WORK TRIP TRAVEL PATTERNS:

A Study of factors Influencing mode choice of Kaduna State Civil Servants

BY

SANI HALIRU

A thesis submitted in partial fulfillment of the requirements for the award of Master of Engineering M.Eng. Degree in Highways and Transportation of Ahmadu Bello University, Zaria - Nigeria.

Department of Civil Engineering
Ahmadu BellO University
Zaria.

January, 1982

D E D I C A T I O N

I dedicate this work to my late mother,

Fadimatu Haliru whom we popularly called **UWANI.**

A C K N O W L E D G E M E N T

I wish to express my profound gratitude to all the staff of Bauchi State Development Board who made this work possible, by sponsoring the course.

My sincere thanks also go to my project supervisor, Dr. Olusegun Adebisi, for his constant checks and numerous useful suggestions throughout the period of the work.

The following have contributed in no small measure in the success of this work: Dr. Attahiru Alfa who went through the whole work and offered suggestions, Mr. N. Khandpur who saw through most of the computer problems, Alhaji Abba Haliru, who had been offering moral and financial assistance whenever the need arose. To all of you I say thank you.

Finally, I wish to thank Mohammed Sanda for taking his time in typing the script.

January, 1982 Sani Haliru

C O N T E N T S

	Pages
Dedication	i
Acknowledgement	ii
Contents	iii
Abstract	1
CHAPTER ONE	2
Introduction	3
CHAPTER TWO	
LITERATURE REVIEW	6
2.1 Previous Studies	6
2.2 Some of the hypotheses	9
CHAPTER THREE	
THE FIELD STUDY	14
3.1 The Study Area	14
3.2 Sampling Procedure	14
3.3 Data Collection	15
3.4 Variables Selected for analysis	19
CHAPTER FOUR	
ANALYSIS	21
4.1 Analytical technique used	21
4.2 Theory of discriminant Analysis	21
4.3 The SPSS Subprogramme "DISCRIMINANT" ..	25
CHAPTER FIVE	
RESULTS	30
5.1 Crosstabulation results	30
5.1.1 Comparison by sex	30
5.1.2 Comparison by occupation	30
5.1.3 Reported travel time	31
5.1.4 The Personal Income	32

5.2 Pattern of Residential distribution .. 34
5.3 Discriminant Analysis results 35
CHAPTER SIX .. ..
CONCLUSION AND RECOMMENDATIONS 60
REFERENCES 66
APPENDIX A .. ..
THE QUESTIONNAIRE USED IN THE STUDY .. 71
APPENDIX B .. ..
THE PROGRAMME USED IN THE ANALYSIS .. 83

ABSTRACT

The journey to work had been the subject of several studies. Results from dome of these studies have been used to formulate models for use in travel demand forecasts. However, virtually all these studies have been carried out in the developed countries. Because of differences in environmental factors, one cannot arbitrarily adapt their findings for use in developing countries like Nigeria. Hence, it is necessary for similar studies to be carried out in Nigeria, so as to evaluate the prospects of transfering results and also to determine the limitations of the study techniques as regards their applicability to local conditions.

This work examines the commuting patterns of some randomly selected Civil Servants working in Kaduna State Government Secretariate.

The questionaire methods of data collection was utilized in gathering information on the travel behaviour of the selected subjects. Questions asked cover both level of service attributes of the modes used and socio-economic characteristics of the respondents. Discriminant analysis was then used to isolate the major factors responsible for differences in mode choice.

Prior to administering the questionaires, the distrubution by income of the total population of Civil Servants, from which samples were taken, was

obtained. Proportionate numbers of worker were then randomly chosen within each income group. However, disproportionately small response rate was obtained from the low income groups. This suggests that special attention has to be paid to low income earners when conducting such studies, with the use of questionaires, in order to have a fair representation of the lower income group. Personal income was found to be a great determinar t of the mode selection of the studied workers. It was also found that transport fare weighs heavily in the mode choice decisions of the workers. This letter findings would seem to be at variance to the general belief that travellers, in developing countries, are mode-captive. However, no other level of service attribute was found to be statistically significant from the discriminant analysis.

The results sugges that when questionaires are used for data collection in developing countries, special attention need be paid to the low income earners. This would yield a more proportionately uniform data representation across the income groups. The results also suggest that variables like travel times do not contribute significantly to the mode-choice decisions, in contrast to findings in similar studies in developer countries. These findings indicate that methods of model development derived in developed countries are not generally transferable to the developing countries.

CHAPTER ONE

INTRODUCTION

This thesis is a study of mode choice patterns of work trip for Civil Servants in Kaduna, the Capital of Kaduna State. The study is aimed at analysing the general factors responsible for the worktrip mode choice patterns of the chosen workers. There are two major reasons for interest in this work, namely:

(i) Worktrips are the most important category of journeys made from the home. Horton et al (1969) indicated that "...among all the traffic generated from the home, journeys to work could be said to dominate both in importance and magnitude...". Hutchinson (1974) also indicated that home-based trips constitute from 80% to 90% of total travels in urban areas and 30% to 45% of these are worktrips.

(ii) Worktrips tend to be distributed unevenly throughout the day, most concentrated into a few peak hours.

Every morning and evening great flows of movement take place between the residential areas and workplaces. The daily movements in large urban areas involve thousands of pedestrians, bicyclists, motorcyclists, public transport and private cars.

This research project is aimed at isolating the important factors that influence worktrip mode choice

patterns of individuals with particular reference to Civil Servants in Kaduna metropolis.

Previously, research into individual choice patterns of worktrips has taken place in Countries such as the United States of America, Norway, Britain, France and the Netherlands among others. However it is still of interest to conduct such studies in Nigeria. Knowledge and experience from such studies would help in determining the extent to which individual choice models can be developed satisfactorily in Nigeria. This would also offer further evidence of the extent to which there may be potentialities for geographic transferability of the methods and possibly even individual models and results.

There are as yet only few attempts made in Nigeria, to examine the role played by transportation systems policies in travel demand analysis and in particluar on some of the problems and possibilities arising in work trip travel estimation. Complexities in the composition of traffic and the distinguishing socio-economic features influencing transportation policies are the underlying impedements in formulating and testing a suitable travel demands model for developing Countries.

Transportation policies have hitherto been derived from models developed for areas outside Nigeria - mostly the Western Countries. It is hoped that results from this work would assist in reflecting a truely Nigerian situation in travel demand forecasting. It should also provide some evidence on the transfer-

ability or otherwise of models developed elsewhere outside Nigeria. The latter would go a long way in helping transportation. Engineer give better advice to the policy makers in their attempts to solve our transportation problems.

CHAPTER TWO

L I T E R A T U R E R E V I E W

2.1 Previous Studies

Characteristics of worktrips have been the subject of many studies. Several models, ranging from purely theoritical to wholly empirical, have been derived to explain the effects of various factors such as landuse patterns, technology, socioeconomic status of the trip makers, level of service etc. on the choice behaviours of the trip makers. This section summerises some of these.

One of such studies by Beesley et al (1974), the 1951 and 1961 commuter census data for Central London were used to draw certain useful conclusions about journey to work, although they made some assumptions which oversimplify real Life conditions. They found that socioeconomic status strongly influences the residential distribution relative to work places and that this influence does not decline much with time. One striking shortcoming of their study was that they failed to account for the influence of availability or lack of availability of vacant residences, Undoubtedly, availability of vacant residences affects the choice of residence.

In his study, Guest (1976 b) investigated the influence of metropolitan population, size and age on worktrip patterns. He used 1960 and 1970 census data

on work places and residence location in 217 standard metropolitan statistical areas (SMSAs) for Washington, to show that metropolitan population, size and age do not exert strong effects on worktrip patterns of metropolitan areas and concluded that work-place exert "a strong though not profourd effect on the location of residences". He further found that work trips from suburban areas to central city were increasing whereas those within the central city were decreasing. This indicates a decline in the role of the city core as both work-place and residence.

In two seperate but identical studies undertaken by McCarthy (1977) and Ojumu (1975), it was found that residential location with respect to job location is a significant factor in an individual's mode-choice for work-trips. McCarthy based his study on a mail survey data obtained from 2078 new residents in 36 San Francisco Bay area communities while Ojumu based his study from questionaires survey administered to selected low income earners in Lagos. In his findings Ojumu reported that the low income earners tend to walk to work when commuting distances are within one kilometer, use bicycle as a means of transport for distances of one to four kilometers whereas they use motocycle, taxi or public bus when distances are beyond four kilometers.

The effects of travel costs, and level of service on mode choice patterns were investigated by Ben-Akiva et al (1976). In their investigations during the development of a disaggregate multimodal model for work-trips, they found that out of pocket travel costs have

no significant influence on mode choice. This is contrary to general expectations. They used data taken from a 1970 home interview travel survey conducted in Eindhoven, the Netherlands. The authors concluded that the probability of anyone choosing a given mode is determined largely by factors other than the level of service offered by that mode. The authors argued that if a car is available to a traveller then there is a very high probability that he/she will choose it regardless of the characteristics of the alternative modes. They also found that socio-economic characteristics, other than vehicle availability, do not significantly influence mode choice. There are other studies undertaken to determine the effects of travel costs, among other factors on mode choice patterns.

In a recent study, Stopher et al (1979), found that walking and waiting times (out-of-vehicle travel time) are considered more onerous than in-vehicle travel time in mode choice decisions. This is contrary to the findings of Ben-Akira et al cited above.

Stopher's study was done on two communities north of Johannesburg, South Africa. Considering their area of study, the data collected, and the survey area, one would still have some reservations as to the applicability of such models in developing country like Nigeria. This is because, for the workplace survey, only 5% of households reported no car while 32% reported ownership of one car, 45% reported two cars, and about 19% reported three or more cars This means that the sampled popu-

lation on which these inferences were made represent a moderately high income, high car ownership group, the type of which is difficult to come by in Nigeria.

Clemente's study tends to confirm the above assertions. Clemente et al (1976) studied the commuting patterns of some male employees of a large manufacturing facility in rural Illinois, and found that the model of metropolitan commuting is not applicable to non-metropolitan regions. This would seem to stress the need for developing appropriate models for Nigerian Urban Centres rather than simply adapting models developed elsewhere.

2.2 Some of the hypotheses so far Presented

Various hypotheses have been advanced from studies on the characersitics of journey to work.

For example, Leipmann (1944) hypothesised that the length of work-trip is casually related to the incidence of absenteeism and even illness, while Carrol (1952) opined that industrial workers seek to minimize distances from workplaces to homes subject to their (workers') financial positions. The latter was subsequently refered to as the "minimisation hypothesis".

Some economists, (Evans (1973), Beesley et al (1974)), observed that rent generally declines away from the centre of the city or major work places, (at first rapidly and then flattens towards the pheripery), while costs of transport increase. They formulated that the choice of residence, given the location of workplace, is constrained by the relationship:

$$P_k q = -(C_k + r.V_k) \quad \text{or}$$

$$C_k + P_k q + r.V_k = 0 \text{ - - - - - - } 2.2.1$$

where:

C_k = the rate at which the direct cost of travel increases with respect to distance.

P_k = the rate at which the rent per unit space falls with respect to distance.

q = number of unit spaces occupied by the household.

r = householders rate of pay and,

V_k = the indirect cost of travel per unit rate of pay.

In equation 2.2.1, it is assumed that the indirect cost of travel is directly proportional to the rate of pay and in such a case, V_k is a fraction to represent this proportionality and $r.V_k$ is the rate at which the indirect cost of travel (the value of travel time) increases with respect to distance. The equation indicates that in their choices of residence, workers trade off space consumption with total commuting costs. In other words, a worker can locate far away from his workplace in order to have more residential space, and spend more on commuting or alternatively, reside near his workplace by consuming less space and saving on commuting. In making this choice, the total cost of commuting and space consumption for any particular worker should remain constant irrespective of the location - this is refered to as the equillibrium state.

The equation would seem to be valid when rents truely decline away from the city centre, but an urban area characterised by accute housing shortage is not likely

to reflect such a phenomenon. When there is accute shortage of housing, the indirect costs (value of travel time) is not likely to show any logical relationship with the rate at which the rent falls with respect to distance. This is the general case in our (Nigerian) growing urban areas. Also the prevalent practice whereby employers provide subsidized housing for workers, is likely to becloud any underlying relationship between commuting costs and house rent or space consumption.

Evans (1973) suggested that different status groups will attempt maximising the utility of their income within a level of residential space preferance. This was confirmed by Beesley et al (1974) from analysis of 1951 and 1961 census data of 60 randomly selected boroughs of South East England.

Howe (1960), hypothesized that journey to work is identical to the movement of electrons subjected to an electrostatic field with residences representing negative charges and workplaces representing the positive charges. Using this hypothesis, Howe confirmed after analysing the O-D survey data from selected communities in the standard metropolitan area of Cincinatti, Ohio, United States of America, that Coulomb's law of electrostatic force could be used to predict the movement of workers from their residences. The Coulomb's law, so used by Howe is very identical to the conventional gravity model used in trip distribution stage of the transportation planning, since in essence what Howe's model indicates is that the probability of movement from

one zone to another is directly proportional to the number of workers in the origin zone, the number of jobs available in the destination zone and inversely proportional to the seperation (measured in distance) between the two zones.

In explaining modal split characteristics of worktrips, McCarthy (1977) hypothesized that residential location in relation to job location exerts significant influence on modal choice for the worktrips.

In one of the few studies so far undertaken in Nigeria, Ojumu (1975), suggested that income greatly affects mode choice of workers especially the low income groups. By studying worktrips of selected low income workers in Lagos, Ojumu found that on the average, 10% of an individuals salary goes on the journey to work, and about 87% use public bus as a means of transport to get to work. This is of course not unexpected, since Ojumu considered low income earners. His findings, however indirectly confirms that for low income earners especially, trip makers in developing Countries are mode captive, since income to a large extent determines the type of mode available to a trip maker.

Stopher et al (1979), after developing some worktrip models for two municipalities in Johannesburg, South Africa, and statistically comparing them with those obtained in the United States of America, suggested that it will not be completely out of place to expect a relatively good locational transferability of mode choice models within a given broad socio-economic

stratum. This happens to be true with South Africa because it is a Country with predominantly western industrial society.

CHAPTER THREE

THE FIELD STUDY

3.1 The Study Area

The study is aimed at analysing general factors responsible for travel behaviour of worktrip makers.

Kaduna, which is the Capital of Kaduna State was chosen for this study, because the state has a well-established Government Secretariate that houses most of the Government Ministries and parastatals. This makes it much easier to obtain raw data within the limited resources available at the time of study. Another reason why civil servants are chosen is because their worktrips are the most frequently done and perhaps the most stable.

There are a total of eleven (out of a total of thirteen Ministries in the state) and two parastatals contained in this Secretariat, with a combined population of about 4,570 workers as at time of survey (September, 1980). This number is fairly large and concentrated in one (destination/origin) point, at which worktrips from various locations in and around Kaduna terminate in the morning and originate in the evening.

3.2 Sampling Procedure

The purpose of sampling is generally to save effort and money by dealing with a subgroup instead of the whole population. To be useful, a sample must be representative of the population from which it was selec-

ted. But even with the best forms of sampling, some degree of accuracy is usually lost. Thus sampling is largely a matter of economics in which cost implication of the possible sample errors are weighed against the costs of full data collection and analyses.

The statistically safe way of selecting a sample is to pick items "at random". For the purposes of this research, the sampling was made randomly. The names of all workers in each ministry are randomly arranged according to income group, i.e. for each income group, the names are arranged randomly. Although the list is stratified by income, the arrangement of the names in each stratum is done without any order (at random). Selection of the names were made systematically by selecting the first of each five consecutive names.

Stratified sampling ensures that every income group is strictly in the right proportion.

Income groups were used, because these were the easiest to get from records readily available. The number of workers in each salary level was obtained from the Chief Accountant of the various ministries and a sample size of 20% was used to determine the number of workers to examine.

3.3 Data Collection

Due to manpower and financial restrictions, questionaire method of collecting data was adapted during the survey. The distribution of the questionaires was done by assistants, according to ministries in turn, over a period of ten (10) days (11th Sept. to 22nd Sept. 1980). Every selected person was traced to his office/

workplace and the questionaire handed to him/her, with the advice that it would be collected the following day. This is to give more time to devote on answering the questions.

The questionaire, a copy of which is presented in Appendix A, is designed in such a way that respondents would not have to read though all the questions. The questionaire was divided into four sections, a general section which is to be answered by everybody; Section A, to be answered by persons who do not own cars; Section B, to be answered by persons who own and used their cars to get to work; and Section C, to be answered by persons who own but did not use their cars to get to work. This arrangement made it possible to include many questions at the same time minimising the time spent on the questionaires by respondents. The questions are made much simpler by providing alternative answers to them.

It is believed that a respondent with an average knowledge of the English language (Secondary School leavers) would be able to satisfactorily answer the questionaire in about ten minutes.

Where it is felt that respondents might not understand the purpose or language of the questionare, the subjects were traced and orally interviewed, the appropriate answers ticked when and as given by the respondents.

The questions were then coded for computer analysis. During the design of the questionaire, seven

modes were considered: Bus, Private car passenger, private car driver, Taxi, motorcycle, Bicycle and walking modes. Questions were also asked to determine the level of service of chosen modes and the socio-economic characteristics of the respondents.

A total sample size of 914, which represents about 20% of the number of workers, was used and the questionaires were administered to each of these selected number, according to the procedure already outlined in section 3.2. A summary of the distribution of the questionaires among the various income groups is given in table 3.1.

Out of a total of 914 questionaires which were distributed, about 431 usable questionaires were returned, with 7 of them having no response on personal income. Thus a total of 46.4% response was recorded with the personal income response.

TABLE 3.1 - THE QUESTIONAIRE DISTRIBUTED BY INCOME

Income Group	Approximate number of persons in group.	Number of questionaire distributed
GL 10 - 16	370	74
GL 7 - 9	501	100
GL 4 - 6	1,636	327
GL 1 - 3	2,066	413
TOTAL	4,573	914

A questionaire is considered not usable when a whole section is not completed or whenever a respondent did not indicate the mode used to get to work. The

response rate is given in table 3.2.

This table clearly shows a very low response from the low income group.

TABLE 3.2 - RESPONSE RATE BY INCOME

Income group	Number of Questionaires Distributed	Returned	Percentage response
GL 10 - 16	74	46	62.2
GL 7 - 9	100	82	82.0
GL 4 - 6	327	255	78.0
GL 1 - 3	413	41	9.9
TOTAL	914	424	

There are various probable causes of this low response; first, this group is not well enlightened as to understand the questions asked and to offer serious answers to them. Secondly, this particular income group did not take the whole exercise with the seriousness it deserves, to the extent that questionaires would be put away and never refered to again.

TABLE 3.3 - TOTAL RESPONSE BY SEX

S e x	Number of Questionaires Distributed	Returned	Percentage response
Male	704	335	47.6%
Female	210	96	45.7%
TOTAL	914	431	

The above table indicates that 22.3% of total response are females while 77.7% males.

3.4 Variables selected for analysis

The STATISTICAL PACKAGES FOR THE SOCIAL SCIENCES (SPSS) was used in the analysis, as this was easily available at the A.B.U. computer centre and adaptable to the computer (CYBER 72).

From the information obtained during the survey, it was necessary to eliminate some of the variables before analysis was performed. The variables removed before the analysis include age at residential location, ownership of house, age of respondent, number of people over the age of sixteen years in respondent's family and personal ownership of cars among others. These were dropped before analysis because not enough information was reported on them by the respondents, for, not more than 82 answers were obtained on each of them out of the total number of 431 questionaires returned.

The data was cross-tabulated using the SPSS sub-programme "CROSSTAB". Some of the interesting results from the CROSSTAB are shown in tables 5.1 to 5.4 in chapter five.

Further analysis was restricted to the following variables:

A. Level of Service Factors

i) In-vehicle travel time

ii) Out-of-vehicle travel time

iii) Transport fares

Private car users were asked to state what their transport fares would have been if they had not used the car as a mode of transport.

B. Socio-economic factors

i) Household income

ii) Personal income

iii) Number of persons in respondents household

iv) Position in household, whether husband, wife etc.

v) Occupation

vi) Number of private cars in respondent's family

vii) Number of driving licences in respondents family

CHAPTER FOUR

A N A L Y S I S

The basic aim of the analysis is to determine which variables, out of these enumerated at the end of chapter three, significantly influence the mode choice habits of the sampled Civil Servants.

4.1 Analytical technique used

Several analytical techniques have been used to investigate trip charasteristics. These vary in rigour and sophistication. One of the most sophisticated and recently developed is the multinomial logit model, which was used by authors like Ben Akiva et al (1976) in the Netherlands. However, the method used for the present work is the "Discriminant Analysis". This method had been widely used by authors like Clemente et al (1976), Wilson (1976 b) and others. One of the reasons for using the less sophisticated discriminant analysis is that the data collected is relatively 'crude' and as such does not require a highly sophisticated technique. Another reason is that the discriminant analysis programme is readily available at the A.B.U. computer centre, since it is one of the packages on the SPSS programme.

4.2 Theory of Discriminant Analysis

The basic goal of dscriminant analysis is to assign an observation X, of unknown origin to one of two (or more) distinct groups on the basis of the value of the

observation. In some problems fairly complete information is available about the distribution of X in the two groups. In such a case this information could be used and the problem treated as if the distributions are known. In most cases however, the information about the distribution of X comes from relatively small samples from the groups.

In the background of the discriminant analysis problem there is the assumption that somehow we are able to classify the initial data correctly. That is, in defining the groups, some variable or variables exist that allow us to establish the group.

Suppose that our population consists of two groups, G_1 and G_2, we observe a k x 1 vector X and must assign the individual whose measurements are given by X to either G_1 or G_2. If the parameters of the distributions of X in G_1 and G_2 are known, we may use this knowledge in the construction of an assignment rule. If not, we use samples of sizes n_1 from G_1 and n_2 from G_2 to estimate the parameters. We need a criterion of goodness of classification. Fisher (1936) suggested using a linear combination of the observations and choosing the coefficients so that the ratio of the difference of means of the linear combination in the two groups to its variance is maximised.

One method of doing this is to maximize the ratio λ where:

$$\lambda = \frac{\text{between-group variation}}{\text{within-group variation}} \quad \text{-------- 4.2.1}$$

The linear combination, known as the discriminant function (which defines a hyperplane for more than two groups) is mathematically given as:

$$Y_{it} = \beta_1 X_{i1t} + \beta_2 X_{i2t} + \ldots\ldots + \beta_p X_{ipt} \ldots\ldots 4.2.2.$$

$i = 1,2\ldots\ldots$
$t = 1,2,\ldots\ldots n_i$

Where X_{ijt} represents the value of j^{th} variable for the t^{th} item in the i^{th} group. For any group i, the mean vector, say μ_{Y_i} known as the group centroid, is given by:

$$\mu_{Y_i} = \beta_1 \mu_{X_{i1}} + \beta_2 \mu_{X_{i2}} + \ldots\ldots + \beta_p \mu_{X_{ip}} \quad ---- \quad 4.2.3.$$

The values $\mu_{X_{ij}}$ represent the means for the j^{th} variable in the i^{th} group. Eqns 4.2.3. above must hold by definition, since the variable Y is a linear combination of the X variables. From Eqns 4.2.2. and 4.2.3. the deviations of any Y_{it} about its means μ_{Y_i} can be written as

$$Y_{it} - \mu_{Y_i} = \beta_1 (X_{i1t} - \mu_{X_{i1}}) + \beta_2 (X_{i2t} - \mu_{X_{i2}}) + \ldots + \beta_p (X_{ipt} - \mu_{X_{ip}}) \quad ---- \quad 4.2.4.$$

The sum of squares, $(Y_{it} - \mu_{Y_i})^2$, is then a measure of with-in-group variation. Where a sample rather than the population is available, we replace population means with sample means. In such cases μ_{Y_i} will be estimated by $\overline{Y}i$, where:

$$\overline{Y}_i = \sum_{t=1}^{n_i} Y_{it}/n_i \ , \ i = 1,2,\ldots.$$

Similarly, we would estimate the population means for the X variables by using:

$$\overline{X}_{ij} = \sum_{t=1}^{n_i} X_{ijt}/n_i \text{ for } i = 1,2 \text{ and } j = 1,2,\ldots,p.$$

Thus, in the special case where there are only two groups, the sample within-group variation is from Eqn 4.2.4., given by:

$$\sum_{i=1}^{2}\sum_{t=1}^{n}(Y_{it}-\bar{Y}_i)^2=\sum_{i=1}^{2}\sum_{t=1}^{n}[\beta_1(X_{i1t}-\bar{X}_{it})+\beta_2(X_{i2t}-\bar{X}_{i2})+\ldots+\beta_p(X_{ipt}-X_{ip})]^2 \quad \ldots\ldots 4.2.5.$$

By defining the pooled covariance matrix as:

$S_* = \frac{1}{n_1+n_2-2}\{X_1' X_1 + X_2' X_2\}$ where n_i is sample size for group i and $X_i' X_i$ is the covariance matrix for group i, Through a vigourous matrix manipulation, Bolch et al (1974) found that the within-group variation could be simplified as:

$$\sum_{i=1}^{2}\sum_{t=1}^{n}(Y_{it}-\bar{Y}_i)^2=\beta'(n_1+n_2-2)S_* \quad \ldots\ldots 4.2.6.$$

where:

$\beta' = [\beta_1\ \beta_2\ \beta_3\ \ldots\ \beta_p]$

The numerator of equation 4.2.1. (ie. between group variation) may be expressed as $(\bar{Y}_1 - \bar{Y}_2)^2$ for the sample. By the same process as above, Bolch et al found that

$$(\bar{Y}_1-\bar{Y}_2)^2 = \beta'(\bar{X}_1-\bar{X}_2)(\bar{X}_1-\bar{X}_2)' \quad \text{------- } 4.2.7.$$

Eqn 4.2.1. then becomes

$$\lambda = \frac{1}{n_1+n_2-2}\,\frac{\beta'(\bar{X}_1-\bar{X}_2)(\bar{X}_1-\bar{X}_2)'}{S_*} \quad \ldots\ldots\ldots 4.2.8.$$

By combining Eqns 4.2.6. and 4.2.7. Eqns 4.2.8. is the function we wish to maximise.

If we let $l = \frac{\beta'(\bar{X}_1-\bar{X}_2)(\bar{X}_1-\bar{X}_2)'}{S_*}$ ……4.2.9.

we can obtain the same result by maximising l since it is proportional to λ. By setting $\frac{\partial l}{\partial \beta} = 0$ we obtain:

$C(\bar{X}_1-\bar{X}_2) - S_*\beta = 0$ ……4.2.10 where:

$C = \beta'(\bar{X}_1-\bar{X}_2)/l$ is a non zero constant. The

estimated values of the discriminant function coefficients are then given by

$$\hat{\beta} = C\, S_*^{-1} (\bar{X}_1 - \bar{X}_2) \qquad \ldots\ldots\ldots 4.2.11$$

C is usually set = 1

If we substitute this solution for $\hat{\beta}$ into equation 4.2.9, we can write:

$$\hat{1} = (\bar{X}_1 - \bar{X}_2)' S_*^{-1} (\bar{X}_1 - \bar{X}_2) = D^2 \ldots\ldots\ldots 4.2.12.$$

which is called Mahalanobi's D^2 or generalised distance.

One can use the distribution of D^2 to test if there are significant differences between the two groups. The variable,

$$F = \frac{n_1 n_2 (n_1 + n_2 - K - 1)}{(n_1 + n_2)(n_1 + n_2 - 2)K} D^2 \qquad \text{----- } 4.2.13$$

where n_1 and n_2 are as defined earlier and K is the number of variables, had an F distribution with K and $n_1 + n_2 - K - 1$ degrees of freedom.

The success of the decision procedure will clearly depend on the amount of overlap between the two distributions. If the overlap is large, many wrong decisions will be made; if on the otherhand, the distributions are far apart, only a few decisions will be in error.

4.3 The SPSS Subprogramme "DISCRIMINANT"

This is a programme package that performs, among others, the discriminant analysis in two ways: either by entering all discriminating variables directly into the analysis or through a variety of stepwise methods, selecting the "best" set of discriminating variables. There are some criteria for controlling the stepwise selection. These

include minimum Mahalanobis' distance between groups, largest minimum between group F and largest increase in average multiple correlation.

In analysing the data in the present work, the stepwise method was adapted. By so doing, based on the above cited criteria, the variables were automatically selected and entered, by the computer, into the analysis in order of discriminating importance.

One of the features of the DISCRIMINANT programme is that it tries to avoid bias in the discriminant functions arising from some variables having large values compared with others, by using the standardized discriminant function coefficients in computing discriminant scores. This means that all variables are in the form:

$$Z = \frac{X - \mu}{\sigma}$$ where:

Z is standardized measure,

X is the variable value,

μ is group mean and,

σ is the standard deviation.

The discriminant score locates the case on the continuum representing the functions. There is a seperate score for each function. Any single score represents the number of standard deviations by which that case is away from the mean of all cases on the given discriminant function.

Group means of the discriminant scores are arrived at by averaging the scores for the cases within a particular group. For a single group the means on all the functions which is the group centroid, is the most typi-

cal location of a case from that group in the discriminant function space, refer Eqns 4.2.3.

Classification is achieved through the use of a series of classification functions, one for each group. Classification function are derived based on the original values of the discriminant scores. There is a separate equation for each group and the case would be classified into the group with the HIGHEST classification score. The classification score is derived by multiplying the raw values of the discriminating variables by the classification coefficients and adding these products with the respective constants.

The position in household and occupation groups were coded as dummy variables ie they have values of either 1 or 0 depending on whether a case belongs to a particular group or not. To determine whether household position and occupation influence mode choice, twenty eight analyses were performed, one each for combination of the household position and occupation. There are seven possible household positions and four identifiable occupation groups to choose from, in the questionaires.

During the analysis, both the standardized and unstandardized discriminant function are derived, together with classification functions. The latter facilitates the classification of a case into an appropriate group while the former enables one determine the relative distribution of cases on the discriminant function continuum.

There are ten variables which are possible candidates for inclusion on any of the analysis, since there are 431 cases, a 99% confidence limit ie $\alpha = 0.01$ is used to determine F for inclusion value. With 10 and 420 degrees of freedom, F for inclusion is read from tables as approximately 10, while using a 95% confidence limit ie $\alpha = 0.05$, with the same degrees of freedom, a value of F for deletion is found to be approximately 5. This controls the selection of the variables to only those that significantly contribute to the discriminating power.

This means that a variable is considered for selection only if it's partial multivariate F-ratio is larger than 10. (This partial F-ratio measures the discrimination introduced by the variable after taking into account the discrimination achieved by the selected variable) This partial F-test is performed before the variable is evaluated on the stepwise entry criterion. A variable whose partial F is less than 10, will not be considered for inclusion. Similarly, a variable already in the model will be removed if its partial multivariate F is smaller than 5. With this control, a maximum of four variables were selected on each of the twenty eight analyses. The pattern of selection is presented in table 4.1.

TABLE 4.1

SUMMARY OF VARIABLES INCLUDED IN THE ANALYSES

VARIABLES SELECTED	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
TF - TRANSPORT FARE	*1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
NOCF - NUMBER OF CARS IN FAMILY	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
PINC - PERSONAL INCOME	3	3	3	4	3	3	3	4	3	3	3	4	3	3	3	4	3	3	3	4	3	3	3	4	3	3	3	4
HPOS - POSITION IN HOUSEHOLD	4	4	4																									
OCC - OCCUPATION																												

	HUSBANDS	WIVES	SONS	DAUGHTERS	RELATIVES	M/LODGER	F/LODGER
		3		3		3	
Admin.							
Profes'l							
Skilled							
Unskilled							
Admin.							
Profes'l							
Skilled							
Unskilled							
Admin.							
Profes'l							
Skilled							
Unskilled							
Admin.							
Profes'l							
Skilled							
Unskilled							
Admin.							
Professional							
Skilled							
Unskilled							
Admin.							
Professional							
Skilled							
Unskilled							

* THE VALUES IN THE TABLE INDICATE THE STEPS AT WHICH THE RESPECTIVE VARIABLE ENTER INTO THE RESPECTIVE ANALYSIS.

CHAPTER FIVE

R E S U L T S

5.1 Cross-tabulation results

Results from the CROSSTAB are shown in tables 5.1 to 5.4 and figures 5.01 to 5.04.

5.1.1 Comparison by sex

Figure 5.01 and table 5.1 illustrate that the walking and bicycle modes of transport are completely dominated by men, while the private car passengers are about equally distributed amongst the male and female users (55/45%) women/men. The fact that females constitute only 22.2% of the subjects analysed would seem to imply that a private car passenger is likely to be a female. It could also be seen that private car drivers, bus, taxi and motorcycle riders are mostly men (58-84%). This can be related to the higher number of male workers in this workplace and the fact that some low income women workers have some family association with the private car drivers, hence the dominance of women in the private car passenger group (55%). The dominance of the male sex in the private car driving can be related to the higher income among men.

5.1.2 Comparison by occupation

Figure 5.02 and table 5.2 illustrate that substantial percentages of the administrative staff, skilled and unskilled labour (clerks, typists, messengers

labourers, masons etc) use the bus as a mode of transport to get to their various workplaces, while the professionals (Lawyers, Doctors, Teachers etc) dominate the private car driving group. These could be related to the lower income of the unskilled labour and higher income of the professional staff. It couldalso be seen that, the administrative staff and professionals dominate the taxi mode while the motorcycle mode is predominantly used by the skilled labour workers (technical staff, masons, plumbers etc). A probable cause of dominance of motorcycle mode by skilled labour workers is the fact that most of the workers in this category do not have fixed working places, since they are routinely assigned to work at various sites. Therefore for their convenience they ought to be freely mobile.

The bicycle users are predominantly unskilled labourers while the working mode group are principally from the professional category of workers. This can be related to the low income of the labourers and some low placed professionals (apprentices for example). However there are still others that due to the fact that they live close to their working place they prefer to just walk across. The decision of such people does not depend on income.

5.1.3 Reported travel time

Figure 5.03 and table 5.3 illustrate the reported average travel times of the four automotive modes (bus, taxi, private car and motorcycle). It could be seen

that for all travel times the private car modes gives relatively the smallest travel times. The figure indicates that the proportion of trips having travel times of 25 min. and less is more for private cars than all others. Taxi mode comes next, then motorcycle and the most time consuming is the bus mode.

For travel times above 25 mins. the motorcycle mode comes next to private car and a higher proportion of users choose to use bus instead of taxi while the choice of taxi comes last. This could be attributed to the fare arrangement of the public transport. The travel times are indicative of distances a subject is away from his workplace. The fare arrangement of public transport (bus and taxi), is such that it becomes more expensive to use taxi to use taxi when distances become long. Unlike the bus, which has fixed fare per 'drop' - this 'drop' could be as many bus stops away from the origin as possible, as long as the final destination of the bus trip is further than the destination of the trip maker, the taxi charging system is not fixed and fares increase with distance from the origin.

5.1.4 The Personal Income

Figure 5.04 and table 5.4 seem to indicate that personal income greatly influences mode choice.

The average income of bicycle users is found to be ₦107 per month with a standard deviation of ₦27.9 as shown in table 5.4. This is not unexpected. The bus, private car driver and motorcycle users have respective

average monthly incomes and standard deviations of ₦144 and ₦57.5, ₦378 and ₦60.8, and ₦182 and ₦84.8; while those for private car passengers, taxi and walking mode users are ₦154 and ₦133, ₦184 and ₦92.8, and ₦194 and ₦99.0 respectively.

This shows that the bus, private car driver, motorcycle and bicycle modes are consistently dominated by certain income groups, most probably close to the mean income for the group, hence the lower standard deviation whereas the taxi, private car passenger and the walking mode have usage from a wider income group range.

These, of course do not take account of those trip makers that are not properly grouped such as new University graduates whose incomes are relatively high but still use the bus or taxi to get to work, because they cannot afford private car ownership and would not want to possess motorcycles. These categories are reflected on the taxi and private car passenger curves in figure 5.04.

There are two or three different identifiable groups within the car passenger groups. First, there are those with high incomes who probably are women who ride as passengers with their husbands to get to work. These are relatively few in number. Within the same group are some senior officials who are driven to work, in official vehicles assigned to them. However since about 50% of car passengers lie within ₦125 to ₦250 monthly income group, it appears that most passengers are those who might not necessarily have high incomes, but because of

some family association with the private car driver they are taken to work as private car passengers. These are mostly the working sons and daughters of private car drivers.

The taxi users are about the most widely distributed over income. This group appears to uniformly span all income groups. It is probable that those whose income are not high go for taxi instead of bus if they live close to their workplaces since there is not much difference in the fares of taxi and bus in such a case and the taxi has the added advantage of door-to-door service. There are yet others who earn high incomes, but could not afford private car ownership, as pointed out earlier.

The walking mode has a surprisingly high average monthly personal income. This may be because of the fact that some high income earners living very close to their working places, walk the short distances to their various work places. This is evidenced by the high value of the standard deviation (₦99.8).

5.2 Pattern of residential distribution

From the reported residential location of these sampled, there appears to be no discernable pattern of residential distribution. This means that for the studied work location, there is insufficient evidence that any extensive analysis of the residential pattern would yield worthwhile results. This is in contrast to some reported findings in other parts of the world, particularly those of Beesley et al (1974) who derived

equation 2.2.1 and Guest (1976 b). A possible reason for the irregular pattern of residential distribution could be the lack of easily available residential accomodation, which is a common phenomenon of most Nigerian Urban Centres. Also the present practice of employers providing quarters for their staff must also have influenced the results.

However, one must admit that in order to be able to adequately investigate the validity or otherwise of equation 2.2.1, a more sophisticated data base than was available for this study would be more appropriate.

5.3. Discrimant Analysis results

In addition to results from Discriminant analysis previously shown in table 4.1, the remaining important results are contained in tables 5.5 to 5.10 and figures 5.05 to 5.07.

Table 4.1 indicates that the first three analyses are similar - these are for all husbands other than unskilled labourers. It also shows that analyses 4, 8, 12, 16, 20, 24 and 28, which are those pertaining to all unskilled labourers are similar. Further, the analyses for all other categories of workers ie 5, 6, 7, 9, 10, 11, 13, 14, 15, 17, 18, 19, 21, 22, 23, 25, 26 and 27 are also exactly the same.

These similarities were confirmed by checking the summary results, plots of centroids and prediction results as given at the end of each analysis. This strong-

ly suggests that for the studied Civil Servants, the work trip mode choice patterns could be adequately described by three separate discriminant functions and classification functions.

Of the three families of functions, one describes the mode choice behaviour of all husbands except those who are unskilled labourers, another describes those of unskilled labourers while the third is concerned with all other categories of workers.

Table 5.5 shows the classification and discriminant function coefficients, and centroids of the various mode groups for all husbands other than those who are unskilled labourers.

Four variables are selected for these analyses - personal income, position in household, number of cars in family, and transport fare.

Investigation of the constant terms of the classification functions obviously shows that the most difficult group to belong to is group 3 (car-driver). The next is group 4 (taxi) followed by group 2 (private car passenger).

The coefficient for transport fare indicate that high value of the transport fare best enhances the classification of a case into group 4 (taxi) but will also enhance the classification into group 1 (bus) and 3 (private car driver). Transport fare however, appears to have the least effect on classification into group 5 (motorcycle). Similarly the number of cars avail-

able to family (NOCF) appears to have substantial effect on classification into groups 2 (private car passenger) and 3 (private car driver).

Being a husband enhances classification into groups 3 (private car drivers) and 6 (bicycle), but has the least effect on the classification into group 4 (taxi). However, the personal income has its greatest effect in the classification into group 3 (private car driver) and has least effect on classification into group 6(bicycle).

Table 5.5 also shows that in the first standardized discriminant function, all the four variables (personal income, position in household, number of cars in family and transport fare) contribute positively towards the function while in the second function two of the four variables (position in household and number of cars in family) contribute negatively and the other two positively.

The percent of trace values given in the table show that by using only the first two discriminating functions in the analysis, 95.4% of the variation of the worktrip mode-choice patterns would be explained by the respective selected variables.

When plotted, the first two discriminant functions would discriminate between private car drivers and other mode users as evidenced by the isolated group 3 centroid point on figure 5.05. The figure also shows that it will be difficult to separate the bus users from the taxi users with any degree of success, as their centroids appear very close to one another.

However, the figures show that taxi users and motorcycle or bicycle users can be successfully separated. These are also confirmed by the prediction results presented in table 5.6, where there is a high misclassification of bus users into taxi group (29.1%) and similarly high misclassification (28.9%) of taxi users into bus mode. The best predicted group is the private car driver group (88.8%) and then the bicycle mode (72.0%).

Basically, in the first standardized discriminant function, personal income is about 25% more important than the number of cars in family, 9 times as important as transport fare and about 20 times as important as occupation, while in the second function, only transport fare makes any comparably significant contribution to the function.

In the case of the second families of functions ie. those for all unskilled labourers, however, unlike the previous analysis, the highest misclassification occurs in the bicycle mode (group 6), where as much as 40% were misclassified into motorcycle mode (group 5). This indicates that the selected variables will not be good predictors of bicycle users. Likewise the walking mode is not predicted with any degree of success, 12.5% were correctly classified while 37.5% are misclassified into each of groups 1 (bus) and 5 (motorcycle). The misclassification of private car passengers into the private car driver group could be attributed to the fact that many high incomed Government officials are driven to their offices in official cars and since income plays a great role, these would normally be put into group 3,

the private car driver group.

The group 3 (car driver) however, is very successfully classified due to the fact that members of this group have high income, which makes them unique as far as the derived discriminant functions are concerned. This means that the variable selected are strong predictors of private car owners.

It is observed that the third set of functions ie for all other workers, gives the highest discrimination of the bus users, 60.3% of bus users are correctly classified.

MODE / POSITION IN HOUSEHOLD		BUS	PRIVATE CAR PASSENGER	PRIVATE CAR DRIVER	TAXI	MOTOR-CYCLE	BICYCLE	WALK	TOTAL
HUSBAND	Count	69	8	72	28	33	24	4	238
	Row %	29.0	3.4	30.3	11.8	13.9	10.1	1.7	
	Column Percent	47.9	29.6	79.1	35.0	58.9	96	50.0	
WIFE	Count	15	5	9	12	3	0	0	44
	Row %	34.1	11.4	20.5	27.3	6.8	0	0	
	Column Percent	10.4	18.5	9.9	15.0	5.4	0	0	
SON	Count	3	1	2	8	4	0	0	18
	Row %	16.7	5.6	11.1.	44.1	11.1	0	0	
	Column Percent	2.1	3.7	2.2	10.0	7.1	0	0	
DAUGHTER	Count	9	2	1	1	0	0	0	13
	Row %	69.2	15.4	7.7	7.7	0	0	0	
	Column Percent	6.3	7.4	1.1	1.2	0	0	0	
RELATION	Count	21	7	5	18	8	1	0	60
	Row %	35.0	11.7	8.3	30.0	13.3	1.7	0	
	Column Percent	14.6	25.9	5.5	22.5	14.3	4.0	0	
M/LODGER	Count	25	3	2	10	7	0	4	51
	Row %	49.0	5.9	3.9	19.6	12.7	0	7.8	
	Column Percent	17.4	11.1	2.2	12.5	12.5	0	50.0	
F/LODGER	Count	2	1	0	3	1	0	0	7
	Row %	28.6	14.3	0	42.9	14.3	0	0	
	Column Percent	1.4	3.7	0	3.7	1.8	0	0	
TOTAL		144	27	91	80	56	25	8	431

TABLE 5.1 - Reported position in Household of Journey to Work Travellers

MODE / OCCUPATION		BUS	PRIVATE CAR PASSENGER	PRIVATE CAR DRIVER	TAXI	MOTOR-CYCLE	BICYCLE	WALK	TOTAL
Administrative Staff	Count	75	14	35	48	31	12	5	
	Row Percentage	34.1	6.4	15.9	21.8	14.1	5.5	2.3	220
	Col. %	52.1	51.9	38.5	60.0	55.4	48.0	62.5	
Professional.	Count	7	9	44	22	8	1	3	
	Row Percentage	7.4	9.6	46.8	23.4	8.5	1.1	3.2	94
	Col. %	4.9	33.3	48.4	27.5	14.3	4.0	37.5	
Skilled Labour	Count	50	4	11	10	17	1	0	
	Row Percentage	53.8	4.3	11.8	10.8	18.3	1.1	0	93
	Col. %	34.7	14.8	12.1	12.5	30.4	4.0	0	
Unskilled Labour	Count	12	0	1	0	0	11	0	
	Row Percentage	50.0	0	4.2	0	0	45.8	0	24
	Col. %	8.3	0	1.1	0	0	44.0	0	
Total		144	27	91	80	56	25	8	431

TABLE 5.2 - REPORTED OCCUPATION OF JOURNEY TO WORK TRAVELLERS

TOTAL TRAVEL TIME \ MODE		BUS	CAR	TAXI	MOTOR-CYCLE	TOTAL
0 - 5 minutes	Count	1	3	-	1	
	Column Percentage	0.7	2.5	-	1.8	
	Cummulative "	0.7	2.5	-	1.8	
6 - 10 minutes	Count	7	6	9	5	
	Column Percentage	4.9	5.1	11.3	8.9	
	Cummulative %	5.6	7.6	11.3	10.7	
11 - 15 minutes	Count	11	12	11	6	
	Column Percentage	7.6	10.2	13.8	10.7	
	Cummulative %	13.2	17.8	25.1	21.4	
16 - 20 minutes	Count	10	21	15	11	
	Column Percentage	6.9	17.8	18.8	19.6	
	Cummulative %	20.1	35.6	43.9	41.0	
21 - 25 minutes	Count	28	39	10	12	
	Column Percentage	10.4	24.6	12.5	21.4	
	Cummulative %	39.5	70.2	56.4	62.4	
26 - 30 minutes	Count	68	29	25	13	
	Column Percentage	47.9	24.6	18.8	23.2	
	Cummulative %	87.4	94.8	75.2	85.6	
31 - 35 minutes	Count	13	6	2	7	
	Column Percentage	9.0	5.1	2.5	12.5	
	Cummulative %	96.4	99.9	79.7	98.1	
35 - 40 minutes	Count	6	1	16	1	
	Column Percentage	4.2	0.7	20.0	1.8	
	Cummulative %	100.0	100.6	99.7	99.9	
Average total travel time		25min	20min	23min	22min	
TOTAL		144	118	80	56	398
Standard deviation		7	7	10	8	

TABLE 5.3 - REPORTED TRAVEL TIMES OF JOURNEY TO WORK TRAVELLERS

AVERAGE MONTHLY PERSONAL INCOME \ MODE		BUS	PRIVATE CAR PASSENGER	PRIVATE CAR DRIVER	TAXI	MOTOR-CYCLE	BICYCLE	WALK	TOTAL
₦ 75	Count	16	1	0	12	2	10	0	41
	Row Percentage	39.0	2.4	0	29.3	4.9	24.4	0	
	Column Percentage	11.1	3.7	0	15.0	3.6	40.0	0	
	Cummulative %	11.1	3.7	0	15.0	3.6	40.0	0	
₦125	Count	52	6	2	26	9	14	4	113
	Row Percentage	46.0	5.3	1.8	23.0	8.0	12.4	3.5	
	Column Percentage	36.1	22.2	2.2	32.5	16.1	56.0	50.0	
	Cummulative %	47.2	25.9	2.2	47.5	19.7	96.0	50.0	
₦175	Count	39	6	0	13	28	1	2	88
	Row Percentage	44.3	6.8	0	14.8	31.8	1.9	2.3	
	Colunm Percentage	27.1	22.2	0	16.2	50.0	4.0	25.0	
	Cummulative %	74.3	48.1	2.2	63.7	69.7	100.0	75.0	
₦225	Count	29	5	1	5	13	0	0	54
	Row Percentage	53.7	9.3	1.9	9.3	24.1	0	0	
	Column Percentage	20.1	18.5	1.1	6.3	23.2	0	0	
	Cummulative %	94.4	66.6	3.3	70.0	92.9	100.0	75.0	
₦275	Count	5	0	7	9	4	0	1	26
	Row Percentgae	19.2	0	26.9	34.6	15.4	0	3.8	
	Column Percentage	3.5	0	7.7	11.2	7.1	0	12.5	
	Cummulative %	97.9	66.6	11.0	81.2	100.0	100.0	87.5	
₦325	Count	2	2	6	9	0	0	0	19
	Row Percentage	10.5	10.5	31.6	47.4	0	0	0	
	Column Percentage	1.4	7.4	6.6	11.2	0	0	0	
	Cummulative %	99.3	74.0	17.6	92.4	100.0	100.0	87.5	
₦375	Count	1	1	34	1	0	0	0	37
	Row Percentage	2.7	2.7	91.9	2.7	0	0	0	
	Column Percentage	0.7	3.7	37.4	1.2	0	0	0	
	Cummulative %	100.0	77.7	55.0	93.6	100.0	100.0	87.5	
₦425 and above	Count	0	4	39	2	0	0	1	46
	Row Percentage	0	8.7	84.8	4.3	0	0	2.2	
	Column Percentage	0	14.8	42.9	2.5	0	0	12.5	
	Cummulative %	100.0	92.5	97.9	96.1	100.0	100.0	100.0	
Av.Pers.Icome		163	154	378	184	182	107	194	
TOTAL		144	25	89	77	56	25	8	424*
Standard deviation		57.5	133	60.8	91.8	44.8	27.9	99.8	

*7 cases had no response on income.

Table 5.4 - REPORTED AVERAGE PERSONAL INCOME OF JOURNEY TO WORK TRAVELLERS

FILE TRANS1 (CREATION DATE = 81/11/23.)

- D I S C R I M I N A N T A N A L Y S I S -

SUMMARY TABLE

TABLE 5.5 CLASSIFICATION AND DISCRIMINANT FUNCTION COEFFICIENTS FOR ANALYSES 1, 2 AND 3

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS LAMBDA	SIG.	RAOS V	CHANGE IN RAOS V	SIG.
1	TF		50.46352	1	.58339	.000	302.78111	302.78111	0
2	NOCF		61.85332	2	.31075	.000	674.78509	372.00398	0
3	PINC		51.51169	3	.18088	.000	1188.11201	513.32693	0
4	HPOS1		10.42756	4	.15748	.000	1289.62262	101.51061	.000

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7
PINC	.31331E-01	.36168E-01	.66113E-01	.34429E-01	.31989E-01	.18481E-01	.36028E-01
HPOS1	1.8366	2.0756	4.2269	1.3718	2.4944	4.4325	1.7836
NOCF	1.5938	5.0347	6.7744	2.0597	1.5341	1.3553	1.1565
TF	9.9649	4.9617	9.1054	11.892	1.7730	2.5308	6.0677
CONSTANT	-5.9750	-6.9722	-19.903	-7.6501	-3.8467	-3.3888	-4.9944

NUMBER REMOVED	EIGENVALUE	CANONICAL CORRELATION	PERCENT OF TRACE	WILKS LAMBDA	CHI-SQUARE	D.F.	SIGNIFICANCE
0	2.12839	.82483	70.6	.15748	786.52823	24	0
1	.77181	.66000	25.4	.49265	301.23802	15	0
2	.09762	.29822	3.2	.87288	57.85167	8	.000
3	.04375	.20473	1.4	.95808	18.21947	3	.000

4 FUNCTIONS WILL BE USED IN REMAINING ANALYSES

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	1	2	3	4
PINC	1.07163	.16267	.29376	1.04496
HPOS1	.26793	-.31526	.78915	-.71564
NOCF	.90666	-.02703	-.54397	-.98555
TF	.10443	1.26767	.21422	-.23935

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	1	2	3	4
PINC	.97586E-02	.14812E-02	.26749E-02	.95152E-02
HPOS1	.53843	-.63357	1.5859	-1.4382
NOCF	.24374	-.42654E-01	-.85839	-1.5552

TF	.323284	3.92431	.656776	-.741962
CONSTANT	-3.15967	-11.65458	-1.34578	-.204148

CENTROIDS OF GROUPS IN REDUCED SPACE

GROUP 1	-.88178	.49891	.19535	.1214
GROUP 2	.45013	-.76502	-1.01775	-.32804
GROUP 3	2.74659	-.02999	.15090	.08279
GROUP 4	-.55821	.99532	-.12794	.00876
GROUP 5	-.75681	-1.51569	-.16681	.31825
GROUP 6	-1.45269	-1.53962	.58166	-.57223
GROUP 7	-.71591	-.41430	.06967	.48511

TABLE 5-5 (CONTINUED)

FIGURE 5.05

PLOT OF DISCRIMINANT SCORE 1 (HORIZONTAL) VS. DISCRIMINANT SCORE 2 (VERTICAL). * INDICATES A GROUP CENTROID.
FOR ANALYSES 1, 2 AND 3

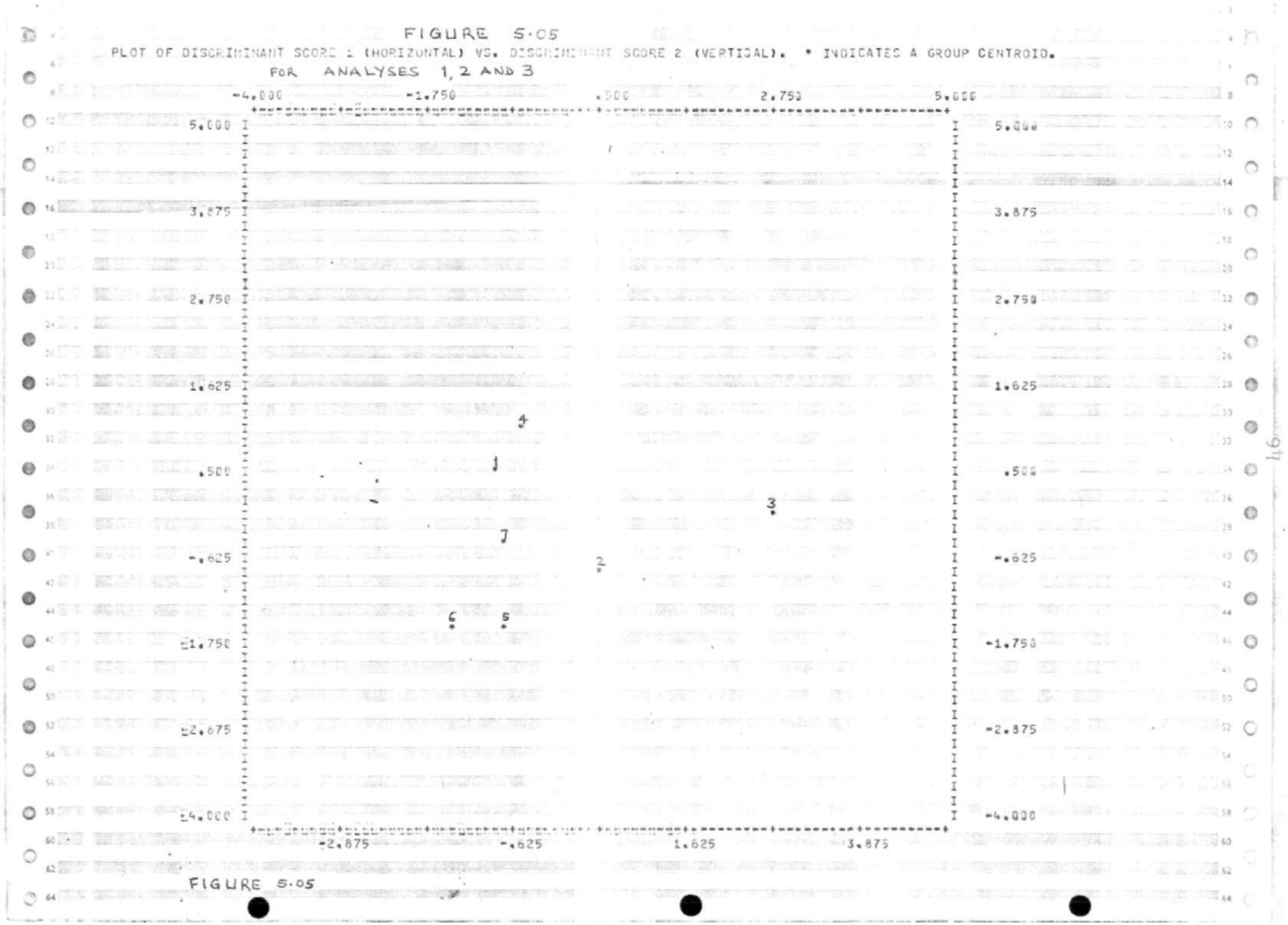


FIGURE 5.05

TABLE 5.6

PREDICTION RESULTS - FOR ANALYSES 1, 2, AND 3

ACTUAL GROUP NAME	CODE	N OF CASES	PREDICTED GROUP MEMBERSHIP GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7
GROUP 1	1	141	64.	7.	[illegible]	41.	4.	8.	16.
			45.4 PCT	5.0 PCT	.7 PCT	29.1 PCT	2.8 PCT	5.7 PCT	11.3 PCT
GROUP 2	2	27	2.	15.	5.	2.	1.	1.	0
			7.4 PCT	55.6 PCT	18.2 PCT	7.4 PCT	3.7 PCT	3.7 PCT	0 PCT
GROUP 3	3	89	0	8.	73.	2.	0	0	0
			0 PCT	9.1 PCT	82.8 PCT	2.2 PCT	0 PCT	0 PCT	0 PCT
GROUP 4	4	83	24.	6.	6.	40.	1.	2.	4.
			28.9 PCT	7.2 PCT	7.2 PCT	48.2 PCT	1.2 PCT	2.4 PCT	4.8 PCT
GROUP 5	5	58	4.	9.	1.	1.	23.	20.	1.
			6.9 PCT	15.5 PCT	1.7 PCT	1.7 PCT	39.7 PCT	34.5 PCT	1.7 PCT
GROUP 6	6	25	5.	0	0	0	2.	18.	0
			20.0 PCT	0 PCT	0 PCT	0 PCT	8.0 PCT	72.0 PCT	0 PCT
GROUP 7	7	8	3.	0	1.	0	3.	0	1.
			37.5 PCT	0 PCT	12.5 PCT	0 PCT	37.5 PCT	0 PCT	12.5 PCT

55.7 PERCENT OF KNOWN CASES CORRECTLY CLASSIFIED

CHI-SQUARE = 613.249 SIGNIFICANCE = 0

FILE TRANS1 (CREATION DATE = 81/11/23.)

* * * * * * * * * * * * * * * * * * D I S C R I M I N A N T   A N A L Y S I S *

SUMMARY TABLE

TABLE 5.7 CLASSIFICATION AND DISCRIMINANT FUNCTION COEFFICIENTS FOR ANALYSES 4, 8, 12, 16, 20, 24 AND 28

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS LAMBDA	SIG.	RAOS V	CHANGE IN RAOS V	SIG.
1	TF		51.46352	1	.58339	.000	302.78111	302.78111	0
2	NOCF		61.85332	2	.31075	.000	674.78509	372.00398	0
3	OCC4		17.31515	3	.24936	.000	789.22189	114.43680	.000
4	PINC		48.60634	4	.14731	.000	1287.16483	497.94294	0

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7
PINC	.34581E-01	.39184E-01	.71738E-01	.36783E-01	.35120E-01	.27821E-01	.38606E-01
OCC4	3.9452	2.4430	4.3550	2.7496	1.9572	13.554	2.2731
NOCF	1.0350	4.3912	5.4601	1.8412	.75479	.30883E-01	.60453
TF	10.150	5.1142	9.3988	12.224	1.9290	3.0882	6.2036
CONSTANT	-5.9351	-6.6712	-18.551	-7.6157	-3.3258	-4.8301	-4.7858

NUMBER REMOVED	EIGENVALUE	CANONICAL CORRELATION	PERCENT OF TRACE	WILKS LAMBDA	CHI-SQUARE	D.F.	SIGNIFICANCE
0	2.02428	.81813	66.7	.14731	814.91056	24	0
1	.72526	.64836	23.9	.44552	344.02890	15	0
2	.21857	.42359	7.2	.76864	111.96346	8	.000
3	.06756	.25157	2.2	.93671	27.81817	3	.000

4 FUNCTIONS WILL BE USED IN REMAINING ANALYSES

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	1	2	3	4
PINC	1.14655	-.05416	-.31485	.96153
OCC4	-.05513	-.16808	-1.12127	-.05679
NOCF	.82401	-.00298	-.01492	-1.09469
TF	.16038	1.27730	-.24438	-.06147

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	1	2	3	4
PINC	.104402E-01	-.493319E-03	-.286693E-02	.874636E-02
OCC4	-.255778	-.779792	-5.20215	-.263459
NOCF	1.30031	-.470084E-02	-.776.16E-02	-1.72745

DISCRIMINANT ANALYSIS 81/11/23. PAGE 97

TABLE 5.7 (CONTD)

CENTROIDS OF GROUPS IN REDUCED SPACE

GROUP	1	-.82827	.52804	-.13644	.16218
GROUP	2	.49125	-.86266	.44301	-.89306
GROUP	3	2.63460	-.12278	-.19145	.10307
GROUP	4	-.41983	.97139	.11288	-.03794
GROUP	5	-.81546	-1.42811	.62685	.22981
GROUP	6	1.82871	-1.42527	+1.53461	-.11420
GROUP	7	-.66384	-.38894	.39429	.42917

TF	.49647	3.95412	-.75637	-.19284
CONSTANT	-3.41152	-1.57786	1.19661	.30766

FIGURE 5.06

PLOT OF DISCRIMINANT SCORE 1 (HORIZONTAL) VS. DISCRIMINANT SCORE 2 (VERTICAL). * INDICATES A GROUP CENTROID.
FOR ANALYSES 4, 8, 12, 16, 20, 24 AND 28

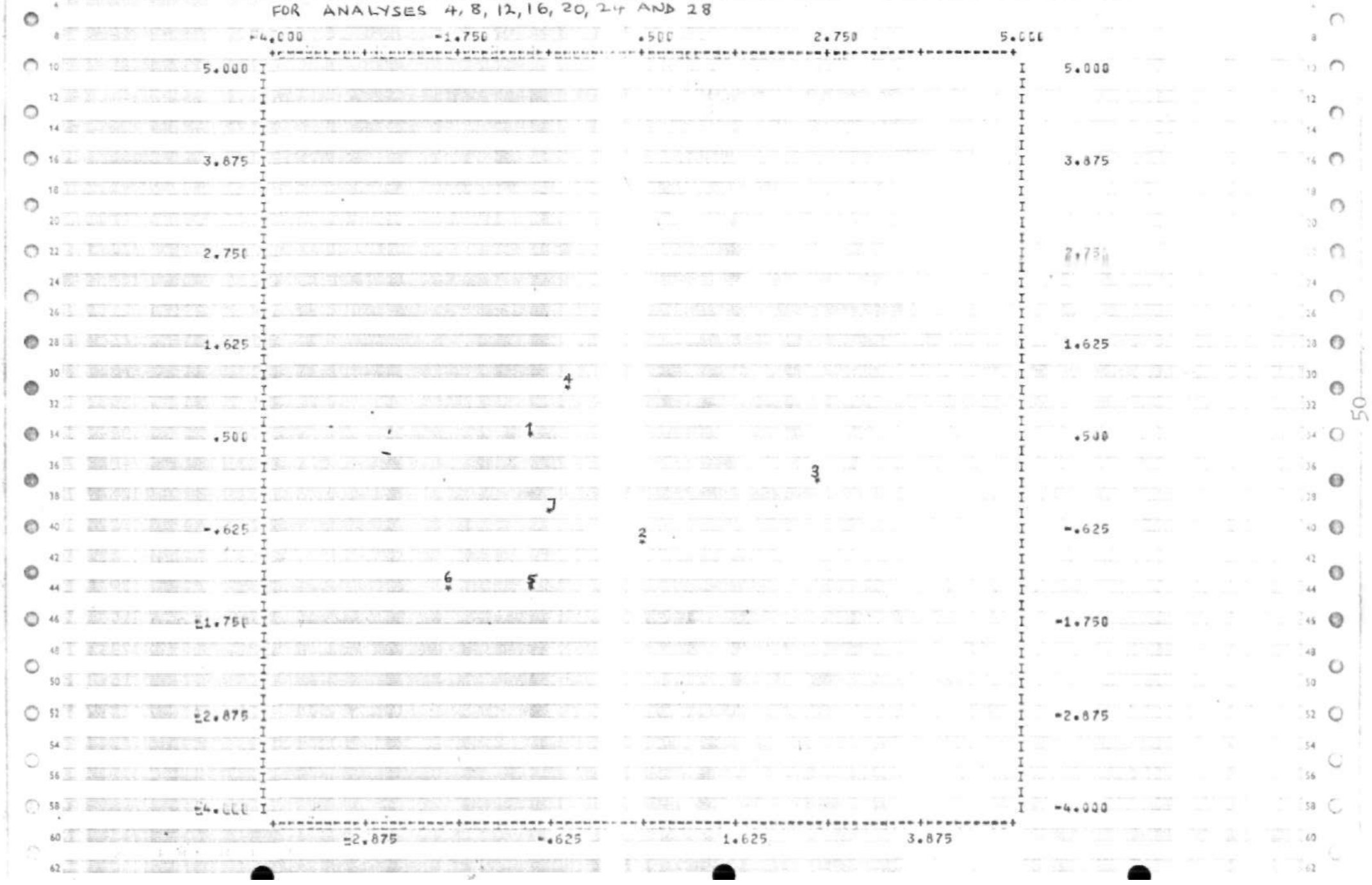


TABLE 5.8

PREDICTION RESULTS - FOR ANALYSIS 4, 8, 12, 16, 20, 24 AND 28

ACTUAL GROUP NAME	CODE	N OF CASES	PREDICTED GROUP MEMBERSHIP GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7
GROUP 1	1	141	7. 49.6 PCT	6. 4.3 PCT	3. 2.1 PCT	31. 22.0 PCT	5. 3.5 PCT	9. 6.4 PCT	17. 12.1 PCT
GROUP 2	2	27	1. 3.7 PCT	13. 48.1 PCT	8. 29.6 PCT	3. 11.1 PCT	2. 7.4 PCT	0 0 PCT	0 0 PCT
GROUP 3	3	89	0 0 PCT	4. 4.5 PCT	80. 89.9 PCT	5. 5.6 PCT	0 0 PCT	0 0 PCT	0 0 PCT
GROUP 4	4	83	17. 20.5 PCT	5. 6.0 PCT	7. 8.4 PCT	47. 56.6 PCT	2. 2.4 PCT	1. 1.2 PCT	4. 4.8 PCT
GROUP 5	5	58	5. 8.6 PCT	9. 15.5 PCT	1 1 PCT	0 0 PCT	42. 72.4 PCT	0 0 PCT	2. 3.4 PCT
GROUP 6	6	25	4. 16.0 PCT	0 0 PCT	0 0 PCT	0 0 PCT	10. 40.0 PCT	11. 44.0 PCT	0 0 PCT
GROUP 7	7	8	3. 37.5 PCT	0 0 PCT	1. 12.5 PCT	0 0 PCT	3. 37.5 PCT	0 0 PCT	1. 12.5 PCT

61.3 PERCENT OF KNOWN CASES CORRECTLY CLASSIFIED

CHI-SQUARE = 776.446 SIGNIFICANCE = 0

FILE TRANS1 (CREATION DATE = 81/11/23.)

- D I S C R I M I N A N T   A N A L Y S I S -

SUMMARY TABLE

TABLE 5.9 CLASSIFICATION AND DISCRIMINANT FUNCTION COEFFICIENTS FOR ANALYSES 5, 6, 7, 9, 10, 11, 13, 14, 15, 17, 18, 19, 21, 22, 23, 25, 26, AND 27

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS LAMBDA	SIG.	RAOS V	CHANGE IN RAOS V	SIG.
1	TF		51.46352	1	.58339	.000	312.78111	312.78111	0
2	NOCF		61.85332	2	.31075	.000	674.78509	372.00398	0
3	PINC		50.50069	3	.18088	.000	1188.11201	513.32693	0

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7
PINC	.33116E-01	.38277E-01	.70121E-01	.357[illegible]E-01	.34393E-01	.22789E-01	.37762E-01
NOCF	1.0114	4.3765	5.4340	1.8[illegible]	.74307	-.50309E-01	.59892
TF	10.140	5.1461	9.2773	11.947	1.8744	2.7103	6.1402
CONSTANT	-5.6552	-6.5639	-18.209	-7.47[illegible]	-3.2569	-1.5265	-4.6929

NUMBER REMOVED	EIGENVALUE	CANONICAL CORRELATION	PERCENT OF TRACE	WILKS LAMBDA	CHI-SQUARE	D.F.	SIGNIFICANCE
0	2.12117	.81785	72.1	.18088	728.42859	18	0
1	.71414	.64546	25.5	.54627	257.57947	10	0
2	.06795	.25024	2.4	.93638	28.00427	4	.000

3 FUNCTIONS WILL BE USED IN REMAINING ANALYSES

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	1	2	3
PINC	1.15856	-.00932	.97503
NOCF	.82573	.01634	-1.09323
TF	.15928	1.30017	-.25133

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	1	2	3
PINC	.105496E-01	-.848343E-04	.887838E-02
NOCF	1.30302	.10185E-01	-1.72511
TF	.493076	4.02494	-.158912
CONSTANT	-3.04599	-11.74024	-1.04331

CENTROIDS OF GROUPS IN REDUCED SPACE

GROUP 1	-.82085	.52525	.06420
GROUP 2	.47947	-1.43324	-.91282
GROUP 3	2.64157	-.08641	.11220
GROUP 4	-1.42411	.94397	1.21521
GROUP 5	-.83075	-1.49680	.20060
GROUP 6	-1.73929	-1.18671	-.12395
GROUP 3	-.67809	1.44732	.40959

TABLE 5.9 (CONTD)

FIGURE 5.07

PLOT OF DISCRIMINANT SCORE 1 (HORIZONTAL) VS. DISCRIMINANT SCORE 2 (VERTICAL). * INDICATES A GROUP CENTROID.
FOR ANALYSES 5, 6, 7, 9, 10, 11, 13, 14, 15, 17, 18, 19, 21, 22, 23, 25, 26, AND 27

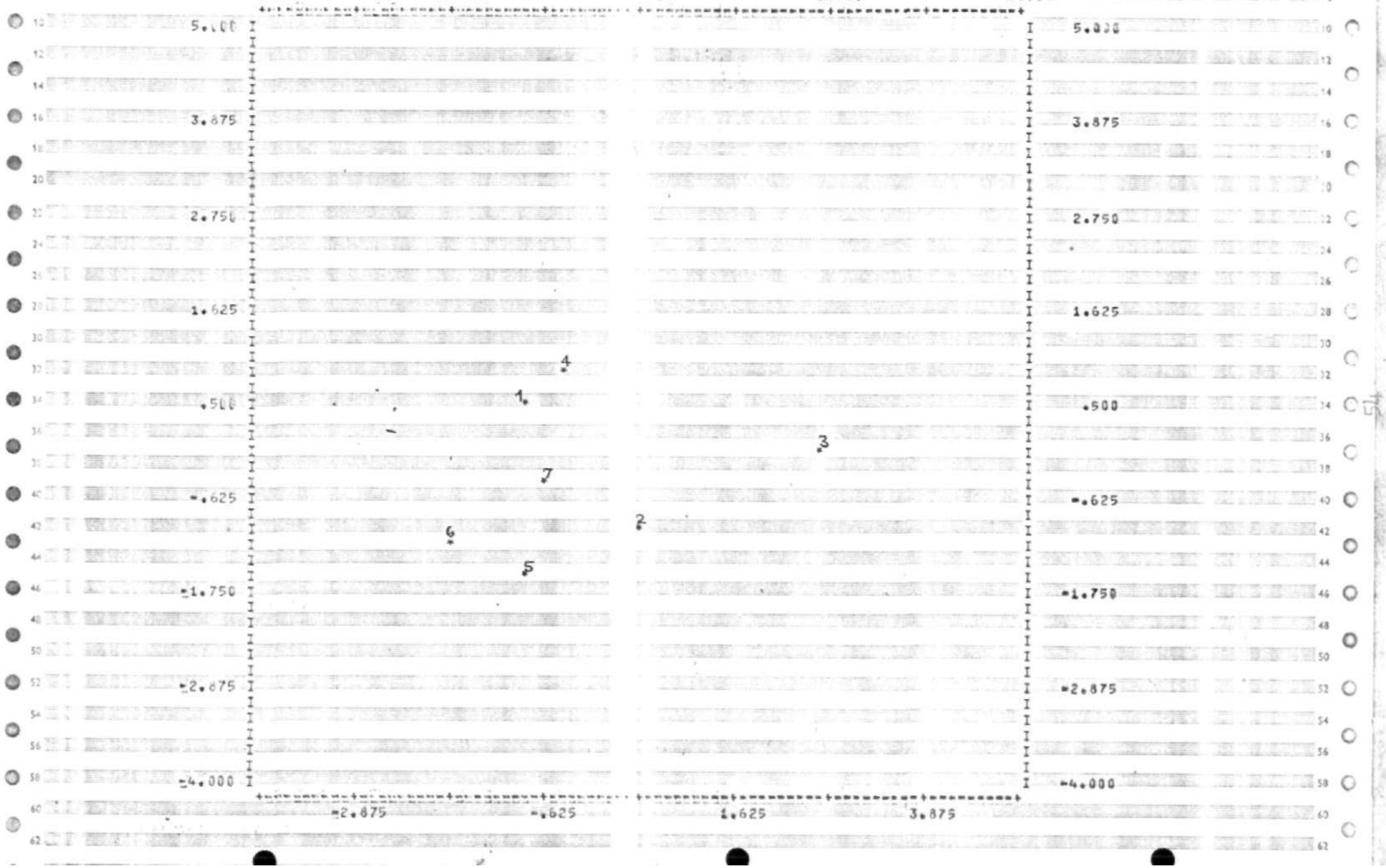


TABLE 5.10

PREDICTION RESULTS - FOR ANALYSES 5, 6, 7, 9, 10, 11, 13, 14, 15, 17, 18, 19, 21, 22 AND 23

ACTUAL GROUP NAME	CODE	N OF CASES	PREDICTED GROUP MEMBERSHIP GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7
GROUP 1	1	141	85.	6.	3.	32.	2.	7.	6.
			60.3 PCT	4.3 PCT	2.1 PCT	22.7 PCT	1.4 PCT	5.0 PCT	4.3 PCT
GROUP 2	2	27	1.	13.	8.	3.	1.	1.	0
			3.7 PCT	48.1 PCT	29.6 PCT	11.1 PCT	3.7 PCT	3.7 PCT	0 PCT
GROUP 3	3	89	0	4.	8.	5.	0	0	0
			0 PCT	4.5 PCT	89.9 PCT	5.6 PCT	0 PCT	0 PCT	0 PCT
GROUP 4	4	83	20.	5.	7.	46.	0	2.	3.
			24.1 PCT	6.0 PCT	8.4 PCT	55.4 PCT	0 PCT	2.4 PCT	3.6 PCT
GROUP 5	5	58	6.	9.	0	0	34.	8.	1.
			10.3 PCT	15.5 PCT	0 PCT	0 PCT	58.6 PCT	13.8 PCT	1.7 PCT
GROUP 6	6	25	6.	0	0	0	2.	17.	0
			24.0 PCT	0 PCT	0 PCT	0 PCT	8.0 PCT	68.0 PCT	0 PCT
GROUP 7	7	8	4.	0	1.	0	1.	2.	0
			50.1 PCT	1 PCT	12.5 PCT	0 PCT	12.5 PCT	25.0 PCT	0 PCT

63.8 PERCENT OF KNOWN CASES CORRECTLY CLASSIFIED

CHI-SQUARE = 863.123 SIGNIFICANCE = 0

RESEARCH UNIVERSITY OF IBADAN NIGERIA RECEIVED 2 6 JAN 1982

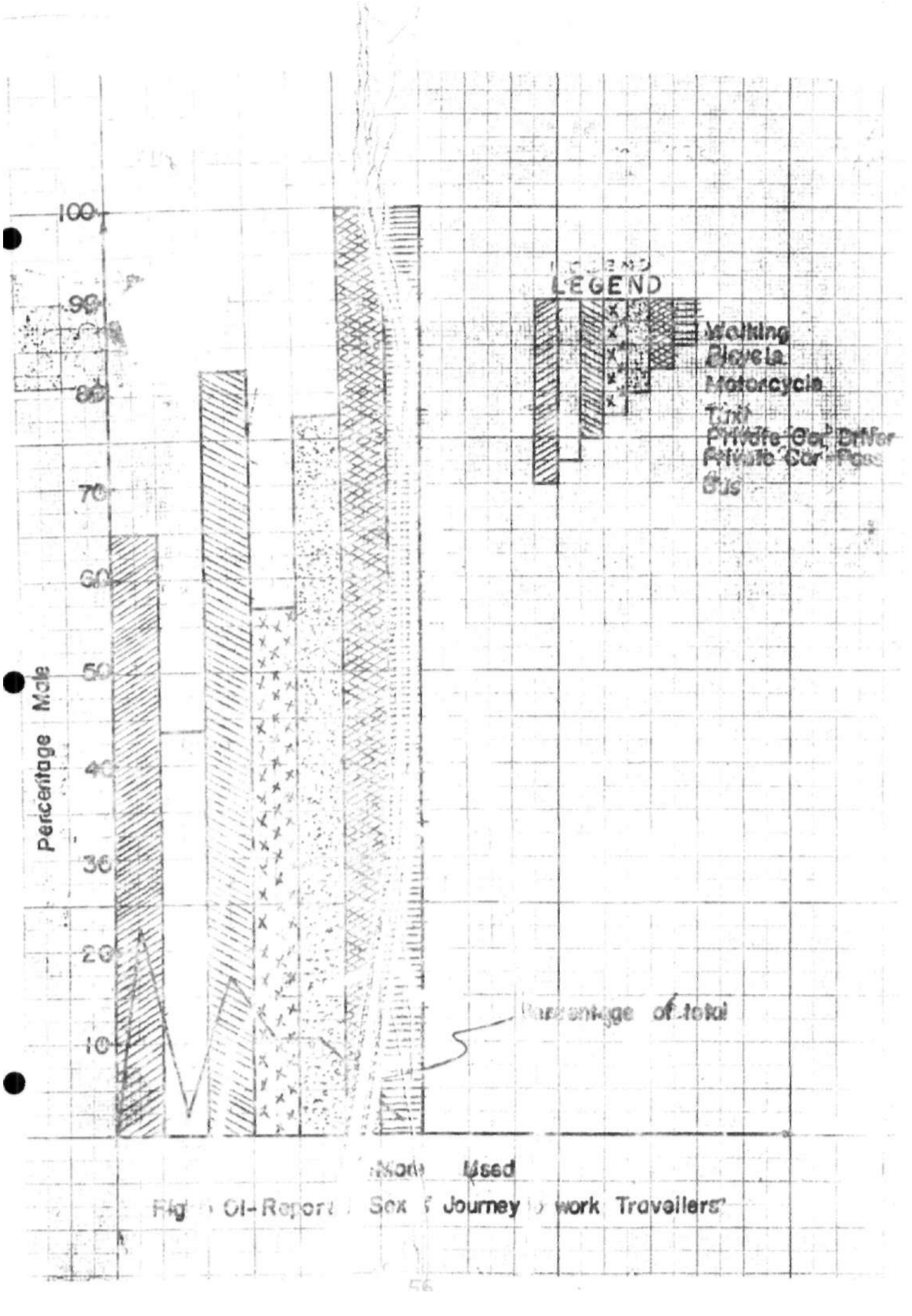


Fig 01-Report Sex of Journey to work Travellers'

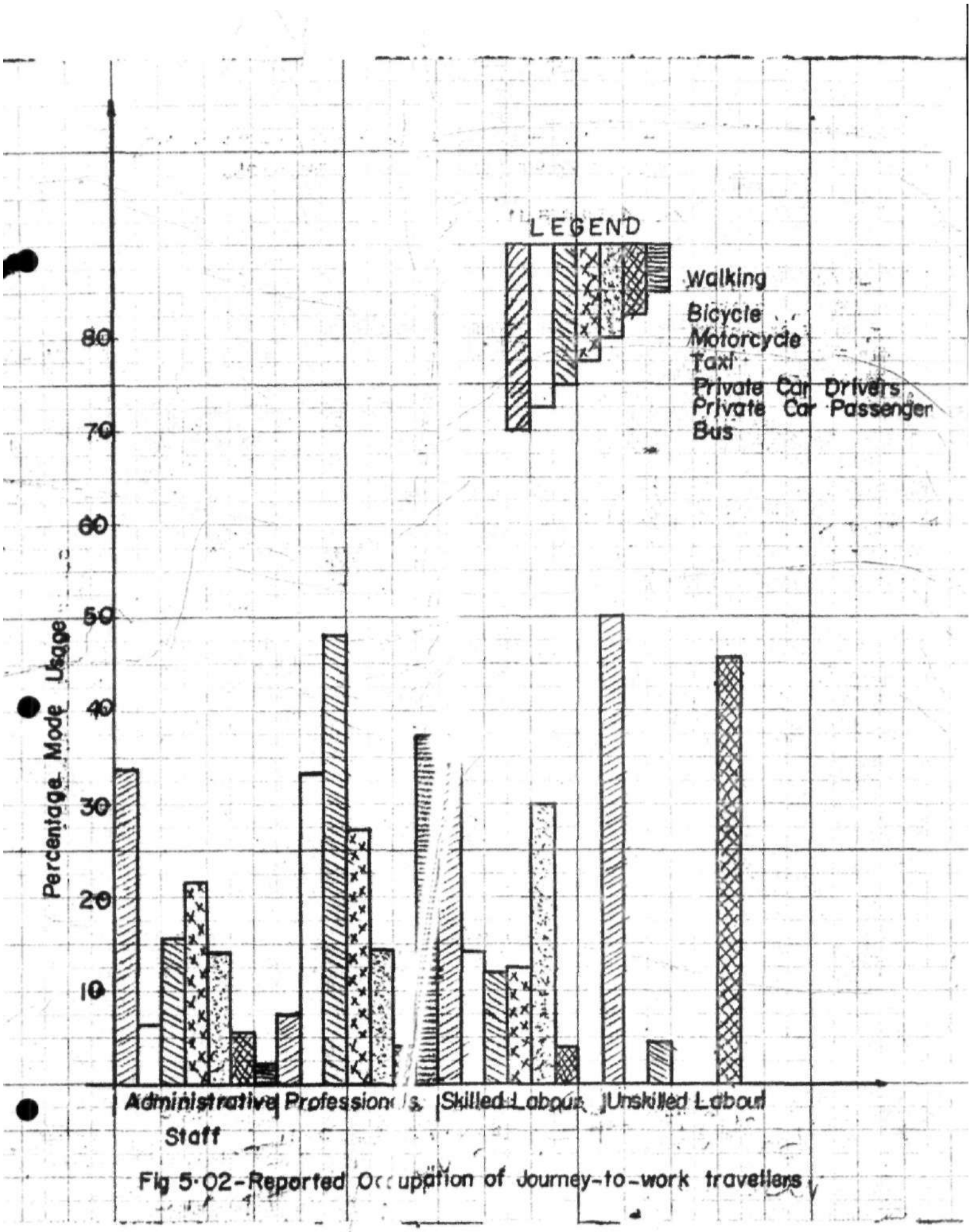


Fig 5·02-Reported Occupation of Journey-to-work travellers

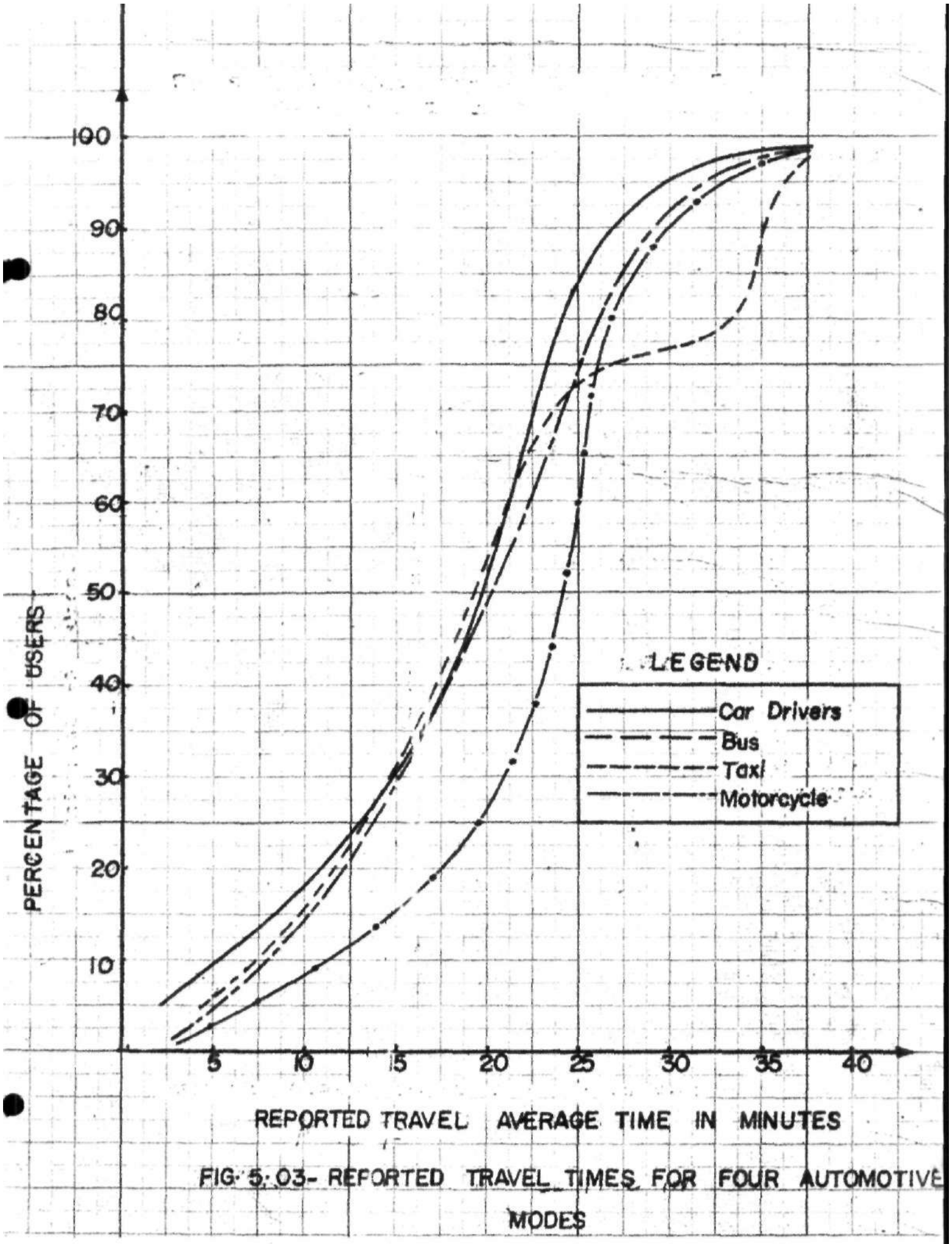
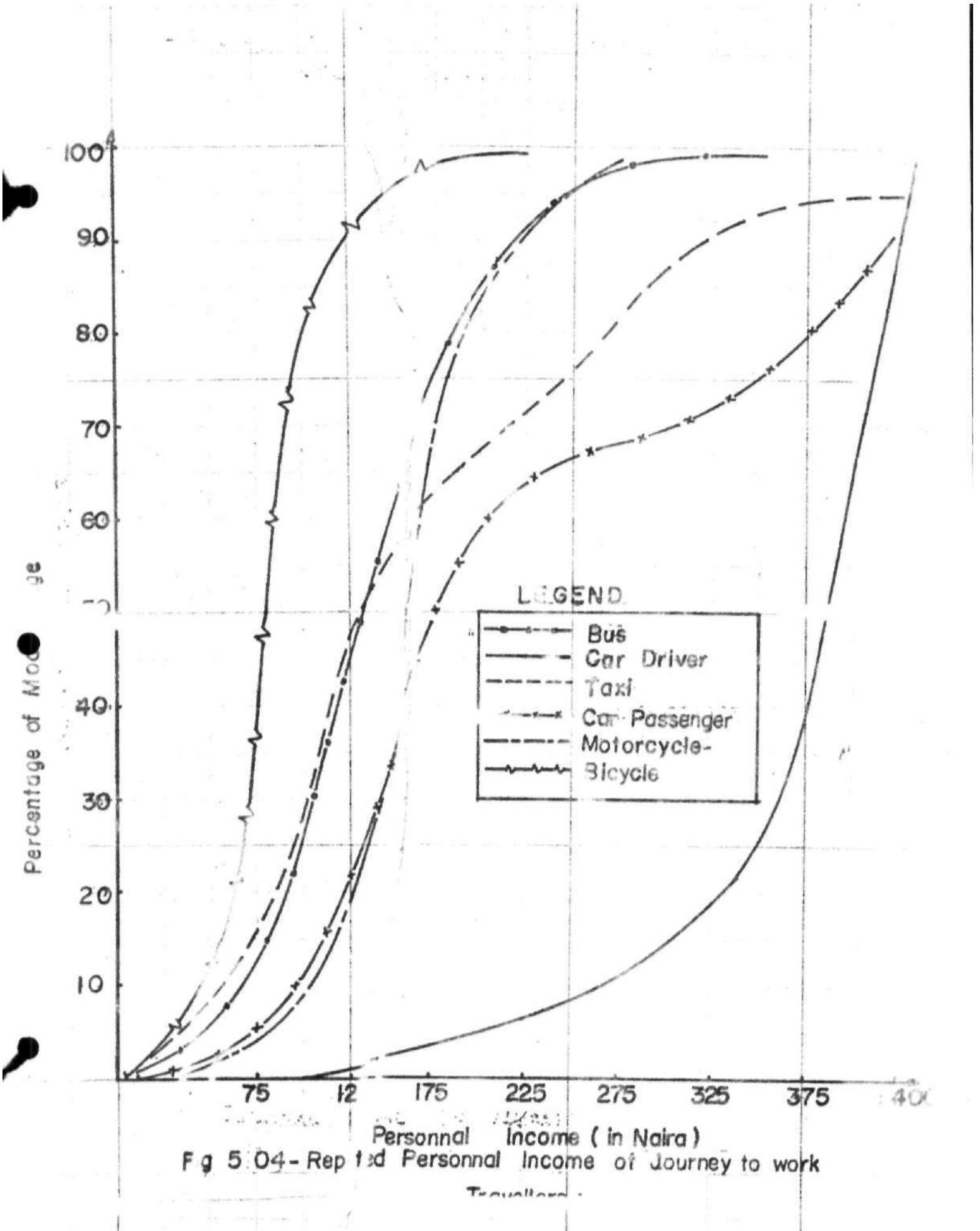


FIG. 5.03- REPORTED TRAVEL TIMES FOR FOUR AUTOMOTIVE MODES



Fg 5.04 - Rep ted Personnal Income of Journey to work

Travellers

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

From the results of the discriminant analysis, it has been found that transport fares, number of cars available in a family, personal income, position in household, and occupation are the principal variables, that significantly affect mode choice of Civil Servants, though to different extents. It was found that three separate analyses were sufficient to describe the mode choice behaviour of the studied workers. All husbands, except those labourers, were found to have identical traits. Similarly, all unskilled workers constitute one group while all remaining workers constitute another.

In all cases it was found that the most important variable in distinguishing between various mode users is personal income which consistently had the highest coefficient in the standardized discriminant function.

Contrary to reports from many writers - Stopher (1979), Ben-Akiva et al (1976) and others, who reported that transport costs (direct) are weighted relatively highly, it is found here to be highly weighted in explaining the worktrip travel patterns.

The non-inclusion of any level of service factor other than transport fare in the discriminant analysis has implicitly disproved the view that the studied workers are captive mode users. With the type of stepwise method employed for the computations, if any other level of service factor had a statistically sig-

nificant influence on mode choice, it would have entered the model. Sonce no such factor entered the model, it only implies that level of service available on any mode exerts an unsignificant influence on mode choice.

Apart from the fact that these findings do not uphold the general view that trip makers in developing Countries are mode captive, (due to the poor transport facilities available, alternative to the private car mode), it is significant that a wider range of socioeconomic factors have been found important, from this study. The fact now is that apart from personal income, being a husband and number of cars possessed in a family are also important factors influencing mode choice

In comparison to Ben-Akiva et al (1976)'s findings that personal income does not affect worktrip travel patterns in the Netherlands, the finding here is that personal income greatly affects the worktrip travel patterns, by influencing mode choice, in Nigeria!

On the basis of the above results, one might rightly caution that, as Stopher (1980) stressed, models developed for developed Countries should not be transfered for use in developing countries without some adjustment. The fact that some previously held beliefs had been refuted here underlines the need for constant review and updating of models suitable for direct application in Nigeria and possibly any other developing country where similar situation exists.

It is suggested that for demand and mode choice analyses, three separate classification functions be adapted as shown by the three distinct analyses groups in

chapter five. The first function, for all husbands other than those unskilled labourers, the second, for all unskilled labourers and the third, for all others. It is further suggested that two discriminant functions be utilized in each of the groups mentioned above.

With the above suggestions in mind, the following are formed:

1. For all husbands other than labourers:

Standardized Discriminant functions

(a) $Y = 1.072\ PINC + 0.268\ HPOST + 0.907\ NOCF + 0.104\ TF$

(b) $Y = 0.163\ PINC - 0.315\ HPOST - 0.027\ NOCF + 1.268\ TF$

The group centroids for the bus, private car passenger, private car driver, taxi, motorcycle, bicycle and walking modes are respectively:

(a) -.882; .450; 2.747; -.558; -.757; -1.453; -.716

(b) .499; -.765; -.030; .996; -1.516; -1.540; -.414

Classification functions:

Group 1: $C = 0.031\ PINC + 1.837\ HPOS1 + 1.594\ NOCF + 9.965\ TF - 5.975$

Group 2: $C = 0.036\ PINC + 2.076\ HPOS1 + 5.035\ NOCF + 4.962\ TF - 6.972$

Group 3: $C = 0.066\ PINC + 4.227\ HPOS1 + 6.774\ NOCF + 9.105\ TF - 19.903$

Group 4: $C = 0.034\ PINC + 1.372\ HPOS1 + 2.260\ NOCF + 11.892\ TF - 7.658$

Group 5: $C = 0.032\ PINC + 2.494\ HPOS1 + 1.534\ NOCF + 1.773\ TF - 3.847$

Group 6: C = 0.018 PINC + 4.432 HPOS1 + 1.355 NOCF + 2.530 TF - 3.389

Group 7: C = 0.036 PINC + 1.784 HPOS1 + 1.157 NOCR + 6.068 TF - 4.994

A case is classified into the group with the highest classification score (C).

2. For all labourers:

Standardized Discriminant functions

(a) Y = 1.147 PINC - 0.055 OCC4 + 0.824NOCF + 0.160 TF

(b) Y = 0.054 PINC - 0.168 OCC4 - 0.003NOCF + 1.277 TF

The centroids on the above functions for the seven respective groups are:

(a) -.818; .490; 2.634; -.410; -.815; -1.829; -.664

(b) .528; -.864; -.123; .972; -1.416; -1.426; -.389

Classification function:

Group 1: C = 0.035 PINC + 3.945 OCC4 + 1.035 NOCF + 10.150 TF - 5.935

Group 2: C = 0.039 PINC + 2.443 OCC4 + 4.391 NOCF + 5.114 TF - 6.671

Group 3: C = 0.072 PINC + 4.355 OCC4 + 5.460 NOCF + 9.399 TF - 18.551

Group 4: C = 0.037 PINC + 2.750 OCC4 + 1.841 NOCF + 12.024 TF - 7.616

Group 5: C = 0.035 PINC + 1.957 OCC4 + 0.755 NOCF + 1.929 TF - 3.326

Group 6: C = 0.028 PINC + 13.554OCC4 + 0.031 NOCF + 3.088 TF - 4.830

Group 7: C = 0.039 PINC + 2.273 OCC4 + 0.605 NOCF + 6.204 TF - 4.786

3. For all other workers

Standardized Discriminant functions

(a) Y = 1.159 PINC + 0.826 NOCF + 0.159 TF

(b) Y = 1.300 TF + 0.006 NOCF - 0.009 PINC

The centroids for the seven respective groups on the above functions are:

(a) -.821; .479; 2.642; -.424; -.831; -1.739; -.679

(b) .525; -.913; -.086; .944; -1.497; -1.187; -.447

Classification functions

Group 1: C = 0.033 PINC + 4.011 NOCF + 10.040 TF - 5.655

Group 2: C = 0.038 PINC + 4.377 NOCF + 5.046 TF - 6.530

Group 3: C = 0.020 PINC + 5.434 NOCF + 9.277 TF - 18.209

Group 4: C = 0.036 PINC + 1.825 NOCF + 11.947 TF 7.480

Group 5: C = 0.038 PINC + 0.743 NOCF + 1.874 TF - 3.257

Group 6: C = 0.023 PINC + 0.050 NOCF + 2.740 TF - 1.52"

Group 7: C = 0.038 PINC + 0.590 NOCF + 6.140 TF - 4.693

One of the dangerous, but perhaps unavoidable limitations of relying on questionaires for data base is that one may not be able to assure proportional representation of the various groups within the sampled population. A good illustration is the incidence arising from the low response from low income earners that was earlier commented upon. Since in many cases a researcher may not have an advance knowledge about the possible

groupings or their charasteristics and the researcher cannot compel the studied subjects to respond, it may be difficult to completely eliminate this problem. However, a very important observation from the present study is that special care need be taken on future studies of this sort.

It should be realised at this point that the findings from this work is only applicable to the civil servants and not to all categories of workers. Since no data was collected on private workers, no conclusion can be drawn on the patterns of their worktrips. It is hereby recommended that a separate study similar to this be undertaken for private workers so as to find out the influence of the various factors on their worktrip patterns.

R E F E R E N C E S

1. Beesley, M.E. & Dalvi, M.Q
   "Spatial equillibrium and journey to work"
   - Journal of transport Economics & Policy
   Vol. 8 September, 1977 pp.197 - 222

2. Ben-Akiva, M. & Martin, G.R.
   "Disaggregate multimodal model for work-trips in Netherlands"
   - Transport Research Record No.569, 1976

3. Bolch, B.W. & Huang C.J.
   "Multivariate Statistical methods for Business and Economics"
   - Prentice Hall Inc., 1974 pp.230 - 238

4. Brand, D.
   "Travel demand forecasting: Some foundation and review"
   - Highway Research Board, Special Report No. 143, 1972

5. Carrol, J.D.
   "The relationship of home to workplaces and the Spatial pattern of cities"
   - Social Forces, Vol.30, 1952 pp.271 - 282

6. Chari, S.R. & Khanna, S.K.
   "Development of Disaggregate Behavioural model - A case study of an Indian City"
   - Australian Road Research Board Proceeding. Vol.8, 1976

7. Clemente, F. & Summers, G.F.
"The journey to work of rural Industrial employees"
- Social Forces, Vol. 55, No.1 1976 pp.212-219

8. Ehrenberg, A.S.C.
"Data Reduction - Analysing and interpreting statistical data"
- John Willey & Sons 1975

9. Evans, A.W.
"The Economics of Residential Location"
- Macmillan Press Ltd, London 1973

10. Fisher, G.R.
"The use of multiple measurements in Taxonomic Problems"
- Annals of Eugenics, 7, 1936

11. Goldstein, M. & Dillon, W.R.
"Discrete Discriminant Analysis"
- John Willey & Sons 1978

12. Guest, A.M. (a)
"Occupation and the journey to work"
- Social Forces, Vol.55, No.1, 1976

13. Guest, A.M. (b)
"Journey to work: 1960 - 1970"
- Social Forces, Vol.55, No.1, 1976.

14. Hoel, P.G.
"Introduction to Mathematical Statistics"
- John Willey & Sons 1971

15. Horton, F.E. & Wittick, R.I.

"A special model for examining the journey to work in a planning context"

- The Professional Goegrapher Vol.XXI No.4 July, 1969

16. Howe, R.T.

"Atheoretical Prediction of Work-trip patterns"

- Highway Research Board, Bulletine No.253 1960 pp.155 - 165

17. Howe, R.T.

"A theoretical Prediction of Work-trip patterns in the Minneapolis - St. Paul area"

- Highway Research Board, Bulletin No.347 1962 pp.156 - 180

18. Hutchinson, B.G.

"Principles of Urban Transport systems Planning"

- Prentice-Hall Inc. 1974

19. Leipmann, K.

"The journey to work"

- Routladge & Kegan Paul, London 1944

20. Lachenbruch, P.A.

"Discriminant Analysis"

- Hafner Press, 1975

21. Miller, I. & Freund, J.E.

"Probability and Statistics for Engineers"

- Prentice-Hall Inc. 1965

22. McCarthy, P.S.

"Residential location and the Journey to work"

- Journal of Transport Economic & Policy Vol.11, 1977 pp.169 - 184

23. Mc Fadden, D.

"Conditional Logit Analysis of Qualitative choice behaviour"

- Frontiers of Economics 1973

24. Ojumu, J.O.

"A study of the journey to work of selected low income workers in Lagos"

- M.S. (U.R.P.) Thesis - A.B.U. Zaria, 1975

25. Reichman, S. & Stopher, P.R.

"Disaggregate Stochastic Models of travel Mode choice"

- Highway Research Record No. 369, 1971 pp.91 -103

26. Richards, M.G. & Ben-Akiva, M.E.

"A disaggregate travel demands model"

- Saxon House, 1975.

27. Speigel, M.R.

"Schaum Outline Series - Theory and Problems of Probability and Statistics"

- McGraw Hill Book Company, 1975

28. Stopher, P.R.

"Transfering Urban Transport Planning methods to Developing Countries"

- Journal of the Institute of Highway Engineers No. 10, October, 1980 pp.8 - 14

29. Talvitie, A.

"Comparison of Probabilistic modal-choice models: Estimation methods and system Inputs"

- Highway Research Records No.392 1972

30. Van de Geer, J.P.

"Introduction to nultivariate analysis for the Social Sciences"

- W.H. Freeman & Co. 1971

31. Wheeler, J.O.

"The structure of Metropolitan work trips"

- The Professional Geographer. Vol. 22 1970 pp. 152 - 158

32. Wilson, A.G. (a)

"A Statistical theory of Spatial distribution Models"

- Transportation Research Vol.3, 1967 pp, 253 - 269

33. Wilson, F.R. (b)

"Journey to work - A study in transportation carried out in the department of transportation and Environmental planning, the University of Birmingham"

- Maclaren & Sons Ltd., London, 1967

A P P E N D I X A

THE QUESTIONAIRE USED IN THE STUDY

THIS SURVEY IS BEING CARRIED OUT BY A POST-GRADUATE STUDENT IN THE DEPARTMENT OF CIVIL ENGINEERING, AHMADU BELLO UNIVERSITY, ZARIA.

****

Your journey to work can be made speedy and direct and with very little inconveniences to you. This can be achieved only if the complete facts about work trips are made available through projects such as this.

Please help by completing this questionaire on the journey to work habits of you and your family. Your answers are STRICTLY CONFIDENTIAL, and your co-operat' will be greatly appreciated. Data supplied will be used purely for research purposes.

INSTRUCTIONS FOR COMPLETING THIS QUESTIONNAIRE

1. General Section to be completed by everyone together with ONE ONLY of the following:

   PART A: To be completed by persons who do not own a car.

   PART B: To be completed by persons who go to work in their own cars.

   PART C: To be completed by car owners who do not go to work in their own cars.

2. In questions which get alternative answers, please TICK the box corresponding to your appropriate alternative.

3. In questions NOT containing answers, please write in your own answers briefly.

GENERAL SECTION - TO BE COMPLETED BY EVERYONE

FOR OFFICIAL USE

S/No. [ ][ ][ ][ ] (1 2 3 4)

1. Home address (Street name and Number) e.g. 25,Emir Road, Unguwan Rimi, Kaduna, or
   12, President Avenue, Bompai, Kano

   ..... Leave blank [ ][ ] (5 6)

   .....

2. How long have you lived at your present home address?
   (i) 0 - 2 yrs [ ] ; (ii) 3-5yrs [ ]
   (iii) 6-10 yrs [ ] ; (iv)More than 10yrs [ ]

   [ ] (7)

Leave blank

3. Do you own or rent the house you are living in now?

(i) Own ☐ ; (ii) Rent ☐

☐ 8

4. How many people are there in your household?

(i) 1 ☐ ; (ii) 2 ☐ ;

(iii) 3 ☐ ; (iv) 4 ☐ ;

(v) 5 ☐ ; (vi) More than 5 ☐

☐ 9

5. Which of the following age groups represents your age?

(i) 16-24 yrs ☐ ; (ii)25-34yrs ☐

(iii) 35-44 yrs ☐ ; (iv) 45-54 yrs ☐

(v) More than 54 ☐

☐ 10

6. How many people in your household including yourself are over 16 years?

(i) None ☐ ; (ii) 1 ☐ ;

(iii) 2 ☐ ; (iv) 3 ☐ ; (v) 4 ☐ ;

(vi) More than 4 ☐

☐ 11

7. How many people in your household are 6 years and above?

(i) 1 ☐ ; (ii) 2 ☐ ; (iii) 3 ☐ ;

(iv) 4 ☐ ; (v) 5 ☐ ;

(vi) More than 5 ☐

☐ 12

8. What is your position in your household?

(1) Husband ☐ ; (ii) Wife ☐ ;

(iii) Son ☐ ; (iv) Daughter ☐ ;

☐ 13

(v) Relation (sharing accomodation ☐

(vi) Male lodger ☐ ; (vii) Female lodger ☐

Leave bla

9. How many vehicle driving licences are held by members of your household?

(i) None ☐ ; (ii) 1 ☐ ; (iii)2 ☐

(iv) 3 or more ☐ ; (v) Don't know ☐

☐ 14

10. Do you personally own a car?

(i) Yes ☐ ; (ii) No ☐

☐ 15

11. How many cars owned by your household?

(i) None ☐ ; (ii) 1 ☐ ; (iii) 2 ☐

(iv) 3 or more ☐

☐ 16

12. How many motorcycles are owne by your household?

(i) None ☐ ; (ii) 1 ☐ ; (iii) 2 ☐

(iv) 3 ☐ ; (v) More than 3 ☐

1 17

13. How many bicycles are owned by your household?

(i) None ☐ ; (ii) 1 ☐ ; (iii) 2 ☐

(iv) 3 ☐ ; (v) More than 3 ☐

☐ 18

14. How did you come to work today?

(i) Bus ☐ ; (ii) Private car passenger ☐

(iii) Private car driver ☐

leave blank

(iv) Taxi ☐ ; (v) Motorcycle ☐ ;

(vi) B cycle ☐ ; (vii) Walking ☐

19

15. What is your occupation?

(i) Administrative Staff (Secretaries, Clerks, Typists Messengers, etc) ☐

(ii) Professionals (Lawyers, Doctors, Accountant, Teachers, Architects, etc) ☐

20

(iii) Skilled Workers (Technical Staff, Masons Plumbers, Carpenters, etc) ☐

(iv) Unskilled Labourers ☐

16. (THE INFORMATION ON THIS QUESTIONNAIRE WILL BE KEPT STRICTLY CONFIDENTIAL).

Please estimate your personal monthly income before tax deductions.

(i) ₦75 - 100 ☐ (ii) ₦101 - 150 ☐;

(iii) ₦151 - 200 ☐ (iv) ₦201-250 ☐;

(v) ₦251 - 300 ☐; (vi) ₦301-350 ☐

21

(vii) ₦351-400 ☐ (viii)More than ₦400 ☐

17. Please estimate your approximate household monthly income before tax deductions

(i) ₦75 - 150 ☐; (ii) ₦151 - 250 ☐;

(iii)₦251 - 350 ☐; (iv) ₦351-450 ☐;

(v) ₦451 - 550 ☐; (vi) ₦551-650 ☐;

22

(vii)₦651-750 ☐; (viii)More than ₦750 ☐

PART A: IF YOU DO NOT OWN A CAR PLEASE COMPLETE THIS PART

Leave blank

1. Do you hold a valid driving licence?

   (i) Yes ☐; (ii) No ☐ 23

2. If you came to work by public transport (bus or taxi);

   (a) how much was your fare?..... 24 25 26

   (b) how many minutes did you spend in/on the vehicle to come to work today?

   (i) Less than 5 min ☐; (ii) 5-10min.☐

   (iii) 11-15 min.☐; (iv) 16-20 min. ☐

   (v) 21 - 25 min.☐;(vi) 26 - 30 min.☐

   (vii) 31 - 35 min.☐;(viii)More than 35 min.

   (ix) Don't know ☐ ☐; 27

   (c) Estimate the time you spent getting to the bus stop or taxi boarding point, waiting for the bus or taxi, and finally getting to your work-place after leaving the bus or taxi:

   (i) Less than 5 min.☐; (ii) 5-10 min.☐;

   (iii) 11 - 15 min.☐; (iv) 16 - 20 min.☐

   (v) 21 - 25 min.☐; (vi) 26 - 30 min.☐

   (vii) 31 - 35 min.☐; (viii)More than 35 min. 28

   (ix) Don't know ☐ ☐

3. If you came by public transport (bus or taxi), how many times did you have to change means of transport before reaching your work-place?

   (i) None ☐; (ii) 1 ☐; (iii) 2 ☐;

   (iv) 3 or more times ☐; 29

4. If you came to work by other means, estimate the time spent out of/off the vehicle used.

   (i) Less than 10 min.☐; (ii) 10-15 min.

   ☐

(iii) 16 - 20 min.☐; (iv) 21 - 25 min.☐;

(v) 26 - 30 min.☐; (vi) 31 - 35 min.☐;

(vii)More than 35 min.☐; (viii) Don't know

(ix) Not applicable ☐ ☐

Leave blank.

☐ 30

5(a) Is the method you used to come to work today your usual means of transport to work?

(i) Yes ☐; (ii) No ☐

☐ 31

(b) If your answer is NO which is your usual means?

(i) Bus ☐; (ii) Private car passenger☐

(iii) Taxi ☐; (iv Motorcycle ☐

(v) Bicycle ☐; (vi) Walk ☐

(vii) Not applicable ☐

☐ 32

6. If you came to work by public transport, which of the following is most inconvenient about coming to work by public transport?

(i) Too far to walk to and from the bus stop or taxi boarding point ☐;

(ii) Too long to wait for bus or taxi ☐

(iii) Not being certain of a seat on bus ☐

(iv) No shelter at the bus stop ☐

(v) Having to change buses ☐

(vi) others? (Please state).....☐

☐

(This concludes Part A. Thank you)

PART B. TO BE COMPLETED BY PERSONS WHO GO TO WORK IN THEIR OWN CARS

1. How many minutes did it take you to drive to work today'

(i) Less than 5 min.☐; (ii) 5 - 10 min.☐

Leave Blank

(iii) 11 - 15 min.☐; (iv) 16 - 20 min.☐

(v) 21 - 25 min.☐; (vi) 26 - 30 min,☐;

(vii) More than 30 min.☐;

(viii) Don't know /☐

☐ 23

2. How many minutes did you spend out of your vehicle on your journey to work? (i.e. in walking from your house to your garage and from your usual parking place to your office).

(i) Less than 10 min.☐; (ii) 10-15 min.☐

(iii)16 - 20 min.☐; (iv) 21 - 25 min.☐

(v) More than 25 min.☐;(vi) Don't know ☐;

☐ 24

3. Do you usually come to work in your own car?

(i) Yes ☐; (ii) No ☐

☐ 25

*4. How far is your home from the nearest bus stop or taxi boarding point you would ave used to travel to work?

(i) Less than 50 metres ☐; (ii) 50 - 100 metres ☐; (iii) 101 - 150 metres ☐;

(iv) 151 - 200 metres ☐; (v) More than 200 metres ☐

☐ 26

5. If you had not driven to work in your own car:

(a) how would you have come to work?

(i) Private car passenger ☐; (ii) Taxi ☐;

(iii) Bus ☐; (v) Motorcycle ☐;

(v) Bicycle ☐; (vi) Walk ☐ ;

☐ 27

(b) how many minutes would it have taken you to come to work by the method you stated above? (Door to door time including walking).

(i) Less than 10 min.☐; (ii) 10-15 min.☐

Leave blank

(iii) 16 - 20 min. ☐; (iv) 21-25 min. ☐;

(v) 26 - 30 min. ☐; (vi) More than 30 min ☐

(vii) Don't know ☐

28

(c) estimate how much it would have cost you to get to work.....

29 30 31

* 6. Would you have any reason for choosing an alternative mode of transport instead of using your own car for the journey to work? (Please give the reason and brief details to clarify your answer).

(i) Yes ☐; (ii) No ☐ .....

.....

32

(This concludes Part B. Thank you).

6

PART C: TO BE COMPLETED BY CAR OWNERS WHO DO NOT GO TO WORK IN THEIR OWN CARS

* 1. Why did you not come to work in your own car today?

(i) Wife/husband uses car to travel to work ☐

(ii) Wife uses car to take children to school ☐

(iii) Roads too crowded ☐

(iv) Journey takes too long by car ☐

(v) Car being serviced or repaired ☐

(vi) Not passed driving test ☐

(vii) Others? (Please state) ☐

23

.....

.....

2. (a) Is the method you used to come to work today your usual means of transport?

(i) Yes ☐; (ii) No ☐

24

Leave blank

(b) If NO, which is your usual means?

(i) Bus ☐; (ii) Private car passenger ☐;

(iii) Taxi ☐; iv) Motorcycle ☐;

(v) Bicycle ☐; (vi) Walking ☐;

(vii) Not applicable ☐

25 ☐

3. How many minutes did it take you to get to work today?

(i) Less than 10 min. ☐; (ii) 10-15min. ☐

(iii) 16 - 20 min. ☐; (iv) 21 - 25 min. ☐

(v) 26-30 min. ☐; (vi)More than 30min. ☐

(vii) Don't know ☐

26 ☐

4. How many minutes did you spend out of the vehicle on your journey to work?

(i) Less than 10 min. ☐; (ii) 10-15min. ☐

(iii) 16 - 20 min. ☐; (iv) 21 - 25min. ☐

(v) 26 - 30 min. ☐; (vi) More than 30 min. ☐

(vii) Don't know ☐

27 ☐

5. If you had driven your car today how many minutes would the journey to work have taken you?

(i) Less than 10 min. ☐; (ii) 10 - 15min. ☐

(iii) 16 - 20 min. ☐; iv) 21 - 25 min. ☐;

(v) 26 - 30 min. ☐;(vi)More than 30min. ☐

(vii) Don't know ☐

28 ☐

6. If you used public transport (bus or taxi), how much was your fare? .....

29 30 31 ☐☐☐

7. How many times did you have to change means of transport before getting to your place of work?

(i) Nil ☐ (ii) Once ☐; (iii) Twice ☐

(iv) More than twice ☐

32 ☐

Leave blank

8. If you came to work by public transport (bus or taxi), which of the following is most inconvenient about coming to work by public transport?

(i) Too long to walk to and from bus stop or taxi boarding point ☐; (ii) Too long to wait for a bus or taxi ☐;

(iii) Not being certain of a seat on bus ☐

(iv) No shelter at the bus stop ☐

(v) Having to change buses ☐

(vi) others? (Please state) ☐ .....

.....

33

(This concludes Part C. Thank you).

A P P E N D I X B

THE PROGRAMME USED IN THE ANALYSIS

VOGELBACK COMPUTING CENTER
NORTHWESTERN UNIVERSITY

S P S S - - STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

VERSION 6.5, -- APRIL 1, 1976

RUN NAME DISCRIMINANT ANALYSIS
FILE NAME TRANS1
VARIABLE LIST FASZ,NOCF,NOD,MOD,OCC1,OCC2,OCC3,OCC4,HPOS1,HPOS2,HPOS3,
HPOS4,HPOS5,HPOS6,HPOS7,PINC,HINC,TF,CAV,IVTT,OVTT
INPUT FORMAT FIXED(15F1.0,2F3.0,2F3.1,2F2.0)

ACCORDING TO YOUR INPUT FORMAT, VARIABLES ARE TO BE READ AS FOLLOWS

VARIABLE	FORMAT	RECORD	COLUMNS
FASZ	F 1. 0	1	1- 1
NOCF	F 1. 0	1	2- 2
NOD	F 1. 0	1	3- 3
MOD	F 1. 0	1	4- 4
OCC1	F 1. 0	1	5- 5
OCC2	F 1. 0	1	6- 6
OCC3	F 1. 0	1	7- 7
OCC4	F 1. 0	1	8- 8
HPOS1	F 1. 0	1	9- 9
HPOS2	F 1. 0	1	10- 10
HPOS3	F 1. 0	1	11- 11
HPOS4	F 1. 0	1	12- 12
HPOS5	F 1. 0	1	13- 13
HPOS6	F 1. 0	1	14- 14
HPOS7	F 1. 0	1	15- 15
PINC	F 3. 0	1	16- 18
HINC	F 3. 0	1	19- 21
TF	F 3. 1	1	22- 24
CAV	F 3. 1	1	25- 27
IVTT	F 2. 0	1	28- 29
OVTT	F 2. 0	1	30- 31

THE INPUT FORMAT PROVIDES FOR 21 VARIABLES. 21 WILL BE READ
IT PROVIDES FOR 1 RECORDS (*CARDS*) PER CASE. A MAXIMUM OF 31 *COLUMNS* ARE USED ON A RECORD.

N OF CASES 431
INPUT MEDIUM DISC
VAR LABELS FASZ FAMILY SIZE/
NOCF NUMBER OF CARS IN RESPONDENTS FAMILY/
NOD NUMBER OF DRIVING LICENCES IN RESPONDENTS FAMILY/
MOD MODE CHOSEN BY RESPONDENT/
OCC1 ADMINISTRATIVE STAFF/
OCC2 TECHNICAL STAFF/
OCC3 SKILLED LABOUR/
OCC4 UNSKILLED LABOURERS/
HPOS1 HUSBANDS/
HPOS2 WIVES/

```
                HPOS3  SONS/
                HPOS4  DAUGHTERS/
                HPOS5  RELATION SHARING ACCOMODATION/
                HPOS6  MALE LODGER/
                HPOS7  FEMALE LODGER/
                PINC   PERSONAL INCOME OF RESPONDENT/
                HINC   HOUSEHOLD INCOME OF RESPONDENT/
                TF     TRANSPORT FARE OF RESPONDENT/
                CAV    CAR AVAILABILITY TO RESPONDENT/
                IVTT   IN-VEHICLE TRAVEL TIME OF RESPONDENT/
                OVTT   OUT-OF-VEHICLE TRAVEL TIME OF RESPONDENT/
VALUE LABELS    MOD(0)NO RESPONSE(1)BUS(2)PRIVATE CAR PASS.(3)PRIVATE CAR DRIVER
                 (4)TAXI(5)MOTORCYCLIST(6)BICYCLIST(7)WALKING
DISCRIMINANT    GROUPS=MOD(2,7)/VARIABLES=PINC,HINC,FASZ,HPOS1,HPOS2,HPOS3,
                HPOS4,HPOS5,HPOS6,HPOS7,OCC1,OCC2,OCC3,OCC4,NOCF,NOD,TF,IVTT,
                OVTT/ANALYSIS=PINC,HINC,FASZ,HPOS1,OCC1,NOCF,NOD,TF,IVTT,
                OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,
                HPOS1,OCC2,NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
                ANALYSIS=PINC,HINC,FASZ,HPOS1,OCC3,NOCF,NOD,TF,IVTT,OVTT(3)/
                METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,HPOS1,OCC4,
                NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
                ANALYSIS=PINC,HINC,FASZ,HPOS2,OCC1,NOCF,NOD,TF,IVTT,OVTT(3)/
                METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,HPOS2,OCC2,
                NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
                ANALYSIS=PINC,HINC,FASZ,HPOS2,OCC3,NOCF,NOD,TF,IVTT,OVTT(3)/
                METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,HPOS2,OCC4,
                NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
                ANALYSIS=PINC,HINC,FASZ,HPOS3,OCC1,NOCF,NOD,TF,IVTT,OVTT(3)/
                METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,HPOS3,OCC2,
                NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
                ANALYSIS=PINC,HINC,FASZ,HPOS3,OCC3,NOCF,NOD,TF,IVTT,OVTT(3)/
                METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,HPOS3,OCC4,
                NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
                ANALYSIS=PINC,HINC,FASZ,HPOS4,OCC1,NOCF,NOD,TF,IVTT,OVTT(3)/
                METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,HPOS4,OCC2,
                NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
                ANALYSIS=PINC,HINC,FASZ,HPOS4,OCC3,NOCF,NOD,TF,IVTT,OVTT(3)/
                METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,HPOS4,OCC4,
                NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
                ANALYSIS=PINC,HINC,FASZ,HPOS5,OCC1,NOCF,NOD,TF,IVTT,OVTT(3)/
                METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,HPOS5,OCC2,
                NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
                ANALYSIS=PINC,HINC,FASZ,HPOS5,OCC3,NOCF,NOD,TF,IVTT,OVTT(3)/
                METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,HPOS5,OCC4,
                NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
                ANALYSIS=PINC,HINC,FASZ,HPOS6,OCC1,NOCF,NOD,TF,IVTT,OVTT(3)/
                METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,HPOS6,OCC2,
                NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
                ANALYSIS=PINC,HINC,FASZ,HPOS6,OCC3,NOCF,NOD,TF,IVTT,OVTT(3)/
                METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,HPOS6,OCC4,
                NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
                ANALYSIS=PINC,HINC,FASZ,HPOS7,OCC1,NOCF,NOD,TF,IVTT,OVTT(3)/
                METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,HPOS7,OCC2,
                NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
                ANALYSIS=PINC,HINC,FASZ,HPOS7,OCC3,NOCF,NOD,TF,IVTT,OVTT(3)/
                METHOD=MAHAL/FIN=10./FOUT=5./ANALYSIS=PINC,HINC,FASZ,HPOS7,OCC4,
                NOCF,NOD,TF,IVTT,OVTT(3)/METHOD=MAHAL/FIN=10./FOUT=5./
OPTIONS         1,6,7,8,11,12,17,18
```

STATISTICS ALL
READ INPUT DATA

DISCRIMINANT OPTIONS 13 THRU 19 NOT YET IMPLEMENTED AND WILL BE IGNORED

055700 CM NEEDED FOR DISCRIM

CASE 337 IN SUBFILE TRANS1 HAS ILLEGAL DATA. BAD VARIABLES WERE SET TO BLANK.