PUBLIC TRANSPORT IN CAPE TOWN: EVALUATING MODAL ATTRIBUTES WITH STATED PREFERENCE MODELS

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1. INTRODUCTION

This paper focuses on the evaluation of modal attributes that were found to be significant mode choice factors amongst private and public transport users in Cape Town. This was based on revealed and stated preference models calibrated on user preference survey data. The paper is one of five papers presented at the 2002 South African Transport Conference on the Cape Town Public Transport Restructuring Study. The paper by Kingma and Cameron gives the background to the User Preference Study in relation to the public transport-restructuring project. A key point of departure in the development of stated preference (SP) models, simulating the impact of various factors in public transport mode choice, was the evaluation of strategic policy issues. Cameron and Kingma describe the formulation and selection of policies for testing by means of the mode choice models. The segmentation of the public transport market and size of each segment were also described. These results facilitated the selection of the segments that needed to be targeted by the policies, and subsequently by the user preference surveys.

The paper by Lombard and Hugo describes the market research process, the design and execution of the user preference surveys, and the results of the current mode choices (revealed preferences) of public transport users. Prior to the surveys, focus group discussions were conducted to obtain an in-depth understanding of mode choice factors and to identify the most important factors for testing in the SP experiments.

To fully appreciate this paper on the evaluation of modal attributes based on the modelling results, the above-mentioned papers should be read first.

Modal attributes were evaluated based on the statistical significance of attributes and their monetary values were determined from the model calibration results. The SP technique was found invaluable in testing the demand for the new taxi recapitalisation type of service for the first time in South Africa. The SP technique also allowed other policies, unfamiliar to many users to be tested, such as rationalised bus services and integrated rail services that require multi-modal trips, transfers and through ticketing.

The paper is structured as follows:
- Section 2 describes the objectives of the SP mode choice modelling task and the scope of the paper in the context of the user preference study.
- Section 3 summarises the policies, market segments and attributes selected for modelling purposes.
- Section 4 discusses the modelling approach, design of the SP experiments, and the model calibration.

- Section 5 presents the main results in terms of the significance and monetary values of various modal attributes based on the model calibration results.
- Section 6 draws conclusions and makes recommendations regarding the value and further role of the SP study in the Cape Town restructuring process and the use of SP techniques in South Africa.

2. OBJECTIVES OF THE SP MODELLING TASK AND SCOPE OF THE PAPER

The Cape Town stated preference study is the second major study of its kind in South Africa. It built on the success of the Durban SP study. SP modelling techniques are used extensively internationally to evaluate the impact of transport policies on users' travel choices (Ortuzar and Willumsen, 2000). Various local studies and basic research indicated that SP techniques is also a valuable tool to be used in a developing country, such as South Africa, provided that the data is gathered by means of a high quality professional market research and modelling process and that special care is taken to overcome the many pitfalls that could be encountered (Van Zyl, Lombard and Lamprecht, 2002; Arentze, Borgers, Chauke, Del Mistro, Lombard, et al 2002).

The main objectives of the Cape Town SP modelling study were the following:
- To determine the trade-offs users are willing to make in their choice of travel mode, as input, and in response to a restructured public transport system.
- To estimate models of user choice and to determine fares and other demand elasticities as key inputs to other programmes forming part of the public transport restructuring programme.

The main modelling tool by means of which the above objectives could be achieved were multi-nomial discrete mode choice models calibrated on revealed (RP) and stated preference (SP) data. Model calibration outputs (logit model and coefficients of variables) are incorporated into a spreadsheet model that allows quick and easy policy testing. The results of the mode choice models will also be built into Cape Town's EMME/2 transport model to test network strategies for the restructuring project.

This paper focuses on an initial assessment of the calibration results of the basic SP and RP models relating to various policy tests and market segments. Further work is still intended to develop the spreadsheet model to test and quantify policy impacts.

3. SUMMARY OF POLICIES, MARKET SEGMENTS AND ATTRIBUTES SELECTED FOR MODELLING

From the evaluation of various policies and market segments that potentially could be addressed by the SP models, the following were selected to be of high priority and appropriate for modelling purposes (Cameron and Kingma, 2002).

Most of the policies, 17 in total, were aimed at public transport captive users in Khayelitsha, Gugulethu, Nyanga and Mitchell's Plain. The policies tested various improved services amongst existing train, bus and mini-bus taxi commuters travelling to the Cape Town CBD, and in a few cases to Wynberg.

Improvements to public transport services related to train services, rationalised bus services and a new midi-bus service reflecting the taxi recapitalisation type of service (hereafter termed 'taxi recap'). Access to these services would be improved by offering feeder services to commuters living far from the existing train stations or the rationalised core bus network.

Two policies were aimed at current private transport users to test their reaction to improved train services from the Southern Suburbs and Bellville to the Cape Town CBD.

Each of the 17 policies was reflected in separate SP experiments conducted during two phases of the user preference surveys. Tables 1.1 to 1.4 indicate the policies tested and the market segments covered in terms of transport mode and geographical area.

The various attributes tested in each SP experiment are also indicated in Tables 1.1 to 1.4. The following nine categories of attributes were tested:

- Public transport fares, car out-of-pocket costs and parking fees
- Door-to-door travel time
- In-vehicle travel time of the line-haul mode
- Access times to the feeder mode in terms of walking and waiting
- Transfer time between feeder and line-haul modes
- Train skip-stop services
- Levels of crowding in trains and buses
- Method of payment such as cash, weekly/monthly coupons, and smart card for bus and taxi
- Levels of train security involving guards at stations and on trains, as well as technological measures in terms of panic buttons and surveillance cameras.

Table 1.1: Main characteristics of SP experiments and model performance for train commuters

Model no.	**Market segment**	**Mode compared to current train**	**Sample size (Interviews x Cards)**	**SP variables**	**Goodness-of-fit* (Rho-square)**
T1	Khayelitsha – CBD	Improved train	79 x 9 = 711	Fare Total time Security (guards & technology) Crowding	0.13
T2	Mitchell's Plain – CBD	Improved train	76 x 9 = 684	Fare Tot time Security (guards & technology) Skip-stop	0.09
T3	Mitchell's Plain –CBD	Taxi Recap	123 x 9 = 1107	Fare In-vehicle time Access time Taxi Method of payment	0.22
T4	Mitchell's Plain – CBD	Rat Bus	116 x 9 = 1044	Fare Access time In-vehicle time Train Security (guards & technology)	0.21

***Note:** The Rho-square value indicates how well the model simulates the choices of respondents relative to a simple model reflecting only modal constants yielding the aggregate modal shares. Values between 0.1 and 0.2 indicate a good fit, while values higher than 0.2 indicate a very good fit.

Table 1.2: Main characteristics of SP experiments and model performance for bus commuters

Model no.	Market segment	Mode compared to current bus	Sample size (Interviews x Cards)	SP variables	Goodness-of-fit (Rho-square)
B1	Khayelitsha - CBD	Train with feeders	75 x 9 = 675	Fare Total time Train guards Train security technology	0.17
B2	Mitchell's Plain - CBD	Train with feeders	25 x 16 = 1200	Fare Tot time Train guards Train security technology Train Skip-stop	0.18
B3	Mitchell's Plain - CBD	Rat Bus vs. Taxi Recap	136 x 9 = 1224	Fare Access time In-vehicle time Taxi Method of payment	0.32
B4	Mitchell's Plain - CBD	Rat Bus	125x9 = 1125	Fare Access time In-vehicle time Crowding Rat bus	0.27
B5	Gugulethu/ Nyanga - CBD	Rat Bus vs. Taxi Recap	125 x 9 =1125	Fare Access time In-vehicle time Taxi Method of payment	0.28
B6	Gugulethu/ Nyanga - CBD	Rat Bus	136 x 9 =1224	Fare Access time In-vehicle time Crowding Rat bus	0.33

Table 1.3: Main characteristics of SP experiments and model performance for taxi commuters

Model no.	Market segment	Mode compared to current taxi	Sample size (Interviews x Cards)	SP variables	Goodness-of-fit (Rho-square)
T1	Khayelitsha – CBD	Train with feeders	80 x 9 = 720	Fare Tot time Train guards Train security technology	0.09
T2	Mitchell's Plain – CBD	Train with feeders	85 x 16 = 1360	Fare Tot time Train guards Train security technology Train skip-stop	0.15
T3	Khayelitsha – Wynberg	Bus with feeders	72 x 9 = 648	Fare Total time Transfer time Bus Method of payment	0.15
T4	Mitchell's Plain – Wynberg	Taxi Recap	66 x = 648	Fare Total time Transfer time Bus Method of payment	0.29
T5	Gugulethu/ Nyanga - CBD	Taxi Recap	131 x 9 =1179	Fare Total time Taxi Recap wait time Bus Method of payment	0.24

Table 1.4: Main characteristics of SP experiments and model performance for car commuters

Model no.	Market segment	Mode compared to current car	Sample size (Interviews x Cards)	SP variables	Goodness-of-fit (Rho-square)
C1	Southern suburbs/ Bellville – CBD	Improved train	208 x 16 = 7728	Car cost Car park fee Fare Total time Train guards Train security technology	0.17

4. MODELLING APPROACH, DESIGN OF SP EXPERIMENTS AND MODEL CALIBRATION

4.1 Modelling approach

The lessons learned from the Durban user preference study were successfully applied in Cape Town. The main features of the modelling approach were the following:

- The use of computer assisted personal interviews (CAPI) allowed real time validation of data and the use of each respondent's current travel characteristics for the SP levels of the current mode. This ensured a high quality of data and high variance in data, leading to improved model performance.

- The specification of the SP levels of the new modes by applying larger percentage changes to the levels of current modes, subject to keeping levels within realistic limits. This is important to overcome the problem of reluctance to change modes and to make it easier for respondents to make reliable trade-offs.

- Specifying realistic background, or controlled information describing modal improvements to respondents.

- Use of binary choices comparing the current mode with an improved new mode.

- Keeping SP designs simple and limited to 4 or 5 variables with 3 levels each, limiting the number of choices per respondent to 9, or 16 at the most.

- Testing a wider range of variables and use of a larger number of experiments amongst different user segments, rather than more variables in fewer experiments.

- Increased target sample sizes of 75 to 120 per market segment

- Collecting both revealed and stated preference data to provide for scaling of the SP models with the RP models.

4.2 Design of SP experiments

The design of the SP experiments involved an elaborate process of specifying draft designs and testing designs against various criteria. The design typically involved all aspects of market research including what information to present and how to present it to elicit reliable choices by respondents between offered modes.

Alternative modes were described to respondents in terms of controlled variables and SP variables. Respondents were then requested to choose one of two modes for various travel scenarios, each presented on a show card on the CAPI laptop computer.

For modelling purposes it was important to specify orthogonal designs, ensuring that there is no correlation between the different SP variables. The specification of the SP levels for each variable was also critical to ensure that realistic trade-offs were offered to respondents between different variables.

The marketing research issues are described in further detail in the paper by Lombard and Hugo (2002). From a modelling perspective, the SP design involved the following activities:

- Identification of variables and measurement units
- Checking whether market research was able to collect reliable data for each variable
- Deciding on a level for each variable in terms of a 20 to 30 per cent change to the level of the current model. Current travel characteristics were reviewed to get an order of magnitude of current levels. In some cases, such as for security and crowding, absolute levels were used rather than relative ones
- The CAPI facility enabled the specification of the levels of the new mode in terms of changes relative to the current mode.
- Checking whether levels would be realistic for respondents in view of prevailing travel patterns, and how the characteristics of the new mode could be explained to respondents.
- Checking from the SP design manual the total number of choices needed for the selected number of variables and levels so that these were within the set limits
- For each experiment testing the boundary arrays which presented the trade-offs between variables. This was done in a spreadsheet by generating the levels for each show card in absolute terms and plotting these on graphs. The boundary arrays must be scattered around a realistic range and present different trade-offs. For example, the cost vs travel time trade-off is given by the value of time. The values of time implied by the cost and time levels, therefore, had to fall within the expected range of between R1 and R20 per hour.
- From the boundary array analysis the levels were refined and tested again in terms of the feasibility criteria mentioned above.
- After the pilot test, the actual choices were analysed to determine whether respondents were varying their choices and what variables are influencing choices. Final refinements were again made in view of the pilot study.

The designs that used four SP variables with 3 levels each, yielded 9 choices (show cards) per respondent. A few designs used 5 variables with 3 levels each, and these yielded 16 choices per respondent.

As the many details regarding the SP levels of each experiment and each variable are not important for the purpose of the paper, these are not provided here to save space. The SP levels of the non-time and non-cost variables were fixed at three discrete levels. The second level and third levels were specified as separate variables in the logit model. The levels for security and crowding are defined in Table 2 as they are only referenced as level 2 and 3 in the tables giving the calibration results.

Table 2: Definitions of train security and crowding levels

Variable	SP Levels	Description
Train Security Guards	Level 1	At least one guard at major stations and a guard on some trains
	Level 2	At least one guard at each station and one guard on each train
	Level 3	At least four guards at each station and four guards on each train
Train Security Technology	Level 1	No security equipment in coaches
	Level 2	A panic button in each coach
	Level 3	A panic button and surveilance camera in each coach
Train/Bus Crowding	Level 1	The train/bus is comfortably loaded
	Level 2	The train/bus is full
	Level 3	The train/bus is overcrowded

4.3 Model calibration process.

The ALOGIT software package was used to calibrate the discrete choice logit models. The software is widely used internationally, and it provides comprehensive calibration statistics as well as allowing full flexibility in model specification. As part of the Cape Town user preference study, however, the Australian model LIMDEP was purchased and is available in the Transport Department to be used for additional policy tests, should they be required.

A wide range of models was calibrated in order to identify the best and most appropriate models for the policy-testing phase. The basic models relating to each policy test and market segment are presented for the purpose of the paper. The survey data allowed models to be segmented according to the following categories:

- by home area;
- by current mode (train, bus and mini bus taxi);
- by accessibility category (close or far from public transport facility);
- multi-modal versus single mode trips;
- by gender
- by population group
- by income group

The market segmentation was introduced in two ways, namely by calibrating separate models for each category or by introducing a dummy segmentation variable in a single model.

Goodness-of-fit statistics were used to select the best models and variables for the policy-testing phase. A t-value of 1.96 indicates that the coefficient of a variable is statistically significantly different from zero at a 95 % confidence level. The Rho-square value of a model indicates whether the model is significantly better than a model with only modal constants (yielding the market shares reflected in the data). A Rho-square value of between 0.1 and 0.2 can be regarded as acceptable while a value of above 0.2 is very good.

5. CALIBRATION RESULTS AND EVALUATION OF MODAL ATTRIBUTES

5.1 Overall performance of models

Tables 1.1 to 1.4 give the sample size and goodness-of-fit (Rho-square) for each SP model, relating to each SP experiment. The Rho-square values range from 0.09 to 0.33, indicating good to very good model fits. It seems that the Phase 2 models, where the sample size per segment was increased compared to Phase 1 models, generally performed better. Another factor, which had a significant impact on model performance, was the reluctance to change factor. In some experiments, a significant percentage of users chose only their current mode, regardless of any improvements offered as part of an alternative mode. This was mainly a problem amongst bus (29 to 41 per cent) and taxi users (12 per cent) who were offered improved integrated rail services. By excluding the non-switchers the performance of the models was greatly improved.

A similar problem was encountered during the surveys amongst car users who were offered improved train services. The problem was identified during the pilot survey, and additional screening questions were, therefore, included in the recruitment questionnaire in order to interview only car users who indicated a willingness to consider train as a possible option. It was found that 80 per cent of the randomly contacted Coloured and 92 per cent of White car users who lived near a train station, were either captive to car, or not willing to consider train. The SP models for car users therefore apply only to between 8 to 20 per cent of the car market accessible to train. Although this is a disappointing result, the absolute size of this market may still be sufficient to attract significant patronage from car users.

These findings indicate that the general negative perceptions that bus, taxi and car users have regarding train services, would require huge investments to make significant improvements to rail services and active marketing to change negative perceptions. Any improvements to bus and taxi services would reduce the positive impact of train improvements in a competitive situation. It would, therefore, also be important to avoid direct competition between subsidised modes and integrate services so that bus and taxi services support train services.

5.2 Evaluation of modal attributes

The initial assessment of modal attributes was done on the basis of the significance of variable coefficients, indicated by the t-value, as well as the equivalent monetary value of the variables. The monetary value of a variable is calculated by taking the ratio of the coefficient of the variable to that of the fare or cost coefficient. The monetary value typically indicates what users would be willing to pay to save one unit of a negative factor, or to obtain one unit of a positive factor.

Tables 3.1 to 3.4 give the monetary values and t-values for each modal attribute for different geographic home areas. Table 3.1 summarises the results for current train users, Table 3.2 for bus users, Table 3.3 for taxi users and Table 3.4 for car users.

Table 3.1: Model calibration results and absolute monetary values of variables for train commuters

Variable (Unit)	Monetary values (Rand per unit) (t-value)[1]	
	Khayelitsha	**Mitchell's Plain**
Fare (Rand)[2]	1.00 (-8.3)	1.00 (-6.0 to –12.7)
Total time (hr)[3]	R0.68 (-4.3)	R1.52 (-4.3)
In-vehicle time (high income) (hr)[4]	-	R0.64 to R1.00 (-2.0 to –2.2)
Access time (hr)[5]	-	Not significant (< -0.8)
Train security (guards and technology)[6]		
Level 2	R0 (-0.1)	R0 (< -1.2)
Level 3	R0.2 (+1.7)	R0.34 (+1.3 to +1.8)
Transfer (dummy)[7]	R0.40 (-3.0)	-
Train crowding[8]		
Level 2	R0.18 (-1.8)	-
Level 3	R0.38 (-3.6)	-
Taxi Recap MOP[9]		
Coupon	-	Not significant
Smart Card	-	Not significant
Train Skip-stop[10]	-	R0.60 (+2.4)

1. Negative t-values indicate negative factors (fare, time), while positive values indicate positive factors (train, security and skip-stop. These variable coefficients are significantly different from zero (t-value greater than 1.96) at 95% confidence level.
2. Fare is very significant. Monetary value indicated as 1.0 as fare coefficient serves as basis for comparison.
3. Total travel time is very significant. Value of time varies from R0.68 to R1.52 per hour
4. In-vehicle time of high-income users. Value of time varies from R0.64 to R1.00 per hour for Mitchell's Plain.
5. Access time (walk and wait to first mode) not significant
6. Train security only marginally significant for highest level
7. Transfer is significant and valued at R0.40 for Khayelitsha
8. Train crowding is only significant at highest level and this level valued at R0.38 for Khayelitsha
9. Taxi recap Method of payment not significant
10. Train skip-stop significant and valued at R0.60 for Mitchell's Plain..

Table 3.2: Model calibration results and absolute monetary values of variables for bus commuters

Variable (Unit)	**Monetary values (Rand per unit) (t-value)**[1]	
	Khayelitsha/ Gugulethu/Nyanga	**Mitchell's Plain**
Fare (Rand)[2]	1.00 (-5.8 to -17.1)	1.00 (-4.1 to –17.8)
Total time (hr)[3]	R1.26 to R1.74 (-2.9 to -3.2)	R4.35 (-4.8 to -6.3)
In-vehicle time (hr)[4]	R0.7 to R1.05 (-1.7 to -3.3)	R0.63 to R1.21 (-2.1 to –3.2)
Access time (hr)[5]	R0.46 to R0.6 (-1.4 to –2.4)	R0.67 to R1.10 (-1.5 to –2.8)
Train security guards[6]		
Level 2	Not significant (-0.4)	Not significant (+0.6)
Level 3	R1.03 (+3.0)	R1.09 (+1.7)
Train security technology[7]		
Level 2	R0.60 (+1.8)	R1.9 (+3.5)
Level 3	R0.95 (+3.0)	R3.0 (+5.3)
Rat bus Crowding[8]		
Level 2	Not significant (-1.6)	Not significant (-1.1)
Level 3	R0.82 (-7.5)	R0.61 (-5.0)
Taxi Recap MOP[9]		
Coupon	R0.37 (+3.1)	R0.28 (+2.9)
Smart Card	R0.48 (+3.8)	R0.25 (+2.5)
Train skip-stop[10]	-	R2.55 (+5.7)

1. Variable coefficients that are significant (t-value greater than 1.96). Negative factors are Fare, Time, Crowding. Positive factors are Security, MOP and Skip-Stop
2. Fare is very significant.
3. Total travel time is significant. Value of time varies from R1.26 to R4.35 per hour
4. In-vehicle time is significant in most cases. Value of time varies from R0.63 to R1.21
5. Access time (walk and wait to first mode) is significant in some cases. Value of time varies from R0.66 to R1.10
6. Train security guards are only significant at highest level for Khayelitsha. It is valued at R1.03 for highest level.
7. Train security technology is only significant at highest level. It is valued at R0.95 to R3.00 for highest level.
8. Rationalised bus crowding is only significant at highest level. It is valued at R0.61 to R0.82 for highest level.
9. Taxi recap Method of payment: Both coupons and smart card significant. Coupons valued at R0.28 to R0.33, and Smart Card at R0.25 to R0.48
10. Train Skip-Stop is significant for Mitchell Plan. It is valued at R2.55.

Table 3.3: Model calibration results and absolute monetary values of variables for taxi commuters

Variable (Unit)	**Monetary values (Rand per unit) (t- value)[1]**	
	Khayelitsha/ Gugulethu/Nyanga	**Mitchell's Plain**
Fare (Rand)[2]	1.0 (-6.0 to -15.0)	1.0 (-9.6 to –12.1
Total time (hr)[3]	R3.96 to R6.51 (-3.2 to -8.2)	R2.59 to R4.07 (-1.5 to –5.7)
Bus transfer time (hr)[4]	Not significant (-0.4)	-
Taxi Recap wait time (hr)[5]	R3.24 to R5.50 (-4.5 to –5.5)	R5.58 (-5.0)
Train Skip-stop[6]	-	R1.3 (+4.2)
Train security guards[7]		
Level 2	Not significant (+0.4)	Not significant (+1.5)
Level 3	Not significant (+0.8)	R0.96 (+2.1)
Train security technology[8]		
Level 2	R1.98 (+2.2)	R1.29 (+3.7)
Level 3	R2.30 (+2.6)	R1.84 (+4.5)
Taxi Recap MOP[9]		
Coupon	Not significant (0)	R0.57 (-2.1)
Smart card	R0.57 (male) (-1.9)	R0.54 (-1.9)
Bus MOP[10]		
Normal Coupon	Not significant (<.5)	-
Through coupon	Not significant (<0.5)	-

1. Variable coefficients that are significant (t-values greater than 1.96). Negative factors are . Fare, Time and Taxi recap MOP. Positive factors are Train Security and Skip-stop
2. Fare is very significant
3. Total travel time is mostly very significant. Value of time varies from R2.59 to R6.51 per hour.
4. Bus Transfer time is not significant
5. Taxi Recap Wait time is very significant. Value of time varies from R3.24 to R5.58
6. Train Skip-stop is significant and valued at R1.30
7. Train Security guards are only significant at highest level for Mitchell's Plain. Highest level is valued at R0.96.
8. Train Security technology is significant at all levels in all areas. Level 2 is valued at R1.29 to R1.90, and level 3 valued at R1.84 to R2.30
9. Taxi coupon payment is only significant for Mitchell's Plain. It is valued at R0.57. Smart Card is significant for males in Khayelitsha and for all in Mitchell's Plain. It is valued at R0.54 to R0.57
10. Bus Method of payment is not significant

Table 3.4: Model calibration results and absolute monetary values of variables for car commuters (combined model for Southern Suburbs and Bellville)

Variable (Unit)	**Monetary values (Rand per unit) (t-value)[1]**
	Southern Suburbs / Bellville
Fare (Rand)[2]	1.00 (-13.0)
Car parking fee (Rand per day)[3]	R0.15 (-6.5)
Total time (hr)[4]	R2.20 (-1.6)
Train security guards[5]	
Level 2	R5.02 (12.06)
Level 3	R6.29 (+14.3)
Train security technology[6]	
Level 2	R2.70 (+7.4)
Level 3	R4.55 (+10.8)
Income (xR1000) Car[7]	R0.15 (+3.6)
Gender (Non-PDI)[8]	
Female (car)	R3.20 (+8.0)
Male (car)	R1.79 (+4.2)
Bellville Car (dummy)[9]	R0.64 (+1.9)

1. Variable coefficients that are significant (t-value greater than 1.98). Negative factors are Fare, Car cost, Parking fee. Positive factors are train security, car amongst higher income users, car amongst white males and females, car amongst Bellville commuters
2. Fare and Car fuel cost are very significant
3. Car parking fee is very significant. It is valued at R0.15 per Rand fuel cost
4. Total travel time is only marginally significant. Value of time is R2.20 per hour
5. Train security guards are very significant for both levels. Level 2 valued at R5.02 and level 3 valued at R6.29
6. Train security technology is very significant for both levels. Level 2 is valued at R2.70 and level 3 at R4.55
7. Income on car utility is very significant. Every R1000 of monthly income increases value of car by R0.15
8. Whites on car utility is very significant. Females value car cost at R3.20, and males at R1.79
9. Bellville commuters on car utility is significant. They value car at R0.64

The following conclusions are drawn from the tabled results:

Fare and cost attributes are the most significant indicating very high t-values across all segments, ranging from – 4.1 to –17.8. The monetary value is indicated by 1.00 in all cases as the cost coefficient was used as the unit of comparison.

Any policy impacting on user costs, such as subsidies or fare changes, would have a significant impact. Such policies would, therefore, be very effective in influencing modal shifts.

Total and in-vehicle travel time are also highly significant, but less so than fare and cost, with t-values ranging from –1.7 to –8.2. The monetary values of total time and in-vehicle time are very low, below R7. In South Africa it was found by several studies that SP models gave significantly lower values of time compared to RP models (Van Zyl and Oberholzer, 2001; Van Zyl, Lombard and Lamprecht, 2001). This trend is much less evident internationally (Wardman, 1998).

The Cape Town results confirmed the South African experience - RP values of time in the Khayelitsha and Mitchell's Plan segments were in the order of R12 to R18 per hour. In the evaluation of policies impacting on travel time, it is, therefore, important to use the more realistic RP values of time, which would indicate a higher time sensitivity than the SP values of time.

The higher income user segments normally tend to indicate higher values of time i.e. they are more time sensitive than cost sensitive. Comparing the values of time across modes and population groups indicate some income effects, with the train users indicating lower values and the Mitchell's Plain commuters indicating higher values for bus and taxi, compared with Khayelitsha and Gugulethu commuters. It is surprising that the higher income car users indicate such low values of time. This is possibly due to the high cost changes offered in the SP experiments in order to overcome the high threshold bias in favor of car, as well as the possible lower incomes of the car market that are willing to use the train.

To conclude, policies affecting total travel time significantly, such as HOV lanes, congestion management, direct express services reducing stops, would impact significantly on modal shifts.

Out-of-vehicle times, such as access time to first mode, waiting time, and transfer time are not always significant. Access time to rationalised bus and taxi recap modes offered to train users, are not significant. Unless walking and waiting times do not significantly affect their total travel time, these would not affect train users mode choice.

Access time to rationalised bus and taxi recap are significant for bus users. However, values of access time are less than that of total travel time and less or equal to in-vehicle-time.

Waiting time for taxi recap, which would display features more similar to scheduled bus services, are significant for taxi users. Waiting times are valued somewhat lower than total travel time for Khayelitsha/Gugulethu users, while Mitchell's Plain taxi users value it somewhat higher than total travel time.

In Khayelitsha/Gugulethu bus transfer time is not significant to taxi users.

These SP results are similar to those found in Durban in that out-of-vehicle times are valued the same as in-vehicle times. This is contrary to international results that indicate out-of-vehicle time to be valued twice as high as in-vehicle time.
(Wardman, 1998)

The RP values of walking and transfer times behave more similarly to international experience. Walking time from home is valued almost double that of in-vehicle-time. Waiting time is valued similar to in-vehicle-time.

It, therefore, seems that the similar values of in-vehicle and out-of-vehicle time are due to typical SP biases, which also relate to the general lower SP values of time compared to RP values of time. Again, scaling of the SP models will be necessary to obtain the more realistic sensitivity of out-of-vehicle time indicated by the RP model.

To conclude, out-of-vehicle time is more important to bus and taxi users than for train users. From the RP evidence, it is safe to assume that the higher income commuters are valuing out-of-vehicle time higher than in-vehicle time. The rationalisation of bus services and introduction of the taxi recap mode, which would result in higher walking times, would have to be designed carefully to limit walking time below acceptable values. It is also important to provide higher frequencies in order to reduce waiting time and to organise transfers efficiently in order to limit transfer time.

Train security in terms of guards is only significant at higher levels for all modes, except for car users for whom the middle level is also significant. The higher level of guards is more significant than the middle level for all modes. However, its significance is still below the 95 per cent confidence level for Mitchell's Plain bus users, and Khayelitsha taxi users. The highest level of guards is valued at R1 for bus and taxi users, and valued much higher by car users, at R5.

Technological security measures are more significant and valued higher than guards amongst Mitchell's Plain bus users (R3) and by all taxi user segments (R1.8 to R2.3). However, car users value guards (R6.3) higher than technology (R4.6).

For train users, only combined levels of guards and technology were tested. Although the highest level is more significant, it is still less than the 95% confidence limit.

To conclude, train security is very important to bus, taxi and car users and any policy to promote rail should seriously consider the highest level of security measures that are affordable. For public transport users more emphasis should be put on technological measures, possibly due to mistrust towards security guards. For car users more emphasis should be put on guards or policing measures.

Crowding on trains and buses are significant at the higher level for bus commuters, but also significant for Khayelitsha train commuters at the middle level. The higher level of crowding is valued at R0.6 to R0.8 by bus users, and valued at R0.4 by train users.

It is concluded that it is important to increase the frequency of trains and buses in peak times to reduce crowding to acceptable levels. When rationalising bus services, the bus fleet size should not be reduced, but the total fleet should be concentrated in the main network in order to limit standing passengers to the minimum.

Method-of-payment indicated different results for different segments. Coupons and smart cards on the taxi recap mode are not significant for train users. Both coupons and smart cards are, however, significant and valued positively by bus users. An interesting result is that Mitchell's Plain taxi users regard taxi recap coupons and smart cards as significant, but as a negative factor. Coupons, either single trip or through tickets are not significant for Khayelitsha/Gugulethu bus users, while smart cards are significant and negative for male users.

It is concluded that the fare collection system adopted for the taxi recap mode would attract bus users, but may deter taxi users unless active marketing can change perceptions. Taxi users who are used to pay cash possibly regard pre-paid ticket systems as inconvenient, but such misconceptions would hopefully be easy to change.

Skip-stop train services are significant and positive for Mitchell's Plain train, bus and taxi users, and are valued higher by bus users (R2.5) and by taxi users (R1.3) than by train users (R0.40). This attribute was specified as skipping stops in Gugulethu and Nyanga. This significant positive factor for Mitchell's Plain users may be the result of increased convenience (less crowding and avoiding delays), but may also relate to racial perceptions including associations with increased incidents of crime of stopping in Gugulethu and Nyanga.

Other socio-economic factors relating to the choice of train amongst car users are significant. Higher income car users have a higher preference for car, while White users also have a higher preference for car, especially amongst females.

Bellville car users have a higher preference for car compared to the Southern suburbs, and promotion of trains along the Southern line would have a greater chance of early success.

Market segmentation and targeting specific markets to attract car users to improved train services will be very important.

Modal constants reflect factors that were not included in the modelled attributes and these also provide useful information. These factors indicate significant positive perceptions towards taxi recap and rationalised bus amongst Mitchell's Plain train users. However, Mitchell's Plain bus users regard train in a negative light, Gugulethu/Nyanga bus users have a negative perception of the taxi recap mode, but a positive perception of rationalised bus.

All taxi user segments have a positive perception of taxi recap, while Mitchell's Plain taxi users have a negative perception of trains. Car users also have a negative perception of trains.

The strong subjective perceptions of users, who tend to be biased in favor of their current mode, would require significant visible improvements and effective marketing to make public transport restructuring policies acceptable.

6. CONCLUSIONS AND RECOMMENDATIONS

The SP study in Cape Town provided well performing models and significant coefficients for most SP variables. It is concluded with increased confidence that SP techniques provide a valid and valuable modelling tool for all market segments, including less-literate people in South Africa, provided that an extensive and professional marketing research and modelling approach is followed, and provided that it is conducted by an experienced study team to overcome the various difficulties that are common in such studies.

Valuable information guiding policy formulation regarding public transport restructuring in Cape Town has been obtained from the initial assessment of the basic SP and RP model calibration results. Final conclusions cannot be drawn until the combined SP and RP models are applied in a spread sheet model in order to determine demand elasticities and test policies. It is recommended that transport planning authorities continue to apply behavioral choice modelling techniques as an affordable and valuable approach to promote and restructure public transport in South Africa that is based on user preferences rather than supply considerations.

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