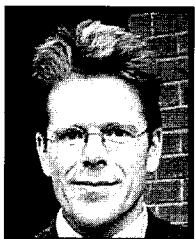




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Applicability of stated preference for mode choice studies among less literate commuters

R Del Mistro and T Arentze

There is concern that research methodologies used in developed countries might not always be transferable to developing countries. This concern is prompted by conditions such as multi-culturalism, multi-lingualism, gender issues and literacy levels. Modal choice information can be collected using stated preference or stated choice questionnaires.

The hypotheses for the study were the following:

- *The level of literacy affects the quality of the responses.*
- *The quality of response is affected by the complexity of the choice to be made.*
- *The quality of responses is affected by the method of presentation.*
- *The quality of response declines with the fatigue of the respondents.*

The data for the study were collected using a questionnaire whereby respondents were required to select between either two or three alternatives described by either three or five attributes. The 364 respondents who took part in the study were recruited at modal transfer facilities in Mamelodi. In-depth interviews were also conducted with 26 of these respondents at their homes.

As a result of the study, the following can be deduced:

- *Stated preference data can be collected from less literate respondents provided that the choice tasks are not complex.*
- *A high degree of care needs to be taken in training interviewers and during the interviews to ensure that respondents – interpret the profiles as hypothetical and do not use their experiential values for the attributes – really apply their minds when making choices / giving responses, and – do not provide responses which they consider to be necessary to be polite or appear intelligent.*
- *The possibility that the mode choice might be made using non-compensatory rather than compensatory decision rules needs to be investigated further.*
- *The qualitative approach to the analysis appears to provide conclusions that are not always consistent with the statistical analysis approach. The reasons for these discrepancies need to be researched further.*
- *The usefulness of in-depth interviews to provide a confidence to quantitative and complex surveys in developing countries needs to be investigated further.*

INTRODUCTION

Ascertaining the needs of the people for government policy development

In essence, the policies/decisions of government are intended to maximise the benefit the population derives from them. Often, decisions taken on purely technical grounds bear little resemblance to the perceptions of the people of their needs and how these needs can be fulfilled. As such, developing

methodologies that can more clearly determine the needs of the people and make government aware of these, will improve the democracy and the benefit derived from the use of scarce resources.

One way to define user needs is to ask the users to state their preference (ie stated preference (SP)); as opposed to observing the choices that they make (which is referred to as revealed preference). The assumption is made that decisions are made on the basis of compensating between the utility achieved by each alternative on the basis of the values

of each attribute. A number of SP studies have been done in South Africa on transport aspects (Van Zyl *et al* 2001). Studies have also been done to examine the validity of compensatory decision rules, for example on shopping choice behaviour (Timmermans 1983), on residential choice behaviour (Phipps & Meyer 1985) or on travel choice (Foerster 1979).

However, to collect this type of information on choice-making requires a complex questionnaire and survey method.

Problems faced in data collection among less literate populations

The problem arises that survey methodologies developed in industrialised countries are not always appropriate in countries with a relatively high level of illiteracy or semi-literacy. Other problems militating against the transfer of survey methodology from the developed world, are the multi-language and multi-culturalism of developing countries such as South Africa.

Pioneering researchers in the field of transportation surveys have reported on the problems associated with the transfer of survey techniques and individual choice modelling procedures from the developed to the developing world (eg Grigg, 1978; Jacobs *et al*, 1980; Stopher, 1979). Problems identified included the misunderstanding of concepts and methods of response by largely unsophisticated respondents, illogical responses and differing interpretations of terminology by different cultural groups.

Problems of data collection in South Africa were identified by Morris and Van der Reis (1980), who found that cultural groups vary in the range of qualifying adjectives used to distinguish levels of feeling in a scale of value judgements.

If the preferences of travellers/individuals/households are known, plans for policy measures can be evaluated before implementation.

The research was aimed at increasing the understanding of the decision-making process among less literate people, with specific reference to modelling their choice-making on the basis of stated preference. To achieve this understanding, the research also needed to find methods of presenting the information on which preferences are to be stated in an understandable way.

MODAL CHOICE IN TRANSPORTATION PLANNING

The four-step model is generally used in transportation planning. Although there is considerable discussion at present on the need to improve this approach (eg Simmonds, 2000; Wegener & Furst, 1999), the four-step approach remains the most generally used in transportation modelling. Modal choice, which is usually the third component of the four-step trans-

port planning model, is considered to be important in that it is the area in which many of the strategic interventions available to a transport authority can be exercised (Orthuzar & Willumsen, 1994).

Modelling modal choice

The most common model for modal choice is the logit function, ie

$$T_i / \sum T_x = e^{f(i)} / \sum e^{f(x)}$$

where T_i is the number of trips made using mode i ; and $f(i)$ is the utility function of making the trip using mode i . The objective in building a modal choice model is to determine the utility function for each mode/alternative. The coefficients of each attribute can be taken to represent the weight of that attribute and are used to rescale the value of the attribute in the utility equation. It is also possible to consider the attributes to be generic or specific to the alternative, eg the utility (or disutility) of time spent on one mode is equal (generic) or different (specific) to the time spent on another mode. The theory and practice of the utility function and its statistical aspects are well documented (eg Orthuzar & Willumsen, 1994; Louviere *et al* 2000).

Because of the structure of the logit equation, it is not possible to use a regression type test to determine the coefficients and the goodness-of-fit of the model. Instead, the maximum-likelihood method is generally used. This approach assumes that while the sample of data can come from several population types, there is one type that is more probable than the others. The maximum-likelihood estimates are the set of coefficients that will generate correct estimates of the decisions in the sample most frequently. The more complex likelihood formulation is converted into the following log-likelihood formulation that is most generally used:

$$LL(\theta) = \sum \sum P_x \log(P_x)$$

where P_x is the probability of the alternative being chosen, using the set of utility coefficients.

To confirm the quality of the model the modeller would test

- the signs of the variables to see that they appear logical
- whether the inclusion of each variable is significant using the t-value, and
- the quality of the model using the likelihood ratio index 'rho-squared (ρ^2)'. This measures whether the inclusion of the variables in the equation significantly improves the log-likelihood of the model. It is calculated as $\rho^2 = 1 - LL(\theta) / LL(0)$.

STUDY OBJECTIVE

The objective of the study described in this paper was to determine if stated pref-

erence methodology could be applied among less literate commuters and not to determine a modal choice model. The study is the comparison between the quality of response to stated preference type treatments by less literate (not having studied beyond Grade 7) and literate respondents (having studied beyond Grade 7). (In this paper, *treatment* is used to refer to a set of *profiles*, which describe the *alternatives* from which the respondent is required to make a choice. Each profile is described in terms of *attributes*, for each of which *values* or *parameters* are given.) The quality of response can be affected by the following:

- *The complexity of the decision task:* This was achieved by presenting respondents with a combination of either two or three alternatives, described by either three or five attributes (ie the three attributes included with or without a feeder to the main mode, the fare and the level of security; to which were added travel time and availability of a seat for the five attribute case).
- *The presentation method:* Two methods were used in the study, namely a verbal and a verbal plus pictorial description of the alternatives and their attributes.
- *Fatigue:* In the interviews, each respondent was presented with a minimum of 16 stated preference treatments. At least eight 'verbal' and 'verbal plus pictorial' treatments were presented to each respondent. The first eight were analysed separately from the last eight. Any decline in the quality of response between the two sets would serve to indicate the effect of fatigue.

DATA COLLECTION

Data collection structure

The data collection process included

- the definition of the experiment on the basis of the hypothesis/es being tested
- the design of the survey questionnaire:
 - first draft design, based on a recent study of household travel patterns (GPMC 2000)
 - focus groups to test the terminology
 - revision of the questionnaire
 - pilot test of the questionnaire among 57 respondents on Saturday 3 and Sunday 4 March 2001 and revision of the questionnaire
- recruitment of respondents
- surveys:
 - stated preference interviews of 364 persons on Saturdays and Sundays during May and June 2001, of which 328 were conducted in two community halls in Mamelodi and 36 at the homes of the respondents
 - in-depth follow-up interviews of 26 respondents during August and September 2001, conducted in the homes of the respondents selected

from the abovementioned SP interviews

- data processing and analysis

Questionnaire design

The questionnaire included six sections:

- *Section 1:* Introductory front page comments and administrative questions.
- *Section 2:* Questions on revealed preference. The respondent was asked to name where he or she lived and worked, the mode selected, the start and end times of the trip, the fare, and reasons for choosing the mode. The respondent was also asked similar questions for the alternative mode/s not selected.
- *Section 3:* The introduction to the stated preference section, which allowed the interviewer to work through a typical stated preference treatment with the respondent.
- *Section 4:* Treatments for the stated preference section. This section was composed of 16 treatments, of which eight treatments were presented in verbal format and eight in pictorial format. The two presentation methods and the treatments within the presentations were presented to the respondents in random order.
- *Section 5:* Questions asking respondents about their experience in answering the stated preference questions (the clarity of the questions, the level of boredom in answering them, the preferred method of presentation and the certainty with the responses given) and their socio-economic circumstances (how long they have been living in Mamelodi, age, education, marital status, gender and household income).
- *Section 6:* Questions to define the structure of the household of the respondent and to collect information on which persons influenced the decisions by the respondent when making decisions about the transport mode, the school for the children, the size of a daughter's 'marriage goods', and house alterations or household purchases. (Not discussed further in this paper.)

The in-depth interviews discussed the responses to the questionnaire and followed the more open approach common in anthropological surveys.

Recruitment of respondents

During the week preceding the weekend on which interviews were to be conducted, respondents were recruited at Mamelodi modal transfer points; that is, train stations, bus termini and minibus ranks. Recruiters were allocated quotas to be recruited on the basis of gender and education. Only commuters working in the Pretoria CBD or in the areas immedi-

ately to the east of the CBD and situated towards Mamelodi were recruited.

Stated preference experimental design

The study was required to determine the impacts of the following factors independently and the two-way interactions between literacy and the other task factors:

- presentation style (verbal and pictorial)
- literacy level of the respondent (less literate, literate)
- number of alternatives presented in choice-sets (two or three)
- number of attributes to describe alternatives (three or five)
- fatigue (number of questions answered)

The design was required to also allow a separate estimation of main attributes used to describe the alternatives in the present study, namely

- the mode (train, bus and minibus)
- feeder to the main mode needed (yes or no)
- price level of main mode (high or low for the mode)
- security (as it is, guards)
- travel time (high or low for the mode)
- seat availability (seldom, always)

Respondents were required to make a choice between either two or three alternatives, and each alternative would be described using either three or five attributes. As such, four designs were required.

To present all the combinations would require too many profiles to be tested (eg the 2-alternative 3-attribute design would require 768 profiles (ie 3 (combination of modes) * 2 (literacy lev-

els) * 2 (presentation styles) * 2³ (three attributes at two levels for the first alternative) * 2³ (three attributes at two levels for the second alternative)). Since this is impractical, a fractional factorial design was used, which was found to require 48, 96, 32 and 32 profiles to achieve orthogonality for the four alternative-attribute combinations, and at the same time allow the estimation of two-way interactions independently from the main effects. One may have expected that the two 3-alternative designs would require more rather than fewer profiles than the two 2-alternative designs. However, the reason why the 3-alternative designs are more efficient is that a factor for varying the composition of treatments can be omitted.

To determine the number of respondents, the rule of thumb was applied that approximately ten replications for each profile are needed to obtain stable estimates of the coefficients for each attribute. Two further limitations were also applied, namely that each respondent was to be presented with questionnaires containing at least 16 choice-sets and that these were to be analysed in two sub-sets to determine the impact of fatigue. From these it can be determined that the minimal sample would require 260 respondents to be interviewed (ie 60, 120, 40, 40 respectively).

Ranges of values of the attributes

Table 1 shows the values at the two or three levels of the attributes used in the descriptions of the alternatives presented to the respondents.

Effect coding was used for each attribute that did not have numerical values (ie mode, feeder, security and availability of a seat), using values 1 (high level), -1 (low

Table 1 Values of the attributes

	LEVEL 1	LEVEL 2	LEVEL 3
Mode	Train	Bus	Minibus
Feeder	No	Yes	-
Cost (rands): train (no feeder)	1,10	2,10	-
Cost (rands): bus (no feeder)	2,80	5,30	-
Cost (rands): minibus* (no feeder)	3,80	7,20	-
Cost (rands): train (feeder)	3,60	4,60	-
Cost (rands): bus (feeder)	5,30	7,80	-
Cost (rands): minibus* (feeder)	6,30	9,70	-
Security	As is	Guards on vehicles and at stations and stops	-
Travel time (minutes): train	65	120	-
Travel time (minutes): bus	55	105	-
Travel time (minutes): minibus*	40	75	-
Availability of a seat	Seldom	Usually	-

* In South Africa, a minibus refers to a 16-seater road vehicle operating without a schedule but usually along a fixed route.

Table 2 Application of effect coding of the modes

		Coding value	
		Train	Bus
Mode	Train	1	0
	Bus	0	1
	Minibus	-1	-1

Table 3 Distribution of respondents in respect of age, gender and education

Education	Age	Gender				All
		Male		Female		
		N	%	N	%	
Up to Grade 7	17-25	14	51,9	13	48,1	27
	26-35	13	32,5	27	67,5	40
	36-45	24	58,5	17	41,5	41
	46+	22	51,2	21	48,8	43
	All	73	48,3	78	51,7	151
Beyond Grade 7	17-25	26	42,6	35	57,4	61
	26-35	31	46,3	36	53,7	67
	36-45	24	50,0	24	50,0	48
	46+	9	50,0	9	50,0	18
	All	90	46,4	104	53,6	194
All	17-25	40	45,5	48	54,5	88
	26-35	44	41,1	63	58,9	107
	36-45	48	53,9	41	46,1	89
	46+	32	51,6	30	48,4	62
	All	164	47,4	182	52,6	346

Table 4 Mode to work by education

Education		Mode to work						All
		Train	Bus	Minibus	Minibus-train	Minibus-minibus	Other	
Up to Grade 7	N	48	6	27	50	15	5	151
	%	31,8	4,0	17,9	33,1	9,9	3,3	100
Beyond Grade 7	N	79	5	62	32	13	3	194
	%	40,7	2,6	32,0	16,5	6,7	1,5	100,0
All	N	127	11	89	82	28	8	345
	%	36,8	3,2	25,8	23,8	8,1	2,3	100,0
From the Household Interview Survey (GPMC 2000) ¹								
Mamelodi West	%	33,2	14,1	34,8			11,9	
Mamelodi East	%	41,4	17,1	36,9			3,8	

¹ This survey only recorded the main mode of travel

Table 5 Some statistics of the base model

	Less literate	Literate	All respondents
#attributes	23	23	23
#choice sets	2 431	3 074	5 506
#alternatives	5 730	6 990	12 722
Adj rho square	0,1736	0,1758	0,1766

level) and 0 (no information for the attribute). Given this way of coding, the estimated coefficient for each attribute expresses the part-worth utilities of the attribute levels relative to an average value, which is necessary here because the fourth and fifth attributes are not included in the 3-attributes tasks. By assigning a zero value in these cases, they are fixed to the average for that attribute. An example of the application of effect coding, as applied to mode description, is shown in table 2.

CHARACTERISTICS OF THE RESPONDENTS

Data for a number of characteristics of the respondents were collected. Only the distribution of the respondents in terms of education level, age, gender and mode choice is described in this paper.

The age, gender and education distribution of the respondents is given in table 3. From this it can be determined that the proportion of literate respondents was larger.

Table 4 indicates the mode used by the respondents on their journey to work, which was the context of the study. The modal splits of residents in Mamelodi West and Mamelodi East are compared to those from the Household Survey (GPMC 2000) in table 4. There appears to be a significant under-representation in the survey of commuters using bus. This could be due to the fact that the Household Survey modal split reflects trips made to all parts of Greater Pretoria, whereas the respondents in this study worked in the CBD and areas to the east of it, which are well served by train and minibus.

QUANTITATIVE ANALYSES

The modal choice model

The parameters for both the variables and the two-way interaction terms were estimated. The interaction variable between any two attributes (including the alternative specific constants) is defined as the product of the levels of the attributes. The statistics for the analysis are given in table 5.

The adjusted ρ^2 values suggest that the models have rather low values for the goodness-of-fit, but that there is no significant difference in this value between the literate and the less literate respondents.

The low values of the ρ^2 statistic, which reflects a high degree of randomness in the stated choices, could suggest one or more of the following:

- a high degree of heterogeneity in – the choices made by the respondents, and

Table 6 Parameter estimates for the base model

Parameter	Less literate			Literate			All		
	Estimate	t-value	p	Estimate	t-value	p	Estimate	t-value	p
Train	0,678	18,136	0,000	0,614	17,540	0,000	0,637	25,123	0,000
Bus	-0,322	-8,049	0,000	-0,327	-8,637	0,000	-0,325	-11,967	0,000
Minibus*	-0,356			-0,287			-0,312		
Feeder	-0,320	-9,723	0,000	-0,361	-11,823	0,000	-0,342	-15,807	0,000
Cost	-0,290	-8,771	0,000	-0,342	-10,542	0,000	-0,319	-14,357	0,000
Security	0,281	9,008	0,000	0,312	9,825	0,000	0,284	13,272	0,000
Travel time	-0,376	-8,423	0,000	-0,461	-11,507	0,000	-0,421	-14,250	0,000
Seat	0,326	6,681	0,000	0,302	7,487	0,000	0,316	10,377	0,000
Train x feeder	0,035	0,796	0,426	-0,030	-0,754	0,451	0,001	0,038	0,969
Bus x feeder	-0,028	-0,613	0,540	-0,094	-2,293	0,022	-0,066	-2,212	0,027
Train x cost	0,221	5,063	0,000	0,242	5,748	0,000	0,235	7,867	0,000
Bus x cost	-0,133	-2,883	0,004	-0,093	-2,287	0,022	-0,120	-4,007	0,000
Train x security	0,017	0,382	0,702	-0,017	-0,421	0,674	-0,004	-0,117	0,907
Bus x security	0,101	2,093	0,036	0,057	1,355	0,176	0,073	2,342	0,019
Train x travel time	-0,042	-0,664	0,507	0,036	0,660	0,509	-0,003	-0,077	0,939
Bus x travel time	-0,118	-1,883	0,060	-0,093	-1,695	0,090	-0,094	-2,305	0,021
Train x seat	-0,128	-2,104	0,035	-0,247	-4,445	0,000	-0,181	-4,512	0,000
Bus x seat	-0,190	-2,926	0,003	-0,095	-1,598	0,110	-0,145	-3,383	0,001
Cost x security	-0,021	-0,479	0,632	-0,053	-1,255	0,210	-0,039	1,293	0,196
Cost x travel time	0,005	0,115	0,908	0,038	0,962	0,336	0,023	0,795	0,427
Cost x seat	-0,029	-0,632	0,527	0,118	2,754	0,006	0,050	1,606	0,108
Security x travel time	-0,028	-0,561	0,575	0,032	0,808	0,419	0,015	0,506	0,613
Security x seat	-0,027	-0,580	0,562	0,015	0,341	0,733	0,003	0,104	0,917
Travel time x seat	0,012	0,241	0,809	0,002	0,042	0,966	0,000	0,016	0,987

*Coefficients estimated from the negative sum of the coefficients of the other two modes, a property of the effect coding.

- the perception by each respondent of the omitted attributes (ie the profiles were inadequately specified)
- an inadequate level of quality control on the part of the interviewers to ensure that
 - all the respondents understood the profiles as intended, and
 - all respondents applied their minds to the choice task
- mode choice (among the respondents from Mamelodi) might not be reflected by compensatory decision rules and other decision-making rules might be more appropriate

Significant attributes and related coefficients and statistical measures

Table 6 presents the coefficient, the t-statistic and probability that the effect of the variable/attribute is not zero for each attribute. The first test of face validity in this type of analysis is whether the signs appear logical. This is the case for the main variables. The negative signs for the attributes 'bus' and 'minibus' simply

reflect the relative utility/preference respondents have for train over the other two modes. The t- and p-values in the table show that all the main effects are highly significant. It can be seen that the following two-way interaction variables are also relevant to either the literate, less literate or combined set of respondents: feeder to bus, cost for train and bus, security for bus, travel time and seat availability for bus, seat availability for train and the interaction between travel cost and seat availability. The fact that some attributes are statistically significant for one mode and not another implies a relative condition. It should be noted that the sign and order of magnitude of main effects and interaction effects are about the same in the three groups, ie indicating that less literate and literate respondents apply similar values to the mode choice attributes.

Testing the hypotheses

The objective of the study was to determine if there were differences between less literate and literate respondents in the applicability of stated preference data

collection. To test this, the model was re-estimated for the two literacy levels versus the number of attributes, the number of alternatives, the presentation style and the first versus last set of eight choices and the goodness-of-fit measured for each segment for comparison purposes. The results of this analysis are given in table 7 and summarised in table 8.

From these two tables the following comments can be made in respect of the hypotheses formulated earlier:

- Increasing the number of attributes from three to five leads to a drastic decrease in the goodness-of-fit value. The decrease in the value supports the hypothesis that an increase in task complexity leads to an increase in randomness of choice. (It needs to be noted that the change in data sets (from the set with 3 attributes to the set with 5 attributes) has an effect on the number of cells from which the goodness-of-fit value is calculated. Hence, a direct numeric relationship between the ρ^2 values cannot be assumed. In this case, the difference is

Table 7 Estimation results of the (base) model for different subsamples

Group	Task type	# attributes	# treatments	# alternatives	L(0)	L(β)	Adjusted ρ^2
Less literate	3-attribute	12	1 154	2 724	-968,57	-689,84	0,2754
Less literate	5- attribute	23	1 276	3 004	-1 067,73	-919,16	0,1176
Literate	3-attribute	12	1 239	2 777	-980,04	-676,70	0,2973
Literate	5-attribute	23	1 834	4 211	-1 491,40	-1 276,64	0,1286
Less literate	Verbal	23	1 189	2 795	-993,23	-772,57	0,1990
Less literate	Picture	23	1 241	2 933	-1 043,06	-869,28	0,1446
Literate	Verbal	23	1 532	3 476	-1 228,95	-1 013,39	0,1567
Literate	Picture	23	1 541	3 512	-1 242,49	-988,80	0,1857
Less literate	2-alternative	23	1 563	3 126	-1 083,39	-856,25	0,1884
Less literate	3-alternative	23	867	2 601	-952,50	-717,79	0,2223
Literate	2-alternative	23	2 223	4 464	-1 547,11	-1 262,36	0,1692
Literate	3-alternative	23	841	2 523	-923,93	-729,07	0,1860
Less literate	First 8 treatments	23	1 205	2 852	-1 014,46	-820,98	0,1680
Less literate	Last 8 treatments	23	1 225	2 876	-1 021,83	-831,06	0,1642
Literate	First 8 treatments	23	1 542	3 502	-1 238,32	-1 007,60	0,1677
Literate	Last 8 treatments	23	1 531	3 486	-1 233,13	-993,04	0,1760
Less literate	Total	23	2 431	5 730	-2 036,99	-1 660,45	0,1736
Literate	Total	23	3 074	6 990	-2 472,14	-2 014,48	0,1758
Total	Total	23	5 506	12 722	-4 509,81	-3 690,45	0,1766

sufficiently large to give confidence that the change in the goodness-of-fit values is significant.) The pattern is, however, not consistent with the second part of our hypothesis that says that the impact for the less literate group is larger than for the literate group, as the decrease in fit is of the same order of magnitude. Task complexity is, however, only one possible explanation. Another is that the increase in error variance may be related to the specific nature of the added attributes.

- The visual presentation method has opposite effects for low and higher educated respondents. It reduces the goodness-of-fit of the less literate and improves that of the literate. The pictorial presentation (which was the verbal presentation augmented by pictorial displays of the attribute values) can be considered to add complexity to the decision-making task over the verbal presentation method. As such, the findings confirm the hypothesis that the more educated are better able to cope with more information.
- The ρ^2 values were found to increase with an increase in the number of alternatives. This apparently contradicts the hypothesis that the goodness-of-fit should decline with complexity of the decision task. This finding may be attributed to:
 - the dominance of the train alternative which was always present in the 3-alternative choice sets, whereas in the 2-alternative choice sets a third of the choice sets included only the bus and minibus alternatives. The

Table 8 Adjusted rho squares by sample segment

	3-attribute	5-attribute	Increase
Less literate	0,2754	0,1176	-0,1578
Literate	0,2973	0,1286	-0,1687
Total	0,2881	0,1301	-0,1580
	Verbal	Pictorial	Increase
Less literate	0,1990	0,1446	-0,0545
Literate	0,1567	0,1857	0,0290
Total	0,1821	0,1692	-0,0129
	2-alternative	3-alternative	Increase
Less literate	0,1884	0,2223	0,0338
Literate	0,1692	0,1860	0,0168
Total	0,1786	0,1812	0,0027
	First 8 treatments	Last 8 treatments	Increase
Less literate	0,1680	0,1642	-0,0039
Literate	0,1677	0,1760	0,0083
Total	0,1721	0,1771	0,0050
	Total		
Less literate	0,1736		
Literate	0,1758		
Total	0,1766		

- the assimilation of information was easier in the 3-alternative choice set,

since the order in which the information is presented is always the same (ie train, bus and minibus), whereas in the 2-alternative choice sets the order of the two alternative modes was random.

Table 9 Understanding of the questionnaire by respondents

	SP interviews (346 respondents)			In-depth interviews (26 respondents)		
	Less literate	Literate	Total	Less literate	Literate	Total
Very confusing	1	3	4	0	0	0
A bit confusing	56	54	110	4	4	8
Absolutely clear	94	136	230	8	10	18
Total	151	193	344	12	14	26

Table 10 Certainty with choices made

	SP interviews (346 respondents)			In-depth interviews (26 respondents)		
	Less literate	Literate	Total	Less literate	Literate	Total
Very sure	99	140	239	8	9	17
Quite sure	50	46	96	4	4	8
Not sure at all	1	5	6	0	1	1
Total	150	191	341	12	14	26

Table 11 Attitudes to the interview

	SP interviews (346 respondents)			In-depth interviews (26 respondents)		
	Less literate	Literate	Total	Less literate	Literate	Total
Interesting	140	177	317	10	13	23
Tiring	10	13	23	2	1	3
Boring	1	3	4	0	0	0
Total	151	193	344	12	14	26

• Comparing results for the first sub-set and last sub-set of eight treatments, we see a marginal decrease in model fit in the low education group and a marginal increase in performance in the high education group. Because the differences are marginal and may not be significant, this cannot be taken to suggest that fatigue effects occur in the low education group and that the effects do not occur in the higher education group.

QUALITATIVE ANALYSES

The previous section discussed the quantitative findings of the study. This section considers the qualitative aspects determined from three perspectives, namely

- responses by the respondents to questions on
 - how confusing they found the questionnaire
 - how interesting they found the questions, and
 - how certain they were of the choices they had made
- how these responses were reflected in the in-depth interviews of 26 respondents
- qualitative evaluation of the responses

Clarity of questions

The responses as to how confusing the questions were to the respondents are summarised for both the SP interviews and the in-depth interviews in table 9. These two methods appear to produce

fairly similar responses to the question, suggesting that almost two-thirds of respondents understood the questions and that there was little difference between the literate and less literate respondents.

The in-depth interviews provided greater insight into the responses, namely:

- Interviewees did not interpret the questions as hypothetical cases, but constantly referred to the current attributes of the modes (eg *a minibus-minibus alternative was not available in the morning; a minibus-bus service was not possible since buses operated like minibuses; Metro Rail's security guards remain on the stations and never board the trains*).
- Some interviewees found some attribute values presented in the stated preference questions unacceptable when compared to the values they presently experienced and chose to *swap items in their minds to correct them*.

Certainty of choices made

Table 10 summarises the responses made by the respondents to the SP and in-depth interviews on how sure they were of the choices that they had made. From this table, it can once again be seen that the SP interviews and the in-depth interviews resulted in similar responses; that there was little difference between the literate and less literate respondents; and that few respondents reported that they were not sure that they had made the correct choice.

Attitudes to the questionnaire

The last question posed to respondents in the questionnaire related to whether they found the interview interesting, tiring or boring. The results of their responses are given in table 11. Once again it can be seen that the vast majority of respondents, whether literate or less literate, reported that they found the interview interesting.

However, comments during the in-depth interviews may suggest that many of the interviewees may not really have understood the questions, but replied positively because of 'good manners' (eg *A visitor/stranger should always be treated with respect, and One should always pretend to be clever in the company of strangers*).

Evaluation of quality of responses

The quality of the completed questionnaires can also be evaluated from

- the comments made by the interviewees, indicating that a respondent was not participating adequately (eg the respondent was bored and disinterested, was not concentrating, had difficulty remembering the alternative attributes, answered the question before the interviewer had finished reading out all the alternative attributes, was clearly not trading off between the given attributes, and was careless and almost haphazard in selecting their answer, made reference to extraneous factors which were not included among the given attributes, but were derived from past personal experience of the given modes or mode combinations), or
- a review of the responses themselves. This was done by an experienced researcher who looked for 'inappropriate' responses usually suggesting that the respondent had succumbed to the 'halo effect', focusing on one particular attribute only and making all mode choice selections in terms of that attribute (which would suggest the use of a non-compensatory decision-making rule). (It is acknowledged that the qualitative definition of valid and invalid response needs to be investigated further.)

Effect of presentation method

Table 12 shows the qualitative analysis of the effect of the presentation method and education level on the quality of response. From this it can be seen that

- when using the verbal presentation method, the literate provide more valid responses than the less literate ($\chi^2 = 4,92$; significant at 5%)
- when using the pictorial presentation

Table 12 Performance on the presentation format by educational level

Presentation method	Education	Valid data		Invalid data		Total
		Number	%	Number	%	Number
Verbal	Up to Grade 7	80	52,6	72	47,4	152
	Beyond Grade 7	125	64,4	69	35,6	194
	Total	205	59,2	141	40,8	346
Pictorial	Up to Grade 7	73	48,3	78	51,7	151
	Beyond Grade 7	120	62,2	73	37,8	193
	Total	193	56,1	151	43,9	344
All	Up to Grade 7	153	50,5	150	49,5	303
	Beyond Grade 7	245	63,3	142	36,7	387
	Total	398	57,7	292	42,3	690

Table 13 Performance on the SP task, by number of mode choices presented

		Valid data		Invalid data		Total
		Number	%	Number	%	Number
Number of alternatives	2	140	59,1	97	40,9	237
	3	51	46,8	58	53,2	109
Number of attributes	3	78	51,7	73	48,3	151
	5	113	57,9	82	42,1	195

method, the literate provide more valid responses than the less literate ($\chi^2 = 6,58$; significant at 2%), and

- when the two education levels are combined, there is no statistical difference between the validity of responses using the verbal or pictorial presentations ($\chi^2 = 0,59$)

Effect of complexity

Table 13 shows the validity of responses in respect of the number of alternatives/modes and the number of attributes. From this it can be seen that

- the respondents had greater difficulty when faced with 3 rather than 2 alternatives. ($\chi^2 = 4,56$; significant at 5%), and
- the number of attributes does not appear to affect the validity of the responses ($\chi^2 = 1,19$)

These two conclusions contradict the findings of the quantitative analysis described earlier.

CONCLUSIONS

The most relevant findings of the study are the following:

- The adjusted ρ^2 statistic of 0,177 tends to indicate that the model has a low value for the goodness-of-fit. This could be due to
 - a heterogeneity in the choices made by the respondents
 - a heterogeneity in their understanding of the characteristics of the mode that were not specified
 - the inability of respondents to apply

their minds to the task facing them, and/or

– insufficient interviewer control of the interview process.

The possibility of the last two inadequacies is reflected in the analyses of a qualitative inspection of the responses and the notes made by the interviewers on the participation of the respondents, as well as the in-depth interviews.

- The main hypothesis, that **the less literate are less able to cope with stated preference data collection methods**, was not proven statistically (ie compare adjusted ρ^2 statistics of 0,174 for the less literate and 0,176 for the literate). However, the qualitative analysis of the responses suggests that the percentage of invalid responses was higher (49,5%) among less literate respondents than among literate respondents (36,7%).
- The second hypothesis, that **the quality of response is affected by the complexity of the model**, is substantiated in respect of the number of attributes (ρ^2 is 0,288 for 3 attributes and 0,130 for 5 attributes) but not in respect of the number of alternatives between which the choice is being made (ρ^2 is 0,178 for 2 alternatives and 0,181 for 3 alternatives). However, the opposite conclusions were reached, using the qualitative analysis approach where the difference in valid responses is statistically significant for the number of alternatives but not for the number of attributes.
- The third hypothesis, that **the method of presentation would affect the quality of response**, is substantiated by the statistical analysis (ie ρ^2 is

0,199 for verbal presentation and 0,147 for the pictorial presentation among the less literate respondents, and 0,157 and 0,186 among the literate respondents), but the effect is different for the each of the two literacy groups. This reduction in response quality with the pictorial presentation among less literate respondents would also substantiate the second hypothesis that increasing complexity affects less literate respondents more than literate respondents. The qualitative analysis found a decline in response quality when the pictorial presentation was used and that this decline was greater among the less-literate, although the changes were not statistically significant.

- The fourth hypothesis is that **the response quality would decline with fatigue** (ie the number of choices made by the respondents). It was found that the response quality declined marginally among the less literate (from 0,168 to 0,164) and increased marginally (from 0,168 to 0,176) for the literate respondents. However, these changes are not considered to be statistically significant.

Comparing the self-evaluation responses with the responses during the in-depth interviews suggests that posing questions for self-evaluation might not provide researchers with a true understanding of the quality of the data collected. In this survey, 69 % of respondents reported that the questionnaire was absolutely clear, 88 % said that it was interesting and 96 % reported being sure that they had made the correct choices. Yet, during the in-depth interviews a number of behavioural patterns emerged, the effect of which needs to be quantified through more detailed analysis of the in-depth interviews. These patterns include

- replying in the affirmative to please a visitor
- giving an answer regardless of being able to give one, and
- respondents being unable to evaluate the profiles as hypothetical situations and choosing to introduce their own experiential values into the decision task

These findings provide the following guidance for future stated preference studies:

- Less literate respondents can participate in stated preference data collection provided the choice tasks are not complex.
- A high degree of care needs to be taken to train the interviewers and to ensure that respondents are actually applying their minds to make well-considered choices, as the responses might often reflect a need to be polite, or appear intelligent, rather than that it is the real decision.

- There still remains the possibility that the mode choice might be made using non-compensatory decision rules. This needs to be investigated further.
- A qualitative approach to the analysis appears to provide conclusions that are not always consistent with the statistical analysis approach. The reasons for these discrepancies need to be researched further.

Acknowledgements

- The research work reported in this paper was funded by the South African – Netherlands Programme on Alternatives in Development (SANPAD).
- The contribution to the study on which this paper is based, by the following researchers: A Borgers (Technical University of Eindhoven), F Chauke (University of the North), M Lombard (TRC Africa), M Makwela (University of the North), H Timmermans (Technical University of Eindhoven), P van der Reis (Private consultant), I Wassermann (University of Pretoria).
- The comments of the reviewers, which improved the paper.

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