Investigating Drivers' Variance in Route Choice between the Home and Work Commute Trip in the AM and PM

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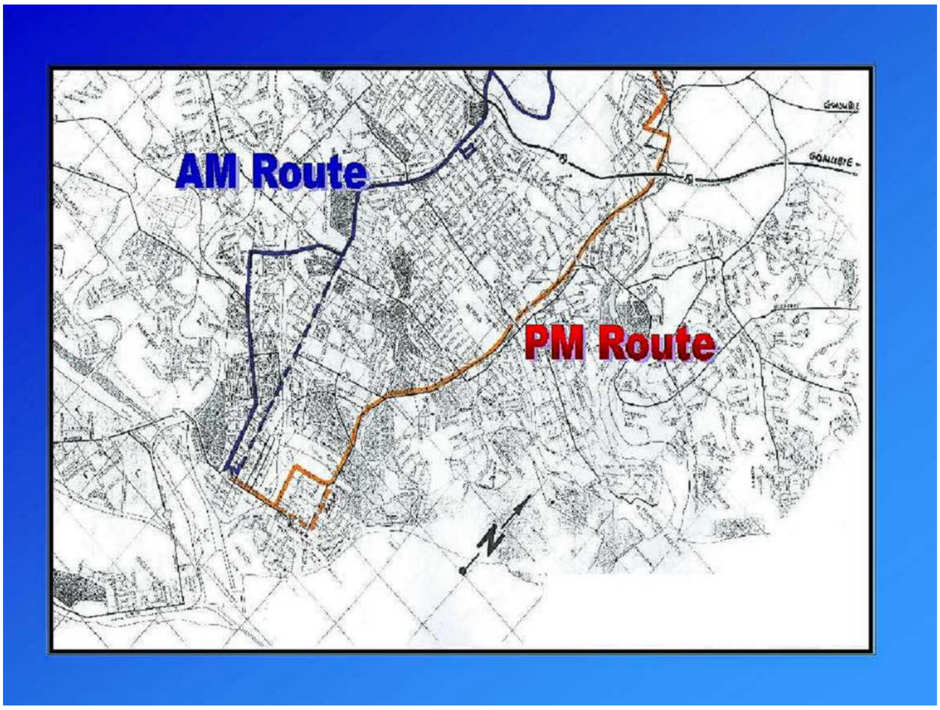

Abstract

Investigating Drivers' Variance in Route Choice between the Home and Work Commute Trip in the AM and PM

The study takes place in the Metropolitan Transport Area of East London, South Africa, a coastal city with a population of 530 000 spread over an area of 210 km^2. Like Auckland, development of its transport network is severely constrained by physiographic conditions such as steep terrain and 4 large river valleys and environmental /social constraints.
A questionnaire survey was undertaken to determine the variance amongst drivers route choice by comparing the AM to the PM Home and Work commute trip. The study set out to determine this variance by measurement of the spatial variance and the variance in route choice factors, which drivers apply when making these two types of trip.

Parametric and non-parametric statistical analyses were used to measure the difference in the spatial values between the trips. The variance in route choice factors was compared with other explanatory variables to determine if the responses were measuring the same or underlying values. The data was further examined to determine if factors such as socio-demographic and personal characteristics influenced the route choices.The study found that 25 % of drivers **significantly** varied (<50% of the route is common) their route between the AM and PM. Time is still considered an important factor, but the unexplained 24 minutes of residual time found between arrival at work and the official work start time, is inconclusive as to how time really affects the route choices. Factors such as congestion and predictability of journey time which could influence departure and journey times appear to be a non-issue. Other factors such as socio-economic and personal characteristics influence the spatial variance of route choice.

Route choice reasons appear to be duplicate for the AM and PM trips, but 45 % of the whole sample of drivers use different routes for the AM and PM, with the amount of overlap of the routes ranging from 0% to 95%. This casts doubt on the current method of traffic modelling in South Africa and indeed most part of the world which predicts the AM conditions and then reverses the flow for the PM conditions. This method leads to an over supply of expensive infrastructure.

Despite the use of different routes, journey times and distances are similar for the two spatially different trips. The spatial variance between the two routes is best expressed as a percentage of route commonality and the physical lateral separation.

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CHAPTER 1
INTRODUCTION

1.1 Background

The continued growth in use of private vehicles, with the resulting increase in the number and length of trips, increased congestion levels and associated externalities, coupled with a decrease in public spending on transport infrastructure, are all elements that contribute to an increasingly unsustainable transport system.

Urban travel patterns in South Africa, as in Auckland, appear to be similar to those found in developed countries and indeed the larger cities there face similar congestion problems as their European counterparts.

Physical constraints imposed by the topography in East London, coupled with the continued lack of funding from government to provide sufficient infrastructure to counter congestion, or even provide alternative transport measures, further compound the transport problems. Clearly, a solution needs to be found to efficiently manage our existing infrastructure and this could be achieved through greater understanding of how drivers interact with the dynamics of the transport network (Wright & Orram 1976). A similar situation exist even in Auckland which is both constrained by the RMA and a long term disinvestment has led to serious shortages in the road network. The lack of corridor opportunities due to topographical constraints does not help the situation.

Presently our understanding of traffic flow is reflected in the design and application of modelling techniques. Common practice in South Africa (Venter C, 2000), and many other places in the world including New Zealand, is to provide for the peak demand. It assumes that if one meets the AM demand then you have also met the PM demand. The modelling techniques applied usually reflect a reversal of the AM flow pattern in the PM. (Robertson, 1999). Should the flow pattern in reality be significantly different because drivers use the choice-set differently, or are affected by factors in a different way which causes them not to mirror their AM routes in the evening, then this assumption could lead to the over-provision of some parts of the infrastructure that many countries can ill-afford.

The outcome of the variance in route choice between the AM and PM would hopefully dismiss this modelling approach, as it is likely the demand for road space could be substantially smaller and the peak flow more dispersed in the PM. (Typically, the north-eastern expressway in East London demonstrates this oversupply, which has an in-bound AM peak flow of 2200 vph and the PM peak out-bound flow of about 20 % of the morning's in-bound flow!) The Auckland flow pattern is indeed very different with the PM peak in many of the corridors larger and less dispersed than the AM.

A practical outcome of this research could be applied to a project that is presently under investigation in East London. This involves a new river-crossing of a bridge some 375m long and 100m high. Providing only 3 lanes (i.e. 2 lanes for the AM flow and 1 for the PM flow) as opposed to 2 lanes either way, because of the reversal of the AM modelled flow, would make a substantial cost saving on this large structure. Further savings on road space and lane provision on the 5 interchanges and 8 km carriageway, would also be substantial.

1.2 Previous work

Bonsall & May (1986) found that minimisation of time and distance on inter-urban travel account for between 75 - 90% of all the choices. For the urban traveller, the position is less clear. In addition to time, cost and distance, drivers also often quote other route and traffic attributes (Vaziri & Lam 1983). Some researchers have found that shortest time is still the dominant criterion whereas others have found that quality of the journey is a major consideration. Research by Ueberschaer (1971) and Hutchingson, McNees & Dudek (1977) found that measures that improved quality of a journey, i.e. lack of congestion, good road design and avoidance of stops, were typically ranked after time and distance criteria. Bonsall & May (1986) postulated that these criteria might encourage some drivers to select routes that are longer in time or distance.

Presently our understanding of traffic flow is reflected in the design and application of modelling techniques to assist transport professionals in managing networks (Iida, Akiyama, Uchida, 1992). Results from other studies have been useful in developing traffic assignment procedures for urban and highway planning. Time and cost studies help with the economic evaluation of highway improvement projects. Route selection has only recently become important in formulating control and management strategies (Vaziri & Lam 1983).

The study set out to determine the variances in route choice between the AM and PM trips with a view that this will provide valuable information on why it differs and how to manage traffic more efficiently. Also Ueberschaer (1971) stated that the easiest trip purpose to research is the home to work, as its' travel pattern is very homogeneous on all working days.

The trip purpose is characterised by:

- The origins and destinations of commuter trips are well defined
- Commuters on their way to or from work drive in a very direct, straight and purposeful manner, and they take routes to reach their destinations promptly.
- Commuters have a good knowledge of the area and know alternative routes

Jones (1983) also found that little research appears to have been done on the variability of route choice other than those done on diversions due to incidents (Heathington, Worrall & Hof, 1970) and (Hutchingson, McNees & Dudek, 1977). This has particular application in the Auckland context as to how the southern Motorway congestion could benefit from this issue, if incorporated in its proposed ATMS system. Bonsall & May (1986) also found that routes chosen by regular drivers vary from person to person, and day to day. They also found that the routes used in the evening are likely to be more variable than the morning trip and also that the routes are unlikely to be a mirror image.

Hutchingson et al (1977) found that 60% of urban commuters had used more than one route to work, and that 37% always or often took a different route on the homeward journey. Jones (1983) concluded from her study that drivers chose the route for work trips based mainly on perceived traffic conditions, but not totally judged on journey time.

This study of driver's attitudes takes place in East London, a coastal city on the eastern seaboard in South Africa with a population of about 530 000 spread over an area of 210 km^2 (ELMET, 1994).

1.3 Applications

The importance of increasing our understanding of route choice has its benefit in applications such as:

1.3.1 **Managing traffic.** During the peak periods it becomes over-utilised and for the balance of the time it remains under-utilised. If we can spread the traffic loading across the system so as not to over-saturate the infrastructure, then we would achieve greater network efficiency.

1.3.2 **The evaluation of traffic control schemes:** As a transport network is developed, altered and maintained, traffic flow patterns become disrupted, resulting in unstable flows which causes increased congestion on the network, before settling into a stable pattern again. (Bonsall & May, 1986). If we increased our understanding of how drivers select routes, it could assist in minimising the knock-on effect that is observed during these unstable traffic flow periods.

1.3.3 **The development and improvement of traffic assignment models:** The work done by Bonsall & May (1986) was stimulated by the fact that the current generation of models such as CONTRAM and SATURN, with their assumptions that route choices can be represented by; *"an appropriately weighted sum of time, distance cost, may not adequately reflect the behaviour of a driver in congested networks."* They also found that drivers using the same origin and destination departing at the same period and reported that they are taking the quickest route were using very different routes. This could mean that one of the two is making a wrong decision or is using other factors to select the route that is not reported. Either way, if a model assumes that time is a dominant criterion, then the model will not accurately reflect the flows that emanate from the above situation. Research by Jones (1983) found that drivers were more willing to divert because of delay and to save travel time on the trip to work than on the trip from work to home. If most models use least cost routes to predict the flows, but the drivers use very different routes between the AM and PM, then it could mean that there are differences in route choice criteria applied and therefore would make the model only accurate in the AM flow.

1.4 Objectives of the Research

The prime objective of the research was to determine the ***degree of variance*** in route choice between the AM and PM home-work-home journey. This would be undertaken by an on-site data collection exercise in a metropolitan transport area in South Africa followed by statistical analysis of the responses to a detailed questionnaire. The target group will be drivers that make regular trips from the outlying residential suburbs along the busiest private mode travel corridor to places of employment in the central business district or commercial centre.

The degree of variance between the AM and the PM will be measured as, **(a)** the spatial variance and **(b)** the variance in route choice factors by comparing drivers' physical routes and route choices for these two trips.

1.4.1 **Spatial Variance:** To measure the spatial variance the following was investigated:

- The proportion of drivers that select different routes for the AM and the PM trip.
- The spatial variation between routes in the AM and the PM measured longitudinally along the respective routes and laterally at the widest parallel section between the routes.

The spatial variance could be influenced by many factors and conditions such as, congestion, personal characteristics, suburb location, experience, network knowledge, trip purpose. This could also be influenced by external factors such as the need to stop en-route or drop-off/pick- up something or someone. The purpose would be to establish how far apart drivers deviate from the one route to the other and how much further they may travel compared to the most direct route.

1.4.2 **Variance in route choice factors:** To measure the variation in route choice factors, the study investigated the difference in route choice factors that were selected for the AM and PM trips. Meeting this objective could possibly lead to a clearer understanding of how to model traffic, as well as what the effect of alternative diversion routes would have on the behaviour of drivers, and hence traffic flows. A study by Watling (1992) summarised previous route choice studies and concludes that the following are considered prime route choice factors.

Table 1: Primary Route Choice Factors

	Route Choice Factors
a)	Direct (operating) cost as opposed to generalised cost
b)	Perceived cost (Subjective combination of direct, and generalised costs)
c)	Physiological factors i.e. age, gender, etc.
d)	Sociological factors such as income, status etc.
e)	Habit

f) Network knowledge; driver experience

g) Traffic factors; delay, congestion, route characteristics

The study has included all these factors listed above by way of a direct response to a question or by revealing these by way of the physical routes that are followed.

CHAPTER 2

ROUTE CHOICE

2.1 Introduction

Transport routes can be defined as "…*being typified by several linkages interconnected by means of nodes. As a result there are usually a number of possible routes between two points, which overlap to varying degrees due to common road segments and nodes.*" Drivers that are confronted with a choice of routes to follow to a destination appear to select these with a very definite choice set in mind. It is in this context that the research looks at what the choices are, how and why are they made.

2.2 How do we navigate

Bovey & Stern (1990) stated that the route choice process is part of human spatial behaviour and how we relate to our environment through our attitudes, emotions, perceptions, cognition and learning.

2.2.1 <u>**What is a route?**</u> Bovey & Stern (1990) define a route as, "*a route is a chain of consecutive road segments connected by nodes. Such chains connect trip origins and destinations*." It is within this context that various choice factors are made. One or more of these factors are usually applied to a particular road segment and remain so or until a pre-set condition or threshold is met after which they are used to re-evaluate or re-prioritise route selection. (Benshoof, 1970)

2.2.2 <u>**What factors do drivers use to select a route?**</u> Typical factors together with attributes that influence these choices are given below:

- **Time:** Route length, congestion, departure time, car sharing and geometric constraints predictability, parking availability,
- **Cost:** Direct and perceived costs, income group, and suburb location
- **Distance:** individual and overall journey distance, actual and perceived.
- **Convenience**: status, gender, trip purpose, habit, predictability, road function class
- **Safety:** gender, income group, and suburb
- **Trip purpose:** School drop, recreational, shopping, incidental business

Horowitz's (1984) paper found that in an attempt to model drivers' behaviour selecting various route choices, the following components were identified. One such model allowed for:

a) Travel cost on day 'k', made up from the mean value as a weighted average of all the previous days.
b) Weightings and error terms are introduced to allow for the variability between drivers for:
    - *Perceptions in cost*
    - *Omission of other variables relevant to route choice and cost*
    - *Differences in cost between individuals*
c) Driver's perceived cost for today is compared with perceived cost history.

Another model suggested route choice was based on previous experience. (Iida, Akiyama, Uchida, 1992).

Watling (1992) refers to work done by Van Berkum, & Van Der Mede (1990) who proposed that drivers based their selection on their previous cost estimate plus habit. So if a driver has to select between two routes and the cost difference is small, then assumption is that the driver selects the route out of habit. If none of the routes are chosen out of habit, then he selects the one with the minimum perceived cost. It must be noted that the cost is applied over the route and not over a single link. The justification being that a driver's frame of reference is built up from his memory of routes. Watling also found that Cascetta (1989) modelled the habit effect using the traffic models STODYN and STODYN 2. Ben-Akiva, De Palma and Kaysi (1991) based their model on cost and predefined departure-time. They used an equation based on generalised cost + delay time + departure time to model the route choice.

This model is based on the following assumptions:

- A portion of pre-specified drivers update historic travel time, the remainder does not.
- Portions of pre-specified drivers receive media reports and update their perceived costs.
- A portion of pre-specified drivers who now have a different perceived cost will review their choice of route and departure time.
- Of these above choices some seek more information and update their perceived travel cost.

Wardman (1986a) used the neo-classical economic approach to model route choices. This approach says consumer behaviour assumes that individuals will trade-off utilities with attributes in identifying that option with greatest overall utility.

Watling (1992) suggests that the basic modelling requirements need to include factors that recognise:

- habit
- driver learning
- familiarity of the network
- variations in demand

He suggested that habit is a strong influence and it is not easily changed due to one day's bad experience, even with route guidance and knowledge of increased cost.

Bovey and Stern (1990) found that earlier studies concentrated on route choices in transportation, but that not many dealt explicitly with route choice behaviour. *" Early efforts to study route choices focused on modelling aggregate choice patterns. Later studies concentrated on disaggregate behaviour. The most recent approach in choice research is in the so-called Discrete Choice Modelling. It focuses on individuals' decision-making processes regarding the choice of destinations, modes, departure times and routes."*

Most other studies have defined a list of route choice factors found to be relevant, although many of these are applicable to inter-urban travel as opposed to urban travel and the transferability of results of these studies are not always clear (Ben-Akiva, Daly & Ramaswamy 1984), (Antonisse, Daly & Ben-Akiva, 1984). A distinction between the two types of travel has to be made (Bovey & Stern 1990). Much research has been done on inter-urban travel compared to the relatively little research on urban travel (Bovey & Stern, 1990), and it is therefore important to recognise the different route choice factors drivers use in urban travel.

2.2.3 <u>What influences the selection of these factors?</u> Benshoof (1970) looked at how the route selection process was influenced by personal and trip-making characteristics such as:

a) **Personal characteristics**: Gender and age
b) **Trip-making characteristics**: Trip purpose and trip frequency

Ulrich (1974) also classified reasons for route choices for all trips into two groups:

a) **Road characteristics;** Route length, road width, number of lanes, pavement conditions, geometric design, traffic control, speed limits, obstructions and scenery
b) **Traffic Conditions;** travel time, waiting time, speed, commercial traffic, public transit in street and pedestrian control.

Bovey & Stern, (1990) state the different choice situations a driver is confronted with are:

a) **Simultaneous Choice:** The driver chooses the entire route before departure.
b) **Sequential Choice:** The driver chooses at each alternative at common nodes of links but is independent of the preceding route.
c) **Hierarchical Choice:** The driver makes a new choice at each decision point, but it is dependent on the previous choice.

Benshoof (1970) thought that his results could be interpreted that route selection for many motorists is a largely irrational process.

2.2.4 How do drivers apply these factors. Ueberschaer (1971) found that even though factors affecting trip patterns from home to work during the morning peak are homogeneous, the drivers coming from the same residential area going to the same industrial area do not all take the same route. Every driver uses the different criteria objectively and subjectively. Vaziri & Lam (1983) also found that many drivers used between four to six reasons together to form a criterion for route selection. Furthermore, most respondents who used the same route to work and back used different weightings and rankings for the route scores.

The importance of factors may also vary depending on trip purpose as stated by Benshoof, (1970) who also found that in the trip to work most of the drivers tended to decide their route before getting into their cars. He found that younger males tended to select their route later than older men do.

Bovey & Stern (1990) stated that " It is our belief that travellers use abstract concepts in evaluating their alternatives, including, for example; time, effort, comfort, safety and predictability. A remarkable fact is that no attempts have been made so far to identify route choice factors within a framework of more general choice behaviour or needs satisfaction."

They suggested that the 4 categories be:

a) the available routes
b) the character of the traveller
c) the trip that is to be made
d) circumstantial instances (previous day's experience, information received etc.)

2.3 Advantages and disadvantages of simulation models

Bonsall & May (1986) used a sample of their study to check the accuracy of state-of-the-art assignment models such as CONTRAM and SATURN to predict the route drivers would use, based on an equilibrium assignment model. They found only 30% of the paths generated to be identical to those used by the sample and the remainder differed substantially! The models tended to predict paths along shorter but congested paths. Furthermore, the results of the model using minimum time as a criteria was only 35% successful comparing the paths from the drivers that selected routes on the basis of minimum journey time. They were unable to clearly find the reasons for the differences, as this could either be due to inaccuracies in the model, its network or flow matrix, or the incomplete knowledge of the drivers.

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CHAPTER 3

PROBLEM IDENTIFICATION

3.1 The East London Metropolitan Transport Area (ELMET).

3.1.1 **General:** East London's options for development, settlement and transport infrastructure are largely influenced by the topography. The city is located in rugged terrain bounded by the Indian Ocean with 4 large river gorges dissecting the city forming a barrier to the north-south movement. As a consequence the transport infrastructure is not only costly to provide, but bridge crossings cause bottlenecks, thus compounding the congestion levels during the peak flow hours. The majority of residential areas are located on the outskirts to the north, north-west and north-east of the city with the employment opportunities in the centre or on the opposite (south-western) end of the CBD, thus requiring longer than ideal trips between home and work. The topographical constraint with limited riverine and estuarine crossings is similar to travel from the suburbs in Auckland to places of work.

3.2 Statement of the hypothesis

3.2.1 **The primary hypothesis:** There is a difference in the route choice between the AM and the PM trips. This difference is noted by the spatial variance between the two routes used on a typical trip to work (AM) compared to the trip from work to home (PM). The route choice criteria applied by drivers may also be different for the AM and the PM trips.

3.2.2 **The secondary hypothesis:** The AM and PM route choice are influenced by factors other than only time or distance. Factors such as the location of schools where children need to be dropped-off in the morning, the avoidance of the peak traffic flows, suburb location and income level would also have a significant influence on route choices.

It is thought that those drivers not making a drop-off at a school may choose the quickest route (i.e. the least congested route) which is not always the shortest route (Lynn, 1978). This behaviour could be due to the following:

- The driver considering time as a higher priority than the direct cost associated with making the journey.
- Drivers' perceived running costs are considerably lower than the actual costs (Outram & Thompson 1978). Ratcliffe (1972) defines this as *"the cost the user thinks reflects the cost to him of making a trip. Due to ignorance, optimism or self-deception on the part of the user, the perceived cost is often less than the total cost."*
- The drivers prefer to use a free-flowing route i.e. a freeway or expressway where:
    a) free-flow conditions prevail (less stop start)
    b) it being perceived safer (less vehicle conflict)
    c) Although longer in distance, shorter journey times are achieved due to higher average speeds (100 km/h vs. 40 km/h) being attained.

Wachs (1967) supports the above hypothesis as he found that drivers' preference towards routes vary as the trip time increased in the peak hours, the tendency is increased towards using freeway type routes where there was access control, less congestion and increased safety. There was a decreased tendency to the shortest routes that had commercial development alongside. Shewey (1982) found that drivers do not seek shorter routes if the savings in distance amount to less than 5 miles on journeys up to 25 miles and if the time difference was less than 5 minutes.

Ueberschaer (1971) found in his study of drivers in Germany, that freeways were preferred and reduced the number of routes used when compared to an area where there were no freeways available. Drivers also stayed on the freeway, until a point nearest their destination is reached. A hypothetical trade-off question was posed to the respondents to establish how much further a driver was willing to travel on the freeway compared to a typical urban route if the longer freeway route saved them time.

The potential benefits of proving this hypothesis would illustrate the need for more integration between land-use and transport provision with the relationship and influences between residential areas, schools and work opportunities becoming clearer.

CHAPTER 4

DATA COLLECTION

4.1 Methods and Design

The best method decided on was to use a survey questionnaire and supplementing this with secondary data from databases contained in traffic study reports produced for the East London Metropolitan Transport Authority (ELMET) by the Core City Consultants, A single stage survey questionnaire was designed based on similar route choice studies done in the past (Benshoof 1970, Ratcliffe 1972, Jones 1983, Watling 1992). The questionnaire was designed and piloted in Leeds during May 2000. After refinement of the questionnaire in Leeds, the questionnaire was then distributed in June 2000 to drivers in East London, South Africa.

4.1.1 <u>Questionnaire design.</u> The questionnaire designed was to establish; (a) the difference (variance) in routes between the AM and PM; (b) what route choice factors have an influence on the route selection for these two types of trips, and (c) how variable these factors are.

A constrained-response question type was preferred, as this would simplify the coding and capturing of the data. For some of the questions an opportunity was provided to add the respondents' own opinion or reason. In order to offset some of the researcher's interest bias many of the questions were based on a hybrid of different questionnaires used in similar surveys (Benshoof 1970, Ratcliffe 1972, Jones 1983, Watling 1992).

Bonsall and May (1986) noted that bias is a very real problem in that respondents tend to overstate regularity in their behaviour. The constrained type question also forces the responses into defined categories or one runs the risk of misclassification of free format answers. To minimise some bias due to response fatigue, the researcher re-arranged the order of some of the route choice constrained - responses. The sequence of the most often quoted factors were mixed into the list, so as to get the respondent to read through all of the responses before making a selection. Based on the responses, this approach appeared to be successful.

A fundamental approach to the design of the questionnaire was to select and design the questions that are so worded to obtain a historical perceived-value response of the various conditions, as opposed to asking them directly to measure the components and report these actual values. The questionnaire also asked the respondents about their "typical" and any other "alternate" journeys. The basis for obtaining data based on their perception of conditions is that drivers tend to base their actions on a historical frame of reference, Bovey and Stern (1990). The study set out to gather data on this frame of reference. i.e. *"Is this delay going to cause me to have a journey time of 5 min or 10 min longer than usually*" or *" Is the traffic going to be worse on this route than what it usually is on the alternatives?"*

Questions for the AM and PM trips were duplicated. The final selection of questions were so designed as to collect data that is based on three broad categories, namely:

- Those dealing with or influencing journey time
- Those dealing with or influencing route choice reasons

- Those dealing with factors that influence route choice decisions

These provided some categorical overlap between the questions that could be used for correlation purposes with the responses in other parts of the questionnaire.

In addition to the above questions drivers' personal characteristics were collected and the spatial selection of their routes were recorded on a map. The AM and PM question numbers did not match exactly due to the omission of two questions that only relate to the AM trip. The numbering was intentionally left unmatched so as to eliminate possible duplication of responses for the AM and PM sections.

4.2 Data collection

As the study focused primarily on the travel patterns of drivers using the dominant north-east corridor, the target population was the drivers that used this travel corridor. The population is estimated to be in the region of 100 000 to 150 000 in these suburbs.

4.2.1 **Target Group:** Due to practicality and the available time, only 250 questionnaires were distributed to motorists in East London that were resident in any of the above-mentioned suburbs

4.2.2 **Primary Data Collection:** The survey was undertaken in June 2000. Due to time constraints it was decided to distribute the forms and collect within a two-week period. The most efficient way decided on was a manual return of the forms to either a collection box or to the controlling person at the respondent's place of work. Of the 250 forms distributed, 99 (40%) were returned.

Of the 99 forms that were returned, four questionnaires were excluded, as the data on them was insufficient. A further three cases did not have the personal characteristics completed, but most other elements of these particular cases were useable for those summary measures and analyses that did not rely on personal characteristics information.

4.2.3 **Secondary Data Collection:** Data contained in the Interim Transport Plan (ELMET 1995) and the Arterial Roads Plan (ELMET 1996) was used to supplement the primary data.

4.3 Conclusions from the data collection

Sufficient data was collected by the survey questionnaire to analyse and test the stated hypotheses. The questionnaire provided sufficient information to cross correlate various responses. The ordinal categories appear to have been well selected with an occasional respondent finding the need to write supplementary information that was not covered by the constrained-response question.

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CHAPTER 5

ANALYSIS OF DATA

5.1 Analysis methods

- Descriptive analysis (all variables)
- Difference in means (parametric and non-parametric tests for the continuous data)
- Contingency analysis (explanation of the nominal and ordinal data)

The first part of the analysis process compared the AM to the PM values. If no significant relationships or differences was noted, then the comparisons were made on a disaggregate level to compare influences of other explanatory variables. Selected sets were also compared for differences within the AM only and then using the same disaggregate variable, for the PM, to investigate the variances within the two types of trips.

5.2 Primary Analysis

The primary analysis concentrated on a single objective, namely to determine what the significant differences are (if any) between the AM and the PM trips. The variables analysed for differences are subdivided into two groups:

- Variables that explain spatial differences
- Variables that explain differences in route choice factors.

As a first step in the analysis procedure the distribution of the data was checked for normality. A screening procedure was adopted before the data was analysed. If the histogram did not adequately conform to the normal distribution curve then non-parametric methods such as the Mann-Whitney, Wilcoxon and Kolmogorov-Smirnov test were applied. Marginal normal distributions were also checked with a Q-Q plot using Blom's proportional estimation formula. If this did not yield a clear distinction for a normal distribution then both parametric and non-parametric test were used and the results checked for consistency. All the tests were undertaken at the 5% significance level unless otherwise stated.

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CHAPTER 6

SUMMARY

6.1 Results

6.1.1 Spatial Analyses:

Trip Length: There is no significant difference in trip length between the AM and PM for the typical and alternative routes. The AM and PM trip length was unaffected by the socio-demographic characteristics of the sample or the amount of route switching.

Trip length is significantly affected by departure time. The earlier the departure times the longer the trip distance. This holds true for both the AM and the PM trips individually.

The AM trip length was unaffected by the need for drivers making a school drop and those that proceed directly to work.

Distance optimisation: There is no difference between the AM and PM optimum trip length. The difference in length is also unaffected by the socio-demographic characteristics of the sample. On average routes are 5% longer than the shortest possible distance. This compares well with Russam & Jeffrey (1986) who estimated that between 3 - 7% of urban travel involves excess travel. Ratcliffe (1972) found that drivers succeeded in selecting routes not exceeding 10% of the length.

Drivers making a school drop on the AM trip made a longer (0,9 km) and less optimal trip measured by length, than drivers that proceed directly to work.

Route Switching: There is no difference in the amount of switching between the AM and the PM trips. On a disaggregate level, gender, age, journey time, departure time, fixed or flexible working conditions or car age (Michaels, 1966) did not affect the amount of route switching for the AM or PM trips individually.

Jones' work (1983) found that route variability appears to be greater for the journey from work to home than the journey from home to work.

The higher the income group the more switching takes place, those drivers living in the far suburbs made more route switches. Bonsall & May (1986) found that there was no clear relationship between the number of alternative routes a driver had tried and either the length of time that they had been making the journey or the precise origin and destination of their journeys. They concluded that the propensity to use a variety of routes is very dependent on personal characteristics. Ueberschaer (1971) also found that route switching increased with distance.

Avoiding traffic and making a school drop on the AM trip caused more switching to take place. Benshoof (1970) found less than 50% changed their routes to avoid traffic congestion.

Table 2 : Comparison of findings (Mannering et al (1994) found:)

Findings by Mannering	This Study's Findings
Males were more likely to change route than females.	Not significant
The greater the familiarity with alternative routes the higher the frequency of change.	Not significant
Commuters that had greater flexibility in departure time were more likely to experiment and use alternative routes	Not significant
Lower income groups were found to be less likely to change routes frequently.	Significant
Older drivers (>30) had more route changes in the PM.	Not significant
Those with more flexibility in departure time also made more route changes.	Not significant

Route Commonality: At least 45% of the drivers use a different route for at least part of their journey to work and back with 25% of drivers using a substantially different route (>50 %) for the AM and the PM. The amount of overlap is dependent on the trip purpose (school drop, work, avoiding traffic). Bonsall & May (1986) found in their sample that less than half (46%) of the PM routes were a mirror image of the AM route and 29% showed a major difference. This correlates well with this study's findings.

Lateral Separation: There is no significant difference in lateral separation between the AM and PM for the typical and alternative routes.

For the typical journey, routes that differ by more than 50% between the AM and the PM, the separation is greater (1,57 km) than those that are less than 50% different (0,47 km). For the alternative routes the drivers living in the far suburbs have a higher separation (1,9km) than those living closer to work (1,0 km) do. The drivers living in the far suburbs have less opportunity to switch routes until they cross the Nahoon River. The larger lateral separation could be induced by the location of the three available bridge crossings over the Nahoon River. No evidence was found in other studies regarding this issue.

Drivers who have lived ≥ 5 years in East London have a greater separation (1,6 km) than those who have been resident for less than 5 years. Drivers who have lived ≥ 20 years in East London have a greater separation (1,72 km) than those resident for less than 20 years.

Drivers with ≥ 10 years driving experience have a greater lateral separation than those with < 10 years experience.

Those drivers that drop children at school have a greater lateral separation (1,2 km) than those proceeding directly to work or avoiding traffic queues.

6.1.2 Route Choice Analyses:

Journey Time: There is very little difference between the AM and PM journey times for the typical and alternative routes. The mean longest journey time for the usual journey is longer in the AM than the PM. Males have lower 'typical and "quickest" journey times than females on usual journeys.

High-income earners (> R120 000 *pa*) have lower journey times for the "quickest" PM trips.

Journey Time vs. Distance Trade-off: On average drivers are prepared to trade distance off with time. Urban drivers would on average be prepared to drive 5 km further for trips that save them 10 minutes and 2,5km further for trips of the same time on a freeway than compared to driving on normal urban roads.

Residual Time and Departure Time: A relatively high portion "free time" (24 minutes) was found between the driver arriving at work and the required starting time**.** A large percentage of drivers stated that they are able to predict their journey time in the AM and PM with a satisfactory degree of accuracy. The occurrence and time spent in traffic queues are low for both the AM and PM. Car sharing or the need to find free on street parking has no effect on departure times.

It could be speculated that drivers prefer the quickest route so as to provide them with a predetermined residual time for personal matters, before they need to attend to their employers business.

Route decision time: The majority of drivers decide on their route before they get into the car. (Approx. 86%) There is no difference between the AM and PM trip. Benshoof (1970) found 69% of his sample decided on the route before they get into their cars.

Road Segment Selection Factors: Other than the need to travel directly to work in the AM and directly home in the PM, 23 % of the drivers needed to drop children off at school in the AM and 11% avoid traffic queues in the PM.

The need to drop children at school in the AM influences departure and journey times. Drivers making a school drop leave earlier and have longer journey times.

Running Costs: The mean perceived running cost is 70% higher than the published Automobile Association cost /km rate. This is contrary to the findings of Outram & Thompson (1978) and Ratcliffe (1972). Socio-economic and personal characteristics have no influence on the degree of difference.

Route choice reasons: The most popular reason for selecting a route is that "it is the quickest" followed by "it is the most convenient" and thirdly "it is the shortest". The popularity of the reasons is the same for the AM and the PM. As a first choice, the first reason remains "it is the quickest" but the second reason is "it has the least delay" with the third reason the same as above, "it is the shortest". The AM or PM trip has no influence on the type of reason selected. Approximately 40% of the sample selected 2 reasons and approximately 25% selected 3 reasons. A similar percentage applies for both the AM and the PM.

Table 3 below compares the research findings with those of previous research findings. East London drivers consider time and traffic as prime reasons for selecting a route whereas other researchers found time and distance the main reasons. Although the prime reason of time appears to be universal, it also confirms the difference in priority of route choice factors between drivers, across the world.

Table 3 : Route Choice Comparison

Ranking	Research findings	Benshoof (1970)	Ueberschaer (1971)
1	It's the quickest	It's the quickest	shortest time
2	it has the least delay	shortest distance	shortest distance
3	it is the shortest	less traffic	less congestion

Time is still a primary reason, but distance and traffic delays are interchangeable in terms of priority.

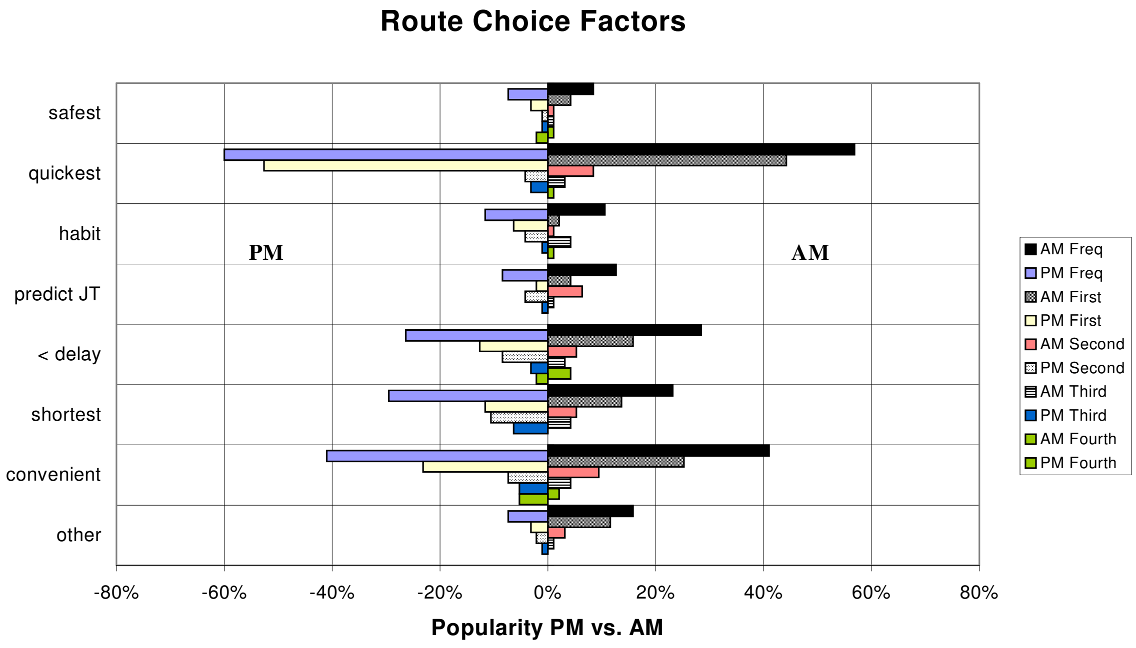

Figure 8

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CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Main Conclusions

- The analysis techniques were found to be appropriate to analyse the data and support the hypotheses.
- A significant portion (45%) of drivers vary their routes between the AM and PM. Various measures were used to describe the spatial variability and variance in route choice factors between the two trips. Some of these factors compared well with other studies and a number of differences were found.
- Consistent route choice factors were used by drivers to select their AM and PM routes, but these routes vary significantly between the AM and PM.
- Despite a substantial amount of spatial variability between the AM and PM routes, time appears to be the major consideration when selecting a route. Journey times are similar for both the AM and PM. There is evidence that the selection of the AM and the PM routes are also influenced by many other factors such as income, gender, suburb location, experience and knowledge.
- An unexplained phenomena of 24 minutes of residual time between the arrival at work and the work start time, could be an indication of an important underlying factor not covered by the constrained-response questionnaire.
- The amount of variability increased with driver experience and increased network knowledge. The lateral separation between routes is on average 1,5 km for routes that vary by more than 50% when comparing the AM to the PM paths, and 0,5 km for routes

that vary less than 50%. Alternative routes had similar spatial variability values when compared to the usual routes followed.

- Trip purpose such as school drops and avoiding traffic induced most of the spatial variability between routes.
- The typical journey times between the AM and PM shows less dispersion in the PM than in the AM. Departure times are selected to suit the distance and journey time. Males tended to have lower journey times.
- Trip length was a poor indicator of variability between the AM and the PM trip. Alternative routes are as good as the usual routes. Few factors or characteristics influenced trip length. Drivers tended to achieve the shortest routes overall in both the AM and PM trips.
- Drivers' perceived running costs were significantly higher than the actual running costs. This confirms that drivers have imperfect knowledge relating to the running costs. The fact that it is higher could either be due to the recent fuel hikes which made drivers far more aware of the fuel cost component or that running costs are not a real issue in urban travel, therefore drivers have scant knowledge of the real cost.

7.2 Recommendations

- The current application of only modelling the AM journeys and reversing the flows for the PM may lead to an over or under estimation of actual traffic conditions. Transport planners and decision-makers need to better understand the differences in route choice and how this influences the AM and PM journeys. The benefit of this would be the resultant savings in infrastructure investment, e.g. If the peak volume is substantially different in the PM than compared to the AM, then scope exists, for example, to provide only 2 lanes in the AM, whereas 1 lane in the PM would suffice. In the case of the Buffalo River Crossing in East London comprising a project equivalent to that of a scheme in NZ of $650 million, this could aid optimal lane provision and institute significant cost savings.
- Only a limited number of analyses could be used on the data and correlation studies of underlying factors compared to choices would be necessary to explain some of the spatial differences found.
- The influence of free-flowing routes such as freeways (motorways) and the impact on route choice could be investigated further.
- Clarity is required on how significant the perceived costs, which are higher than the actual costs, influence the route decisions.
- Other areas of analyses could include:
  1. The aggregate effect route choice has on the traffic volumes in the AM and PM on the different types of road facility (freeway vs. urban).
  2. How the drivers react to congestion in the AM and PM
- Further validation studies could be undertaken in other areas to test transferability of the findings.

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