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Modelling the non-monetary component of generalised travel costs for use in the cost-benefit analysis of bus transit facilities

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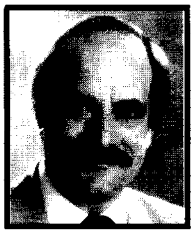
This paper describes the concept of generalised bus transit travel cost and analyses its components. Based upon this analysis a model is formulated to assist in determining the non-monetary portion of generalised travel costs of bus transit commuters for application in urban transport planning. Emphasis is placed on the calculation of generalised travel costs for use in the cost-benefit analysis of urban public bus transport projects.



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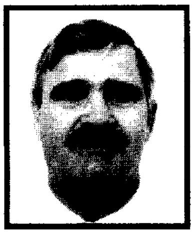

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INTRODUCTION

The purpose of this paper is to present a model that can be used for the estimation of generalised transit travel costs for application in the cost-benefit analysis of urban bus transport praojects.

Travelling does not normally contribute to the satisfaction of any need – people travel because they wish to do something at their destination. As transport therefore does not occur for the sake of the journey itself but is only a means to an end, there are accompanying sacrifices. The higher the level of disutility, the less travellers would be willing to undertake trips. The components of this disutility are the following:

- monetary cost (usually the travel fare in the case of transit journeys)
- travel time (usually regarded as a sacrifice, or it has a negative value attached to it), and
- negative qualitative aspects (eg discomfort and inconvenience endured, safety risks, exposure to frustration, unreliable service, walking times, and waiting times at passenger transport terminals and transfer facilities)

The particular intensity or level of the experience of disutility is called generalised cost. The demand for transport is thus not simply dependent on travel costs or fares but in fact on the general associated opportunity costs. Goodwin (1974:24) argues that the generalised cost of a trip is expressed as a single, usually monetary, measure combining, generally in linear form, most of the important but disparate costs that form the overall opportunity costs of the trip. Button (1993:86) concludes that the characteristic of generalised cost is that it reduces all cost items to a single index that may be used in the same way as monetary costs are in cost-benefit analysis.

If a traveller does decide to undertake a journey, assuming utility-maximising behaviour, he will choose that mode which has the lowest generalised cost for him. But what must be realised here is that the mode which has the lowest generalised cost in the eyes of the user does not necessarily also have the lowest perceived monetary cost. For example, a commuter may perceive that trips to work by bus or train may be considerably more advantageous financially than car trips, but his personal bias against riding by bus or train may represent such a degree of disutility that the generalised cost of a car journey may be considerably lower than that for transit journeys. It is therefore clear that well-designed terminal and transfer facilities which function effectively, and with stops on their feeder routes which are optimally placed, will reduce the generalised cost of transit trips considerably and therefore increase commuters' willingness to travel by transit.

On the basis of the above points the generalised cost of a trip for a traveller can be defined as the degree of perceived disutility, based on user sacrifices, that offers resistance to the undertaking of a journey or the selection of a particular mode by a traveller.

VALUATION OF THE NON-MONETARY PART OF GENERALISED TRAVEL COSTS PER PASSENGER MAKING USE OF TRANSIT FACILITIES

The opportunity costs of transit operations are borne by transit operators. Therefore it should be noted that these costs and travellers' fares are not added together in determining recurring costs in a cost-benefit analysis. To avoid double counting only the non-monetary part of travellers' generalised travel costs is added to the opportunity costs of transit operators in determining the economic travel cost portion of recurring user costs. Travel time is regarded as having an opportunity cost – travellers are presumed to have other activities they would prefer to engage in if they were not travelling – whose 'value' depends upon a traveller's willingness to pay to shift the time from travel to another activity (Lee 2000:47).

It is often argued that relative door-to-door travel time is a reliable substitute to represent the relative generalised cost users attach to commuting. Total door-to-door travel time could consist of five components: access, waiting, travelling, transfer and exit. The relative generalised cost of these periods varies as travellers experience them with different degrees of resistance or intensity of disutility (ECMT 1973:60). A passenger is seldom able to give an exact figure for a trip's degree of disutility. It is nevertheless possible to estimate any given trip's disutility from analysing how people have behaved in the past. Assuming passengers are rational, they tend to choose modes and routes that have the lowest disutility. By looking at a large number of such choices in a great variety of situations, it is possible to infer a set of weights and penalties for each component of a trip (Horowitz 1981:149).

Value of time

The latest recommendations of the World Bank (Gwilliam 1997:4) with respect to the evaluation of travel time savings are that (1) values of time savings, both for leisure and work, should always be considered in economic evaluation of projects, and (2) special attention should be given to (a) modally specific values, (b) variation of values by journey length, (c) the relationship between the value of time and income, and (d) excess travel time (walking, waiting, transferring).

In allocating time between activities, according to the classical time-use model, the individual must trade off the extra consumption that work earns against the forgone leisure which it requires. But he also has possibilities of extending the amount of working or leisure time available by spending extra money to save travel time. For example, this may arise in the choice between fast and expensive modes or routes and cheaper, slower alternatives, or in the broader context of choices of work, business and leisure activity and residential location. By analysing the relative sensitivity of such choices to variations in money and time cost, the implicit value of time of decision-makers can be identified.

There is a view that for non-working time the value of time savings should be the same for all modes, routes and trip purposes. The resulting uniform or equity value is consistent with the position that scarce investment funds should not be directed towards projects that are more likely to benefit individual travellers with a higher willingness to pay simply because they have a greater ability to pay. The latter argument rests on the proposition that the value of travel time savings is a function of personal income (Hensher 1995:13). In the authors' opinion the minimum living level wage approximates the time value of all transit-captive commuters reliably enough to serve as the shadow price or surrogate value at which they will start to sacrifice leisure time for periods of work.

Employers, trade unions, authorities that subsidise transit-captive commuters, and other interested parties often require information about what constitutes a 'living wage'. This is particularly relevant when a minimum wage or the remuneration of unskilled workers has to be determined.

In South Africa the authoritative work in this regard is done by the Bureau of Market Research (BMR) at the University of South Africa. In an attempt to give empirical content to the concept of a living wage, the BMR (1997) developed a measure called the minimum living level and the supplemented living level. The minimum living level (MLL) indicates the minimum financial requirements for the basic needs of a family if they are to maintain their health and have acceptable standards of hygiene and sufficient food, clothing and lodging.

The items allowed for in calculating the MLL include (i) food, (ii) clothing, (iii) compulsory payments to local authorities in respect of rent, water, electricity and miscellaneous services, (iv) domestic fuel and light, (v) washing and cleaning materials, (vi) education, (vii) transport (work, school and shopping), (viii) contributions to medical funds, other medical and dental expenses, and (ix) replacement of household equipment.

MLLs are calculated in February and August of each year for 26 areas. For each area there are as many as 12 different MLLs, calculated according to household size and place of residence. The MLL data are widely used as a guide in wage negotiations and settlements.

Many planners have adopted a rule-of-thumb that says the value of time while waiting is twice the value of time while riding. This rule-of-thumb has been reconfirmed so often that it is now accepted without much question. A transit operator can accordingly achieve the same improvement in the disutility of a trip by eliminating two minutes of riding or by eliminating one minute of waiting. Waiting can be reduced by better schedule co-ordination, better passenger information, improved punctuality and eliminating transfers wherever possible.

Surveys conducted by Navin (1974:11) have indicated that walking and waiting are respectively approximately 2,3 and 3,0 times more disagreeable than riding.

According to AASHTO (1977:105) the value placed on walking and waiting times is usually 1,5 or 2,0 times the in-vehicle travel time per person per hour. This value can be higher in cases where the quality of extra-vehicular convenience and safety is poor.

Horowitz (1981:149) has suggested the following weights for use during fair weather conditions:

Time component	Weight
Riding while seated	1,0
Walking	1,25
Walking with luggage	3,0
Unproductive waiting	2,0
Productive waiting	1,0
Riding while standing	3,0

In a paper by author Pienaar (1986) the generalised cost for users on different urban transport modes in South Africa was calculated by investigating the relative door-to-door travel times of commuters in different transit vehicle classes. Walking times at route terminals and waiting times at transfer points were both multiplied by a factor of 2,0. The assumption was that travellers' generalised cost of walking and waiting time is double that of in-vehicle travel time.

Ortúzar and Willumsen (1990:262) are of the opinion that walking and waiting time during access, transfer time and exit time must be weighted with factors which vary in value between 2,0 and 3,0.

On the basis of various studies on this, Vuchic (1992:280) recommended that multiplication factors of 2,0 be used to weight walking time and 2,5 be used to weight waiting time and in-vehicle standing times in order to arrive at a generalised travel cost.

According to the MVA Consultancy (1994:263) the British Department of Transport recommends that walking and waiting time should be valued double that of in-vehicle time.

According to the World Bank (Gwilliam, 1997:3) recent European studies show transfer times and waiting times with values between 1,33 and 2 times those of in-vehicle times.

A model to determine the non-monetary portion of generalised travel costs can be formulated as follows (Pienaar, 1998:3.15):

$$NMGC = U\left[\left(\frac{VT}{60}\right) + \left(\frac{A}{60}\right)(a-1) + \left(\frac{B}{60}\right)b + \left(\frac{C}{60}\right)c + \left(\frac{D}{60}\right)d\right] \quad (1)$$

where

$NMGC$ = The average non-monetary part of generalised travel costs per transit passenger expressed in rands

U = Opportunity cost of travellers' trip time per hour. (In the case of transit-captive commuters it is recommended that the shadow price of U should be set equal to the minimum living level wage)

VT = The total in-vehicle travel time per person per journey, expressed in minutes. This includes the time spent in transit vehicles as well as time spent in vehicles used to approach and depart from the terminal

A = The total in-vehicle standing time per person per journey, expressed in minutes

B = The walking time per person per journey, expressed in minutes. Walking time comprises the time needed by the passenger to walk from the point of origin to the terminal and from the terminal to his destination

C = The waiting time per person during access, expressed in minutes

D = The total transfer time per person, expressed in minutes
A = Time weighting factor for in-vehicle standing time. (Note that the in-vehicle travel time of standing passengers is included in VT, and that A represents the time of only those who stand, whenever they stand. To avoid double counting with respect to variable VT, the value 1,0 is subtracted from a)
B = Time weighting factor for walking time (during access and egress only)
C = Time weighting factor for waiting time (after access)
D = Time weighting factor for transfer time (including walking and waiting during transfer)

A procedure to determine the non-monetary portion of generalised travel costs will broadly include the following:

- Estimate the average total door-to-door travel time of the users of a system. In this process the following variables need to be researched: the actual location of the points of origin and destination of prospective transit travellers who will use the passenger transport terminal or modal transfer facility; their average walking time during access (this is a function of walking distance to this facility and average walking speed); average waiting and transfer times at the facilities (the latter is a function of mainly vehicle time headways); travel time of modes; average in-vehicle standing times; and average walking time during exit.
- The calibration of factor weights whereby walking, waiting, in-vehicle standing and transfer times are weighted: these values will depend on, among other things, the age, gender and income level of the passengers, and on climatic conditions. Gathering such information is done through terrain-specific investigation and questioning of potential passengers. If there is no opportunity for terrain-specific research, the default values recommended later on in this paper could be used.

Estimation of the disutility that bus passengers attach to travel time while standing, relative to vehicle travel time while seated (variable a in equation 1)

A survey was conducted during March 1998 at Mowbray bus terminus in Cape Town and at Bellville bus station with a view to estimating the disutility that bus passengers attach to vehicle travel time while standing, relative to vehicle travel time while seated.

Passengers who indicated that they often have to stand in a bus during travel, because of the unavailability of a vacant seat, were asked: (1) how long (in minutes) they usually have to stand, and (2) how much extra travel time (in minutes) would they tolerate should it be possible to guarantee seated travel throughout.

The details of the survey results pertaining to male and female respondents at Mowbray bus terminus and at Bellville bus station appear in tables 1 through 4. Time constraints limited these surveys to obtaining 180 responses (109 male and 71 female). However, the surveyors (who were acquainted with the nature of local transit services) judged that the respondents constitute a true representation of all passengers using the service.

The survey results suggest that the weighting factor for standing time should be 1,9. A rounded default weighting factor of 2,0 for both genders with respect to vehicle travel (riding) time while standing is recommended. This recommendation is supported by the fact that (1) both the median and mode values of the surveys are equal to 2,0, (2) the standard deviation of all the observations is only 0,36 and (3) the literature survey has shown that the factors whereby standing time is weighted usually vary between 1,5 and 3,0 with increments of 0,5 between them.

Commuters' attitudes towards walking times (variable b in equation 1)

During the 1980s the National Institute for Transport and Road Research (of which the authors were members) undertook a study of 1 045 black commuters living and working throughout the Pretoria area. This was the Pretoria Black Commuting Study (Morris 1983).

The commuters interviewed were selected to be representative of the great variety of journeys (long, medium, short, bus, train, minibus taxi, mixed mode, with and without transfers, etc) undertaken by public transport in the Pretoria area. Among the 1 045 commuters interviewed, there were 497 bus-only commuters, 184 train-only commuters and 55 minibus taxi-only commuters. The remaining 309 commuters used two or more modes during journeys.

The objectives of the study were threefold:

- to establish the facts and reality of black commuting (how do commuters reach their places of employment in Pretoria, what modes do they use, how long does the journey take, etc?)
- to establish the levels of service considered satisfactory and unsatisfactory by black commuters
- to investigate in detail the key operational aspects of the public transport

Table 1 Details of responses obtained during a survey at Mowbray bus terminus in 1998 aimed at estimating the disutility that male bus passengers attach to travel time while standing, relative to travel time while seated

Number of respondents	Standing time (minutes)	Additional travel time tolerated (minutes) per respondent	Implied time weighting factor
2	5	0, 5	1,50
1	6	5	1,83
2	7	7, 10	2,21
5	8	5, 5, 8, 8, 10	1,90
5	9	0, 5, 10, 10, 15	1,89
8	10	5, 5, 10, 10, 10, 10, 15, 15	2,00
4	12	10, 10, 12, 15	1,98
2	15	10, 15	1,83
1	20	15	1,75
2	25	25, 30	2,10
1	30	30	2,00
33		Weighted average = 1,9	

Table 2 Details of responses obtained during a survey at Mowbray bus terminus in 1998 aimed at estimating the disutility that female bus passengers attach to travel time while standing, relative to travel time while seated

Number of respondents	Standing time (minutes)	Additional travel time tolerated (minutes) per respondent	Implied time weighting factor
1	4	5	2,25
2	5	5, 5	2,00
1	6	5	1,83
3	7	5, 5, 10	1,95
2	8	5, 10	1,94
4	9	5, 10, 10, 15	2,11
6	10	10, 10, 10, 10, 15, 15	2,17
2	15	15, 20	2,17
1	20	30	2,50
22		Weighted average = 2,1	

Table 3 Details of responses obtained during a survey at Bellville bus station in 1998 aimed at estimating the disutility that male bus passengers attach to travel time while standing, relative to travel time while seated

Number of respondents	Standing time (minutes)	Additional travel time tolerated (minutes) per respondent	Implied time weighting factor
3	3	0, 2, 3	1,56
4	4	0, 1, 4, 5	1,63
8	5	0, 0, 1, 2, 3, 3, 5, 5	1,48
3	6	0, 2, 5	1,39
6	7	2, 3, 4, 7, 7, 10	1,79
4	8	5, 5, 8, 10	1,88
7	9	5, 7, 8, 9, 9, 10, 10,	1,92
10	10	5, 5, 7, 8, 10 ,10, 10, 10, 10, 15	1,90
9	12	5, 6, 7, 10, 10, 10, 12, 12, 12	1,78
8	13	8, 10, 10, 10, 10, 13, 13, 15	1,86
9	15	5, 10, 12, 13, 15, 15, 15, 171/2, 20	1,91
4	20	10, 15, 15, 20	1,75
1	25	15	1,60
76	Weighted average = 1,8		

Table 4 Details of responses obtained during a survey at Bellville bus station in 1998 aimed at estimating the disutility that female bus passengers attach to travel time while standing, relative to travel time while seated

Number of respondents	Standing time (minutes)	Additional travel time tolerated (minutes) per respondent	Implied time weighting factor
3	4	0, 3, 5	1,67
5	5	0, 1, 3, 5, 5	1,56
2	6	5, 5	1,83
4	7	5, 7, 7, 10	2,04
2	8	8, 10	2,13
4	9	5, 9, 9, 10	1,92
7	10	5, 10, 10, 10, 121/2, 15, 15	2,11
6	12	10, 10, 10, 15, 15, 15	2,04
5	13	10, 13, 13, 15, 15	2,02
4	14	10, 15, 15, 20	2,07
5	15	10, 15, 15, 15, 20	2,00
1	18	25	2,39
1	20	30	2,50
49	Weighted average = 2,0		

Table 5 Relationship between satisfaction and home-end walking times

Home-end walking time (minutes)	Number of respondents			
	Satisfied	Mixed feelings	Dissatisfied	Total
0 < 5	204	7	124	335
5 < 10	193	23	116	332
10 < 15	73	19	70	162
15 <	43	10	113	166

Table 6 Relationship between satisfaction and work-end walking times

Work-end walking time (minutes)	Number of respondents			
	Satisfied	Mixed feelings	Dissatisfied	Total
0 < 5	274	9	22	305
5 < 10	196	18	47	261
10 < 15	147	19	79	245
15 <	86	15	120	221

system which cause dissatisfaction and to identify the reasons why these problems exist

Walking times at both the home-end and the work-end of the journey were obtained. Both times were calculated as the difference between the time of leaving home and the time of arriving at the bus stop or station (home-end) and the difference between the time of arriving at the final bus stop or station and the time of arriving at the place of work (work-end). All these times were sufficiently well known to the commuters to produce adequate reported walking times.

Table 5 shows how satisfaction decreased and dissatisfaction increased as home-end walking time increased. Walks of up to ten minutes were largely satisfactory, but there was substantial dissatisfaction with walks of 10-15 minutes. Most commuters were dissatisfied with walks that exceeded 15 minutes.

The relationship between satisfaction and work-end walking time (see table 6) was anomalous in that dissatisfaction with walks of only up to five minutes was surprisingly high.

According to Morris (1985) commuters who expressed their 'satisfaction' with walking times indicated that they regarded walking time minutes (on average) as twice as costly as riding time minutes, and that commuters who were 'dissatisfied' with walking times regarded walking time minutes (on average) as three times more costly than riding time minutes. In this study the 'mixed feelings' assessment is assumed to indicate a relative disutility rating of 2,5 (ie the average disutility of 'satisfactory' and 'dissatisfactory' walking times). Based on these relative cost assessments, the weighted average disutility factor for home-end walking minutes relative to riding minutes, using table 5, is 2,3. The similar disutility factor for work-end walking time, based on table 6, is 2,5. A default weighting factor of 2,5 with respect to walking during access and egress is recommended.

To the authors' knowledge a survey similar to the study by Morris has not been conducted in South Africa recently. In view of the fact that commuting conditions in South Africa have not changed significantly over the last two decades, and the values reported by Morris correlate well with values reported in other countries, the results are still deemed to be valid.

Estimation of the disutility that transit passengers attach to waiting time during access (variable c in equation 1)

Approximately 95% of the respondents in the Pretoria Black Commuting Study stated less dissatisfaction with waiting times at a facility (ie after arriving at a facility but before departure) than with walking times. The remaining 5% indicated that they felt uneasy while waiting at overcrowded facilities. The latter group stated an indifference (in terms of disutility) between walking to terminals and waiting at terminals. None of the commuters were more dissatisfied with waiting times than with walking times.

During surveys at Mowbray bus terminus, Bellville bus station and Stellenbosch-Pniel 10 of 95 commuters who stated the measure of disutility that they attach to transferring also expressed an opinion on waiting times during access (see discussion on the estimation of variable d below). In the main these commuters stated that they regard transferring as a greater nuisance than waiting during access.

Based upon the above reactions the following default weighting factors are suggested with respect to waiting time during access:

- at a well-designed and sheltered facility which functions effectively c : 1,5
- at a partially sheltered facility functioning neither well nor poorly c : 2,0
- at a badly designed and unsheltered facility which is relatively disorganised c : 2,5

Estimation of the disutility that bus passengers attach to transfer time relative to seated vehicle travel time (variable d in equation 1)

A survey was conducted during 1996 at Mowbray bus terminus (next to Mowbray railway station) in Cape Town with a view to estimating the relative disutility that bus passengers attach to transfer time at the terminus/transfer facility. (This is a partially sheltered facility functioning neither well nor poorly.)

Transferring passengers were asked: (1) how long (to the nearest five minutes) their total journey time from boarding the first bus to alighting from the last bus usually lasts; (2) how long (to the closest 2,5 minutes) their transfer time usually lasts; and (3) if it were possible to catch a bus on which a seat is guaranteed and on which no transferring takes place, but the total travel time increases due to the circuitous nature of the route followed, how much extra travel time they would tolerate (to the closest 2,5 minutes), taking all-year-round weather conditions into consideration.

Of the approximately 80 passengers approached during the survey, 27 usable responses were obtained. These responses are summarised in table 7.

In an attempt to increase the reliability of the above results obtained in 1996 at Mowbray bus terminus, the facility was again visited in the last week of February 1998. Exactly the same questions asked in the 1996 survey were again posed to transferring passengers. Of the 38 passengers approached during the survey, 14 usable responses were obtained. These responses are summarised in table 8.

The survey results suggest that the appropriate weighting factor for transfer time at Mowbray bus terminus should be 2,4. The results obtained during the two surveys do not differ significantly. However, a default weighting factor of 2,5 with respect to transfer time at partially sheltered facilities which function neither well nor poorly is recommended.

A similar type of survey was conducted at Bellville bus station (next to Bellville railway station) during the first week of March 1998. Bellville bus station is a sheltered facility which functions effectively.

Of the 106 passengers approached during this survey, 43 usable responses were obtained. These responses are summarised in table 9.

An average implied time weighting factor of 1,91 was obtained from the Bellville bus station data. However, a rounded default weighting factor of 2,0 with respect to transfer time at sheltered facilities which function effectively is recommended. A different default value as the value recommended for transfer time at facilities which function neither well nor poorly is supported by the fact that a one-directional variance analysis indicated that the averages obtained during the Mowbray and Bellville surveys differ significantly.

Table 7 Summary of responses obtained during a survey in 1996 aimed at estimating the disutility that bus passengers attach to transfer time relative to seated travel time at Mowbray bus terminus, Cape Town

Total travel time (minutes)	Duration of transfer (minutes)	Additional travel tolerated (minutes)	Implied time weighting factor
25	10	10	2
30	5	10	3
30	7,5	10	2,33
30	10	10	2
30	10	12,5	2,25
35	5	5	2
35	5	10	3
35	10	10	2
40	7,5	10	2,33
40	10	10	2
40	10	15	2,5
45	5	7,5	2,5
45	7,5	10	2,33
45	7,5	12,5	2,67
45	10	15	2,5
50	5	10	3
50	10	10	2
50	10	15	2,5
55	7,5	10	2,33
55	10	15	2,5
60	5	10	3
60	7,5	10	2,33
60	10	15	2,5
60	12,5	15	2,2
75	10	10	2
75	10	15	2,5
90	10	15	2,5
			Average 2,4

Table 8 Summary of responses obtained during a follow-up survey in 1998 aimed at estimating the disutility that bus passengers attach to transfer time relative to seated travel time at Mowbray bus terminus, Cape Town

Total travel time (minutes)	Duration of transfer (minutes)	Additional travel time tolerated (minutes)	Implied time weighting factor
30	5	10	3
30	10	15	2,5
30	10	20	3
35	5	5	2
35	7,5	10	2,33
40	5	7,5	2,5
40	10	10	2
45	10	12,5	2,25
50	5	5	2
50	10	10	2
50	15	20	2,33
60	10	10	2
60	10	15	2,5
70	10	15	2,5
			Average 2,35

Table 9 Summary of responses obtained during a survey in 1998 aimed at estimating the disutility that bus passengers attach to transfer time relative to seated travel time at Bellville bus station

Total travel time (minutes)	Duration of transfer (minutes)	Additional travel time tolerated (minutes)	Implied time weighting factor
20	5	2,5	1,5
20	7,5	5	1,67
25	5	5	2
25	10	7,5	1,75
30	5	5	2
30	5	5	2
30	7,5	5	1,67
30	7,5	5	1,67
30	10	7,5	1,75
30	10	10	2
35	5	5	2
35	10	10	2
35	12,5	10	1,8
35	15	10	1,67
40	5	2,5	1,5
40	5	5	2
40	5	5	2
40	7,5	5	1,67
40	10	5	1,5
40	10	7,5	1,75
40	10	7,5	1,75
40	10	10	2
40	10	10	2
40	10	10	2
40	12,5	10	1,8
40	12,5	15	2,2
45	5	5	2
45	5	5	2
45	7,5	10	2,33
45	10	5	1,5
45	10	10	2
45	12,5	10	1,8
50	5	5	2
50	5	7,5	2,5
50	7,5	7,5	2
50	10	10	2
50	10	10	2
60	7,5	10	2,33
60	7,5	7,5	2
60	10	10	2
75	10	10	2
75	10	10	2
			Average 1,91

A similar survey was conducted at Pniel (near Stellenbosch) where bus passengers who commute between Stellenbosch and Paarl have to transfer. The transfer location is not sheltered and no seating and ablution facilities exist. The transfer area is not paved: during windy conditions the air is dusty and during periods of rain the waiting area becomes muddy; as such the transfer conditions can be judged as poor.

Of the 16 passengers who transferred there during the surveyed journey eleven usable responses were obtained. An average implied time weighting factor of 3,09 was obtained (3 statements implied a weighting of 2,0; 4 statements implied a weighting of 3,0; and 4 statements implied a weighting of 4,0).

A default weighting factor of 3,0 with respect to transfer time at unsheltered and disorganised transfer locations is recommended. A different default value as the value recommended for transfer time at transfer facilities which function neither well nor poorly is supported by the fact that a one-directional variance analysis showed that the averages obtained during the Mowbray and the Stellenbosch-Pniel surveys differ significantly.

Default values

The factors whereby time is weighted usually vary between 1,5 and 3,0 with increments of 0,5 or 0,25 between them. A factor of 1,0 indicates no weighting while a factor of 3,0 usually indicates the highest degree of resistance.

The default values recommended below are based on suggested weights obtained through conducting an international literature search and the stated preference surveys conducted in Bellville, Cape Town, Pretoria and Stellenbosch reported in the preceeding sections.

Component of trip	**Time weighting factor**
Vehicle travel time (sitting) (VT)	1,0 (no weighting)
Vehicle travel time (standing) (A)	*a* : 2,0
Walking time during access and during exit (B)	*b* : 2,5
Waiting time during access (C)	
• at a well-designed and sheltered facility which functions effectively	*c* : 1,5
• at a partially sheltered facility functioning neither well nor poorly	*c* : 2,0
• at a badly designed and unsheltered facility which is relatively disorganised	*c* : 2,5
Transfer time (including waiting time) (D)	
• at a well-designed and sheltered facility which functions effectively	*d* : 2,0
• at a partially sheltered facility functioning neither well nor poorly	*d* : 2,5
• at a badly designed and unsheltered facility which is relatively disorganised	*d* : 3,0

CONCLUSIONS

Generalised transit travel costs consist of (1) monetary cost, (2) travel time, and (3) negative quality aspects.

The monetary cost component of travelling by transit is usually represented by the travel fare. As the opportunity costs of transit operations are borne by transit operators, it should be noted that these costs and travellers' fares are not added together in determining recurring costs. To avoid double counting only the non-monetary part of travellers' generalised travel costs is added to the opportunity costs of transit operators in determining the economic travel cost portion of recurring costs.

The minimum living level (MLL) wage may be used as surrogate value of time at which transit commuters will start to sacrifice leisure time for periods of work. The estimation of the MLL wage is described in the text.

Negative quality aspects to which approximate disutility values can be attached are walking, waiting, transferring, and standing while riding. A method that can be used to estimate or scale these disutility values is supplied in the text. If there is no opportunity for terrain-specific research, the set of default values suggested in the text can be used as a proxy for these disutility values.

A model to determine the abovementioned costs can be formulated as follows:

$$NMGC = U\left[\left(\frac{VT}{60}\right)+\left(\frac{A}{60}\right)(a-1)\right.$$
$$\left.+\left(\frac{B}{60}\right)b+\left(\frac{C}{60}\right)c+\left(\frac{D}{60}\right)d\right]$$

The meaning of the symbols used in the formula is given in the text.

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