

JOURNEY TO WORK: MODAL SPLIT IN THE CITY OF GWERU, ZIMBABWE

By

Steve Jerie¹

Abstract

The thrust of urban planners today is to develop methods of travel for adaptation to their environments. This is meant to match the high population growth rates in developing countries. Transportation congestion is a problem faced many cities today. Routes and facilities tend to be overloaded, trips tend to be long and services provided for public transport become inconsistent and inconvenient. This study examines the factors that influence modes of travel used by the commuters in Gweru as a first step towards isolating the causes of transport problems. This way the needs of different socio-economic groups can be understood. An attempt is also made in this study to use simple travel models in determining modal split. These models are adapted in the context of the study area.

Introduction

One of the least understood phrases of traffic analysis is that of modal choice (Bruton, 1992; Lioukas, 1982). Most scholars have suggested that if the most efficient and economical balance between the public and private sectors of any transportation network is to be achieved, it is vital to understand the factors which motivate this choice. The journey between home and workplace represents a very important component of all travel in an urban area. In the earliest stages of economic development, home and workplace were often synonymous and a journey to work did not exist. However, with economic development, commuting distances began to increase.

The increase in commuting has been a result of large scale increase of commerce and industry and this has necessitated separation of workplaces and places of residence (Mbara, 1994; Monroe and Maziarz, 1985). This development has therefore involved workers in a certain amount of travel. Improvements in transportation technology have also facilitated the separation of workplace and place of residence. The improvements in transport have been witnessed in the greater mobility of workers today than in the past. A phenomenon known as 'the journey to work' has resulted from this mobility.

The Concept of Modal Split

Modal choice incorporates the concept of modal split, which according to Bruton (1992) is the proportionate division of the total number of choices between different methods or modes of travel. It can be expressed numerically as a fraction, a ratio or as a percentage of the total number of trips. Modal choice is influenced by a number of variables that range from traffic engineering and landuse variables to the sociological and environmental factors. It is, however,

¹ Steve Jerie is lecturer in the Department of Geography and Environmental Studies, Midlands State University, Zimbabwe.

important to isolate the most sensitive factors that influence modal choice and then incorporate them into a mathematical model. Many scholars have underlined the importance of time in modal choice (Lioukas, 1982; Bruton, 1992; Kunaka, 1996; Mutizwa- Mangiza, 1993). Transport costs also become important to the traveller when examined in the context of income. Accordingly, Mogridge (1989) notes that costs of running a car or expenditure on car purchase is determined by the level of each household's disposable income. Car ownership therefore becomes sensitive to income, price of fuel, degree of urbanization and the extent of the road network.

In the European suburbs of Harare in the 1970s, low densities of population were a notable feature. This meant that the motorcar was the commonest form of travel to work as no public transport could be provided for such low densities. European incomes outside the primary sector were on average six times higher than those of Africans. Europeans could therefore afford to purchase cars for use in the journey to work. In Zimbabwe, the period after 1980 saw a marked change in modal choice. Following the legalisation of emergency taxi use in November 1982, modal choice by households based on all trips, was wider. Modal choice in Harare, for example could be made from the Zimbabwe United Passenger Company (ZUPCO) buses, emergency taxis, metered taxis, motor cycles and bicycles (Maunder and Jobbins, 1988).

It is widely acknowledged by scholars that rapid rates of urbanization put a strain on transport services. In Zimbabwe the rapid growth of urban settlements has not been matched by improvements in the provision of adequate transport services. The low standards of living of the majority of people have meant that most people cannot afford to have private cars. Most people therefore depend on public transport when commuting between places. The public transport itself is characterised by inefficiency, poor maintenance, discomfort and unaffordability especially to the poor.

Bruton (1992) noted that of the factors influencing modal choice, most cannot be quantified accurately and reliably. Such factors include comfort and convenience. The individual traveller only considers the potential substitution between alternative modes in his relevant choice if his usual choice becomes less attractive in terms of relevant characteristics of the alternative.

Data Collection and Design of Survey

In this study 322 questionnaires were administered to households in Gweru chosen using a random number table on a grid of 1:5000 survey maps. These were directed at people who travel to work at any time of the day. Sampling was thus directed at both captive public transport users who do not have access to a car for the particular trip under study and choice transport users who are in a position to choose whether to use a car or public transport for a particular journey. The questionnaire was designed to collect information on personal characteristics (i.e. socio – economic and demographic structure), modes of transport used, workplaces, routes used to workplaces, travel times, travel costs and the inconvenience factors related to commuting. Traffic censuses were also undertaken. Secondary data sources included bus timetables and transport related publications.

Modes of Transport Used

Travel patterns of Gweru residents can be depicted in two ways. Firstly, this is on the basis of share by each mode to 14 workplaces (Table 1). Modes are also broken down on the basis of private and public transport in the collated work places as shown in Table 2. A large split of the travellers (45.3%) use public transport in the form of commuter omnibuses, 17% use buses whereas 37.3% use private transport (motor vehicles, cycles or foot).

A number of different forms of transport are used in Gweru to ferry commuters from one place another. In the journey to work, the common types used include conventional buses, bicycles, private cars and some foot to work. Commuter omnibuses dominate public transport because of their dominance in numbers. However, a sizeable number prefer conventional buses because of their lower cost. The bus companies providing public transport in Gweru include Musengi, Murwisi, T and H, Tombs, Zijena and the Zimbabwe United Passenger Company (ZUPCO).

Table 1: Modal Split on Routes To Fourteen Workplaces

Work Places	No.	%	Car	Commuter	Bus	Foot	Cycle
CBD	133	41.3	28	69	26	7	3
Heavy Industrial Sites	76	23.6	11	30	15	13	7
Light Industrial Sites	20	6.2	6	8	2	2	1
Hospital	16	5	3	7	-	5	1
Low Density Areas	12	3.7	4	6	1	1	-
High Density Areas	21	6.5	5	8	4	2	2
Midlands State University	12	3.7	4	6	1	1	-
Thornhill Air Base	5	1.6	2	2	2	-	-
Zimbabwe Military Academy	3	0.9	2	1	2	-	-
Guinea Fowl	2	0.6	1	1	1	-	-
Portland Cement	4	1.2	2	-	-	-	-
All Colleges	4	1.2	2	2	2	-	-
National Railways	5	1.6	2	2	1	-	-
Outside Gweru	9	2.8	3	4	2	-	-
Total	322	100	75	146	56	31	14

Table 2: Collated Modal Choice of All Respondents

Work Places	Car %	Commuter %	Bus %	Foot %	Cycle %
CBD	37.3	47.3	46.4	22.6	21.4
Industrial Areas	22.7	26.0	30.4	48.4	57.1
Residential Areas	12.0	9.6	8.9	9.7	14.3
University and Colleges	5.3	5.5	5.4	3.2	0
Other Areas	22.7	11.6	8.9	16.1	1.0

Commuter omnibuses dominate public transport as a mode of travel used especially by commuters heading for the CBD and the industrial areas. Most commuters also use the conventional buses to travel to work, but the problem with these is that they are too few to accommodate all the workers. Table 3 shows the bus companies that provide public transport in Gweru.

Table 3: Bus Companies Providing Public Transport Services in Gweru

Bus Company	Fleet Size
Murwisi	1
Musengi	3
T and H	6
Tombs	4
Zijena	2
ZUPCO	2

Source: Ministry of Transport and Research Findings (2004)

A total of 18 buses service the whole of Gweru urban. This is a small number when the commuting population of the city is taken into consideration. Out of the 18 buses only one ZUPCO bus is providing a very erratic service on the Senga- MSU route, but the situation is better on the Mkoba route, which is serviced by more ZUPCO buses.

Time Related Characteristics as Factors in Modal Split

In modern modal split models relative travel times between competing modes influence modal choice. The measure of travel ratio is expressed as a ratio of travel time to work by public transport divided by the door-to-door travel time by private car. The formula used for calculating the travel time ratio is:

$$\text{Travel Time Ratio (TTR)} = (x_1 + x_2 + x_3 + x_4 + x_5) / (x_6 + x_7 + x_8)$$

Where X_1 = time spent in public transport vehicle

X_2 = time spent changing between public transport vehicles

X_3 = time spent waiting for public transport

X_4 = time spent to public transport at origin

X_5 = time spent walking from public transport vehicle at destination

X_6 = time spent driving car

X_7 = time spent parking vehicle at destination

X_8 = time spent walking from parked car at destination

There is a difference between commuter omnibus users and conventional bus users in terms of travel times, travel time ratios and percentages of total travellers using a particular mode on a route. An example is the case of Mkoba peak hour travellers who work in the city centre. The bus user has a total travel time of 36 minutes to the Midlands State University. The travel time for a kombi on the same route is 15 minutes and the car user takes just 8 minutes. The travel time ratios and travel times are illustrated in Table 4.

Table 4: Travel Times and Travel Time Ratios on the Mkoba-City-MSU Route

	Bus	Commuter Omnibus	Private Car
Travel Time in minutes	36	15	8
Travel Time Ratio	4.5	1.9	-
Percentage using mode	12	59	29

The modes associated with a shorter travel time (cars and commuter omnibuses) tend to be favoured over those with longer travel times.

Though the travel time provides a useful measure of the impact of time on modal choice, it may be difficult at times to justify it on a separate intuitive basis. This can be illustrated using 3 commuter users from South Downs to the Midlands State University (Table 5).

Table 5: Relative Travel Time Ratios and Travel Time Differences of Three Commuters on the South Downs – City – MSU Route

	Respondent 182 (A)	Respondent 30(B)	Respondent 86 (C)
Time by Kombi(mins)	36	38	20
Time by Private Car (mins)	18	30	10
Travel Time Ratio	2	1.3	2
Travel Time Difference (mins)	18	8	10

From the table, if it is the ratio of travel time that is important for people to decide what to do, then the car is almost equally preferable for individuals A and C, but less preferable for B, other things being equal. When travel time differences are considered to be important, the car is almost equally preferable for B and C, but more preferable for A. However, despite the limitations which may be imposed by the travel time ratio, it can always be a useful statistic in predicting travel behaviour.

Economic Status of the Traveller as a Factor in Modal Choice

The economics of any journey is a prime consideration to the Gweru commuter. The measure used to explain and predict the impact of travel cost on modal choice is that of relative travel cost ratio. This measure is expressed as the out of pocket travel cost by public transport divided by the out -of -pocket cost by car;

$$\text{Travel Cost Ratio (TCR)} = X_9 / (X_{10} + X_{11} + 0.5X_{12}) / X_{13}$$

Where:

X_9 = fare by public transport

X_{10} = cost of petrol

X_{11} = cost of oil

X_{12} = cost of parking

X_{13} = average car occupancy

Other costs of running a vehicle such as road tax and insurance are ignored since most drivers do not consider these when making a particular journey. In the case of Gweru average travel cost ratios were computed for the most common journeys to work i.e. the journey to work in the C.B.D. and the journey to work in another suburb/industry via the C. B. D. The results of these computations are shown in Tables 6 and 7.

Table 6 Travel Cost Ratios on the Suburb – City Route

Mode of Transport	Bus	Kombi	Private Car
Travel Cost Z\$	800	1200	6500
Travel Cost Ratio	0.12	0.19	-
Percentage Using Mode	23	44	33

Table 7: Travel Cost Ratios on the Suburb-City-Suburb Trip

Mode of Transport	Bus	Kombi	Private Car
Travel Cost Z\$	1000	2400	10 000
Travel Cost Ratio	0.1	0.24	-
Percentage Using Mode	47	36	17

The travel costs by car are generally higher than those of public transport as the ratios are for a greater part less than one. When travel cost ratio decreases it means traveling costs by car may be higher hence an increasing proportion turn to public transport. A typical example is whereby the routes which had 50% (e.g. the Mkoba – City route) of commuters turning to public transport were the ones which had the value per route whilst the South Downs – City Route had the lowest percentage (12.5%) of commuters turning to public transport. Travel costs by car to South Downs were thus deemed not too high and less commuters turned to public transport.

Travel costs in Gweru influence the route taken to work. Longer routes are more expensive as it takes more time to reach the intended destinations. However, it has been argued by Konafani (1983) that if the individual is faced by a number of alternative routes for a journey and if these routes are identical in every respect except travel time, then it is safe to assume that the individual will choose the one with the shortest travel time and a deterministic choice of mode is made. In the case of Gweru, if the traveller's response to differences in travel costs is related to his/ her income then route use can be predicted as follows:

$$V_i = -0.2t_i = 1.0c_i$$

Where

B

v_i = Choice of function
 t_i = Travel time in hours
 c_i = Travel cost
B = annual income in thousand dollars

The rate of substitution between cost and time is:

$$\frac{dc}{dt} = -0.2 B$$

The marginal rate of substitution between cost and time is the rate at which an individual is willing to exchange money for time. This marginal cost is proportional to income. Value of time per hour is 20% annual income in thousands of dollars. A person with an income of \$20 000 000 annually values time at \$4 000 per hour and one earning \$50 000 000 values time at \$10 000 per hour. An individual is therefore bound to choose the route, which bears the least cost in travel.

Socio- Economic Factors Influencing Modal Choice

The apparent influence of travel costs of public transport for the work trip combined with the relationship between income and car ownership, can indicate that the economic class of the traveller may influence modal choice.

The choice between modes can often be characterized as a trade off between expensive, but less convenient means and inexpensive, but less convenient means. In Gweru, 23.9% own cars and this is contrasted with 67.7% who use cars to work. It was also established that (setting aside breakdowns and fuel shortages) all car owners used their cars in the journey to work. Table 8 shows the modal split among the non -car owners.

Table 8 Modes of Transport used by Non Car Owners (September- October 2004)

Monthly Income Z\$	Car %	Bus %	Commuter %
500 000 and less	1.1	2.3	2.6
501 000 – 1000 000	5.3	1.8	4.0
1001 000 – 1500000	3.4	4.3	8.8
1501000 – 2000000	4.7	7.8	16.5
2001000 and above	2.0	8.0	27.4
Total	16.5	24.2	59.3

The general picture is that there are more commuter users per income group as the income levels increase. For example there are 8.8% commuter users and 4.3% bus users in the \$1 001 000 - \$ 1 500 000 category. These proportions increase to 16.5 and 7.8% in the \$1 501 000- \$2 000 000 categories respectively.

Inconvenience Factors Related To Public Transport

The inconvenience of public transport usage both from the service and vehicle viewpoints has been widely considered by many as a contributory factor in the declining preference of public transport usage. Analysis of the inconvenience factors was based on the captive audience

for public transport. This group, being forced to use public transport daily would be more critical and would have first hand, long term assessment of the inconvenience of public transport in Gweru.

The inconvenience factors included service level factors, such as waiting times at bus stops, distance of bus stop relative to the residence, effect of transfer during work trip and congestion on roads leading to workplace. Results indicated the waiting times for the bus and pick up for the commuter being the most inconvenient factors (Table 9).

Table 9: Inconvenience Factors Related To Public Transport (% Commuters)

Factor	Conventional Bus	Commuter Omnibus	Total Commuters
Long waiting times	30	16	46
Long in-vehicle time	20	12	32
Pick-up point too far	4	10	14
Involves transfer	4	4	8

For the bus users, waiting times were too long and this affected people in the lower income groups who deemed using the bus as a saving over the more costly commuter. In-vehicle time for the bus users also ranked second and constituted a very large proportion of the time for the whole journey. As an inconvenience factor, bus users ranked transfer time third just as did commuter users. The results, however, varied from CBD and other non-CBD workers since CBD trips do not generally involve transfer.

As far as the commuter users were concerned the greatest inconvenience involved the longer distances to the main pick up points in the suburbs or the city. This complaint was registered mainly by the residents of Mkoba suburb which houses the majority of Gweru's working population.

The difference in emphasis placed on the length of wait at the commuter pick up point by employees from the CBD and the industrial areas near Mkoba high density area can possibly be accounted for by considering the psychological effect of the waiting times. The CBD oriented trips are shorter than non-CBD trips and an equal waiting time for both journeys makes a greater psychological impact on those persons making the shorter trip. It becomes apparent to them that the waiting time is a large proportion of their travel time. In Gweru, the combined waiting and walking time took up to 40% of the total time of trips to the CBD and 25% of the time to the industrial areas.

Survey results indicated that that 46% of the car users preferred to use private transport because the journey by public transport involved longer waiting time. Travel time data analysis

indicated that work trips were involving longer waiting times for buses than for commuter omnibuses. The average value of waiting time difference between buses and commuters was at least 31 minutes even for those who knew bus time tables well. From the results relating to the preference of the use of the car for the work trip, travelling time ranked second indicating its relative importance. Travel times by car were perceived to be shorter than for commuters and the buses. However, it would be doubtful that if an actual time difference perceived would have made as great an impact on the traveller's modal choice if a measure competitive time was available to all. A number of persons who had been using cars for the journey to work over a long time would not have any real measure of the public transport travel time and the psychological impression of a slower, less efficient public transport is held by many. This may be a reason for the high rating given to this particular factor.

When asked why car owners would prefer not to use the car in the journey to work, the factor given the highest rating of 36% was that of increasing running costs (fuel, oil, parts etc). This reflects the current opinion of motoring conditions in Zimbabwe's urban areas. Lack of suitable parking has gained prominence as a factor (20%) especially among CBD workers.

Conclusion

Modal choice in Gweru is influenced by a number of factors including the characteristics of the traveller (incomes and car ownership) characteristics of the transportation system, which include travel time ratios, travel costs and behavioural factors ie human perception about particular modes of travel. Under habitat conditions typified by the journeys to and from work, the individual Gweru traveller only considers potential substitution between alternative modes in his/ her usual choice becomes less attractive in terms of the relevant characteristics of the alternative than it was previously. The potential substitution is related to the objective of understanding the relationship between cost and time so as to directly value savings in travel time.

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