Car-User Responses to Travel Demand Management Measures: Goal Intentions and Choice of Adaptation Alternatives

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1. Introduction

Congestion, noise, air pollution, and depletion of energy are among a host of expected future environmental and social consequences of the increasing worldwide trend in car ownership and use (Goodwin, 1996; Greene and Wegener, 1997). Indeed, many metropolitan areas are already experiencing these urgent problems with the result being the suggestion and implementation of a number of policy measures aimed at addressing the aforementioned consequences.

There are many conceivable policy measures that may reduce the levels of car-use related congestion, noise, and air pollution in metropolitan areas. Some of them (e.g., increased capacity of road infrastructure, improved car technology, or limiting speed) do not necessitate a reduction in car use. However, a general assessment of the current state is that measures reducing the demand for car use must be implemented in metropolitan areas (e.g., Hensher, 1998). In addition, it is desirable to change car use with respect to when and where people drive, particularly on major commuter arteries during peak hours and in city centres. Since the proposed measures focus on changing or reducing demand for car use, they are generally referred to as *travel demand management* (TDM) measures (Kitamura *et al.*, 1997; Pas, 1995).

The various policy measures aimed at reducing the consequences of ever-increasing car use differ in efficiency, cost, technical feasibility, and political feasibility. Vlek and Michon (1992) suggest that the following TDM measures, ordered from more to less coercive, are feasible ways of implementing car-use reduction policies: *physical changes* such as, for instance, closing out car traffic or providing alternative transportation; *law regulation*; *economic incentives and disincentives*; *information, education, and prompts*; *socialization and social model-*

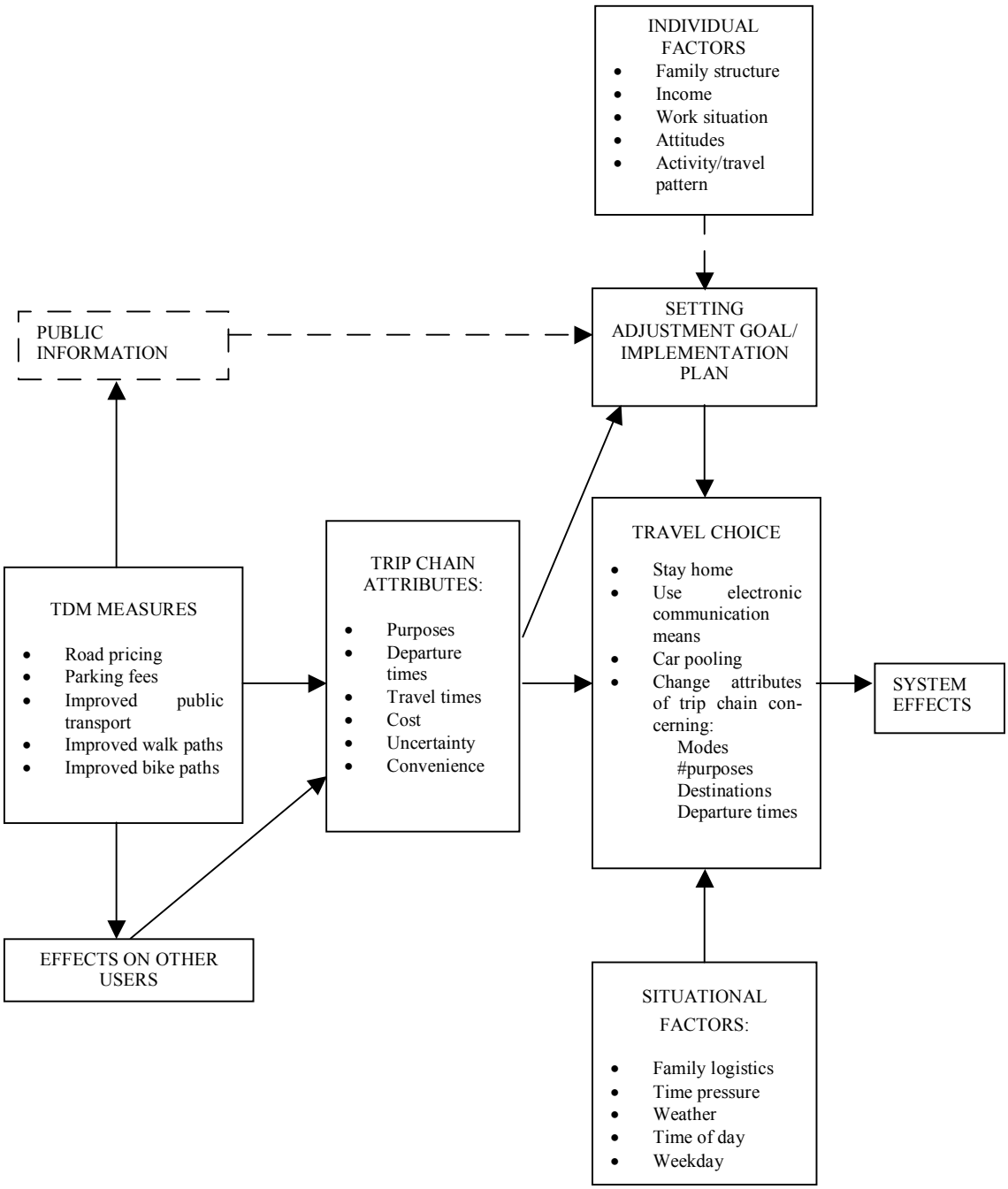
ling targeted at changing social norms*;* and *institutional and organizational changes* such as, for instance, flexible work hours, telecommuting, or "flexplaces." As they further note, the more coercive strategies may have negative side effects outweighing the expected benefits such as costs or sacrifices that households will not accept, whereas the less coercive strategies may be based on untenable assumptions about how much households are willing and able to change their car use.

Figure 1 presents the conceptual framework proposed by Gärling *et al.* (2002) with the aim of analysing the effects of TDM measures on private car use. Travel options are defined as bundles of attributes describing trip chains (including purposes, departure and arrival times, travel times, and monetary costs). Over time, it is assumed that car-owning households compare the current situation to a reference value or goal. If they experience a discrepancy, some action is carried out on the environment with the aim of minimising this discrepancy. Following from this, it is claimed that choices of travel options have two classes of determinants: (1) The bundles of attributes characterizing them, and (2) the goals set by the households. If a TDM measure is implemented, a car-use reduction goal may be set when households detect declines in travel options such as increased monetary costs or travel times. After having set a car-use reduction goal, households form implementation intentions.

Implementation intentions entail commitment to a plan for how to attain the goal (Gärling and Fujii, 2002). Such a plan in turn consists of sets of predetermined choices contingent on specified conditions. In making plans for how to reduce car use, households may choose among a wide range of options such as staying at home and thereby suppressing trips to out-of-home activities, perhaps using electronic communication means instead of driving, car pooling, travel to closer destinations, or using other travel modes. Households may also choose longer-

term strategic changes such as moving to another residence, changing work place, or changing work hours (e.g., compressing the work week).

Figure 1 A conceptual framework of the effects of TDM measures on private car use



Source: Gärling *et al.* (2002) page 61

If households set a goal to reduce car use that has monetary costs, time costs, or inconveniences, it is hypothesised (Gärling *et al.*, 2003a, 2003b) that they prefer options that attain this goal at minimal cost. That people adapt in this way has consistently been demonstrated in research on cost-benefit tradeoffs in decision making (Payne *et al.*, 1993). Since it may not be possible to immediately attain the car-use reduction goal, it is further hypothesised that a lexicographic decision rule is implemented over time (Svenson, 1998). As indicated in Table 1, the first stage is assumed to consist of making car use more efficient by chaining trips, car pooling, or choosing closer destinations. The cost is an increased need to plan ahead. The resulting change in car use may however not be sufficient to attain the car-use reduction goal.

Table 1 Adaptations to TDM measures

Choice options	**Possible costs**
More efficient car use • Trip chaining • Car pooling • Choosing closer destinations	Additional planning
More efficient car use Trip suppression	Additional planning Activity suppression
More efficient car use Trip chaining Mode switching	Additional planning Activity suppression Increased time pressure Inconveniences

In addition to making car use more efficient (implying increased planning), trips may be suppressed in order to achieve greater car-use reduction (implying changes in activities). Still, these changes may be minor, perhaps solely involving the suppression of isolated shopping trips. Leisure activities are most likely to be the next removed from the activity agenda or to

be substituted by in-home activities. Least likely are probably changes in employment status from full to part-time work.

The car-use reduction goal may still not be attained unless other travel modes are chosen. For instance, since work cannot easily be suppressed, public transport may be chosen for such trips. Additional planning, increased time pressure, and inconveniences are costs associated with mode switching. In addition, in order to alleviate a potentially harmful increased time pressure (Gärling *et al.*, 1999; Koslowsky, 1997), suppression of activities would also be necessary.

If the TDM measure is non-coercive or the cost of adaptation is too high, then there is also the possibility that people may cease searching for other adaptation alternatives to implement. They may instead give up their car-use reduction goal. This abandonment of a goal requiring great effort and costs is hypothesized to be more likely when the magnitude of the required reduction is large, a finding that has been demonstrated in research on goal-setting (e.g. Yearta *et al.*, 1995; see also Locke and Latham, 1990, for a more general review of this research area).

1.1 Summary of studies

The aim of the present research is to examine the nature of the goals households form in response to a range of TDM measures, their commitment to these goals, and the implementation intentions adopted in order to achieve these goals.

The same three scenarios consisting of TDM measures that are presently in operation in the world were utilised in the studies to be presented. These TDM measures vary on the aforementioned coercion continuum. The scenarios were *prohibiting car traffic from entering the*

city centre, road pricing, and *individual marketing* (all scenarios are reproduced in Appendix A).

A dual data-collection procedure was utilised. Study 1 was a focus group study that primarily sought to investigate those who regularly use the private car. Participants' goals, and their motivation to reach these goals, were ascertained as well as adaptations they would consider as a response to a TDM measure in order to achieve their goals. In contrast to providing a list of various alternatives for households to choose amongst, Study 1 attempted to gain some insight into the creativity of households' adaptation process and to examine which adaptation alternatives households may conceive of themselves.

Study 2 was an internet questionnaire study building upon the responses provided by focus group participants with respect to choice of adaptation alternatives to TDM measures. Here, the aim was to examine the size of the car-use reduction goals set by households in response to the TDM measures and the changes they would implement in order to achieve these goals. Emphasising the complementary nature of the dual data-collection process, whereas Study 1 obtained a range and breadth of goals (not necessarily confined to car-use reduction) and adaptation alternatives, Study 2 provided quantitative estimates of the car-use reduction that households would implement in response to the TDM measures, as well as the frequency of adaptation alternatives they would implement in order to achieve these goals.

2. Study 1: Focus Groups

A focus group can be defined as a planned discussion in a non-threatening, open environment aimed at obtaining participants' beliefs and perceptions on a specific topic of interest. Group sizes may range from 4 to 10 participants. A skilled moderator leads the discussion with the

aim being to encourage participants to share their ideas, beliefs, thoughts and opinions. Separating focus groups from other procedures such as individual interviews or questionnaires is the fact that they allow for group interaction, thereby arguably providing greater insight into why certain beliefs and opinions are held (for a detailed review of focus group procedures and their theoretical underpinnings, see Fern, 2001; Krueger, 2000). It is thus argued that focus groups encourage more critical thinking on the part of participants as a direct result of the interaction between other participants and the moderator, either of whom may question, challenge or agree with the participant's own belief and opinions.

2.1 Method

2.1.1 Sample selection

A screening questionnaire, for which no reimbursement was offered, was sent out using electronic mail to 600 randomly selected technical and administrative employees at Göteborg University, Sweden. Of these 600 e-mails, 37 could not be delivered due to the employee having left their place of employment (with no update to the catalogue of employees having been made), being on holiday, on leave or due to there being a permanent fatal error in the e-mail address.

The questionnaire consisted of several modules. Of relevance to Study 1 were the modules obtaining sociodemographic information and current driving behaviour (broken down into work, shopping and leisure trips). A question was also asked to determine whether or not respondents were interested in participating in a group discussion.

The response rate to the questionnaire was 48.3%. Table 2 presents the sample descriptives calculated from responses to the sociodemographic questions and from responses to questions

concerning current car use.

Table 2 Sample descriptives (Study 1)[1]

Sample descriptives	Interested in focus group participation[2]		
	Yes (n = 40)		No (n = 68)
	Participated in a focus group		
	Yes (n = 20)	No (n = 20)	
Sex (% men)	35.0	5.0	27.9
Age (years) (M/SD)	43.9/11.6	46.6/10.9	46.3/10.7
Tertiary education (%)	60.0	50.0	60.3
Married/cohabiting (%)	75.0	65.0	69.1
Households with child(ren) (%)	55.0	55.0	57.4
Possession of driving license (%)	100.0	95.0	86.8
Access to car(s) (%)	100.0	95.0	75.0
Annual driving distance, km (M/SD)	11794/6755	9305/7276	9671/11790
Current monthly car use - work trips (frequency) (M/SD)[3]	13.1/11.0	8.5/11.5	9.4/11.0
Current monthly car use - shopping trips (frequency) (M/SD)[3]	5.5/3.4	5.6/3.2	4.8/5.9
Current monthly car use - leisure trips (frequency) (M/SD)[3]	6.5/6.9	4.5/2.4	5.1/5.9

Notes:

1. No significant differences were found for either mean values or frequencies between any of the groups in Table 2. The exception was the proportion of men in those respondents who were interested in participating in a focus group but did not participate. This was a conscious decision on the part of the researchers given the low relative frequency of males among technical and administrative staff, with the result being that males indicating a willingness to participate were aggressively recruited.

2. Those respondents (n = 164) not indicating whether or not they wished to participate in a focus group are not included in the table.

3. A five point Likert-scale was utilised (never, 1-3 times/month, 1-2 times/week, 3-4 times/week, or 5 or more times/week) with frequencies converted to midpoints of the intervals (0, 2, 6.4, 15, and 25.7 times per month).

Selection for participation in the focus group discussions was based on two criteria: (i) that respondents to the questionnaire indicated a willingness to participate in a focus group, and

(ii) that respondents used the private car at least 3-4 times per week for at least two activities (work, shopping, or leisure). The combination of these criteria, along with the ability to find a time suitable to more than one potential focus group participant, reduced the number of focus group participants to a total of 20. This, together with the demanding nature of the tasks, led to the decision being made to conduct a series of five focus group sessions. As seen in Table 2, the characteristics of questionnaire respondents who used the car a great deal and did not wish to participate in a focus group discussion did not greatly differ from the characteristics of those respondents who wished to participate in a focus group discussion.

2.1.2 Procedure

Upon arrival at the agreed time and place, participants were briefed about the aims of the discussion, the fact that it was confidential and completely voluntary and that they could leave the discussion at any time without risking their reimbursement (2 movie passes) for participation. All discussions lasted approximately 90 to 120 minutes and were videotaped and recorded with the consent of the participants.

The procedure for each focus group was the same. When all participants had arrived and refreshments had been served, an ice-breaker question was posed that could be answered quickly and easily by all participants. The next stage consisted of presenting participants with a detailed description of a TDM measure as it had been implemented in a certain region of the world. Participants were free to ask for clarification or elaboration after presentation of the scenario. The discussion proper then began asking participants for (i) their opinion of the TDM measure; (ii) their opinion if the particular TDM measure were to be implemented in Göteborg; (iii) the way in which such a TDM measure would affect their work, shopping and leisure travel; and (iv) the way in which they would attempt to counteract any consequences

resulting from the implementation of the TDM measure.

After having discussed the base scenario, participants were presented with additional information concerning what had been done in conjunction with the implementation of the TDM measure (e.g., improving public transport). In order to ascertain any change in opinion, participants were then asked for (v) their revised opinion of the TDM measure, if any; and (vi) the way in which the TDM measure would affect their work, shopping and leisure travel.

Having fully discussed the TDM measure, participants filled in a questionnaire gauging their opinions of, and beliefs in, the effectiveness of the TDM measure. The discussion then moved on to the next TDM measure with the same procedure being followed. The order of scenario presentation was from coercive to non-coercive and not randomised or counterbalanced. The reason for this was that previous research has demonstrated the often strong negative reactions people have to such coercive measures (e.g., Jones, 1995) and it was felt that placing the least coercive measure at the end would not exacerbate such negative reactions by providing a positive reference point, should these negative reactions again be found. Finally, prior to concluding the focus group, participants discussed (vii) their opinions of demand-based solutions to traffic problems and (viii) which other measures, if any, they would prefer to see implemented and the reasons for this.

2.2 Results

The results selected for presentation are limited to focus group participants' responses to the presented TDM measures. Although participants were asked for their opinions and attitudes of the various TDM measures (in terms of acceptability, effectiveness and fairness), these are not reported here.

2.2.1 Reliability

Two independent raters coded a focus group transcript on the basis of a predetermined coding scheme, which had been designed free of input from the raters. The coding scheme corresponded to the main topics covered during the focus group discussions. The discussions among focus group participants were coded into broad categories and finer units, with quotations being selected by raters in order to support their categorization. These quotations included simple agreements to another's comment as well as body language (e.g., nodding head in agreement). Comments unable to be placed into the theoretically predetermined categories were noted as "other comments". Furthermore, participants who did not express an opinion were classified accordingly. After meeting with the first two co-authors to discuss differences and clarify any other issues and problems, the two research assistants coded the remaining focus group transcripts (as well as the original test focus group transcript). The inter-rater reliability prior to discussion was .69. After discussion of the scheme and of any differences and misunderstandings, inter-rater reliability increased to .92. In the following sections a description of all views expressed and opinions held in the focus groups is provided. The selected quotations serve as examples underlining the more widely-held views.

2.2.2 Prohibition of car-traffic in the city centre

Participants were asked whether or not prohibition would affect their work, shopping and leisure trips and, if so, in which ways. Despite the coerciveness of prohibition, most focus group participants did not believe the measure would have such a great effect on their travel. The reasons for this, with respect to work trips, had mainly to do with the fact that many did not work in such a central location (and that prohibition would in all likelihood not cover an area much larger than that described in Cambridge). For those participants who believed their

work trips would be affected, the most common effects provided were in terms of convenience and time:

> "… you could only drive the car part of the journey in and this would have immediately been more complicated."

As expected, given the coerciveness of the TDM measure and given the inability to suppress work trips, responses to prohibition included using public transport. A few participants said that they would work from home (although not necessarily as a consequence of the TDM measure because they already teleworked on a semi-regular basis).

With respect to shopping trips, the consensus again was that prohibition would have very little effect mainly because the type of shopping activities one requires the car for is no longer done in the city centre but, rather, either at large outlets on the outskirts of town or at local stores closer to the home. For the few participants who believed that prohibition would affect their shopping trips, the response (in the case where home delivery was not an option) was to consciously select destinations outside the city centre and:

> "… to travel elsewhere so that you don't come across [bollards or other such obstacles used for keeping out cars from the city centre]."

Finally, leisure trips were also not greatly affected because it was assumed, like in Cambridge, that traffic would only be prohibited during certain times of day and that these times did not coincide with when most focus group participants had the time to partake in leisure activities (i.e., evenings and weekends). Furthermore, if it was the case that one could not drive all the way into the centre, participants' response was to drive the car as near as possible to the city boundaries and, presumably, walk the rest of the way given the belief in how costly public transport is:

> "You would be prepared to park the car somewhere along the way … which would not be more than half a mile … plus it isn't cost effective if the whole family has to go by bus."

2.2.3 Road pricing

Participants were aware that the effectiveness of a road pricing scheme modelled after Singapore's was dependant on the size of the restricted area and the cost and hours of operation. Even so, relative to prohibition, road pricing was seen as having an effect on a greater number of participants and as having a greater effect on participants' work trips than on other trip types:

> "I would naturally try to leave half an hour earlier in the morning."

> "It would make me more motivated to take the bus."

It is worthwhile noting that route changing was not a strategy as a result of the fact that the scenario discussed was based on the Singapore model which is an area pricing scheme despite its name. Even though the road pricing TDM measure was regarded as having a greater impact on participants' work trips in terms of either better planning (changing the time of a trip to avoid paying the toll) or mode switching, there were still a substantial number of participants who claimed they would not be affected by this particular TDM measure either because they could not change their workplace or because they would integrate the cost of driving into a more general account having to do with cost of going to work (i.e., the cost is not associated with driving per se):

> "I would probably continue to drive anyway. I mean I have no alternate workplace where I live so I would either need to move or change job."

> "As long as you have your workplace [inside the tolled area] you need to take the cost into account … that it costs however much per week to get to work with these road tolls."

For both shopping and leisure trips little effect was expected of road pricing. If one is to go

shopping or go to the movies or participate in another leisure activity, then the cost of driving is not seen as such but as part of a general "going out" or "leisure" account:

> "I think you would be prepared to pay. If you are going in [to town] to enjoy yourself you can pay a little extra for the car."

> "There would be little effect because those hours required to do your shopping you would want to pay for so as to be able to arrive comfortably and leave with your purchases."

Other reasons given for not being affected by road pricing had mainly to do with the fact that one did not do his or her grocery shopping within the presumed tolled area. Those participants who claimed to be affected by road pricing would, by and large, avoid the central area of Göteborg (as opposed to switching modes or time of travel as was the case for work trips).

2.2.4 Individual marketing

When individual marketing was thought to have an effect, participants stated that their work trips would be most likely affected than either their shopping or leisure trips. This is because public transport service levels were assumed to be better when the majority of the workforce travelled to the workplace:

> "I have travelled the same route to my workplace every day since late 1998 [and] the same route home … that is, I could almost certainly be informed of a better route than the one I have consistently travelled, a quicker way with public transport."

Importantly, even participants who were ambivalent to the idea of individual marketing were often willing to test the programme in the long term:

> "If the [programme] period was long term, people would take the chance and test to see how it works for them. I can imagine that I probably would not use the car at all for travel to work if I didn't save as much time as I thought I did."

Those participants who did not believe they would alter their work-related travel provided

reasons based either on poor quality of public transport, on notions of the freedom provided by the car, or on the fact that not using the car to travel to work prevented them from combining the homeward trip with other activities such as going to the gym, socialising or grocery shopping:

> "I experience [using the car] as having freedom. You can shop on the way home, which I can't do if I use the tram because there are no stores on the way home from work."

The prospect of influencing participants' shopping and leisure trips was, however, minimal. The overwhelming majority of participants would continue to shop and perform leisure activities as they do currently. The reasons provided had to do with either practicality or convenience (particularly for shopping trips but also for leisure trips) or with the fact that using the car as part of a leisure activity was part of the enjoyment:

> "… it's just pragmatic to have the car for shopping trips."

> "… it doesn't seem like fun at all using public transport in my free time."

A final point with respect to individual marketing was the distinction made by participants between changing trips (from car-based to public transport-based) and changing people (from car users to public transport users). Some regarded the TDM measure's tailored information (often cited as a reason for Individual Marketing's success) as its biggest potential drawback and limitation. This is because it was believed that should people need to change their usual travel they do not have the ability to search the system themselves and find the information they require because everything was previously tailor-made and automatically provided for them:

> "One also needs to be aware of not only the usual home-work-home route but of also a lot of other things. One needs to have a certain habit, if this tramline is not in operation, then I can take this bus instead."

2.2.5 Reactions to improvements to the baseline TDM scenario

For each of the three various TDM scenarios, participants were first presented with a baseline scenario, asked their opinions and reactions, and thereafter asked for their opinions and reactions to the same scenario but with improvements, such as improved public transport, new services and so forth. These improvements were based on the actual improvements made in each of the cities forming the basis of each TDM scenario.

In the case of road pricing and individual marketing, there was little change in opinion and, as expected, little change in participants' reported adaptations should such a TDM measure be introduced. In the case of prohibition, however, the majority of participants believed the improvements made the overall situation better, particularly a 'Park and Ride' scheme. In line with this, opinion improved. Yet, stated adaptations (e.g., driving as close as possible to the city centre) were no different from those reported above for the baseline prohibition scenario.

2.2.6 Other findings

Participants were also questioned with respect to what they thought of TDM-based solutions to traffic problems and what other steps and policies they would prefer to be implemented. These are presented here within the context of car-use reduction.

There was a wide range of opinions with respect to what participants thought of such TDM measures. These opinions could broadly be categorised into those who believed that something new and different (as opposed to the traditional expansion of the road network) is needed and those who believed the opposite and contended that it was a matter of poor planning and building (and not expansion of the network per se):

"Something needs to be done. You just can't keep on building and building [new roads]. I mean all it

> really is about is one and a half hours of congestion in the morning and evening … these are actually just temporary bottlenecks."

> "I think it's important that traffic is free-flowing and that it isn't just our [i.e., people who have a car] fault. Rather, those responsible for planning have a responsibility to expand or improve [the road network]. I believe a lot of [these problems] can be built away … some overall coordination in this issue is needed and I think that's missing in this town and that it has a lot to do with planning."

When asked what other measures they would like to see in order to achieve a car-use reduction goal, participants provided a range of possibilities such as introducing or increasing petrol taxes, introducing large subsidies for alternative energy fuels, minimizing the ability to make tax deductions for certain trips, better and more frequent public transport and even free public transport. Additionally, participants believed an information campaign to understand the motivation behind all the various TDM measures would assist in increasing acceptability and in motivating them to reduce car-use:

> "… with respect to prohibition, one can justify it in many ways: minimising noise, greater accessibility for pedestrians and cyclists etc. (sic.) … that's okay with me. But with road pricing it feels as if there are more obscure motives behind the policy … one needs to justify and motivate the reasons for it. Is it to minimise traffic jams? Minimise carbon dioxide emissions? Increase safety? What's the reason for it?"

Finally, participants also stated that combinations of the three TDM measures would probably be more effective in getting them to reduce their car use and in assisting them in their adaptation. In general, individual marketing was seen not as a TDM measure in its own right, but as a complement to the remaining TDM measures that could assist in how people could reduce their car use. Furthermore, this was directly linked to the differences in level of coerciveness of the TDM measures:

> "The first two [prohibition and road pricing] are a kind of punishment. This one [individual marketing] presents us with opportunities and options … this can be experienced as a positive thing."

> "[Individual marketing] would perhaps ease the consequences of road tolls … There would thus be a need for a type of service like [individual marketing]."

2.2.7 Summary

All three TDM measures appeared to make participants believe that work trips would be more affected than other trip types and, in most cases, the main response of participants was to switch mode and to a lesser extent (in the case of road pricing) change the time of travel. When participants stated that they would not be affected by the TDM measures in question, it was mainly due to their workplace being outside the affected area or to a willingness to accept the additional costs.

The problem with influencing shopping and leisure trips lay more in the fact that these activities tended not to be conducted in the TDM-affected area or, if they were, then the hours during which participants would normally conduct these activities allowed them to continue using the car without additional costs being incurred. Additionally, people were willing to regard the increased costs as belonging to an "entertainment account" or equivalent and not as being associated with driving per se. An adaptation unique to shopping and leisure trips was changing destination so as to be able to continue using the car.

The focus group discussions also revealed that participants were divided when it came to opinions of demand-based traffic and transport policies and that they had various opinions with respect to what other measures they would like to see implemented if they were to reduce their car use. Finally, the general consensus was that combinations of the TDM measures discussed in the focus groups would be more effective in reducing car-use and in assisting with choice of adaptation alternatives, particularly given the opinion that individual marketing functioned as more of a complement to the remaining TDM measures.

3. Study 2: Internet Survey

The primary aim of Study 2 is to obtain estimates of the size of car-use reduction goals that households would set and implement in response to the three TDM measures. A concomitant aim was to obtain estimates of the amount and frequency of adoption of a series of adaptation alternatives that participants would implement in order to achieve these car-use reduction goals.

The survey questionnaire was comprised of nine modules obtaining the following information: (i) sociodemographic information; (ii) current car use; (iii) awareness of problems related to the level of car traffic in Göteborg (problem awareness), adapted from Vlek *et al.* (1999); and (iv) importance (i.e., weights) of various traffic-related characteristics, such as accessibility and air pollution.

The various scenarios were then presented to each participant, as outlined in Appendix A, but without the section entitled "Additional information" which was used only in the focus group discussions. Each scenario also had clickable thumbnails of relevant pictures and maps. The following modules were presented for each scenario: (v) attitude to the TDM measure in question; (vi) expected car use in a scenario with such a TDM measure; (vii) frequency of adoption of a series of adaptation alternatives in response to the TDM measure, as well as whether these are more or less frequent than is currently the case; (viii) whether or not the traffic-related characteristics, for which importance ratings were obtained, would increase or decrease in response to the implementation of the TDM measure in question, as well as whether this would be a positive or negative occurrence.

A final module was presented to respondents asking them to rank the various TDM measures in order of preference. Furthermore, respondents were also given the opportunity to comment

on what they thought of such policies and what other type of measures and policies, if any, they would prefer. The time required to answer the questionnaire was approximately 35 minutes.

Examining the goals households set in response to the TDM measures and the alternatives selected in order to achieve these goals, required that modules (i), (ii), (vi), and (vii) be analysed.

3.1 Method

3.1.1 Sample selection

The targeted sample in Study 2 consisted of 600 randomly selected employees from all levels and areas of duty (e.g., professors, technicians, research assistants, project managers, administrative staff) at Göteborg University, excluding those who had been contacted in Study 1.

The selected sample was contacted by e-mail with a letter containing a description of the aims of the research, a link to the questionnaire and their unique ID number should they wish to participate. Participants were also promised a lottery ticket (worth approximately EUR 2.50) in return for their participation. Due to permanent failures in the e-mail address, maternity/paternity leave, annual leave and employees who had recently left the university as a place of employment, a total of 553 (92.1%) e-mails were actually delivered. Respondents were first contacted on a Monday and given a week to respond prior to any reminder being sent out. A total of three reminders were sent to respondents, with the last reminder stipulating that the questionnaire would no longer be accessible after 12 pm on the Friday of the week in which the last reminder was sent. In total, 304 responses were received. Removing participants who had examined the questionnaire but had failed to answer any questions yielded an

effective response rate of 52.6% (i.e., 291 usable responses).

Table 3 presents the sample descriptives calculated from responses to questions obtaining sociodemographic information and from responses to questions concerning current car use.

Table 3 Sample descriptives (Study 2)

Characteristics (N = 291)	n	Descriptive
Sex (% men)	291	53.6
Age (years) (M/SD)	291	44.8/11.9
Tertiary education (%)	282	90.7
Household income, in ’000 SEK (M/SD)	276	483.5/186.3
Residing in central Göteborg (%)	291	49.1
Married/cohabiting (%)	284	74.6
Households with child(ren) (%)	283	43.0
Possession of driving license (%)	278	88.3
Access to car(s) (%)	284	71.5
Problem awareness (M/SD)[1]	278	29.58/7.71
Annual driving distance, in kilometres (M/SD)	204	10850.7/9251.7
Current monthly car use - work trips (frequency) (M/SD)[2]	283	7.6/9.8
Current monthly car use - shopping trips (frequency) (M/SD)[2]	280	5.0/6.0
Current monthly car use - leisure trips (frequency) (M/SD)[2]	282	4.5/5.2

Notes:

1. Problem awareness was an index composed of six questions with seven-point Likert scales.

2. A five point Likert-scale was utilized (never, 1-3 times/month, 1-2 times/week, 3-4 times/week, or 5 or more times/week) with frequencies converted to midpoints of the intervals (0, 2, 6.4, 15, and 25.7 times per month).

3.1.2 Data analyses

Of the 291 questionnaire responses, 92 respondents had either no driving license or no access to a car. These respondents were excluded from all subsequent analyses.

A preliminary analysis was conducted to estimate the effect of differences in level among individual participants. A new variable was created by summing each individual's 9 car-use reduction scores (i.e., 3 TDM scenarios by 3 trip types). This variable (referred to as individual level differences or ILD) was the dependent variable in a regression analysis where the independent variables were income, problem awareness and residential location. For an Adj. R^2 = .056, $F(3, 1787) = 33.80$, $p < .001$, each regression coefficient ($\beta_{income} = .14$; $\beta_{problem\ awareness} = .11$; $\beta_{residential\ location} = -.15$) was statistically significant, $p < .001$. The ILD variable was included in the subsequent regression analyses thereby permitting the separation of variance attributable to individual differences from variance attributable to the effects of a treatment (i.e., TDM by trip type).

A regression model of the determinants of the size of the car-use reduction goal was estimated with the independent variables being the main effects of coerciveness of the TDM measure, trip type (assumed to vary in how discretionary various trips are) and the interaction between the TDM measures and trip type and the TDM measures and each of income, problem awareness and residential location.

In order to obtain estimates of the amount and frequency of adoption of different adaptation alternatives that participants would implement in order to achieve their car-use reduction goals, a second regression analysis was conducted testing the validity of the proposed cost-minimisation principle for households' adaptation to TDM measures. In this regression analysis size of the car-use reduction goal (frequency per month) was the dependent variable. The independent variables were the stated choices of the various adaptation alternatives: more efficient car use (defined as the mean of "conducting more errands per trip" and "car-pooling with others"); trip suppression (defined as the mean of "conducting fewer shopping strips

(more frequent weekly shopping or shopping over the internet)", "conducting fewer leisure activities outside the home" and " working from home (teleworking)"); mode change (defined as the mean of "switching from the car to other transport modes" and "choosing other destinations so as to not require the car"); choosing other destinations so as to continue using the car; and, changing the time of the car trip. Additionally, interactions between each of these adaptation alternatives and the TDM measures and the trip types were included in the analysis.

As outlined in Table 4, in both regression analyses, categorical variables are contrast coded and continuous variables centred. The contrasts defined in Table 4 were designed so as to test the hypothesis that that the more coercive a TDM measure is, the greater the set car-use reduction goal. Similarly, larger car-use reduction goals are hypothesised to be more likely for discretionary trips, such as shopping and leisure, than non-discretionary trips, such as work. In addition, as seen in Figure 1, it is hypothesised that other household and individual characteristics such as income, problem awareness and accessibility to work and services (i.e., residential location) may modify the influence of TDM measures on goal setting. That is, we expect an interaction between these variables and contrasts TDM1 and TDM2.

Testing the validity of the proposed cost-minimisation principle was done by correlating the size of the car-use reduction goal with the stated choices of adaptation alternatives, which vary in effectiveness and cost. In line with Gärling *et al.*'s (2003a, 2003b) hypothesised hierarchical structure of adaptation, significant correlations with all the stated choices of adaptation alternatives were expected but, when regressing onto size of car-use reduction goal, a significant regression coefficient would be obtained only for the most costly and effective adaptation alternatives.

Table 4 Summary of variables and main effect contrast coefficients (where applicable) for regression analyses 1 and 2.

Contrast-coded variable	Contrast label	Contrast coefficients		
		Prohibition	Road pricing	Individual Marketing
TDM measures	TDM1	1	-1	0
	TDM2	.5	.5	-1
		Work	Shopping	Leisure
Trip type	TRIP1	1	-.5	-.5
	TRIP2	0	1	-1
Residential location	RES1	Central Göteborg 1		Non-central Göteborg -1

Continuous variable (centred)	Label
Individual level differences	ILD
Household income	INC
Problem awareness	PA
More efficient car use	EFF
Trip suppression	SUP
Mode change	MOD
Choose other destination to continue using car	DES
Changing time of car trip	TIM

3.2 Results

3.2.1 Regression 1: Determinants of size of car-use reduction goal

The results are presented in Table 5. The model accounts for almost 39% of the variance in the size of the stated car-use reduction goal. A great deal of the variance is attributable to individual differences (ILD). However, as revealed in the preliminary analysis only a small portion (5.6%) of this variance is due to income, problem awareness and residential location.

Table 5 Results of regression analysis 1, with expected car-use reduction (M = 1.28, SD = 5.00) as dependent variable (n = 199)

Independent variable	M	SD	r	p	β	t	p
ILD	1.31	3.12	.623	< .001	.623	29.92	< .001
TDM1		.82	.022	.177	.021	1.02	.308
TDM2		.71	.023	.162	.052	1.98	.048
TRIP1		.71	.026	.133	.026	1.27	.204
TRIP2		.82	.021	.189	.021	1.00	.317
TDM1 × TRIP1		.58	.006	.405	.006	.28	.779
TDM1 × TRIP2		.67	-.008	.361	-.008	-.41	.682
TDM1 × RES1		.77	-.011	.319	-.007	-.31	.757
TDM2 × TRIP1		.50	.004	.425	.004	.21	.834
TDM2 × TRIP2		.58	.002	.470	.002	.09	.928
TDM2 × RES1		.45	-.013	.294	-.046	-1.70	.089
TDM1 × INC		135 949.62	.023	.170	.023	1.08	.280
TDM2 × INC		117 735.83	.006	.394	.006	.28	.779
TDM1 × PA		6.31	.010	.335	.013	.60	.549
TDM2 × PA		5.47	.028	.121	.029	1.39	.165

Adj. R^2 = .388, F(212, 1578) = 4.72, p <.001

The results thus demonstrate that, with one exception, the coerciveness of the various TDM measures, the type of trip undertaken or the interaction between these two factors do not play a large role in determining the size of respondents' reduction goals. The exception is the contrast comparing individual marketing with the remaining two coercive TDM measures (TDM2). As expected, individual marketing results in smaller car-use reduction goals than the more coercive measures.

3.2.2 Regression 2: Adaptations in achieving car-use reduction goal

The results presented in Table 6 show that the model accounts for slightly more than 40% of the variance. Again, a great deal of variance is attributable to individual differences (ILD). However, there are also a host of significant effects linking adaptation alternatives and car-use reduction goal.

The three adaptation alternatives *more efficient car use* (EFF), *trip suppression* (SUP), and *mode change* (MOD) all show significant correlations with the car-use reduction goal. Furthermore, the size of the correlation increases as the adaptation alternatives vary from less to more costly and effective. As expected, a significant positive regression coefficient is obtained only for the most costly and effective adaptation alternative. However, EFF has a significant negative regression coefficient in the multiple regression model suggesting that, controlling for other adaptation alternatives, it has a negative partial correlation with car-use reduction. In fact, $r_{(\text{partial})} = -.060$. Yet, partly because the other adaptations in the proposed hierarchy correlate positively with EFF, $r_{(\text{EFF}\times\text{SUP})} = .440$ and $r_{(\text{EFF}\times\text{MOD})} = .463$, more efficient car use can be argued to be positively related to car-use reduction.

Suggesting qualifications to the assumed invariance of the cost-minimisation principle, the in-

Table 6 Results of regression analysis 2, with expected car-use reduction (M = 1.28, SD = 5.00) as dependent variable (n = 199)

Independent variable	M	SD	r	p	β	t	p
ILD	1.31	3.12	.623	< .001	.621	31.33	< .001
EFF		.78	.046	.027	-.065	-2.39	.017
SUP		.62	.073	.001	.033	1.35	.177
MOD		.79	.123	< .001	.078	2.75	.006
DES		.78	.029	.106	.010	.43	.522
TIM		.92	.060	.006	-.038	-1.44	.150
TDM1 × EFF	-.03	.70	-.074	.001	-.060	-2.63	.009
TDM2 × EFF	.00	.49	-.019	.213	.058	1.99	.047
TRIP1 × EFF	.00	.55	.059	.006	.037	1.60	.110
TRIP2 × EFF	.00	.64	-.022	.172	-.026	-1.10	.271
TDM1 × SUP	-.01	.53	-.007	.219	.008	.33	.741
TDM2 × SUP	.03	.42	-.015	.184	-.013	-.50	.617
TRIP1 × SUP	.00	.44	.062	.004	.049	2.11	.035
TRIP2 × SUP	.00	.51	-.039	.049	-.048	-2.09	.037
TDM1 × MOD	.01	.68	.000	.493	.012	.48	.631
TDM2 × MOD	.02	.52	.020	.195	-.013	-.44	.660
TRIP1 × MOD	.00	.56	.047	.023	.037	1.43	.153
TRIP2 × MOD	.00	.64	.022	.173	.060	2.28	.023
TDM1 × DES	.00	.68	.023	.163	-.018	-.90	.368
TDM2 × DES	.09	.51	-.061	.005	-.046	-1.98	.048
TRIP1 × DES	.00	.55	.003	.451	-.020	-.97	.332
TRIP2 × DES	.00	.65	-.012	.302	-.007	-.35	.726
TDM1 × TIM	-.06	.76	.010	.341	.003	.12	.904
TDM2 × TIM	.08	.65	-.001	.479	-.017	-.59	.555
TRIP1 × TIM	.00	.65	.008	.370	-.037	-1.54	.124
TRIP2 × TIM	.00	.76	.003	.448	-.006	-.23	.818

Adj. R^2 = .401, F(223, 1567) = 4.70, p <.001

teractions between EFF and each of the two TDM contrasts were significant. The positive coefficient for TDM2 × EFF suggests that more efficient car use is more frequently chosen as the adaptation for coercive TDM measures (prohibition and road pricing) than for individual marketing. Also, the negative coefficient for the interaction term TDM1 × EFF indicates that more efficient car use is more frequently chosen under prohibition than under road pricing.

The interaction between suppression (SUP) and each of the trip types was also significant. TRIP1 × SUP suggests that car trips to work are more frequently suppressed than the more discretionary shopping and leisure trips while TRIP2 × SUP suggests that suppression of shopping trips is less frequent than of leisure trips. At the same time, however, the significant interaction between mode change and trip type (TRIP2 × MOD) suggests that one more frequently changes mode for shopping trips than for leisure trips. Finally, the significant TDM2 × DES interaction indicates that changing destination to continue using the car is a more frequent adaptation strategy to coercive TDM measures than individual marketing.

4. Discussion

While it is inappropriate to directly compare the focus group and questionnaire based study given their different aims (i.e., gauging creativity of household responses compared with estimating size of reduction goal and adaptation alternatives), it is, however, apparent that some of the results complemented and tended to be consistent with one another. For example, the opinion of individual marketing as not a 'real' TDM measure but as a complement to the more coercive measures corresponds nicely with the finding from Regression 1 that the car-use reduction goal was smaller for this TDM measure than for the more coercive measures.

With respect to the effects of TDM measures on the setting of car-use reduction goal, both

Study 1 and Study 2 revealed that very little change was required by car-users in order to adapt. Inconveniences arising from a TDM measure tended to be resolved wherever possible by changing travel pattern (e.g., driving to other destinations or changing time of travel) rather than by reducing car use. This resulted in the most common reduction in frequency of car use (per month) being none at all, with a consequent mean car-use reduction goal of 1.28 for the internet survey.

With respect to adaptation alternatives, the focus group discussions permitted a richer interpretation of many of the findings from the internet survey. For example, the interactions TRIP2 × SUP and TRIP2 × MOD suggest that participants are not likely to suppress their shopping trips (i.e., they will continue to use their car as before, presumably because of the convenience when conducting weekly grocery shopping, as revealed in the focus group discussions) but they will consider a mode change (presumably for purchasing a few items at the local store, which is within walking or cycling distance, although this was not mentioned in the focus group discussions). The same interactions imply that people will conduct more leisure activities at home but will not switch mode (if and when they participate in activities outside the home, as also revealed in the focus group discussions).

The interaction between how discretionary a trip is and suppression (TRIP1 × SUP) may seem implausible given that it implies suppression is more likely for work trips. Unfortunately, Study 1 did not provide any clear reasons or insights into why this may be the case. However, when one considers that the internet survey sampled academic and teaching staff (and not solely technical and administrative staff as in Study 1), it is both possible and plausible that the survey sample has greater flexibility permitting it to occasionally work from home and continue driving to work on other occasions.

In Study 1, focus group participants tended to indicate a greater tendency to switch mode for work trips (than for any other adaptation alternative). In contrast, the relevant interaction (TDM1 × MOD) was not significant in the internet survey. Related to this was the fact that there was no significant interaction between the TDM measures and trip type, despite this being mentioned in the focus group discussions. For example, it was thought that if individual marketing were to have an effect, then it would be for work trips rather than the remaining trip types.

Such discrepancies may be attributable to sample specific characteristics, notably that Study 1 exclusively utilised technical and administrative staff, whereas Study 2 expanded the sample to include academic and teaching staff (with the result being that only 25% of the sample was comprised of technical and administrative staff). This may account for differences in ability to telework and in differences in how the various TDM measures are perceived to influence various trip types. One must also remember that the participants in Study 1 comprise a small, self-selected group with greater car dependence, and the aim was not to compare results between the studies in this manner. The reason as to why switching mode was the most frequently mentioned adaptation alternative may be that this is what car users spontaneously think of when setting a car-use reduction goal. In the internet survey the adaptation alternatives are given and may therefore trigger other responses.

In Study 2 the failure to obtain support for many of the hypothesised effects of TDM measure or trip type on choice of adaptation alternative could be a result of the aforementioned small car-use reduction goal. This is consistent with previous research that has shown that people are reluctant to change (Gärling and Axhausen, 2003). In order to measure such smaller changes a finer scale may be required than the one utilised in the present research.

Both studies suggest that there is a need for a revised cost-minimisation principle. For example the negative regression coefficient obtained for EFF, together with the obtained partial correlation with car-use reduction and the intercorrelation with other adaptation alternatives suggest that car-use reduction increases as EFF increases. However, the sensitivity of EFF is smaller than the sensitivity of MOD or SUP as empirically indicated by the correlation coefficients between EFF, MOD, SUP and car use reduction and as theoretically predicted by the hierarchal order of adaptations among EFF, MOD and SUP. In addition, there may be other unknown factors affecting EFF differently from the other adaptation alternatives (e.g., there may exist personal preferences for MOD - that is, more effective adaptation - to EFF - that is less effective adaptation - or personal preferences in the opposite direction). In other words, there might have been individuals who stated they would switch mode (MOD) but did not use the car more efficiently (EFF), and those who stated they would use the car more efficiently but not switch mode. If such individuals exist, EFF should have a negative coefficient in the multiple regression model incorporating MOD as independent variable. Such personal factors are not captured by ILD.

There may, however, also be an alternative explanation independent of the need to posit individual differences in preference for certain adaptation strategies. It may be the case that the proposed hierarchy outlined in Table 1 is not nested. Rather, it may be the case that when an individual progresses from less costly adaptation alternatives to more costly adaptation alternatives they desist or are prevented from implementing the less costlier alternatives. Using the results from the internet survey as a case in point, it may be the case that when an individual decides to switch mode in response to a TDM measure (after initially having responded with more efficient car use), then car-use reduction increases whilst more efficient car-use decreases. Put another way, there are simply less car trips with which to use the car efficiently.

Hence, the negative regression coefficient for more efficient car use in a regression model with costlier adaptation alternatives such a trip suppression and mode change.

It is important, however, to note that the cost-minimisation principle itself need not be questioned but, rather, the ways in which people perceive the possibilities of implementing the principle with respect to personal preferences and with respect to the various adaptation alternatives. They may be aware of the fact that such alternatives are contingent on other factors such as trip purpose. For instance, mode switching may be less costly but nonetheless effective for work trips than for other trip purposes due to the greater availability of public transport. On the other hand, walking to other stores may be an alternative for shopping trips. Future research will, thus, need to determine the contingencies surrounding the cost-minimisation principle with a finer car-use reduction scale and with careful consideration of sample characteristics. Examination of three-way interactions may be in order and it may also prove worthwhile to examine the nature of individual level differences in greater detail (e.g., income may interact with a TDM measure's coerciveness which may interact with trip purpose).

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Appendix A: Scenarios utilised in Studies 1 and 2

A 1: Prohibition of car traffic in the city centre (Cambridge, UK)

(Cambridgeshire County Council, 2003a, 2003b)

Base scenario:

The city of Cambridge is a lively trafficked historic city in England. Its streets date from the Middle Ages and are not designed for today's traffic flows. Instead of expanding the road network, Cambridgeshire County has chosen another solution.

The Council has decided to impose considerable restrictions on private car traffic in the central parts of the city. The policy package is comprised of two parts. Firstly, the area inside the ring road, which is called the Inner Ring Area, has been divided into 8 sub-areas. These 8 sub-areas have only one entry and exit point to and from the inner-ring road. Secondly, pedestrian zones have been created in the liveliest business areas and in residential areas. Parking is not permitted in the pedestrian zones 24 hours a day, 7 days a week. Car traffic is not permitted between the hours of 10am and 4pm, Monday to Saturday, except for those vehicles that have a special permit.

Time-activated traffic barriers known as bollards have been designed so as to sink into the ground for cars or busses with a special permit in the form of an electronic id-card. This applies, for example, to taxis.

Additional information:

The Council has also improved and upgraded the public transport system. In addition, there is a combined parking and public traffic service which provides free car parking outside the ring area with the use of the public transport system to travel to and from the city centre (i.e., Park and Ride). A return ticket with this service is cheaper than parking your car in the inner city area if you plan on being there for more than 2 hours.

A 2: Road pricing (Singapore)

(Foo, 1997, 2000; Goh, 2002)

Base scenario:

In Singapore, a city-state with about 3.5 million inhabitants, various forms of road pricing in the city centre have been implemented by the government over the past 30 years. The latest system in Singapore is called ERP (Electronic Road Pricing). This means that one has to pay to be able to drive his or her car within a zone referred to as the "Restricted Zone", which is about 7 square kilometres in size and has about 30 entry points.

All entry points are clearly marked with portals over the road and when the ERP system is in operation, the words "In Operation" flash on screens situated on the portals. ERP works with the assistance of these portals, an in-vehicle unit which is in every type of vehicle and a smart card system. There are antennae, cameras and optical detectors situated on the portals. When a vehicle approaches the portal, the ERP system communicates with the in-vehicle unit, identifies what type of vehicle it is (i.e., car, taxi, truck, motorcycle etc.), deducts the appropriate fee from the card which is loaded with money and, if a transgression is detected (e.g., no in-vehicle unit or insufficient funds on the card etc.) the vehicle and license plate is photographed. The prices vary depending on vehicle type and time of entry into the "Restricted Zone". For example, the average price for a private car is SGD 1.00. The price levels are reviewed every 3 months. If the congestions levels are too high then the prices are raised, if the roads are not being sufficiently utilised then the prices are lowered.

Additional information:

Singapore has also improved and upgraded its public transport system in conjunction with the development of the ERP system.

A 3: Individual Marketing (Perth, Australia)

(Department of Transport Western Australia, 1999, 2001)

Base scenario:

The city of Perth, Western Australia has a population of approximately 1 million. In an attempt to reduce traffic by 10%, a programme known as "TravelSmart" has been introduced.

In the suburb South Perth (population 37 000), a part of the TravelSmart Programme known as Individual Marketing has been introduced. Individual households are contacted. Information is gathered about the type of car users living in the household and if they are interested in using alternatives to the car. The decision to participate

in the programme is left to the household.

Those households that are interested in beginning to use alternative modes of transport to the car are provided with information about the various modes in the Perth area (cycle, busses, walking, etc). They are offered personal advice about their trips. This information consists of personalised timetables, which can be sent by post, received over the phone or by a home visit from a consultant who analyses the household's trips and provides suggestions for alternatives to the car.

It has been found that an important reason as to why people do not refrain from using the car more often is that they believe that the same trip with another transport mode (walking, cycling, public transport) would take twice as long and cost one third more than is actually the case. About half of the households with easily-implemented alternatives are unaware of the individual marketing service. The TravelSmart Programme contributes with correct information. It is then up to the household to decide whether or not they wish to continue using the car.

Additional information:

Improvements and upgrades have also been made to the public transport system.