Patterns of Time-Budget Expenditure in Nigeria

G. ADEGBOYEGA BANJO AND PETER J.B. BROWN

By using data relating to Nigeria, this paper reports the results of analyses directed toward examining the validity, in a Third World context, of the postulate advanced by a number of authors that the amount of time spent traveling has certain stable properties and can serve, therefore, as an alternative parameter to trip rate for use in deriving estimates of future travel demand. Analysis of relations between traveler characteristics and time-budget-expenditure patterns reveals the significant influence of engagement in supplementary employment on both travel and nontravel activities. Explanations are put forward to account for similarities and differences found in patterns of daily travel-time variation displayed by residents of Lagos and Ibadan. These explanations lead to the formulation of tentative hypotheses about the relations between different aspects of travel-time variation and transportation system characteristics as a settlement evolves. In particular, it is suggested that mean daily travel time is likely to be reduced as a result of implementing measures introduced to resolve problems diagnosed during a period of transportation system overload. Attention is drawn to the implications of this and other relations for transportation modeling and time-valuation practice in Third World cities.

In recent years, a considerable amount of research effort has been devoted to examining the usefulness of travel-time budgets in the explanation of patterns of travel behavior (1-4). Much of this work has been concerned with investigating the possibility that the amount of time (or money) spent in daily travel has certain stable properties in different conditions and that people sharing certain characteristics will display similar patterns of time (and money) expenditure. As a result, time-budget expenditure has been suggested as an alternative parameter to trip rate for use in deriving estimates of future levels of travel demand. This paper contributes further to this debate concerning the usefulness of travel-time budgets by examining the validity of the above postulate in a Third World context by using data gathered in the course of an investigation of theoretical and methodological aspects of time-valuation practice in developing countries (5,6).

Following an examination of the relations between socioeconomic characteristics and time-budgeting behavior, a detailed comparison is presented of daily travel-time allocations reported by residents of Lagos and Ibadan, Nigeria. This analysis seeks to establish whether the observed patterns of variation display any form of consistency or stability and, if so, how such stability might be explained.

DAILY TIME-BUDGET EXPENDITURE IN LAGOS AND IBADAN

Data and Survey Background Information

Before presenting the results of the analyses, it is appropriate to draw attention to a number of important features of the survey and the country in which it was carried out. The analyses were performed on data gathered in a questionnaire survey carried out over a three-week period in May and June 1978. The survey yielded an effective sample size of 423. At the time of the survey, the interviewees, all of whom were in employment, were engaged in traveling between the cities of Lagos and Ibadan either by air or by road (car-taxi or midi-bus modes). The majority of the respondents were residents of either Lagos or Ibadan (those resident elsewhere accounted for only 8 percent of the observations included in the tabulations headed All in Tables 1 and 2).

A notable feature of the developing Nigerian economy over the past decade has been the high rate of growth in the gross national product (GNP), which has been sustained at an annual rate of roughly 10 percent. This rapid expansion has given rise to a serious shortage of suitably qualified and skilled personnel and, as a consequence, there has been an increasing tendency for members of the labor force to engage in the practice of multiple employment. For this reason, in collecting information about the daily allocation of time, a distinction was made between main and supplementary employment. From the survey it was found that as many as 27 percent of the respondents were engaged in supplementary employment. This was despite the fact that, at the time of the survey, legislation directed toward making such activity illegal on the part of government employees was given much publicity and might have been expected to discourage respondents from disclosing such involvement.

Trade-Off Patterns in Allocation of Time Among Discretionary, Economic, and Travel Activities

The aim of this section is to draw attention to important features of the patterns of time-budget expenditure displayed by survey respondents. The amount of time devoted to seven broad groups of activities is given in Table 1, in which mean time values are tabulated with respect to engagement or otherwise in supplementary employment and place of residence. For convenience, these activities are further grouped according to a threefold categorization often adopted in the time-budget literature. This information, which is the main focus of the present discussion, is also presented in Figure 1, together with an indication of the time spent on the same seven activities, broken down in turn with respect to sex, individual car ownership, income, and occupation of the respondent. Table 2 provides information on the distribution of respondents across these subgroups and the extent of their engagement in supplementary employment.

Table 1 reveals that there is a broad similarity between the overall patterns of time allocation reported by Lagos and Ibadan residents. The only notable differences appear to be in the lesser amounts of time devoted to sleep and social and leisure activities by those residents of the two cities who are engaged in supplementary employment. However, if engagement or otherwise in supplementary employment is itself used as the basis for comparison, then more significant differences in time allocation can be distinguished.

Engagement in supplementary employment can be seen to be associated with less time being spent on both travel (0.8-1.0 h) and social and leisure activities (0.6-0.7 h) in each city. Furthermore, the 7.6-7.7 h devoted to main employment by those with supplementary employment is 0.5 h less than the time reported by those with only one source of employment.

The amount of time devoted to supplementary employment by residents of Lagos and Ibadan is 2.6 and 2.8 h, respectively, which represents approximately one-third of the time devoted to main employment (7.7 and 7.6 h). Making even the conservative assumption that the wage rate associated with this supplementary employment is the same as that received from main employment, it is evident that a significant proportion of income is derived from this source. The possible effects of supplementary

Table 1. Time (in hours) devoted to different activities by employed respondents.

Activity	Lagos		Ibadan		All	
	A	B	A	B	A	B
Discretionary						
Sleeping	7.1	6.8	7.2	7.7	7.1	7.2
Eating	1.4	1.1	1.3	1.2	1.4	1.1
Social and leisure	4.0	3.3	4.1	2.5	4.1	3.0
Total	12.5	11.2	12.6	11.4	12.6	11.3
Economic						
Main employment	8.2	7.7	8.2	7.6	8.2	7.7
Supplementary employment	-	2.6	-	2.8	-	2.6
Total	8.2	10.3	8.2	10.4	8.2	10.3
Travel						
To work	1.5	1.2	1.3	1.0	1.4	1.1
For other purposes	1.8	1.3	1.9	1.2	1.8	1.3
Total	3.3	2.5	3.2	2.2	3.2	2.4
Total	24.0	24.0	24.0	24.0	24.0	24.0

Note: A = employed respondents who are not engaged in supplementary employment, and B = employed respondents who are engaged in supplementary employment.

Table 2. Proportions of respondents not engaged or engaged in supplementary employment.

Criterion Variable	A (%)		B (%)		All (%)	
	Column	Row	Column	Row	Column	Row
Sex						
Male	74	70	74	30	74	100
Female	26	70	26	30	26	100
Car ownership						
Noncar owners	59	73	63	27	62	100
Car owners	41	37	37	30	38	100
Income						
Low	47	72	46	28	47	100
Middle	38	74	25	26	37	100
High	15	67	19	33	16	100
Occupation[a]						
Group 1	40	73	37	27	39	100
Group 2	35	69	40	31	36	100
Group 3	25	74	23	26	25	100

Notes: The table is set up to show column- and row-wise proportions. A and B are defined in Table 1.

[a]The occupation groups are specified as follows: group 1 = administrators, managers, and self-employed professionals; group 2 = middle-management personnel; and group 3 = clerical and skilled and unskilled manual workers.

employment on total income (and travel behavior) are discussed elsewhere (6).

Figure 1 provides a graphical impression of the effect of engagement in supplementary employment on the time-budgeting behavior of different socioeconomic groups. A pattern that emerges from an examination of the figure is that those in high-income and higher-occupational-status groups tend to devote more time to supplementary employment. This is reflected in the observation that car owners spend approximately 20 percent more time in this way than noncar owners.

With respect to travel activities, on average, respondents without supplementary employment spend 1.4 h traveling to and from work and 1.8 h for other purposes, thereby producing a mean daily travel time of 3.2 h. The corresponding figures for those with supplementary employment are 1.1, 1.3, and 2.4 h, respectively. The resultant difference in total daily travel time of 0.8 h (48 min) represents 25 percent of the former employment group's total.

It is further evident from Figure 1 that engagement in supplementary employment has a marked influence on the amount of time devoted to travel for nonwork purposes, especially among males and high-income Lagos respondents. With this latter exception and the shorter travel-to-work times reported by medium-income and middle-management Ibadan residents with supplementary employment, the patterns of variation in travel-time use displayed by Lagos and Ibadan residents are broadly similar. Finally, it is interesting to note that car owners derive a fractional time advantage over noncar owners and slightly more so for those with supplementary employment.

The main conclusion to emerge from this brief discussion is that the above analyses provide evidence of the significant impact of engagement in supplementary employment on the pattern of daily time-budget expenditure. Almost without exception, those respondents engaged in this activity have been found to sacrifice time, which would otherwise be devoted to the six other activities recorded, in order to supplement their income from their main employment. This time substitution is most noticeable with respect to social and leisure activities, followed by the time devoted to travel for purposes other than the journey to work. In the former case it appears that the proportion of variation in social and leisure time attributable to engagement or otherwise in supplementary employment is greater than that accounted for by differences in sex, car ownership, income, or occupation group. The apparent similarity between the amounts of time devoted to travel in Lagos and Ibadan is discussed further below. Meanwhile, the discussion now turns to a closer examination of the above daily travel-time information, following an initial comparison with corresponding data derived from studies undertaken in other countries.

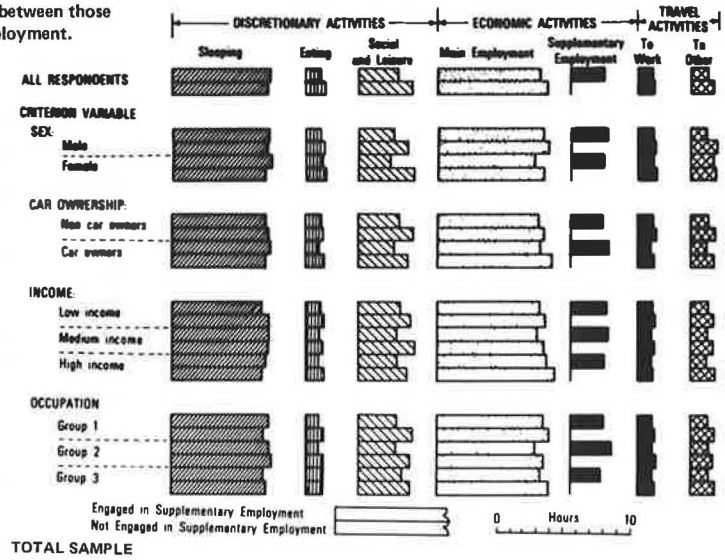
DAILY TRAVEL-TIME EXPENDITURE IN LAGOS, IBADAN, AND OTHER LOCATIONS

One of the major difficulties encountered in carrying out comparative time-budget investigations is that much of the information available was originally collected for purposes other than a time-budget analysis. Often the data employed relate to population subgroups specified according to different criteria; in some cases travel times are recorded for the population as a whole while in others only for travelers. Similarly, some sources specifically exclude consideration of walk trips, while in others it is assumed that the time devoted to all forms of travel is included, and this applies in the case of the Nigerian data. The time periods over which information is gathered also varies, the usual and least-satisfactory source being one-day surveys. Nevertheless, as far as it is possible to judge from the sources of information used in compiling Table 3, the figures are broadly comparable insofar as all data relate to travelers only. However, the above observations dictate that caution be exercised in drawing inferences from the information presented.

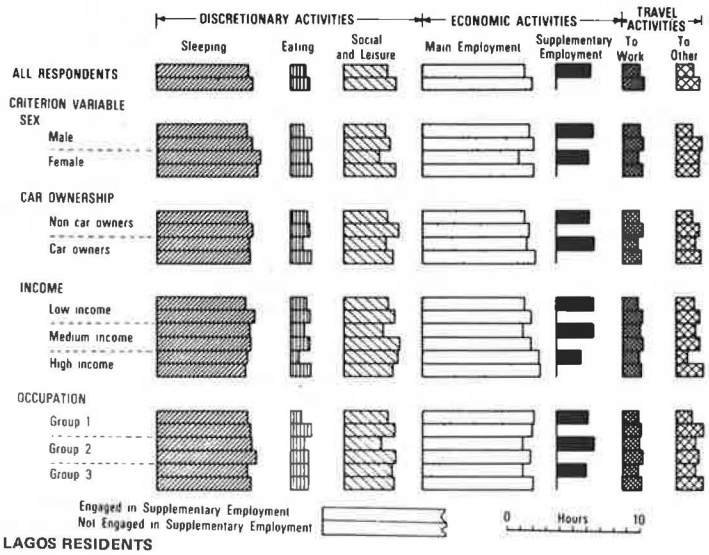
It is apparent from Table 3 that more time is devoted to travel, both to work and for other purposes, in Lagos and Ibadan than in any of the other cities, with the exception of Lima-Callao in Peru. It appears that residents of the two Nigerian cities spend between 50 and roughly 200 percent more time traveling than the residents of relatively densely developed Western European countries such as Belgium and England. These are very large differences that are likely to be explained by, among other factors, marked differences in modal split, the quality of provision of transportation networks and services, and perhaps differences in the relative locations of residential areas and employment and other activities.

Of course, it is always possible that the respondents in the Nigerian survey consistently overestimated their travel time, although there is no other

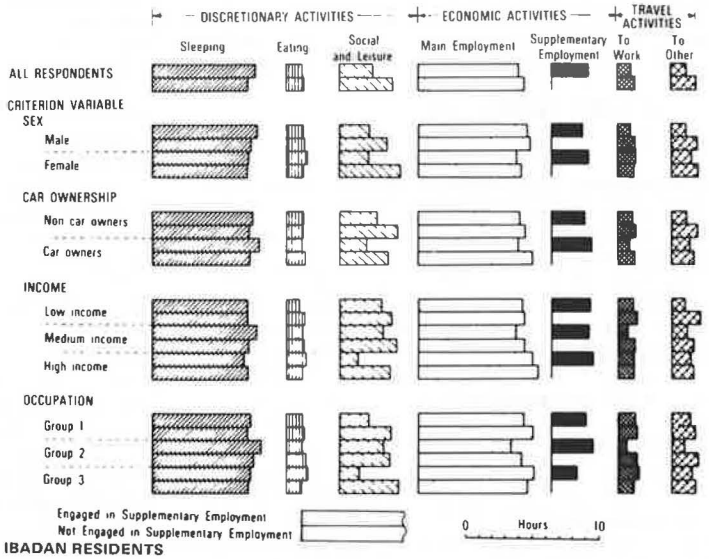
Figure 1. Time devoted to different activities: comparison between those respondents engaged and not engaged in supplementary employment.



TOTAL SAMPLE



LAGOS RESIDENTS



IBADAN RESIDENTS

Table 3. Mean daily travel times and percentages for selected locations.

Location	Source	Travel to Work and Back		Travel for Other Purposes		Total (min)
		Minutes	Percent	Minutes	Percent	
Ibadan, Nigeria		74	42	104	56	178
Lagos, Nigeria		84	45	102	55	186
Six cities, France	7	50	51	49	49	99
Osnabruck, Federal Republic of Germany	7	45	44	58	56	103
Hayerswerda, German Democratic Republic	7	61	57	46	43	107
Gyor, Hungary	7	62	58	45	42	107
Four cities, United States	7	49	43	65	57	114
Kazanlik, Bulgaria	7	56	48	61	52	117
Olomouc, Czechoslovakia	7	58	49	61	51	119
Belgium	7	65	52	60	48	125
Lima-Callao, Peru	7	89	51	74	49	163
England	8	48	69	22	31	70
Reading, England	9	-	-	-	-	86
London, England	10	-	-	-	-	88
Washington, D.C.	1	-	-	-	-	73
Singapore	11	-	-	-	-	79
Bogota, Colombia	11	-	-	-	-	94

evidence to support this deduction. Furthermore, it is interesting to note that the only other data presented in the table relating to a city in a developing country of a similar size and pattern of development, Lima-Callao in Peru, displays the closest similarity to the Nigerian figures, especially with respect to travel-to-work time. Close examination of Table 3 further reveals that a lesser proportion of travel time is devoted to the journey to work in Lagos and Ibadan than in virtually all other cases. These differences raise a number of questions to which it is difficult to supply definitive answers.

First, it is not clear, for example, whether the Nigerian journey times are associated with a similar or greater number of trips or individual journeys than is the case in the other locations. However, the recent Lagos Metropolitan Area Transportation Study (12) indicated that trip rates were similar to those recorded in Western countries. Second, it is perhaps likely that a significantly greater proportion of journeys in Lagos and Ibadan are undertaken on foot or by means of relatively slow or inefficient forms of public transportation. A further explanation could lie in the observation that traffic conditions in the two cities during the peak and off-peak periods are equally poor or display less difference than is found in Western cities--a feature that might result in longer journey times for other purposes than would otherwise be expected. These points will be returned to in later discussion.

VARIATION IN MEAN DAILY TRAVEL TIMES IN LAGOS AND IBADAN

The above observations that relate to the unusually high values of daily travel time recorded by residents of Lagos and Ibadan prompted the closer analysis of variation in these values among survey respondents. The mean daily travel times, which were featured in Table 1 simply by place of residence, are presented in Table 4 for each of the respondent subgroups used in Table 2; the variation around subgroup means is expressed, for the sake of comparability, in terms of the coefficient of variation.

The table reveals more clearly the earlier-noted differences in the travel times of respondents with and without supplementary employment, their respective means being 146 and 197 min. The reduction in the amount of time devoted to travel for nonwork purposes, which is associated with involvement in such activity, is again seen to be substantial, i.e., a 36-min difference (79 compared with 115 min), which contrasts with the difference of only 15 min (67 and 82 min, respectively) in journey-to-work times. However, the significance of this difference may perhaps be called into question by the relatively small size of the Ibadan resident sample.

In an effort to seek explanations for the above travel-time differences, it is possible to examine the influence of socioeconomic and other factors in the light of the earlier discussion of overall time allocations. A possible explanation is that supplementary employment leads to a higher relative income and thus a greater likelihood of car ownership and greater propensity to make motorized trips that, in turn, could be interpreted as an increased ability to purchase time savings (6).

With respect to income, it can be seen from Table 2 that almost half (46 percent) of those engaged in supplementary employment fall in the low-income group, and that the participation rate among low-income respondents is relatively low (28 percent). In contrast, while high-income respondents account for only 19 percent of those engaged in supplementary employment, the rate of involvement of this group is relatively high (33 percent). Although this suggests a greater propensity to engage in supplementary employment among those with a higher income, this evidence of the influence of income is not conclusive by virtue of the fact that significant differences in behavior may well be obscured within the low-income group, accounting as it does for such a large proportion of the population. This qualification is required because it is likely that the participation rate is affected by (at least) two very different motives. On the one hand, respondents with a very low basic income may literally need to secure supplementary employment in order to ensure their survival; alternatively, high-income and high-status respondents may well be driven by aspirations to a still higher standard of living in seeking to exploit the opportunities open to them. Indeed, support for this view exists in the finding by Banjo (6) that those of low income spend comparatively more time in supplementary employment than their high-income counterparts while in fact earning less for these longer hours compared with higher-income respondents.

In Table 4 there is evidence of only a marginal overall reduction in travel time with increasing income, which conceals significant variation, both in terms of journey to work and other purposes, in Lagos and Ibadan. Indeed, the consistency of the relation between increasing income and travel-time

Table 4. Mean daily travel times for respondents engaged and not engaged in supplementary employment.

Criterion Variable	Lagos Residents						Ibadan Residents						All Respondents[a]					
	Travel to Work		Travel for Other Purposes[b]		Total Travel Time (min)	Sample Size	Travel to Work		Travel for Other Purposes[b]		Total Travel Time (min)	Sample Size	Travel to Work		Travel for Other Purposes[b]		Total Travel Time (min)	Sample Size
	Time (min)	V	Time (min)	V			Time (min)	V	Time (min)	V			Time (min)	V	Time (min)	V		
Sex																		
Male																		
A	88	0.6	115	0.5	203	44	78	0.7	117	0.6	195	50	80	0.6	117	0.5	197	137
B	80	0.6	70	0.6	150	36	61	0.8	67	0.5	128	14	72	0.6	75	0.6	147	58
Female																		
A	92	0.6	100	0.4	192	14	73	0.6	128	0.5	201	16	84	0.6	113	0.5	197	47
B	65	0.4	101	0.4	166	13	77	1.1	92	0.4	169	6	72	0.6	99	0.3	171	20
Car ownership																		
None																		
A	91	0.6	109	0.6	200	63	78	0.7	118	0.6	196	51	84	0.6	113	0.6	197	175
B	71	0.5	87	0.5	158	44	66	0.7	69	0.6	135	14	71	0.5	83	0.6	154	65
One or more																		
A	83	0.6	113	0.5	196	27	79	0.5	105	0.6	184	36	78	0.6	107	0.5	185	102
B	71	0.7	67	0.4	138	24	46	1.0	71	0.4	117	13	62	0.8	74	0.4	136	43
Income																		
Low																		
A	90	0.6	107	0.6	197	43	82	0.8	129	0.5	211	30	86	0.6	110	0.6	196	110
B	69	0.5	81	0.6	150	33	67	0.8	61	0.7	128	6	70	0.5	80	0.7	150	42
Medium																		
A	87	0.6	110	0.6	197	27	79	0.5	108	0.6	187	33	80	0.6	108	0.6	188	90
B	77	0.5	88	0.5	165	18	41	0.7	66	0.5	107	11	63	0.6	78	0.5	141	32
High																		
A	81	0.6	119	0.4	200	9	74	0.5	99	0.7	173	9	74	0.6	113	0.5	187	35
B	69	0.9	46	0.2	115	7	75	0.8	86	0.3	161	5	62	0.9	73	0.4	135	17
Occupation																		
Group 1																		
A	86	0.6	119	0.5	205	24	81	0.5	110	0.6	191	39	79	0.6	115	0.5	194	109
B	72	0.7	67	0.5	139	18	76	0.8	82	0.4	158	13	71	0.7	76	0.4	147	40
Group 2																		
A	94	0.6	100	0.6	194	42	86	0.7	122	0.5	208	24	90	0.6	104	0.6	194	96
B	76	0.5	87	0.6	163	29	36	0.6	52	0.6	88	11	68	0.6	82	0.7	150	43
Group 3																		
A	83	0.6	124	0.5	207	22	66	0.8	107	0.6	163	22	77	0.7	114	0.6	191	69
B	64	0.5	84	0.5	148	21	91	0.7	91	0.6	182	2	64	0.6	82	0.5	146	24
All respondents																		
A	89	0.6	111	0.5	200	163	78	0.6	113	0.6	191	87	82	0.6	115	0.6	197	277
B	71	0.6	79	0.5	150	68	60	0.9	74	0.5	134	27	67	0.6	79	0.5	146	108

Notes: V = coefficient of variation, A = employed respondents who are not engaged in supplementary employment, B = employed respondents who are engaged in supplementary employment. Occupation groups are defined in Table 2.

[a]Includes residents of Lagos, Ibadan, and elsewhere. [b]These values are from smaller sample sizes, as fewer people responded to this question.

savings is only found in the case of journey-to-work travel by those not engaged in supplementary employment. Travel for other purposes by the same groups displays conflicting trends in Lagos and Ibadan, which contributes to the similarity of the overall travel times. Furthermore, the variation of travel times recorded by those with supplementary employment does not follow any systematic pattern in relation to income, except in the case of the overall sample. If anything, the supplementary-employment group shows more variability in terms of travel time for other purposes, as indicated by the higher values of the coefficient of variation.

Careful interpretation is also required in examining the second stage of the above-hypothesized relation between engagement in supplementary employment and the ability to purchase time savings, which is displayed in its relation with car ownership. As noted earlier, while only 37 percent of those with supplementary employment were car owners, the participation rate among car owners was relatively high at 30 percent compared with only 27 percent among noncar owners. This shows some consistency with the notion that the propensity to engage in supplementary employment is stronger among higher-income groups, as it can be assumed (and demonstrated) that there is present the familiar high correlation between car ownership and income. However, the relation between car ownership and travel-time variation, not to say time savings, is more subtle and appears to be subject to the influence of local traffic and travel conditions.

To introduce this discussion, note that the differences in total travel time between car owners and noncar owners are not very great and only slightly larger for those respondents in supplementary employment (see Table 4). However, when the times recorded by Lagos and Ibadan residents are examined, more interesting distinctions can be drawn. In the case of journey-to-work travel by those not engaged in supplementary employment, Lagos car owners have a slightly shorter journey time than noncar owners (83 compared with 93 min), whereas in Ibadan the two groups have almost identical travel times (79 and 78 min, respectively). On the other hand, for those engaged in supplementary employment, this pattern is reversed. Indeed, in this case, the Lagos resident figures are identical (71 min) while the work journey travel time by Ibadan car owners is only 46 min compared with 66 min for noncar owners--a difference of 20 min. However, the Ibadan times are subject to greater variability, as reflected by the higher values of the coefficient of variation.

Interpretation of these differences must be made in the light of knowledge of the local travel conditions. In simple terms, it can be stated that traffic congestion and general movement problems are more serious in Lagos than Ibadan, which is in part

reflected in the higher overall travel times recorded by Lagos residents. What this suggests is that, while car owners in Lagos are unable to gain any significant travel-time savings over noncar owners in the journey to work, Ibadan car-owning residents with supplementary employment are better able to take advantage of the less-congested local traffic conditions and thus achieve a significant saving in travel time. This saving could also be due in part to the greater likelihood of the latter group traveling outside the relatively congested evening peak periods during which those car owners without supplementary employment gain no advantage. Persistence of congestion outside the peak period in Lagos could equally account for the similarity of the car owner and noncar owner supplemetary employee times recorded by Lagos residents. These differences in the peak and off-peak conditions experienced in Lagos and Ibadan could also go some way toward explaining the earlier-noted greater overall variability present in the reported Ibadan travel times.

What emerges from the above discussion is a measure of support for the hypothesized relation between engagement in supplementary employment and an ability to purchase time savings through increased income and propensity to own a car, mediated by the effects of local travel conditions. What is not evident, of course, is the direction in which these relations might operate. It remains unclear, for example, whether it is engagement in supplementary employment that provides the means to purchase and run a car and secure the consequent achievement of time savings, or whether it is higher basic income and vehicle ownership that makes it more practical for such respondents to engage in supplementary employment. Given the apparent extent of the influence on travel time of engagement in supplementary employment, these issues appear to justify further study but would need to be the subject of a more detailed investigation than that pursued here.

To conclude this empirical section, which is concerned with daily travel-time variation, the principal findings are now summarized. The most striking feature of mean daily travel-time variation to emerge from the analysis is the consistently high overall values recorded by both Lagos and Ibadan residents. It has been shown that these high values conceal a fair degree of variation in the time devoted to both journey to work and other travel, with an unusually large proportion of travel time reported as being attributable to nonwork purposes, especially among those not engaged in supplementary employment. Engagement in supplementary employment greatly influences travel-time expenditure, which reduces the travel time associated with nonwork purposes and increases its variability. Furthermore, there is some degree of consistency in the effect of involvement in this activity on the patterns of travel-time use reported by Lagos and Ibadan residents, once the differences in travel time that here have been attributed to differences in the characteristics of the local transportation systems and patterns of development are taken into account. Finally, the greater variability observed in Ibadan resident travel times than that reported by Lagos residents may be explained by the greater contrast experienced in Ibadan between peak and off-peak period travel conditions.

The apparent importance of the transportation system and development characteristics in accounting for the differences in travel time prompted the further exploration of some of the ways in which features of the local pattern of travel demand and local travel conditions are likely to be reflected in variations in travel times. In the final section of this paper, an initial attempt is made to identify some of the relations between these characteristics and the amount of variation in travel-time values that can be expected as a major settlement evolves.

TRAVEL-TIME VARIATION IN CHANGING CONDITIONS

To gain a clearer understanding of how various sets of conditions contribute toward the occurrence of variation in observed travel times, both at one point in time and between different points, it is appropriate to first seek to adequately describe the patterns of variation before proceeding to formulate theories and models that can serve to explain and simulate such variations. What is attempted here is a tentative start on this process of description. Inevitably, the ideas put forward are hedged about with a multitude of assumptions, most of which remain implicit in this exploratory discussion. However, it is hoped that the exercise of setting down the ideas will at least provoke further thought as to how the approach pursued might be better developed and how the relations hypothesized might be tested empirically.

Dimensions of Travel-Time Variation

It is useful initially to distinguish the various dimensions of travel-time variation. With respect to a particular journey, these can include day-to-day or trip-to-trip differences in travel times recorded by individuals traveling by the same mode or by different modes via different routes or at different times of the day. In the longer term, variation can be attributed to changes in transportation networks and their methods of operation or to changes in the pattern of demand. Similarly, overall amounts of time devoted to travel, as opposed to the time required to complete a particular journey, will be subject to variation as these broader system characteristics change over the longer term.

In the travel-time-budget literature, the term "stability" is often used rather loosely to refer to similarity in the mean daily travel times recorded by different groups of travelers. In this context, however, it is suggested that this term might be better used to refer to invariance of observed travel-time values over relatively lengthy intervals between observations. From observations that relate to one point in time or, more precisely, a cross-sectional day survey, it might be more appropriate to use the term "uniformity" in the description of limited differences in travel times between groups of travelers such as, for example, car users or bus users. This notion of uniformity can be extended to relate to uniformity or little variability between modes, as in the case of a particular journey that takes roughly the same time by bus or by car. Alternatively, it can be used to refer to little variability within modes, which would relate to there being little variation in the time taken to complete a particular journey undertaken many times by the same mode.

The likelihood of the occurrence of such uniformity in the short term and stability in the longer term can be seen to be a function of the complex interaction of (at least) three sets of factors, which can be summarized as follows:

1. The spatial pattern of demand;
2. The configuration and relative efficiency, cost of use, etc., of road and public transportation networks; and
3. The temporal pattern of demand (here taken to refer to variation in demand throughout the day).

Variation in travel times associated with a particular journey can arise, for example, from a mismatch between the spatial pattern of demand and the capacity of transportation networks leading to overloading, congestion, and delays at particular points, the extent and frequency of which are influenced by the temporal pattern of demand. Thus, the degree of uniformity observed will depend on the state of these interrelations at one point in time, while stability will be dependent on the way in which these factors covary with the passage of time.

Hypothetical Example of Travel-Time Variation and Settlement Evolution

It is possible to identify a range of sets of conditions in which the relation between the demand for different modes of transportation and the quality of service provided by those modes (itself a function of system supply) can give rise to differing ranges of variation in travel times. This can best be illustrated in the simple case of the availability of the car and bus-based public transportation. The sets of conditions can be represented in diagrammatic form, again in simple discrete terms, as displayed in Figure 2. In the diagram, there is an implicit time dimension and chronology of events or states that here are intended to trace the stages of evolution of a growing settlement.

Figure 3 is a diagrammatic representation of the hypothesized trajectory of mean daily travel-time variation as a settlement passes through the five stages of development referred to in Figure 2 but, in this case, with the process of change treated in a continuous rather than discrete manner. This treatment introduces the requirement to describe the rates of change of different conditions, the form and timing of which it is possible to represent only crudely. However, what is sought at this stage is not necessarily precision but a first approximation to the direction and degree of change that are likely to be observed in each of the parameters of travel-time variation, as represented in the lower part of Figure 3.

The conditions represented by A (Figure 2) are taken to correspond to the very early stages (predevelopment stage) of a settlement's existence, during which travel demand is relatively low and within the capacity of infrastructure provision. Under these conditions, it is likely that there will be little adverse interaction between the performance of car and bus, little variation in travel time from journey to journey by the same mode, but a marked advantage to car users in terms of travel time, which assumes a relatively low frequency of public transportation service.

If demand grows significantly and the capacity of the transportation system is not increased to match this growth, the resulting mismatch can be expected to give rise to the progressive deterioration in conditions represented by B. The effect of the increasing level of demand on the performance of inadequate transportation networks is assumed to be reflected in an increase in mean daily travel time (Figure 3), while the range of difference in mean travel time for a particular journey by bus and car decreases, which reflects a reduction in car traffic speed due to congestion. At the same time, the range of variation in individual journey times by bus and car will increase, in part reflecting a growing contrast between peak and off-peak conditions.

It is suggested that eventually, with demand continuing to exceed supply, a degree of stability in

Figure 2. Travel-time variation at different stages of settlement development.

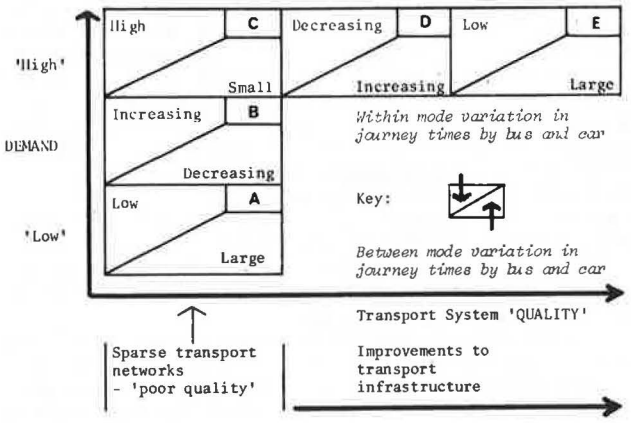
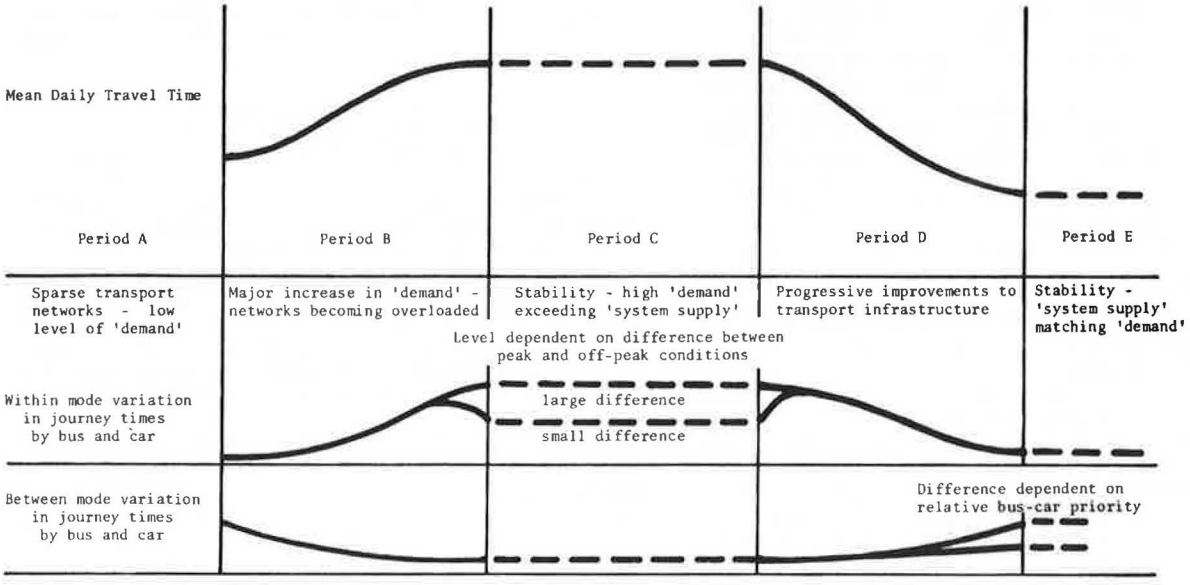


Figure 3. Variation in mean daily travel time and other aspects of travel-time variation at different stages of settlement development.



mean daily travel times is likely to be observed (period C), perhaps over a number of years, together with a stabilization both of differences between mean journey times by bus and by car and of variation in individual journey times by bus or car. It is further suggested that it is when or even before such conditions prevail that initial attempts may be made to eliminate causes of congestion through local road network improvements, to upgrade public transportation services, and generally to improve the quality of service experienced by car and bus users. As these piecemeal improvements are made to the transportation infrastructure (period D), the travel times recorded by car and bus users can be expected to fall, contributing to a decrease in mean daily travel time (Figure 3), which assumes--and this may be a key assumption--that the rate of improvement achieved exceeds the rate at which demand for movement continues to grow. Efforts to alleviate problems can be expected to result in a progressive decrease in the variability of travel times by car and by bus. Meanwhile, as such benefits are gained, there is likely to be an increase in the difference between average car and bus times for a specified journey.

Ultimately, following a sustained program of investment and improvement, it is suggested that a stage may be reached (period E) at which road and bus system capacities more closely match the higher level of demand. In these conditions, journey-to-work variation in travel time within each mode is likely to be low, but the difference between car and bus mean journey times relatively high, which reflects their relative operational capabilities, the extent of this difference in part being dependent on the relative priority given to each mode. Thus, with car and bus able to operate in nearer to ideal conditions, it can be expected that mean daily travel time will flatten out, but at a lower stable level than that observed during the period of system overload represented by period C.

Discounting for the moment the effect of assumptions about, among other factors, actual modal split, relative modal costs, changes in trip orientation, peaking of demand, etc., this seems to be a simple but plausible description of the evolution of transportation conditions in a developing settlement.

Observed Conditions and Extension of Hypothesis

With respect to the earlier empirical analysis of travel-time variation, it is appropriate at this point to note that the conditions described as corresponding to stage C appear to coincide quite closely with those currently observed in Lagos. As described in the earlier discussion, these can be characterizied by acute problems of traffic congestion, little difference between travel times attainable by car and bus and between the conditions experienced during the peak and so-called off-peak periods, together with a high value of overall daily travel time. Ibadan, on the other hand, is thought to be a little behind Lagos on the evolutionary curve, perhaps approaching stage C, where it has less acute congestion problems, a degree of between-mode variability, and a greater contrast between peak and off-peak conditions, but increasing within-mode variability.

By contrast, it is suggested that, in many cities in developed countries, conditions are closer to those associated with stage E at which a relatively low mean daily travel time is observed, accompanied by low between-mode and high within-mode variability. This is not to suggest that these conditions are necessarily stable at this relatively low point on the curve depicted in Figure 3. Indeed, stability in these terms is seen to be dependent on the existence of a balance or equilibrium between demand and rate of system supply. Thus, this hypothesis could be extended to suggest that further growth in demand, which exceeds the rate of supply, can be expected to result in an upward swing in the curve (and associated changes in the other parameters) and a subsequent downswing as further improvements are implemented. The pattern of change could in this way be expected to display damped oscillations, with a tendency toward a lower mean daily travel time as technology provides progressive improvements in modal performance.

Some Implications of Hypothesized Relations

After this brief digression, we can now return to the main line of argument. If the above can be taken to be a reasonably realistic representation of the changes in some of the key components of travel-time variation as a settlement evolves, it raises a number of important questions about the assumptions that can be made concerning future changes in travel-time parameters at the different stages of this evolutionary path.

It was suggested above that it is at stage C, the period when demand greatly exceeds system supply and there is relative stability in mean daily travel time accompanied by low between-mode and high within-mode variability, that the first steps are taken to alleviate the more acute problems of congestion. It is further suggested that it is at this stage that recognition of the existence or persistence of movement problems is likely to prompt the seeking of professional advice as to how these problems might be resolved in the longer term. In other words, consultants are most likely to be called on to draw up plans for the development and improvement of the transportation system only when this stage has been reached. Furthermore, it is observations of travel conditions prevailing at this time that are likely to provide the information on which forecasts of future changes in travel behavior and justification for such plans will be based.

If the logical assumption is made that an aim in formulating these plans will be the achievement of a balance between demand and system supply, then this analysis points to the need to recognize that such a balance is likely to be attained in, or result in, very different conditions of travel-time variation from those currently observed. The fundamental point to be noted is the likelihood of the pattern of travel-time variation at the plan realization stage of settlement evolution, which is characterized by the following:

1. A lower level of mean daily travel time,
2. A greater range of difference between mean journey times by bus and by car for a particular journey (greater between-mode variation), and
3. The possibility of a lower range of variation in individual journey times for a particular journey by bus or car (less within-mode variation).

This has important implications for both the predictive use of models of travel behavior and the values of time employed in the evaluation of future plans. If model parameters are estimated by using data that relate to conditions in which demand greatly exceeds supply, and the model parameters used in forecasting future patterns of travel behavior are dependent on the existence of a particular set of travel-time-variation conditions, then clearly such forecasts must be used with great caution.

Similarly, it is argued that the valuation placed by travelers on time savings, which are gained in

the observed period of system overload and congestion, is likely to be different from that attached to corresponding time savings achievable under the conditions that this analysis suggests will prevail when a better balance between demand and system supply has been attained. This and other aspects of travel-time valuation are the subject of extended discussion elsewhere (6).

CONCLUSIONS

In the earlier sections of this paper, various aspects of the pattern of time-budget expenditure in Nigeria were examined. Engagement in supplementary employment was demonstrated to be an activity that has a significant effect on the allocation of time to the other activities recorded by survey respondents. In particular, engagement in this activity was shown to be associated with a reduction in daily travel time, especially that with respect to travel for purposes other than to or from work, and with greater variability in the time devoted to such travel.

The unusually high values of mean daily travel time recorded by Lagos and Ibadan residents, together with the explanations offered for the similarities and differences in travel-time variation in the two cities, in addition to that attributable to income and car-ownership effects, prompted the further exploration of possible relations between such variation and features of the local transportation system. It was concluded that, should the hypothesized relations between mean daily travel time and transportation system evolution be confirmed by other studies, they can be expected to have important implications for transportation modeling and time-valuation practice in Third World cities.

In the introduction to the final section of the paper it was noted that the ideas put forward are still somewhat tentative and require further elaboration. However, it is hoped that they will serve to stimulate further thought on the dynamics and implications of changes in the pattern of travel-time variation.

ACKNOWLEDGMENT

We gratefully acknowledge the financial support provided to Banjo by the Rees Jeffreys Road Fund, and we wish to express our thanks to J.A. Proudlove for his helpful comments. However, any errors, omissions, and shortcomings must remain our responsibility.

REFERENCES

1. Y. Zahavi. Travel Characteristics of Cities in Developing and Developed Countries. International Bank of Reconstruction and Development, Washington, DC, Staff Working Paper 230, 1976.
2. Y. Zahavi. Travel Over Time, Final Report. Urban Planning Division, FHWA, U.S. Department of Transportation, 1979.
3. P.B. Goodwin. The Usefulness of Travel Budgets. Transportation Research A, Vol. 15, No. 1, 1981, pp. 96-106.
4. J.C. Tanner. Expenditure of Time and Money on Travel. Transportation Research A, Vol. 15, No. 1, 1981, pp. 25-38.
5. G.A. Banjo. The Theoretical Basis of Travel Time Savings Valuation Practice in Developing Countries. Department of Civic Design, Univ. of Liverpool, Liverpool, England, Working Paper 15, 1980.
6. G.A. Banjo. Travel Choice and the Value of Travel Time Savings in Developing Countries with Special Reference to Nigeria. Department of Civic Design, Univ. of Liverpool, Liverpool, England, Ph.D. thesis, 1981.
7. A. Szalai. The Use of Time: Daily Activities of Urban and Suburban Populations in Twelve Countries. Mouton, The Hague and Paris, 1972.
8. H.F. Gunn. County Surveyors' Trip Rate Data Bank: Analysis of Travel Times, 1974. Institute for Transport Studies, Univ. of Leeds, Leeds, England, Working Paper 119, 1979.
9. L.S. Prendergast and R.D. Williams. Individual Travel Time Budgets. Transportation Research A, Vol. 15, No. 1, 1981, pp. 39-46.
10. J.N. Landrock. Spatial Stability of Average Daily Travel Times and Trip Rates Within Great Britain. Transportation Research A, Vol. 15, No. 1, 1981, pp. 55-62.
11. G.J. Roth and Y. Zahavi. Travel Time "Budgets" in Developing Countries. Transportation Research A, Vol. 15, No. 1, 1981, pp. 87-96.
12. Lagos Metropolitan Area Transportation Study, Final Report. Federal Ministry of Works, Lagos, Nigeria, 1976.

Publication of this paper sponsored by Committee on Traveler Behavior and Values.

Analytically Derived Classifications of Daily Travel-Activity Behavior: Description, Evaluation, and Interpretation

ERIC I. PAS

One phase of a research study designed to enhance our understanding of urban travel behavior is discussed. In particular, this paper comprises the description, evaluation, and interpretation of analytically derived classifications of daily travel-activity behavior. A methodology that facilitates systematic identification of groups of similar travel-activity patterns is used to derive the typologies reported and examined here. This methodology is applied to a sample of 236 daily travel-activity patterns drawn from the Baltimore travel demand data set. Each of the sample observations is described by the set of stops made in a 24-h period; each stop is characterized by activity and time of day. The paper explores the hypothesis that a set of daily travel-activity patterns can usefully be described by its membership in a limited number of interpretable general classes. The results reported here show that the 236 daily patterns can be grouped into between 12 and 5 relatively homogeneous groups while retaining between 64 and 46 percent of the information in the data. The results also show that the