Factors affecting Route Choice of Commercial Vehicle Drivers

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Abstract:

Route choice decisions by commercial vehicle drivers may have a significant impact on the efficiency of freight movements and hence on transport costs. This paper reports on the results of research aimed at understanding the route choice behaviour of freight vehicle drivers. Empirical evidence is presented on the factors which influence the choice of urban route by commercial vehicle drivers in urban networks. Results from a survey of 100 freight vehicle drivers in Brisbane, are discussed in detail. The study was concerned with the influence on route factor choice such as vehicle size, trip purpose as well as road network and driver characteristics. Most drivers perceived that they had only three main routes to their destination. Most freight vehicle drivers found less congestion and the shortest route to be the most important factors affecting their route choice. As expected, the impact of toll roads on route choice was also more pronounced for owner-drivers rather than company drivers. Heavy commercial vehicle drivers perceived road surface quality to be almost as important as travel time, when making route choice decisions. Drivers of articulated vehicles placed a greater emphasis on road width, road alignment, number of turns and traffic lights, and congestion when compared with rigid vehicle drivers.

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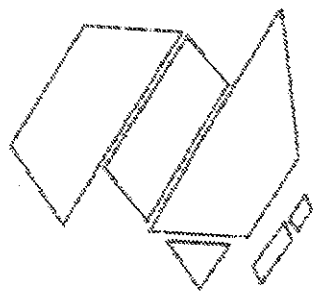

1. INTRODUCTION

There is growing community concern about the adverse environmental impacts of commercial vehicle traffic in terms of air pollution, noise and visual intrusion, as well as the road accident incidence of such vehicles. More efficient route choice is one way in which some of these community-wide costs can be reduced. One of the first steps in this process is understanding the factors affecting the route selection behaviour of commercial vehicle drivers.

Although there have been a number of studies concerned with route choice behaviour of drivers, very few have focussed on drivers of commercial vehicles in urban areas as pointed out by Bovy and Stern (1990). These authors provide a comprehensive review of past research into knowledge acquisition and route evaluation processes of drivers. There is general agreement that the minimisation of travel time and cost are the two most commonly stated criteria for route selection of private vehicle drivers. There is also evidence which indicates that the choice process is a complex one which depends of an individual's characteristics, attitudes and perceptions, Vaziri and Lam (1983), Benshoof (1970). The role played by driver experience and habit is of particular significance in urban freight transport route selection and knowledge acquisition. As discussed by Richardson (1982), there is a range of factors which contribute to 'choice inertia'.

The nature of freight being moved, vehicle size, and the operating characteristics of the sender and receiver may influence route choice decision making processes. For example, constraints related to time of operation of the receiver may override travel cost and other route attributes. Vehicle size will influence the route selection process by placing constraints on available alternatives due to road geometry considerations.

2. PAST ROUTE CHOICE RESEARCH

Major Influencing Factors

There are a wide variety of variables which influence drivers to select a particular route. Varizi and Lam (1983) report in one of the most comprehensive studies undertaken. They considered 31 basic variables in an attempt to correlate some of the route choice decisions. The problem is complicated further when deciding whether the development of a single set of choice variables is viable, or whether external factors need to be considered as discussed by Richardson (1982) and Mirichandani and Soroush (1987).

Duffell and Kalombaris (1988) used a more simplistic approach by considering route choice as a function of three variables namely time, distance and 'congestion'. Hutchinson et al (1977) and Hall (1983) also found that time and distance were dominant factors. According to Stern et al (1980), driving effort (both physical and psychological) needs to be considered in conjunction with time and distance variables. Benshoof (1970) found that congestion and stoppages were of primary concern in route selection.

The perceived dominant route choice factors are different among similar studies further emphasising the high level of variability in driver route selection. This variability is extended to daily fluctuations in route choice.

A few studies have shown that there is considerable variability in weekday travel and that the assumption of habitual route choice may not be valid (Hansen and Huff, 1982; and Huff and Hansen, 1986). In a separate study, Mannering (1986) considered daily variability in route

selection with respect to congestion and driver attributes and concluded that individual characteristics are important in determining driver route choice.

Adaptive route choice involves adjusting route choice to information learned on the day of travel. The time of choosing the proposed route is an important consideration which has been analysed by Bovy and Stern (1990). They proposed three time-spans for route choice decisions: (1) at the start of the journey; (2) at each decision point; (3) at decision points with choices being dependent on previous decisions

A review of urban freight modelling research is given by Ferreira and Bitzios (1991).

3. SURVEY OF COMMERCIAL VEHICLE DRIVERS IN BRISBANE

Survey Objectives

A pilot survey of 100 commercial vehicle drivers was undertaken by means of personal interviews. The survey is part of a research project aimed at developing driver route choice behavioural models for freight movements in urban areas. The survey was specifically designed to achieve two objectives, namely: (i) To improve understanding about the major factors influencing the route choice decisions of commercial vehicle drivers; and (ii) To test the effectiveness of using a short personal interview questionnaire to obtain attitudinal as well as factual information from commercial vehicle drivers during the course of their work.

Questionnaire Design

The questionnaire was designed for freight vehicles passing through or travelling within Brisbane and was concerned with the driver's current trip or his/her next trip. In the few cases that neither the current trip nor next trip were known, the drivers were questioned about their most recent trip in Brisbane

A primary objective of the survey design was to keep the questionnaire as short as possible to minimise disruption to drivers. A one page survey incorporating twenty questions was decided upon with each questionnaire taking approximately two minutes to complete

The questions used are based on establishing any differences between the drivers' perceived and actual route choice criteria. The actual route choice criteria is dependant on the origin, destination and intermediate stops for the trip. Consequently these questions need to be included and compared to whether the route chosen was fixed by a trucking company or the local authorities.

A set of route choice selection criteria was adopted based on results from Sweatman (1990), Stephenson and Williamson (1988) and the Burnett Commercial Vehicle Study (1991). The following choice factors were used: travel distance; congestion; travel time; number of turns & traffic lights; toll-ways; road alignment (vertical); road surface condition and road width.

Drivers were asked to rank these factors using an importance scale. Drivers were also asked about the number of main routes which they perceived to be available for a specific trip.

Factual information was also collected regarding: time, date and location of the survey; type of vehicle and operator type; frequency of route usage and drivers' age and experience.

After conducting a small pilot survey, the questionnaire was modified to overcome some minor problems. For example, it was found that drivers found it difficult to rank factors on a scale using five importance levels (from extremely important to not important). A scale of three levels was adopted (extremely important, important and not important).

The vehicle classes used in the survey included rigid vehicles, semi-trailers, truck-trailers, B-Doubles, Light Commercials, and Other. The rigid vehicles includes all rigid trucks with a Gross Vehicle Mass (GVM) greater than 2.5 tonnes.

The alterations to the pilot survey proved to be successful in the first round of surveys and were adopted throughout the study

Survey Locations

Most of the industrial activity in Brisbane is located in the suburbs to the south-west of the city. Consequently almost 80 percent of the 100 interviews were conducted in this area. The remaining interviews were conducted in the northern and central suburbs of Brisbane.

Three basic types of locations were used for the survey, namely: petrol stations; weighbridges and refuelling stations; and transport firm loading bays.

4. SURVEY RESULTS

Vehicle and Driver Characteristics

Of the 100 interviews completed 44 percent were based on drivers of rigid vehicles, 47 percent on semi-trailers and only 9 percent on light commercial vehicles. Light commercial drivers were the most difficult to survey due to their tight schedules and relatively short stopping times at petrol stations and depots.

Owner-drivers comprised 45 percent of the total sample. Employees of transport firms made up 48 percent of respondents. The remaining 7 percent of drivers worked for a company whose main business was not that of goods transport. Sixty percent of drivers were between the ages of 35 and 55 as shown in Figure 1. The experience of drivers ranged from 6 to 30 years.

Trip Characteristics

As shown in Figure 2, 69 percent of drivers stated that they were both loading and unloading in the study area on their next trip. Only 3 percent of respondents were making a through trip without intermediate stops in Brisbane

Figure 3 shows the extent to which drivers were travelling to/from the inner city of Brisbane on the day of the survey. The bulk of the trips did not include stops in inner city suburbs (defined as those with postcodes between 4000 and 4010). Just over 90 percent of vehicles with at least one stop in the inner city were rigid trucks and light commercial vehicles with only 2 semi-trailer drivers noting that they were travelling into the city

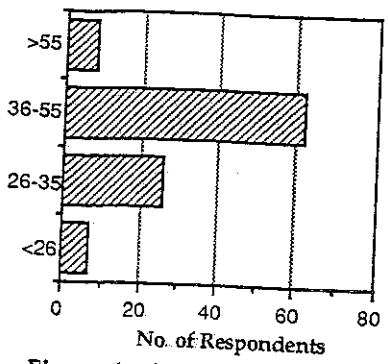

Figure 1 - Age Distribution of Drivers

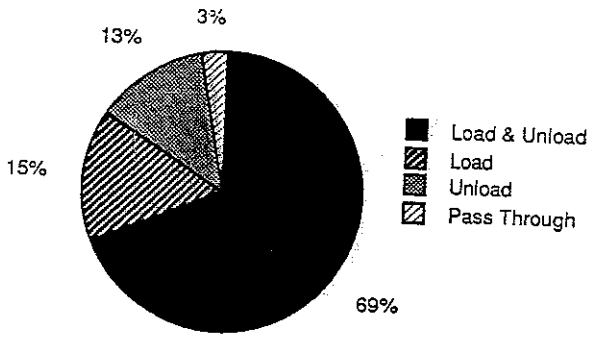

Figure 2 - Trip Purpose

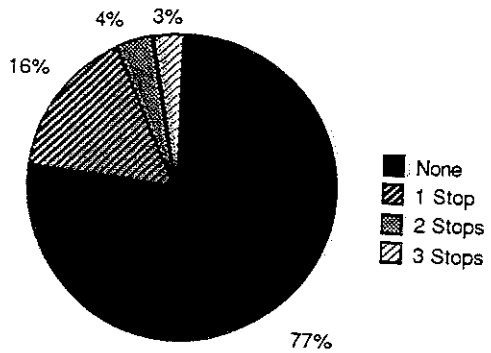

Figure 3 - No. of Inner City Stops

Major Route Choice Factors

Overall Results

Figure 4 shows the level of importance attached by drivers to the eight choice factors included in the questionnaire. As shown in Figure 4 almost 80 percent of drivers perceive 'congestion' to be 'extremely important' in determining route choice. Only 5 percent believe that congestion was not important in the route selection process. The second most important factor was perceived to be travel distance, with 60 percent of drivers ranking it as 'extremely important'. Overall, the number of both turns and traffic lights was considered to be as important as travel distance. In general, drivers were divided over the importance of road surface, road width and less hills when choosing between alternative routes with fairly even results in all three importance levels. Between 30 and 40 percent of drivers found those factors to be 'extremely important'.

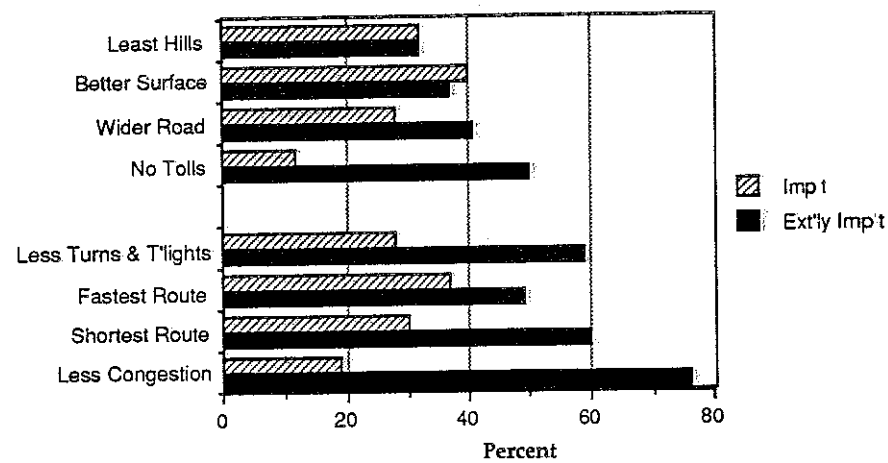

Figure 4 - Choice Criteria - Importance Rating

An importance scale of only three levels makes it difficult to determine clearly the relative level of importance of closely related factors. However, the more commonly used scale of five levels was found to be difficult to administer in practice.

The importance of toll roads as a factor affecting route choice gave distinctly divided results. Fifty percent of drivers believed that using the toll-way was 'extremely important' when selecting which route to use. This increased to 61 percent for semi-trailer drivers indicating that the tolls are having a far greater impact on the route choice of larger freight vehicles. Drivers of these larger vehicles suggested that although the costs of these toll-ways are a major issue another problem existed in the stopping at the toll-gates which are normally located on free-flowing arterials. Forty-two percent of transport firm drivers stated that toll-ways were not a major consideration as the fee was paid by the company, adding that they

was not economically feasible for them to use toll roads as these roads removed a large proportion of their profit margin. Others argued that toll-ways did reduce their overall costs when considering time and fuel savings.

A handful of drivers suggested that the route choice criteria used in the survey were interrelated and could not be considered in isolation. Three drivers also suggested that these factors did not account for vital criteria such as weather conditions. Another criteria which was proposed was that of overtaking lanes. Two drivers noted that they would prefer to use a dual lane carriageway rather than a single lane carriageway. In this way, they would cause less disruption to traffic flow.

Another important factor is whether the vehicle is loaded or not and the type of load being carried. Five percent of drivers stated that their preferred route choice criteria would be altered if they had a different load. For example, the importance of less hills, congestion and turns and traffic lights is critically dependant on the commodity type being carried.

A problem was also recognised with newly installed red-light cameras at some intersections. Some drivers suggested that the traffic light changes at some of the intersections using these cameras were 'too fast'. Heavy vehicles require sufficient time to accelerate through these intersections and consequently drivers have been avoiding the routes where these cameras are installed. Some drivers also recognised that when carrying toxic materials or wide loads, the route choice flexibility maybe severely reduced.

Vehicle Types and Driver Effects

As shown in Figure 5, drivers of articulated vehicles placed a greater emphasis on road width, road vertical alignment, turns and traffic lights, and congestion than was the case with rigid vehicle drivers. Travel time and road surface quality were considered of similar importance by drivers of both types of vehicles.

The smaller vehicles were more concerned with the fastest and shortest routes. As expected, light commercial vehicle drivers placed much more emphasis on time and distance due to their relatively tight schedules. However, the results of the survey related to these smaller vehicles are based on a sample size which is too small for valid conclusions to be drawn.

Another consideration affecting freight vehicle route choice is the frequency of route use. Drivers using the same route less than once per week placed greater emphasis on toll roads and less turns and traffic lights than more frequent users did. More frequent users stated that traffic lights and toll-ways are unavoidable and are therefore not considered as vital route choice criteria. In particular, more frequent users were more concerned with wider roads and faster routes.

Obliged Routes

An important consideration when studying the factors affecting route choice is the recognition of obliged or fixed routes. Fixed routes are those routes which either a transport firm or a government authority direct the driver to use.

Only eight percent of drivers stated that they did not choose the route they used, seven percent relating to rigid vehicles and one percent to semi-trailers. In some cases drivers stated that they were often given one route which they must not use (eg. toll-ways). In other cases,

that they were often given one route which they must not use (eg. toll-ways). In other cases, drivers were allowed to choose their own route as long as they stopped in prescribed suburbs in a predetermined order. Although not completely fixing the driver to one route, these constraints do hamper the drivers route choice flexibility

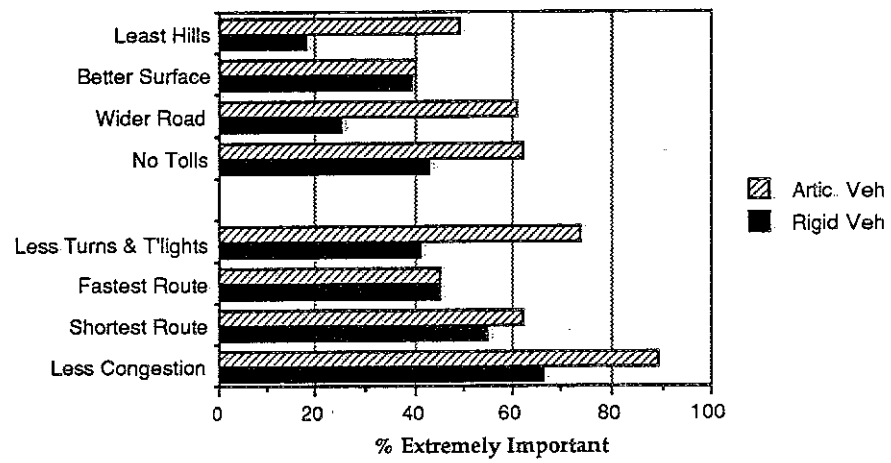

Figure 5 - Choice Criteria - Importance Rating by Vehicle Type

Drivers' Route Choice Set

Figures 6, 7, and 8 show the number of routes perceived to be available for all drivers, rigid vehicles and articulated vehicle drivers respectively

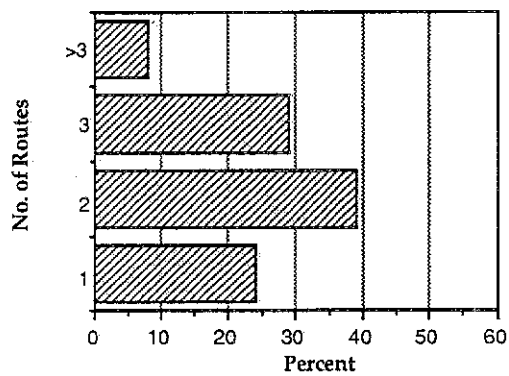

Figure 6 - Perceived Choice Set - All drivers

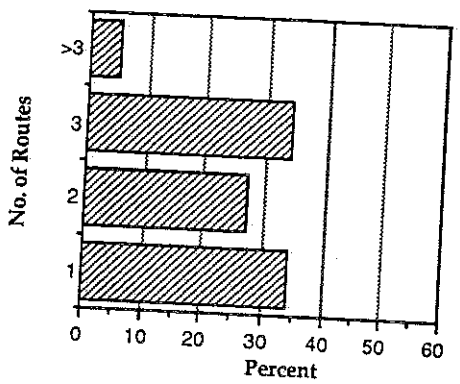

Figure 7 - Perceived Choice Set - Rigid Vehicles

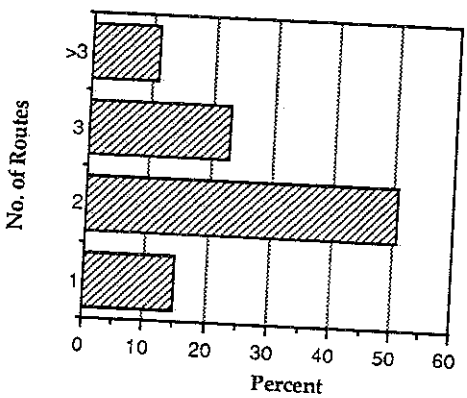

Figure 8 - Perceived Choice Set - Semi-trailers

Some 92 percent of drivers believed that there were only a maximum of three routes available, as shown in Figure 6. The majority of drivers (63 percent) believed that there were only two major routes available. This result compares with previous studies which found that most drivers think there are only two to three routes available and very few think there are more Bovy and Stern (1990).

This result needs to be studied in light of the driver's full understanding of the meaning of the phrase "available routes". In most cases drivers stated that although there were only two to three feasible routes available, many more existed. Drivers believed there were more routes available during peak times than are available at off-peak times. When congested conditions force drivers away from their habitual route, they may become more aware of a larger number of possible alternatives

When the results are disaggregated by type of vehicle, it is found that 65 percent of semi-trailer drivers perceive a maximum of two main routes available. The corresponding percentage for rigid vehicles was 60 percent.

Drivers' Route Knowledge

Drivers were questioned on how they perceived their knowledge of the alternative routes in the area that they were about to travel through. The following results were observed: Very good - 42%; Good - 28 %; Average - 23%; Not very good - 7%. (% equals percent of sample)

For rigid vehicle drivers, 53 percent believed their knowledge was very good while only 28 percent of semi-trailer drivers did so. This result needs to be considered in light of the number of rigid vehicle drivers who are local operators as compared to the articulated vehicle drivers who often operate interstate.

Drivers claiming to have above average knowledge of the area believe there are less routes available for their next trip, when compared with less confident drivers. This suggests that as the level of local knowledge increases the speculative routes are removed from the driver's route choice set and a more restricted set of alternatives emerge. Habitual route selection may also develop for these more experienced drivers. Once drivers become 'fixed' to these routes it is difficult to alter their route choice patterns.

This result was emphasised further by comparing the frequency of route use to perceived knowledge of drivers. Eighty percent of drivers using the same route between 1 and 5 times per week believed that their knowledge of the available routes was above average. This compares to only 43 percent of drivers using the route less than once per week who believed they had above average knowledge as shown in Figure 9.

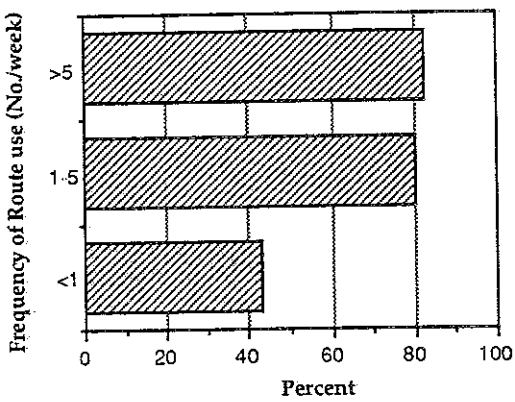

Figure 9 - Perceived Route Knowledge - 'Above Average'

Use of Radio Reports

Approximately two thirds of drivers made use of traffic reports on either the two-way radio system or the public broadcasting system. A few drivers stated that they would only use the reports when an accident had occurred and neglected the information when it was based on general congestion. A handful of drivers also disputed the accuracy of these reports based on their personal experience. The results suggest that the use of these reports is not related to the driver's years of freight carrying experience as shown in Figure 10.

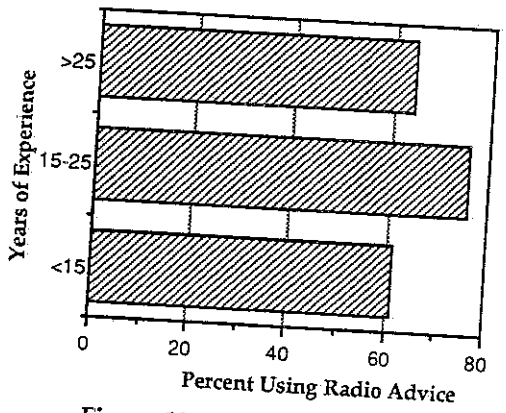

Figure 10 - Radio Advice Usage and Experience

Drivers using the route most often are more likely to use these traffic reports, as are drivers perceiving to have above average knowledge of the available routes, as shown in Figure 11. The same proportion of drivers used these reports during both peak and off-peak traffic periods.

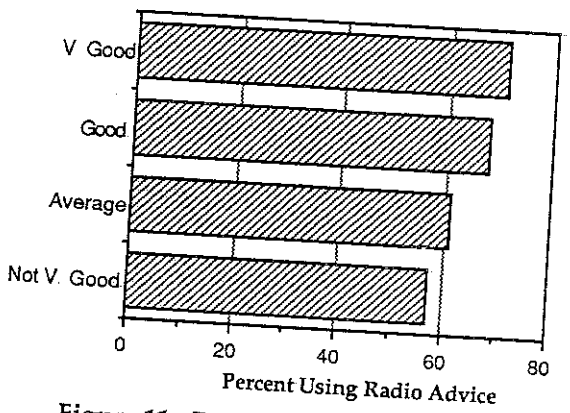

Figure 11 - Radio Advice Usage and Perceived Knowledge

5. SUMMARY AND CONCLUSIONS

General

In general, most drivers placed a larger emphasis on congestion and distance factors than road characteristics when selecting their route.

Drivers of articulated vehicles place greater emphasis on road widths, vertical alignment and road surface condition than rigid vehicle drivers. Travel time and road surface were ranked of similar importance by articulated and rigid vehicle drivers.
Toll roads also appeared as a major factor affecting route choice with approximately half the drivers stating that they would not use these roads. More importantly, this figure increases to 61 percent in the case of semi-trailer drivers. Tolls are commonly charged on a per-axle basis and drivers of these larger vehicles had far greater charges placed on them than the smaller rigid and light commercial vehicle drivers did. This result has a significant bearing on recent Brisbane policies concerning moving these larger road freight vehicles away from built-up areas.

More frequent users of a particular route also tend place less emphasis on toll-ways and less turns and traffic lights than infrequent users. This behaviour moves these more frequent users further towards habitual route choice by reducing the number of factors affecting their route choice.

When considering the use of traffic reports, drivers perceiving to have above average knowledge of the routes in the area used these reports more than the less confident drivers.

The results obtained suggest that the degree of habitual route choice is closely related to both the level of experience and the perceived level of knowledge of the area. As drivers gain increased knowledge and experience of the routes in an area their route choice set is reduced to one or two major routes.

Although most drivers are aware of the range of alternative routes that are available, they do not always make their selection based on minimum perceived costs. Two reasons for this are the use of 'habitual' routes and obliged routes. Obliged or "fixed" routes, where drivers have no input into their route selection, were found to be used in only 8 percent of cases. In addition to these routes, there is sufficient evidence to suggest the presence of "partially fixed" routes. In this case drivers select their own route from a restricted set of available alternatives. Examples of partially restrained route choice occur where drivers are told they must not use a certain route and where intermediate stops are prescribed in a set order.

The results presented here suggest that the decision criteria of freight vehicle drivers are different from those of passenger vehicle drivers. When modelling route choice it is necessary to account for the fundamental physical differences (in terms of shape, size, speed and manoeuvrability) between freight and passenger vehicles. These physical factors, as well as driver experience and route knowledge differences clearly distinguish passenger from freight vehicle route choice.

Further Research

Current urban transport planning models designed mainly for person-movements, incorporate route choice algorithms based on the minimisation of travel costs (travel time is usually used as a proxy for transport costs) Van Vliet and Dow (1979). The use of such route choice models for real time route guidance systems has recently been investigated by Hislop et al (1991)

The results of the surveys proposed in this research project will indicate the extent to which existing models can be used to predict the choice of route by freight vehicle drivers in urban networks. In addition, it will be possible to calibrate behavioural route choice models specific for freight vehicle drivers. The logit and probit formulations have been proposed in past route choice research Robertson and Kennedy (1979), Ben-Akiva, et al (1984) The latter used a two staged approach to route choice decisions, namely the generation of the choice set and the route selection process itself. Using the results form the drivers' self-completion questionnaire (revealed preferences) and in-depth interviews (stated preferences), individual route choice models can be developed.

By quantifying the relative importance of route attributes, it will be possible to infer values of time for urban freight tripmaking using both revealed and stated preference data. These results will be particularly useful to predict the impact of urban tolls on road usage.

In addition to the physical differences between road freight and passenger vehicles, each type has a different set of critical route choice criteria. The effects of road surface, road width and less hills are far greater concern to these larger road freight vehicles than they are for the more manoeuvrable and more flexible passenger vehicles.

For practical purposes and due to a lack of sufficient data, freight vehicle assignment has in the past been grouped with passenger vehicle assignment. There is sufficient evidence from this analysis to suggest that the route selection criteria for freight vehicles is intrinsically different to that of passenger vehicles.

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