roads. Figure 4.5 shows how these savings are spread over the network. It can be seen that immediately to the North West of Cambridge there are increases in lost time (red) with savings (in blue) further from the city centre and to the south. Thus despite a significant movement from car to motorcycle for the owners, the impacts on congestion in and around Cambridge are limited due to the relatively small number of existing motorcycle owners.

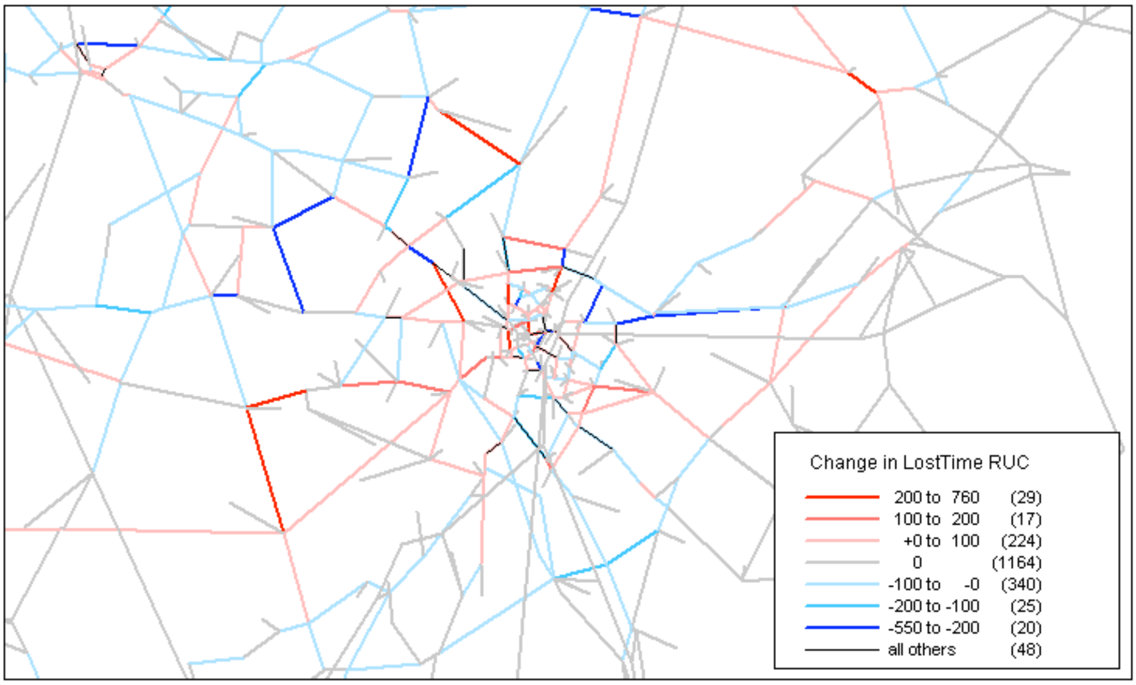

Figure 4.5: Change in lost time per link on introduction of road user charging

Test 4 – Impact of increased motorcycle ownership

4.31 As already clearly seen from the results of the preceding tests, the policy impacts on existing motorcycle usage are extremely limited due to the very low number of motorcycle owners and users. It is therefore increased motorcycle ownership that offers the opportunity for other policy instruments to have a more important role in influencing motorcycle travel. Since the change in ownership is so significant in terms of motorcycle use, it was considered appropriate that the model testing phase should consider the effects of a fairly dramatic change.

4.32 Since increasing car costs would be expected to lead to an increase in motorcycle ownership, this test was undertaken both on its own relative to the Base run and also combined with the road user charging policy carried out as Test 3 (reported later as Test 5). The model run tested an increase in motorcycle ownership of 50% using the same pattern of owners and non-owners as in the Base run. This results in approximately 3% of the population being motorcycle owners rather than the current 2%.

4.33 There are no assumed changes to the travel characteristics in this initial run with increased ownership. With higher levels of motorcycle owners, the anticipated result was higher motorcycle usage with marginally lower use of car and other modes. The change in mode shift for both the owners and the remaining non-owners is shown in Table 4.12. The increase in car trips by motorcycle owners is 52%, higher than the average 50% expected, with motorcycle use for these people increasing in line with expectations. When considering all trips made there is approximately a 50% increase in usage in line with the 50% increase in ownership with reductions in all other modes.

Table 4.12: Change in trips by mode for both motorcycle owners and non owners

Mode	Non Owners	MC owners	All
Car	-1.6%	52.1%	-0.7%
Cycle	-0.9%	50.7%	-0.7%
Walk	-1.5%	50.6%	-0.8%
Bus	-1.9%	52.5%	-1.2%
Rail	-2.6%	48.9%	-1.1%
M/C		49.6%	49.6%
Total	-1.6%	50.7%	0.0%

4.34 The resulting change in trip characteristics are shown in Table 4.13. With more owners the average length cost and time of their trips all increase slightly. However the additional motorcycle journeys are shorter, cost less per kilometre and travel slightly more slowly than the original group.

Table 4.13: Change in motorcycle owners trip characteristics with increased ownership

Grand Total	Trip length	Cost/trip	Cost/km	Time/trip	Speed
Car	0.7%	0.7%	0.0%	1.1%	-0.4%
Cycle	0.3%			0.3%	0.0%
Walk	0.3%			0.3%	0.0%
Bus	0.0%	0.0%	0.0%	0.9%	-0.9%
Rail	2.8%	2.9%	0.1%	0.9%	1.8%
M/C	0.9%	0.5%	-0.5%	1.1%	-0.1%
Total	1.0%	1.0%	0.1%	1.2%	-0.2%

4.35 The change in kilometres and time travelled does not vary significantly across the different types of road when the levels of ownership are increased. Likewise the growth in district to district movements is close to 50% for all areas, with slightly lower than average growth for trips starting / ending in Huntingdonshire and slightly higher than average for those to / from East Cambs.

Table 4.14: Growth in district to district motorcycle movements with increased ownership

	Destination district					
Origin	City	South Cambs	East Cambs	Huntingdonshire	External	All
City	49%	52%	52%	48%	50%	50%
South Cambs	50%	51%	52%	46%	51%	50%
East Cambs	48%	54%	51%	48%	54%	51%
Huntingdonshire	47%	51%	51%	48%	53%	49%
External	40%	51%	50%	49%		48%
All	49%	51%	51%	48%	52%	50%

4.36 The impacts on congestion in terms of changes in lost time are shown in Table 4.15. All roads except motorways save lost time through the reduction in car trips. As in the road user charging test, the most time is saved on non urban single carriageways. These roads carry the largest number of pcu kilometres in the base run so small reductions in load or improvements in congestion will lead to savings in lost time.

Table 4.15: Changes in lost time by road type

Road Type	Change in total lost time (pcu mins)	Change in lost time / km (mins / km)
1 Motorways	259	0.00
2 Dual Carriageways	-7,963	-0.01
3 Non urban Single Carr A road	-62,930	-0.04
4 Non urban B and minor roads	8,864	0.02
5 Urban B and minor roads	-4,987	-0.03
7 Urban Single Carr A roads	-4,231	-0.03
All roads	-70,989	-0.02

4.37 The distribution of the lost time changes across the links in the network are shown in Figure 4.6. Although the overall savings in lost time are of a similar magnitude (70,000 minutes) the pattern of time savings is slightly different. With the increased ownership there are mode widely dispersed savings of a smaller scale with only a limited number of links typically close to Cambridge that deteriorate.

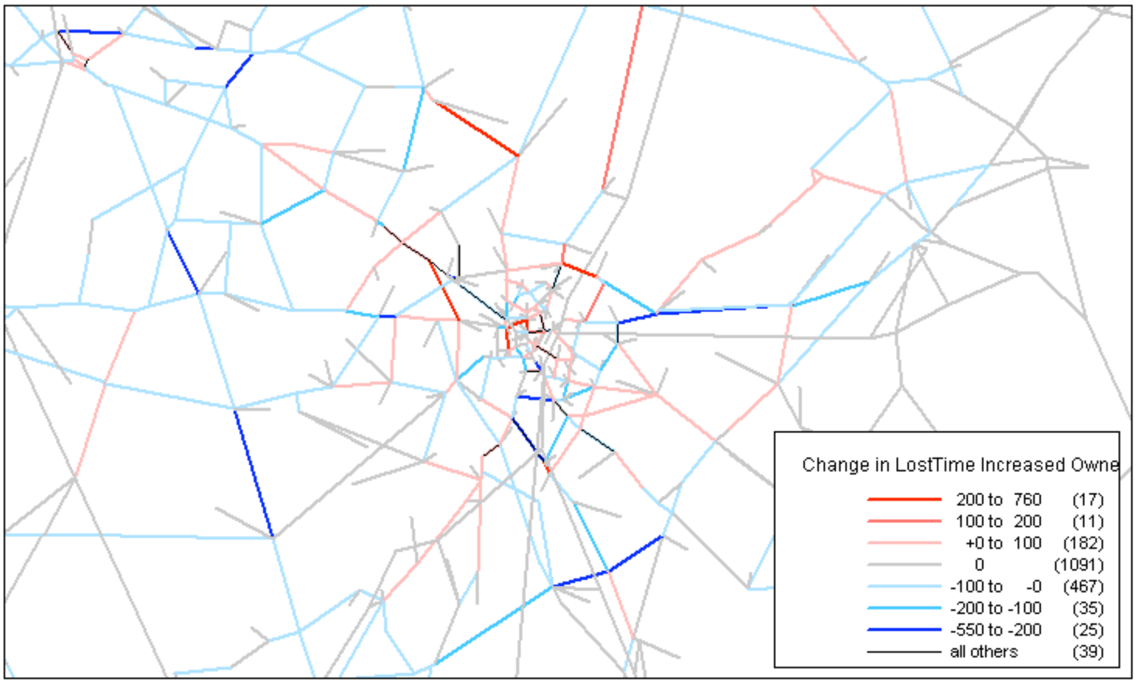

Figure 4.6: Changes in lost time per link with increased motorcycle ownership

Test 5 – Increased motorcycle ownership combined with road user charging

4.38 As outlined in Section 2 the most positive impact in terms of increasing motorcycle usage that can relatively easily be investigated is to combined road user charging for cars with increased ownership. Increasing the cost of car usage is likely to lead to increased motorcycle ownership and as this link is not embedded within the models some external assumptions have been made to consider how the combined effects would impact on travellers choices and the resulting highway conditions.

4.39 The test carried out is a straightforward combination of the preceding two runs with the ownership increased by 50% and a 10p per kilometre charge introduced on all road links for motorcycle owners only. The results from this test have been compared both with the Base run and with Test 4 where the motorcycle ownership levels were increased.

4.40 As shown in Table 4.16 the combined effect of road user charging and increased ownership results in fewer trips by non owners on all modes than in the Base run. Nearly 12% of the increased motorcycle owners move from car when road user charging is introduced – this compares with a 10% change when the road user charging was applied to the Base levels of ownership. The combined effect of this policy test results in 1.1% fewer car trips on the highway network than in the Base run. This compares with a reduction in car trips of 0.7% through increased motorcycle ownership and 0.3% reduction when road pricing is introduced to the smaller group of owners. There is therefore scope for reducing car traffic both through encouraging increased motorcycle ownership and by increasing the cost of car travel.

4.41 The growth in motorcycle trips increases by 60% with the charging reinforcing the additional use through increased ownership.

Table 4.16: Change in trips by mode with increased ownership and road user charging

	% change from Base			% change from increased ownership		
Mode	**Non Owner**	**MC owner**	**All trips**	**Non Owner**	**MC owner**	**All trips**
Car	-1.7%	34.8%	-1.1%	-0.1%	-11.8%	-0.4%
Cycle	-1.7%	50.1%	-1.5%	-0.6%	0.3%	-0.6%
Walk	-1.6%	50.1%	-0.9%	0.0%	0.3%	0.0%
Bus	-1.4%	57.2%	-0.7%	0.6%	3.4%	0.6%
Rail	0.3%	57.1%	2.0%	2.0%	5.9%	2.2%
M/C		60.4%	60.4%		7.5%	7.5%
Total	-1.6%	50.7%	0.0%	0.0%	0.0%	0.0%

4.42 The change in district to district motorcycle movements compared with the Base run is shown in Table 4.17. Here it can be seen that the increases within the City are well below average with those to and from external zones much higher than average.

Table 4.17: Change in district to district motorcycle trips compared with Base run

Origin	City	South Cambs	East Cambs	Huntingdon –shire	External	All
City	52%	60%	67%	77%	114%	54%
South Cambs	59%	62%	76%	76%	116%	65%
East Cambs	64%	75%	57%	86%	76%	64%
Huntingdonshire	74%	77%	83%	56%	92%	61%

External	61%	76%	59%	64%		66%
All	56%	65%	60%	59%	97%	61%

4.43 All movements gain motorcycles with the introduction of road pricing with patterns similar in Table 4.18 to those shown earlier for road pricing alone in Table 4.10. Here it can be more clearly seen that the larger increases are in the longer inter district trips and particularly to / from the external zones.

Table 4.18: Change in district to district motorcycle trips compared with increased ownership

Origin	City	South Cambs	East Cambs	Huntingdon-shire	External	All
City	2%	5%	10%	19%	43%	3%
South Cambs	6%	7%	16%	20%	43%	9%
East Cambs	10%	14%	4%	25%	14%	8%
Huntingdonshire	18%	17%	21%	6%	26%	9%
External	15%	17%	6%	10%		12%
All	5%	9%	6%	7%	30%	7%

4.44 The following two tables show how the average trip characteristics have changed for the owners as a result of the policy initially compared with the Base run (Table 4.19) and secondly compared with the increased ownership test (Table 4.20).

Table 4.19: Change in motorcycle owners trip characteristics for increased ownership and road user charging compared with Base run

Mode	Trip length	Cost/trip	Cost/km	Time/trip	Speed
Car	-9.7%	132.9%	158.0%	-7.2%	-2.8%
Cycle	0.1%			0.1%	0.0%
Walk	0.1%			0.1%	0.0%
Bus	6.9%	0.8%	-5.7%	3.5%	3.4%
Rail	-0.8%	-1.3%	-0.5%	0.5%	-1.2%
M/C	8.7%	2.7%	-5.6%	5.4%	3.1%
Total	0.1%	59.3%	59.2%	-0.1%	0.2%

Table 4.20: Change in motorcycle owners trip characteristics for increased ownership and road user charging compared with increased ownership run

Mode	Trip length	Cost/trip	Cost/km	Time/trip	Speed
Car	-9.7%	156.4%	184.1%	-8.1%	-1.7%
Cycle	-0.2%			-0.2%	0.0%
Walk	-0.2%			-0.2%	0.0%
Bus	6.8%	0.8%	-5.6%	2.4%	4.3%
Rail	-3.5%	-4.2%	-0.7%	-0.1%	-3.4%
M/C	7.8%	1.9%	-5.4%	4.0%	3.6%
Total	-0.6%	65.8%	66.9%	-1.3%	0.7%

4.45 From the tables it can be seen that the road user charging is the main cause of changes in trip length by mode. The longer car trips are those most likely to change mode with the resulting cost per kilometre travelled increasing significantly. Combining the two changes results in a greater improvement in the speed of car travel, but less overall improvement as travellers move to slower modes such as bus. While the average cost per trip increases significantly with the introduction of road pricing, the increased ownership does dilute this effect slightly both for car trips and across all trips taking place.

4.46 Average motorcycle speeds increase on all road types. The changes relative to the Base are greater than compared with the increased ownership alone, suggesting the combined impacts are lower levels of congestion. The increase in kilometres travelled is greater on motorways than other roads. Since the motorcycle trips lengthen there will be a greater likelihood of them using motorways compared with other roads, this will also contribute to the overall increase in speeds as more trips occur on faster routes.

Table 4.21: Change in motorcycle trip kms and speeds by road type

	Compared to Base		Compared to increased ownership	
Road Type	M/C Kms	M/C Speed	M/C Kms	M/C Speed
1 Motorways	107%	0%	37%	0%
2 Dual Carriageways	83%	1%	21%	1%
3 Non urban Single Carr A road	75%	1%	16%	1%
4 Non urban B and minor roads	73%	1%	15%	0%
5 Urban B and minor roads	57%	1%	3%	0%
7 Urban Single Carr A roads	65%	1%	9%	0%
All roads	75%	3%	16%	2%

4.47 The changes in lost time on the entire highway network are shown in Table 4.22. There are significant savings compared with the Base run, but at 35000 minutes saved these are approximately half the savings achieved with the introduction of road user charging alone. The increases in motorcycle ownership when combined with road user charging result in increases in lost time compared to increased ownership alone and compared with introducing road pricing alone. This impact is slightly surprising with the increases in lost time occurring primarily on the non urban single carriageway A roads and to a lesser extent on the urban roads.

Table 4.22: Change in lost time on highway network with road user charging and increased ownership

	Compared to Base		**Compared to increased owners**	
Road Type	**Lost time**	**Lost time / km**	**Lost time**	**Lost time / km**
1 Motorways	-245	0.00	-504	0.00
2 Dual Carriageways	-8204	-0.01	-241	0.00
3 Non urban Single Carr A road	-20065	-0.01	42865	0.03
4 Non urban B and minor roads	-5459	-0.01	-14322	-0.02
5 Urban B and minor roads	-835	0.01	4152	0.03
7 Urban Single Carr A roads	-1081	0.00	3150	0.03
All roads	-35888	-0.01	35101	0.01

4.48 The changing pattern of lost time on the highway network compared with the Base (indicating a saving) is shown in Figure 4.7 From the map it can be seen that there are a few links in the network with significant savings. A few links become more congested but these are relatively few in number. The additional benefits of introducing road pricing (by comparing Figure 4.7 with Figure 4.5) are noticeable on the A14 to the North West and North of Cambridge and on the A10 to the South. The links experiencing significant savings in lost time are the same links improving with increased ownership alone.

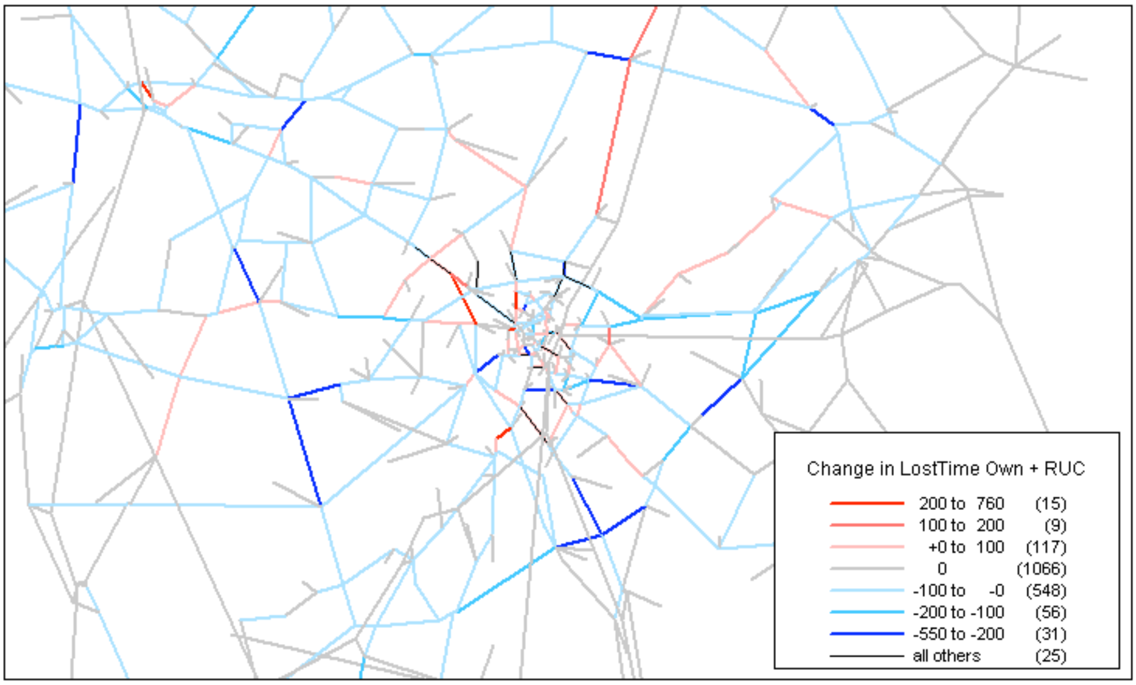

Figure 4.7: Change in lost time compared with Base run

5 IMPACT OF INTRODUCING MOTORCYCLES IN LASER

5.1 Within the LASER model there were twenty one matrices of travel demand. Two of these segments represent goods vehicle travel and did not therefore require any modification. Eighteen of the segments represented the personal trips made for different trip purposes by persons with different levels of car availability. To represent the motorcycle owners effectively these eighteen matrices were divided into those trips by persons not owning motorcycles and those who do own motorcycles and can thus choose to use them. The owners were estimated by applying the ownership model derived in Phase 1 of the study to the 2001 Census data for the population. The trip matrices were then sub divided into owners and non owners by applying the set of ownership proportions to the home end of the trip matrices. The remaining trip segment in LASER is the professional employer's business trips. These were not modified for the motorcycle work.

5.2 The resulting patterns of motorcycle trip origins and trip destinations in the LASER model for the Base year of 1997 are shown in Figure 5.1 and Figure 5.2.

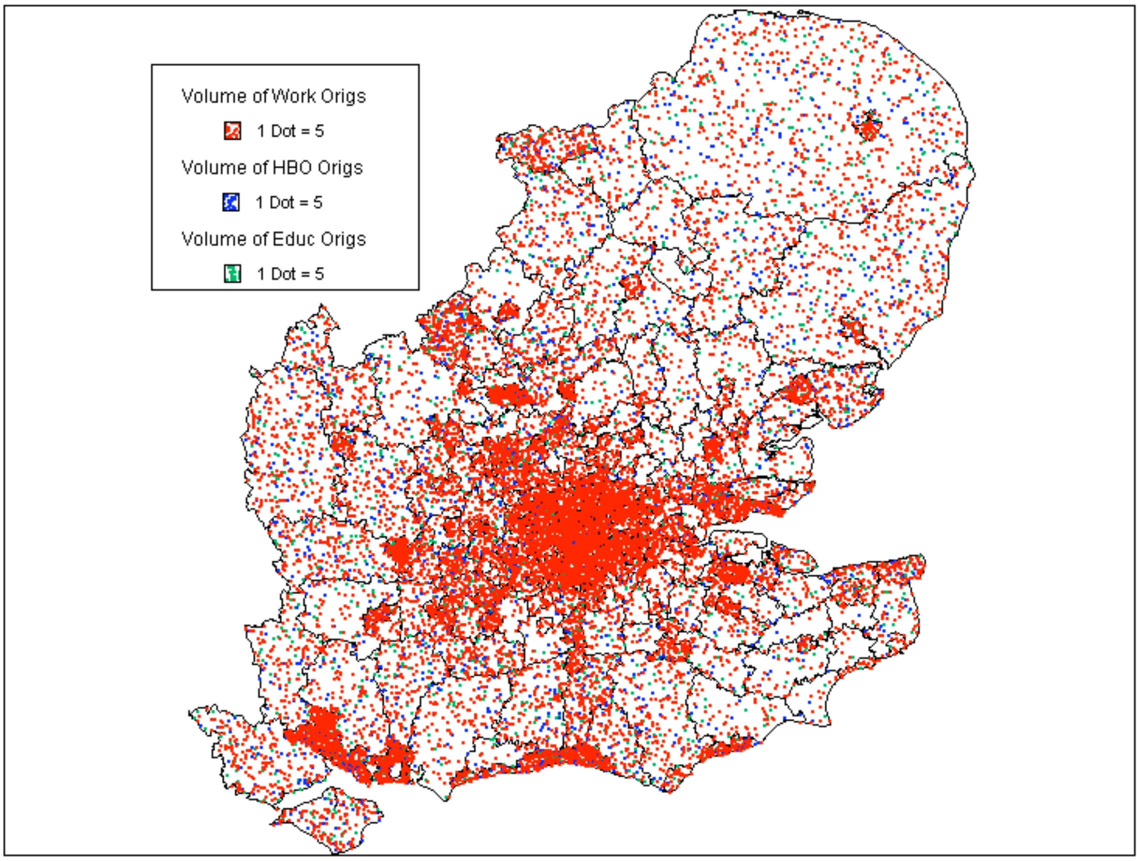

Figure 5.1: Modelled motorcycle trip origins in LASER model, 1997 Base year

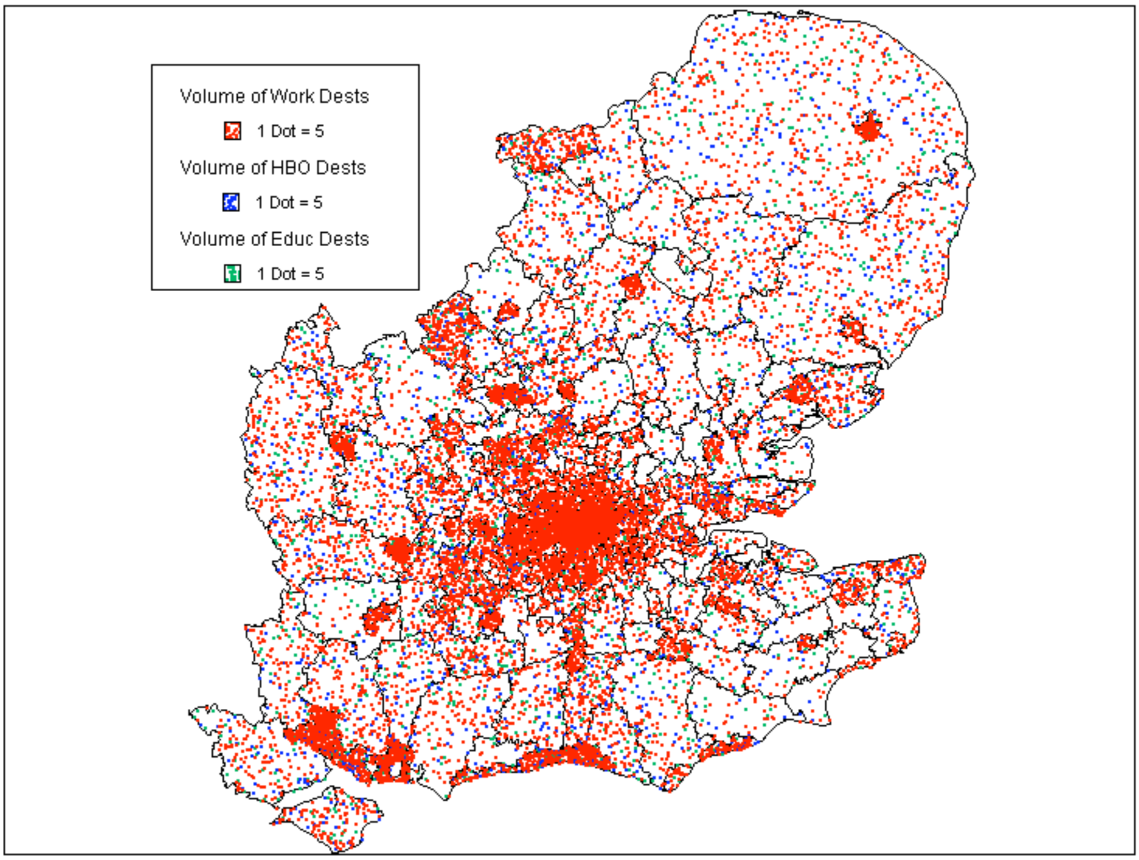

Figure 5.2: Modelled motorcycle trip destinations in LASER model, 1997 Base Year

5.3 The majority of the motorcycle trip ends are in London and in the urban areas mirroring the largest concentrations of population. The south coast does appear to be attractive for motorcycling in the model as seen from analysis of 1991 Census journey to work data. The noticeable differences between the pattern of origins and destinations in the figures are not large. Destinations are more concentrated on Inner London and the urban centres.

Table 5.1: Region to Region motorcycle trips in LASER model, 1997 Base run

	Destination Region (trips)					Destination Region (%)				
Origin Region	**CL /IL**	**OL**	**SE**	**East**	**Total**	**CL /IL**	**OL**	**SE**	**East**	**Total**
Central & Inner London	5238	796	242	148	6425	5%	1%	0%	0%	6%
Outer London	6374	5792	754	413	13333	6%	6%	1%	0%	13%
South East Region	4543	2641	41733	520	49436	5%	3%	42%	1%	49%
Eastern Region	3297	1396	543	26088	31324	3%	1%	1%	26%	31%
LASER study area	19453	10625	43272	27168	100517	19%	11%	43%	27%	100%

5.4 A majority of the motorcycle trips take place wholly within the South East Region (42%). London attracts more motorcycle trips than the Eastern Region, although it accounts for fewer motorcycle trip origins. The motorcycle trips with destinations in Central and Inner London are fairly evenly split between the different origin areas. Very few trips leave Central or Inner London to go to destinations outside London.

Mode Choice

5.5 The modal split patterns obtained from the motorcycle usage model implemented within LASER are shown in Figure 5.3 for the London, non London (South East and Eastern Regions) parts of the LASER study area in addition to the overall split of trips across the modes. The mode split patterns are shown for both the motorcycle owners based on the models developed in Phase 1 and for the non-owners which continue to use the original calibrated mode choice models from the LASER model. London and elsewhere are shown separately since London has a very different pattern of public transport usage to other areas.

5.6 As in the MENCAM model, the distinction of motorcycles reduces the number of car trips taking place. This is to be expected since the LASER model definition of car originally included motorcycle journeys. In both London and outside London, the number of bus trips for the owners increases significantly with the use of the new mode usage model. In London there are also increases in the estimated number of trips by the slow modes, walk and cycle. These results are not believed to be realistic particularly since the surveys undertaken during Phase 1 had difficulty in obtaining sufficient numbers of respondents who own motorcycles and regularly use public transport as an alternative to motorcycles.

5.7 Some work was undertaken to adapt the usage models estimated in Phase 1 to structures more consistent with the original LASER model structure and to account for the inclusion of significant amounts of public transport availability and usage that are present in London, but not wholly accounted for in the model estimation work. This improved the mode choice model for owners, but did not resolve all the oddities seen. The complex structure of the LASER model combined with its sheer size, made further manual improvements of the usage model impossible to achieve whilst retaining sufficient detail from the Phase 1 work. Further work to bring the two model structures more in line with one another would be desirable prior to any extensive use of LASER for policy testing relating to motorcycles.

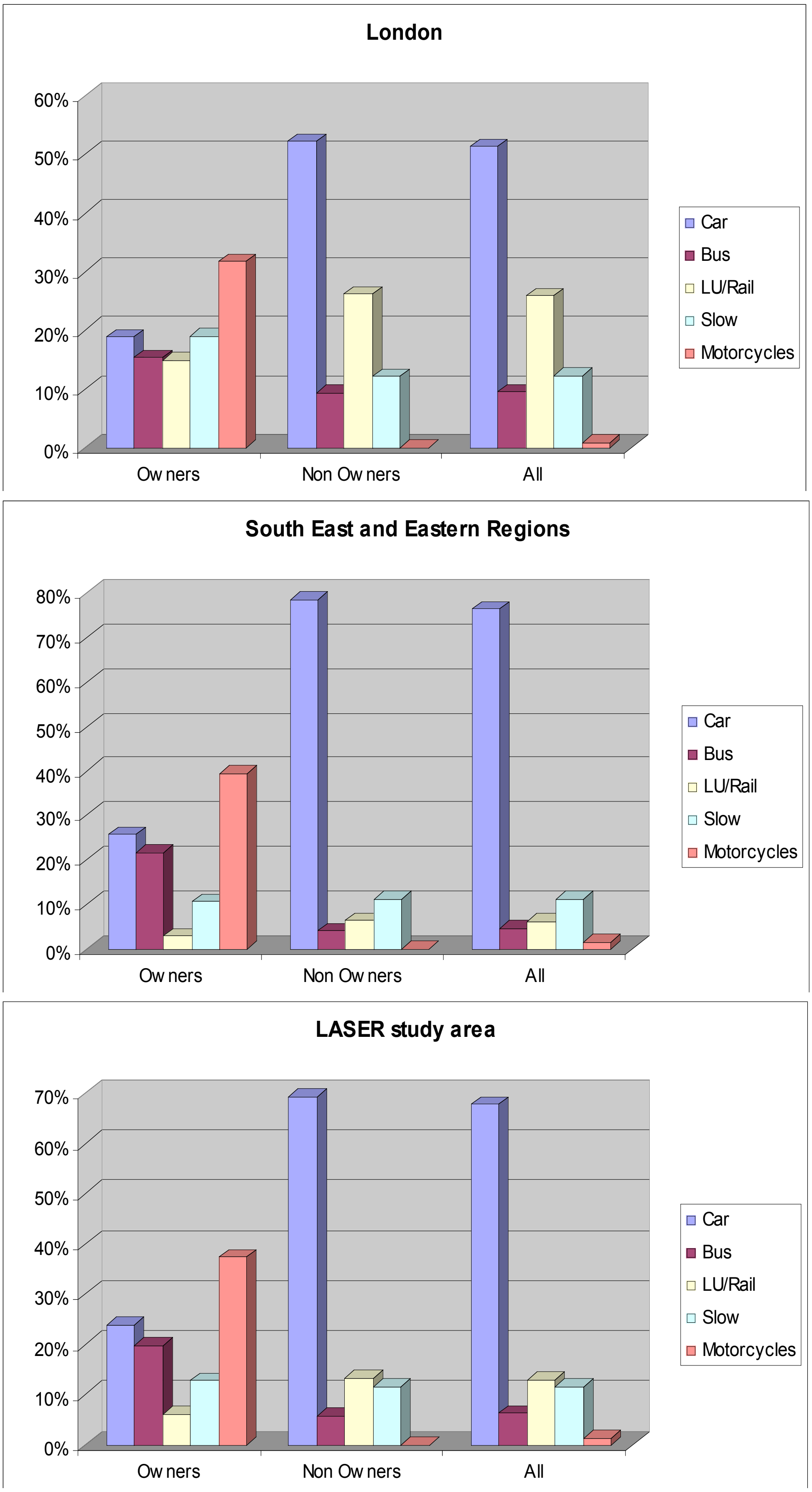

Figure 5.3: Modal split for motorcycle owners and non owners within LASER study area

Journey Characteristics

5.8 The average modal journey characteristics for both the motorcycle owners and non-owners obtained from the LASER model are shown in Table 5.2. The mode choice model for the non-owners is unmodified from the original LASER model, while that for owners is derived from the Phase 1 work.

Table 5.2: Average journey characteristics for 1997 LASER Base run

	Average trip length (kms)		**Cost per trip (£)**		**Cost per km (£)**		**Time per trip (mins)**		**Speed (km/hr)**	
	Owners	Non-Owners	Owners	Non-Owners	Owners	Non-Owners	Owners	Non-Owners	Owners	Non-Owners
London										
Car	8.52	9.16	0.42	0.47	0.05	0.05	22.32	22.40	22.91	24.54
Bus	7.44	5.18	0.58	0.45	0.08	0.09	39.00	33.94	11.45	9.16
Rail	8.12	15.46	0.79	1.55	0.10	0.10	37.69	46.83	12.93	19.81
Slow	2.96	1.36	0.00	0.00	0.00	0.00	31.42	14.63	5.66	5.56
M/C	15.35		*		*		34.54		26.66	
All	7.29	6.71	0.28	0.44	0.04	0.06	32.41	24.09	13.50	16.72
Rest of study area										
Car	16.28	12.01	0.80	0.60	0.05	0.05	43.06	24.56	22.69	29.35
Bus	15.52	6.95	1.14	0.57	0.07	0.08	72.18	47.49	12.90	8.78
Rail	14.67	50.37	1.39	5.23	0.09	0.10	80.35	89.81	10.95	33.65
Slow	3.74	1.42	0.00	0.00	0.00	0.00	36.35	14.55	6.17	5.84
M/C	24.19		*		*		45.45		31.93	
All	15.47	9.66	0.59	0.55	0.04	0.06	51.62	24.49	17.98	23.67
LASER Study Area										
Car	14.88	11.30	0.73	0.57	0.05	0.05	39.30	24.02	22.71	28.23
Bus	13.89	5.96	1.03	0.50	0.07	0.08	65.51	39.91	12.73	8.96
Rail	11.79	26.04	1.12	2.67	0.10	0.10	61.59	59.85	11.49	26.11
Slow	3.41	1.39	0.00	0.00	0.00	0.00	34.28	14.58	5.98	5.73
M/C	22.45		*		*		43.31		31.10	
All	13.28	8.65	0.51	0.51	0.04	0.06	46.49	24.35	17.14	21.31

5.9 The table shows that the average speed of travel on car for the non-owners is higher than for the M/C owners in all areas suggesting that the trips experiencing more congestion are those most likely to find motorcycle an attractive alternative. Motorcycle owners are less likely to make the longest rail trips, but the model does suggest they make longer bus trips than average which seems unlikely. The 10p per mile cost (in 2003) prices converted to 5.4 pence per kilometre in 1997 prices is coded for the motorcycle ride mode. However the resulting cost for motorcycle trips cannot be extracted from the LASER model since the cost component was modified to allow the required three term disutility function specified by the RAND usage model to be implemented.

5.10 The following set of figures (Figure 5.4 to Figure 5.7) show the average journey length and average journey time for motorcycle trips to and from each LASER model zone. The lengths of journeys starting in or close to London are shorter than those starting in other parts of the South East, although those starting in Central London are longer than average. A few areas around the South East – notably along the South Cost, Canterbury, and just outside Cambridge and Oxford support shorter motorcycle journeys, but a majority increase in length with increased distance from London. For the destinations the pattern is almost reversed with the longest trips ending in Central and Inner London and the shortest journeys being to destinations to the East of London, and along the south coast. A number of towns around the South East are also picked out with relatively shorter journey times for trips arriving there compared with journeys to the more rural areas. The pattern of motorcycle journey times by zone are similar to the distances, with a few notable differences, such as trips starting along the M11 corridor.

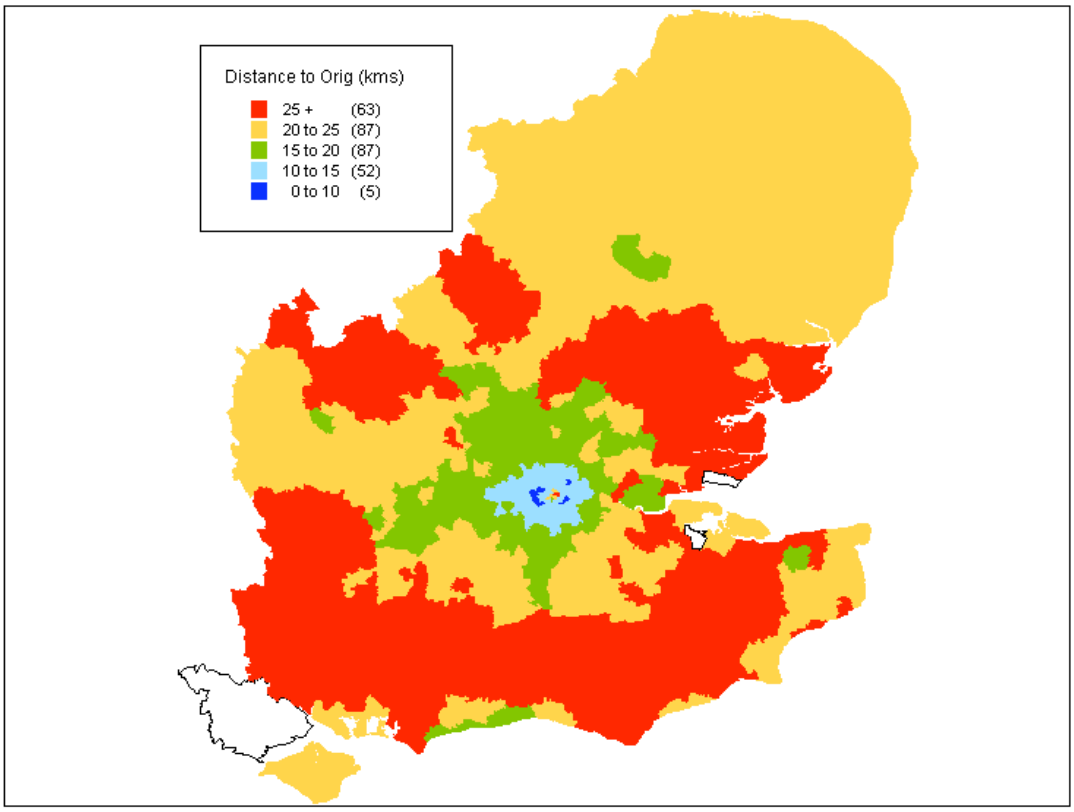

Figure 5.4: Average motorcycle journey distance from each origin zone – 1997 Base run

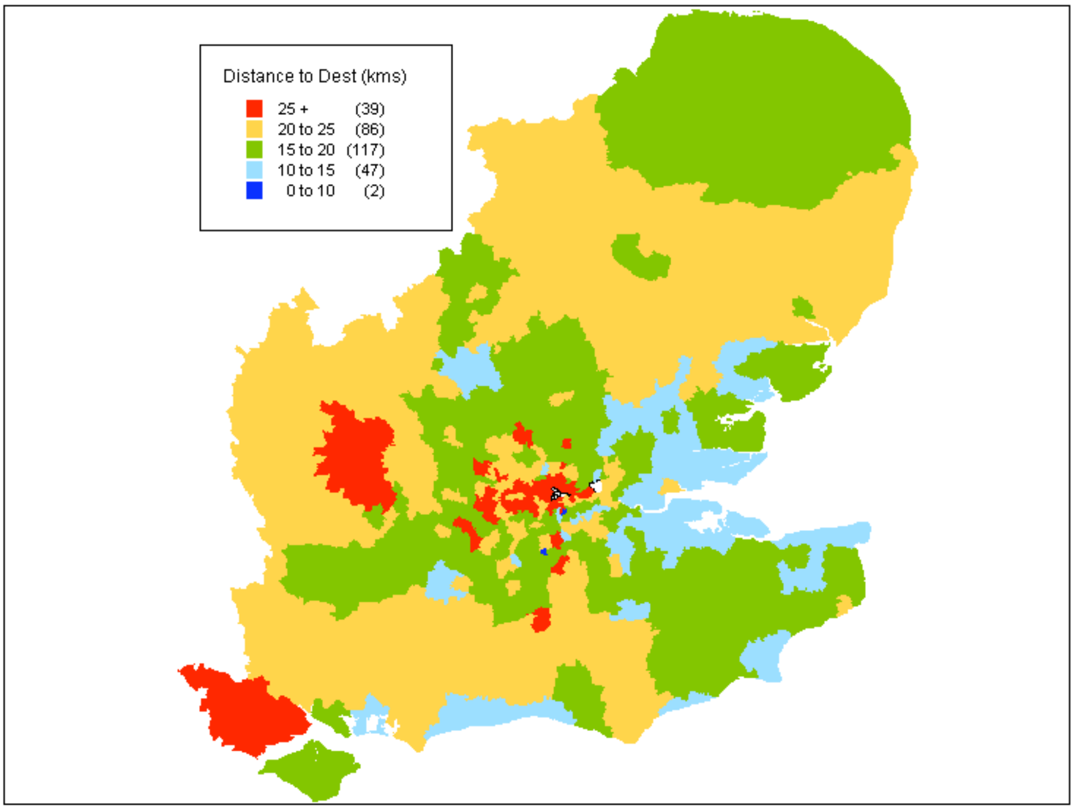

Figure 5.5: Average motorcycle journey distance to each destination zone – 1997 Base run

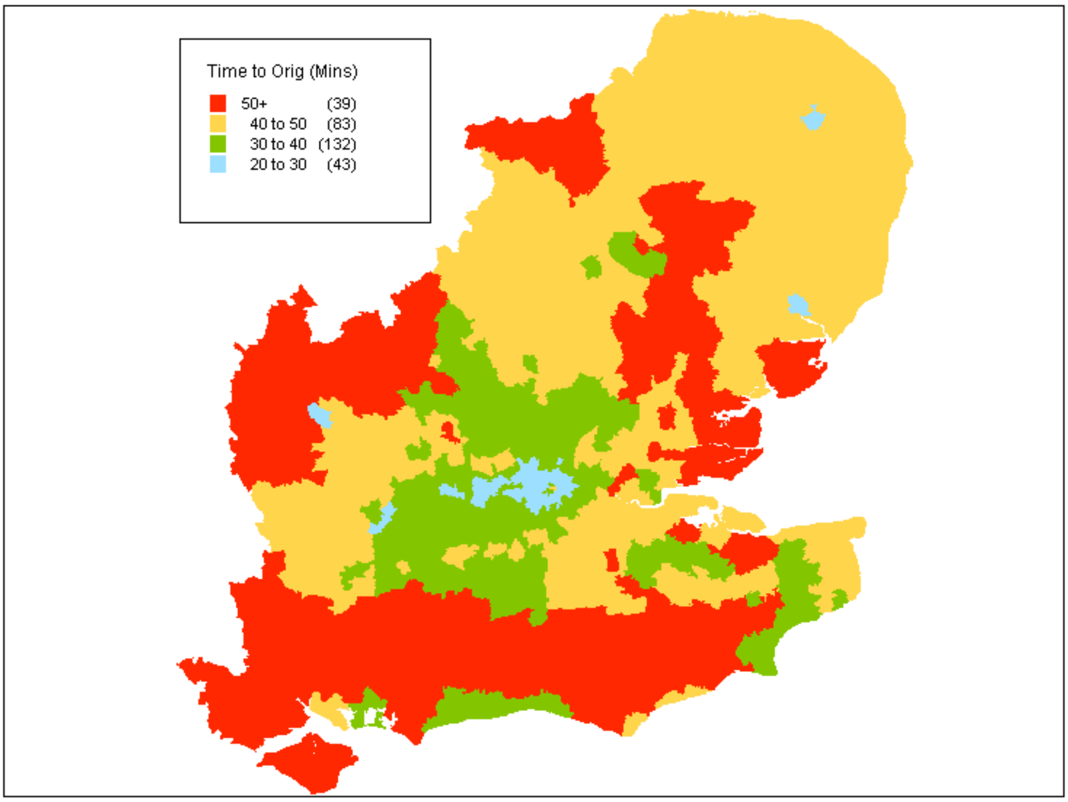

Figure 5.6: Average motorcycle journey time from each origin zone – 1997 Base run

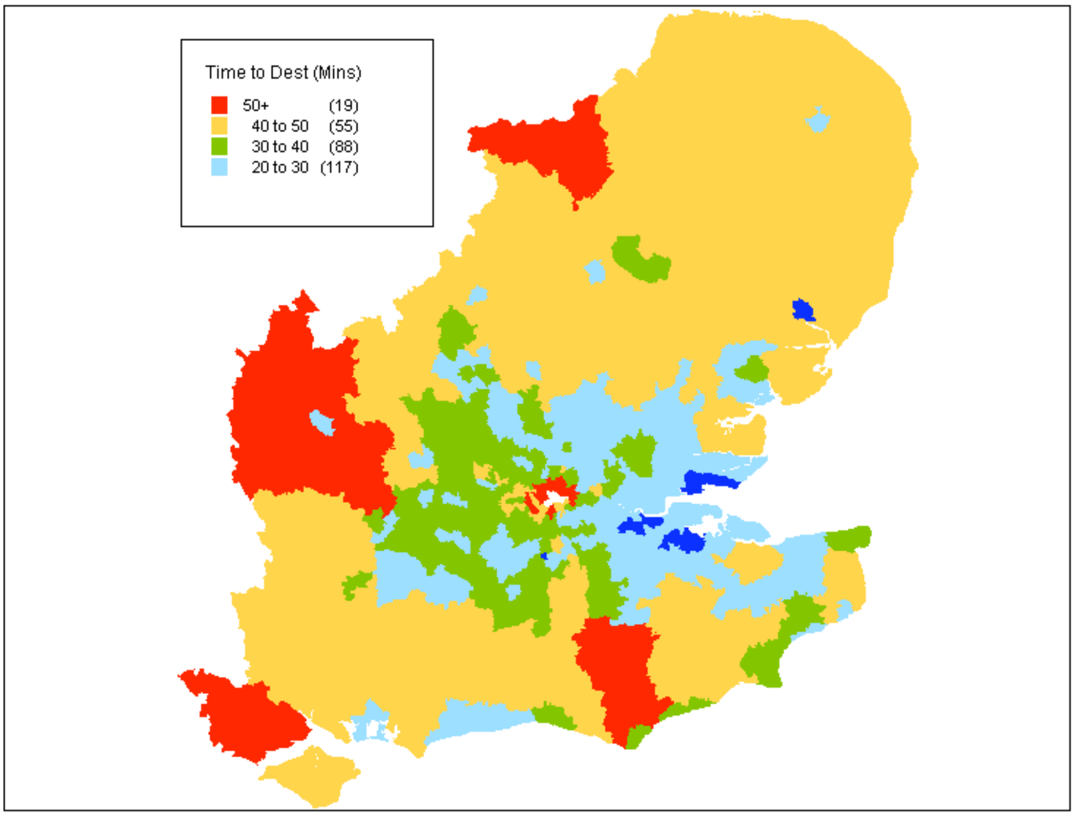

Figure 5.7: Average motorcycle journey time to each destination zone – 1997 Base run

Congestion and Lost time

5.11 The more strategic nature of the LASER model compared with the MENCAM model makes it less suitable for the analysis of congestion on a link by link basis. As part of the standard LASER model analysis used for policy testing on behalf of the Department, the average speeds, journey times and levels of congestion have been attributed to the ward or zones through which the different stretches of road are located. As might be expected the greatest levels of congestion are in and around London, with much less congestion in the outer parts of the South East and Eastern Regions.

5.12 Table 5.4 shows the lost time per trip and per kilometre for the different road types in the model. As might be expected the greatest level of congestion is experienced on single carriageway roads which is where a majority of the urban travel occurs and where motorcycle journeys could benefit compared with cars.

Table 5.3: Lost time per car kilometre by County in LASER, 1997 Base run

Link location	Total time (Seconds)	Vehicle-km	Time lost per veh-km (Sec)
Central	53,302,746	643,904	82.781
Inner London	275,694,584	3,554,209	77.568
Outer London	518,511,835	9,479,378	54.699
Kent	90,653,951	5,732,389	15.814
Oxon	49,911,013	2,964,783	16.835
Bucks	86,458,808	3,884,945	22.255
Berks	84,133,285	3,745,234	22.464
Hants	124,469,340	6,655,906	18.701
Surrey	165,146,797	7,343,487	22.489
W Sussex	44,572,212	2,538,639	17.558
E Sussex	28,799,187	1,345,466	21.405
Essex	126,999,787	6,076,752	20.899
Beds	30,895,066	1,970,896	15.676
Herts	123,548,551	5,793,316	21.326
Cambs	44,947,597	2,911,785	15.436

Table 5.4: Lost time per trip and per kilometre travelled by road type, LASER 1997 Base run

Road type	Total lost time (mins)	Lost time per trip (mins)	Lost time per km (mins)
Motorway	5,101,037	0.31	0.18
Dual Carriageway	4,640,531	0.29	0.28
Single Carriageway	20,367,170	0.48	0.75
All road types	30,108,738	0.38	0.33

WSP Group