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Priority assessment of transportation projects in the central Witwatersrand area of South Africa.

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1994
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(iv) The forecast period is to be such that predictions can be made with a reasonable degree of confidence (for transport infrastructure this is usually a maximum period of 20 years).

(v) The costs and benefits are to be considered over the entire analysis period.

(vi) The comparisons of costs and benefits may accrue at different times during the analysis period. They must be adjusted so that they all relate to a single point in time.

(vii) All financial considerations are irrelevant to the analysis.

Schutte (1984) has stated that "Economic evaluation, which is a money based technique, takes into account only the 'cost involved' factors". These 'costs involved' are made up of facility construction costs of a project which take into account;

- - the total capital investment including land costs,
- - facility maintenance costs,
- - vehicle running costs which include;
  - fuel costs, tyre costs, oil costs, depreciation costs, vehicle maintenance costs,
  - accident costs,
  - time costs.

Up until recently the methods of analysis have tended to look only at the economic performance of a project, paying cursory attention to the other implications, Recently, with greater public awareness of social and environmental issues, more utility orientated methods have come to the fore.

Economic analysis is the predominant method of measuring project performance whilst the methods which measure problem severity are almost exclusively utility analysis.

The economic and utility methodologies are covered in some depth in this chapter so as to give an understanding of the basic technical and present philosophies behind their use.

2.2 Economic Analysis.

2.2.1. Introduction

Burton and Slavik (1976) have defined seven principles for economic studies, an abbreviated version is shown below:

(i) The economic analysis is money-based.

(ii) The analysis is a study of the future therefore:

1. The forecasts should be realistic.
2. All past investments and events are irrelevant.

(iii) All alternatives, including the do nothing alternative, are to be considered.

CHAPTER 2

REVIEW OF PRIORITY ASSESSMENT PROCEDURES

2.1 Introduction.

Priority assessment is seen by Irick (1978) as a part of a 15 step-procedure which he calls the basic programming process. It starts with the project initiation and goes through to modification of the final project.

The projects which are considered for priority rating in the area must be independent projects. Weston and Brigham (1981) describe independent projects as "..... pieces of capital equipment that are being considered for different kinds of projects or tasks which need to be accomplished".

In the project process, before being submitted to the Core City for assessment, the projects will have had to be shown to be of metropolitan significance during their submission to the Core City so, even after priority assessment has shown certain projects to be lower priority than other projects, they are all of worth to the metropolitan area as a whole.

Wilmot (1984) proposed that the procedures could been divided into two major types; the procedures which measure the performance of a project; and the procedures which measure the severity of the problem.

The methods of measuring these procedures are based on economic analysis, utility analysis or a combination of these two.

was undertaken using the Analytical Hierarchical Process which analyses pair comparisons.

Assessment sheets have been developed to give a unified scale for each of the issues. To ensure that the method remains durable and flexible it is essential that the issues are given the same score.

The method has been tested on the CWRSC projects for the 1992/93 financial year.

The results of these tests indicate that the first stage assessment significantly reduces the number of projects going forward for the second stage assessment. None of the projects that would have received funding in the past five year period would have been eliminated from the second stage assessment.

The saving on resources, by the reduction of projects going forward for detailed analysis, would have been significant.

The dissertation indicates that there is no single, universal priority methodology which can be applied to the types of projects which the metropolitan authorities have to assess. Each metropolitan area should assess its needs and aspirations and develop a long term transportation strategy which will in turn assist in selecting and/or adapting the most suitable priority assessment procedure.

To ensure the credibility of any assessment procedure it should not promote projects because they are politically correct, or so as to ensures that all participating authorities receive something. It may be felt that it is necessary to do these things but they should form part of the financial control not part of the priority process.

priority lists were used to ensure that the available moneys were allocated to the most meritorious projects.

With the passing of time attitudes towards transportation related issues, availability of information, and transport systems themselves have changed. It appears that the present priority rating system is unable to address these changes and so the possibility of using a new methodology needs to be investigated.

1.2 Present Methodology Review.

An assessment of the priority assessment techniques indicates that they can be divided into two distinct types, economic analysis and utility analysis. With the exception of the Durban Metropolitan area all the metropolitan areas in the Republic use utility analysis techniques.

The present method used in the CWRSC area, although sufficient for its time, is not robust or flexible enough to address the changing priorities, aspirations or types of project put forward for funding in the area.

1.3 The New Methodology.

A new two stage methodology is proposed. The first stage uses a successive sub-setting technique to eliminate the projects which, as they don't address sufficiently the needs of the area, have no chance of receiving funding. The second stage uses a detailed sufficiency rating technique to assess the remaining projects.

Five issues relating to transport projects have been identified as being of major import in the area. These are given a weight by analysing local authority officials views and relating them to the population of the relevant local authority. The analysis

CHAPTER 1

INTRODUCTION

1.1 Introduction.

The Central Witwatersrand Regional Services Council (CWRSC) includes the towns and cities of Alexandra, Diepmeadow, Dobsonville, Johannesburg, Randburg, Roodepport, Sandton and Soweto. It forms part of the area once covered by the Johannesburg Metropolitan (JOMET) area for which Johannesburg City Council Management Committee acted as the Core City.

One of the functions of the CWRSC is the allocation and distribution of Central and Provincial Government Funds for the implementation of transportation projects.

In the nineteen sixties there was plenty of money available for projects as is illustrated by the fact that the construction work proposed in the first ten year transport plan for the area in the 1960's was completed in six years.

The second transport plan, which was formulated in 1972, has still to be completed.

As money became less and less available for transportation projects in the Republic, the development of a systematic method of priority rating became more and more important.

Following the Driessen report (DOT)1974 the Core City officials developed a methodology for assessing the priority of projects in the JOMET area. The subsequent

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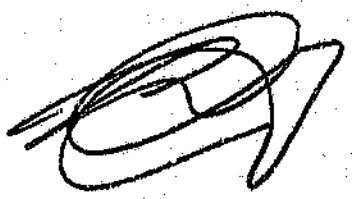
ACKNOWLEDGEMENTS

I would like to thank the following people and institutions, without who's help this thesis would not h, 'e been possible; Dr. R. Del Mistro, Mr. J. Kelly, Mr. B. Carlson, Mr. I. Symon, Mrs. D. Campbell, Mr. P. Booynes, The University of the Witwatersrand, The University of Brighton, the staff of the Metropolitan Planning Department of Johannesburg City Council and the staff of the constituent local authorities in the area of the Central Witwatersrand Regional Services Council.

ABSTRACT

Existing priority assessment procedures are reviewed with a view to identifying a methodology which will be appropriate for use in the Central Witwatersrand Regional services Council area. It is concluded that a two stage methodology is most appropriate, adopting a successive sub-setting technique and a detailed sufficiency rating technique respectively. The methodology is tested on the 1992/93 project list.

I declare that this thesis is my own, unaided work. It is being submitted for the degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination on any other University.



PRIORITY ASSESSMENT OF TRANSPORTATION PROJECTS IN THE CENTRAL WITWATERSRAND AREA OF SOUTH AFRICA

by

Peter Joseph CONWAY

A thesis submitted to the Faculty of Engineering, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science

1994

He also states that the formulation considers all benefits and costs to all goals in one enumeration.

The methodology does have a disadvantage which was described by Hill (1968). The system does not appear to recognise that costs and benefits have only instrumental value, a criteria of maximising net benefits in the abstract is therefore meaningless and there is no way of knowing whether the costs and benefits listed are relevant.

Sweet in 1986 developed, for South Africa, a similar sufficiency rating system which short-listed projects using three criteria and then assessing the projects in terms of value for money. Two levels of sorting were applied to the projects, firstly on level of benefit and secondly on value for money.

The three criteria that Sweet selected were:

a) Problem Severity.

b) Success rating.

c) Estimation of the benefits.

Two other issues that Sweet considered necessary to address were

a) Value for money.

b) Project Selection.

$ indicates a monetary value is used,

M indicates a quantitative non monetary value is used,

i indicates that the item is intangible,

- indicates that there is no cost or benefit accrued to this section.

Once the matrix has been prepared the costs and benefits that accrue to each sector are normalised, usually subjectively by an individual assessor or by a committee, aggregated and compared for each plan.

This method has several advantages, these are :

(i) The method lays a basis for a rational decision.

(ii) The decision maker is able to balance the monetary aspects against intangible aspects.

(iii) Sectors of the community which will bear the cost and benefits are identified.

(iv) With this method it is possible to appraise those elements that are high in cost or low in benefits.

Lichfield says the method will lead to a more "educated", responsible and rational policy decision.

by Lichfield(1960) and Sweet's adaptation of this method for the South African situation.

Lichfield in 1960 developed a methodology of putting monetary values, quantitative values and intangibles into a matrix format and comparing the accrued costs and benefits for each project under investigation.

The concept of the method is best illustrated by the theoretical outline as shown in Lichfield's paper and shown in Table 2.1.

	PLAN-A				PLAN-B			
	BENEFITS		COSTS		BENEFITS		COSTS	
	PRODUCERS							
X	$	$	-	$	-	-	$	$
Y	i	i	-	-	i	i	-	-
Z	M	-	M	-	M	-	M	-
	CONSUMERS							
X_1	-	$	-	$	-	$	-	$
Y_1	i	i	-	-	i	i	-	-
Z_1	M	-	M	-	M	-	M	-

Table 2.1 The Balance Sheet (from Lichfield 1960).

The different sectors which are affected by the two plans are considered as producers denoted by X, Y and Z and consumers denoted by X_1, Y_1, and Z_1.

The cost and benefits on both a capital and annual basis are indicated as follows:

Goals achievement.

Successive sub-setting.

One of the best illustrations in South Africa of Sufficiency Rating is the method developed by Sweet(1986). The Goals Achievement methodology is best illustrated using the system developed by Hill(1968), and Successive Sub-setting is best illustrated by the methodology developed by Harness and Sinka(1984).

The three techniques are discussed below.

2.3.2. Sufficiency Rating

Sufficiency rating techniques select items which are considered important to the community.

The simplest form measures how well a project achieves set goals or objectives. This is usually undertaken by measuring criteria which reflect these goals and objectives. The scores are very often assessed on an linear scale of 0 to 10, as in the method developed for the Georgia Department of Transport (Mak and Jones 1976). These criteria are then weighted in relation to their importance to the community.

The total weighted scores can then be taken in descending order or, as described by Shaffer and Fricker in 1987, as a percentile of the maximum score. A priority list is then developed from this information.

There are many variations of this technique using different scoring scales and different items. Two techniques are shown here. The balance sheet method developed

f) Value for money is not the same for different sectors of the community. This is especially relevant to South Africa with its differing social structures. Because of this the social aspects of projects are difficult to measure in a monetary way (Baxa 1984)

g) Broad assumptions are made during the analysis and so the final estimates can only be approximations Sweet(1986).

h) Weston and Brigham (1981) stated, "There is no single rate of interest in the economy; at any given time, there is an array of different rates". If this statement is true it is difficult to decide which rate of interest to use.

i) Starkie in 1979 also stated that the sensitivity to small changes in the discount rate is highly significant.

2.3 Utility Analysis.

2.3.1. Introduction

In an attempt to overcome some of the shortcomings of the economic analytical methods, utility analysis methods have been developed.

These methods, although numerous, have certain characteristics in common. They all have goals against which projects are measured or an assessment of the problem severity. Some of the methods combine these two.

There are three major techniques used for the utility analysis of projects, these are:

Sufficiency rating.

With the extensive usage of the methods various disadvantages have come to the fore:

a) It is hard to determine the life expectancy of a road or facility. As Mason *et al* stated in 1979, "Each type of road has been determined to have a different useful life".

b) To be effective, economic analysis requires large amounts of complex data. Starkie (1974) recommend that the data is updated every two years. The initial data collection and the update c time consuming and expensive.

c) There is uncertainty in the future of details and accuracy of costs for example, few people in 1970 forecast the rapid rise in fuel cost in 1972 yet this is one of the major factors in economic analysis of transport projects.

d) Economic analysis does not take into account environmental, political or social aspects of a project. Only the single goal of economic efficiency (Hill 1968) is considered. Since Hill made his observations in 1968 the methods have tried to address these problems but Roe stated, in 1987, that cost/benefit analysis still fails to provide an acceptable method of handling the problems associated with disparate criteria.

e) Economic analysis only shows how a project will perform, not the severity of the existing conditions which may have a major influence on the priority of a project, also economic analysis cannot measure the secondary impacts of a project.

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e) Economic analysis only shows how a project will perform, not the severity of the existing conditions which may have a major influence on the priority of a project, also economic analysis cannot measure the secondary impacts of a project.

2.2.8. Discussion of Economic Methods

Economic analysis is an advanced numerical process of project evaluation based on monetary data alone (Wilmot 1984). There are two basic types of analysis, namely the absolute measurement methods, which measure the difference between the benefits and costs, and the cost/benefit ratio methods. The absolute methods show the maximum benefit whilst the cost/benefit ratio methods give an indication of value for money.

Shaffer and Fricker (1987) have indicated that the most appropriate methods for assessing mutually exclusive projects are the Equivalent Uniform Annual Cost method or the Present Worth Cost method as if both costs and benefits are used then there must be a common goal, e.g. to put a route between town A and town B.

The main advantages of economic analysis of projects are:

a) It is relatively simple if there are many items which can be given a cost, such as wear and tear or maintenance.

b) There is a wealth of information on the costs.

c) The methods are tried and tested having been used extensively in the past for many different types of analysis.

d) The approach used is a systematic approach and as such high quality of personnel is not necessary for any standard type of project.

e) The methods indicate which of the projects under consideration will yield the greatest net economic benefit (Baxa 1978).

2.2.6. The Rate of Return (ROR)

This method determines the rate of return that will equalise the present worth of costs and the present worth of benefits, that is it finds the rate of return which will balance the benefits against the costs. To be economically justifiable the scheme must have a rate of return that is equal to or greater than the balancing rate of return.

With this method the discount rate is actually calculated and so gives a more comprehensible result. With different projects the projects with the lowest discount rate is the better.

The ROR or i is calculated from:

$$\sum_{t=0}^{n} \frac{b_t}{(1+i)^t} = \sum_{t=0}^{n} \frac{c_t}{(1+i)^t}$$

2.2.7. The Benefit Cost ratio (B/C)

This method, unlike the NPV method which finds the difference between the benefits and costs, finds the ratio of the benefits to the present worth of costs. A project must have a ratio of more than 1 to be economically justifiable.

This method uses a single discount rate as in the NPV method.

This is shown as:

$$B/C = \frac{\sum_{t=0}^{n} \frac{b_t}{(1+i)^t}}{\sum_{t=0}^{n} \frac{c_t}{(1+i)^t}}$$

taken into account by a discount rate. The results are given in absolute terms and for there to be a benefit they must be greater than zero. If they are zero or negative there is no economic reason for undertaking the project.

Using the symbols which have been used previously with the additions of:

b_t = benefits in year t due to the project

c_t = costs in year t

the method can be expressed as;

$$NPV = \sum_{t=0}^{n} \frac{b_t}{(1+i)^t} - \sum_{t=0}^{n} \frac{c_t}{(1+i)^t}$$

2.2.5. The Equivalent Uniform Annual Net Return (EUANR)

This method is similar to the NPV method but the net present value of the project is multiplied by the appropriate capital recovery factor and is expressed as an equivalent uniform annual net return. This is done annually for the projects.

So if b = annual benefits

then:

$$EUANR = b - c\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$$

This method only takes account of the cost of a project and so is best suited to ranking alternative projects, for example, whether route A or route B is best as a by-pass, rather than independent projects, as it assumes benefits will be the same for all alternatives.

2.2.3. The Present Worth of Cost (PWC)

This method is similar to the EUAC method except that the equivalent uniform annual cost, defined by T above, are discounted to their present worth. A discount rate is used to take the time value of money into account. Both this method and the EUAC method assume that the expenditure is a minimum so that the project with the low cost present worth of costs is considered the best. Using the symbols used previously, this method can be expressed as:

$$\mathrm{PWC} = C + T\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

As with the EUAC methodology this method only considers the costs of a project and so, as with the EUAC method, is best suited to ranking alternatives.

The next four economic methods come under the heading of cost-benefit anal[y]sis that is the cost (usually discounted to present day values) are compared in some [w]ay to the benefits (also discounted to present day values).

2.2.4. The Net Present Value (NPV)

This method determines the difference between the present worth of an additional investment and the present worth of the benefits resulting from the additional investment that is, the costs and benefits of a project. The time value of the money is

Schutte is adamant that the three main cost components are the only components to be taken into consideration.

Schutte went on to identify six main economic evaluation techniques in use at present, these are:

(i) The Equivalent Uniform Annual Cost (EUAC).

(ii) The Present Worth of Cost (PWC).

(iii) The Net Present Value (NPV).

(iv) The Equivalent Uniform Annual Net Return (EUANR).

(v) Rate Of Return (R...).

(vi) Benefit Cost ratio (B/C).

2.2.2. The Equivalent Uniform Annual Cost (EUAC)

This method takes the total cost of such project and expresses it as an equivalent uniform annual cost. The total cost includes all construction, maintenance and road-user costs. The method takes a discount rate and applies it to the initial capital cost to convert it to a future compound amount, the future being the forecast period. To this is added the annual costs of the project.

Using T = annual costs

C = construction costs

i = discount rate per annum.

and n = number of years

then $$\text{EUAC} = T + C\left[\frac{i(1+i)^n}{(1+i)^{n-1}}\right]$$

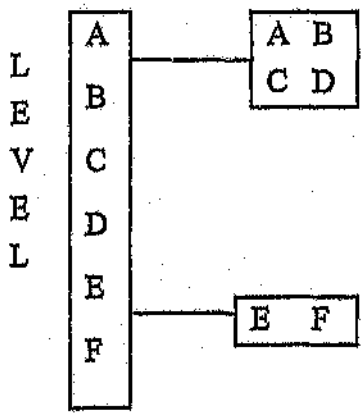


Figure 2.5 Single category/Two level.

Figure 2.5 illustrates a single category, two level system. The projects are looked at in relation to one category, e.g. vehicles per hour, and divided into two levels.

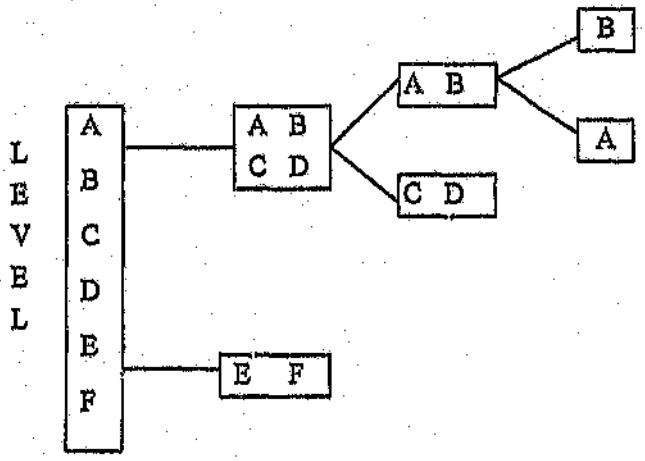


Figure 2.6 Multi category/Two level.

Figure 2.6 shows a multi category, two level system. In this system there can be numerous categories which are divided into two levels.

Some of the advantages of the system are:

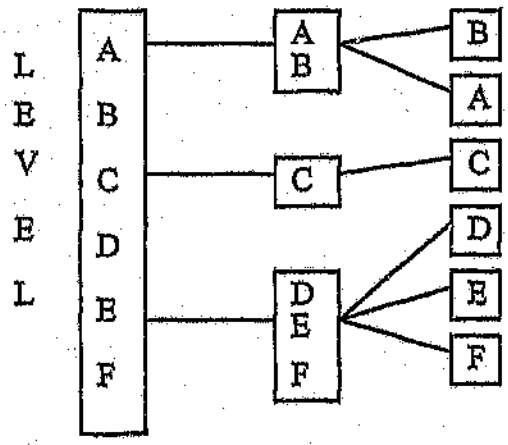


Figure 2.3 Multi category/Multi level.

Three other methods of sub-setting are shown in Figures 2.4, 2.5 and 2.6.

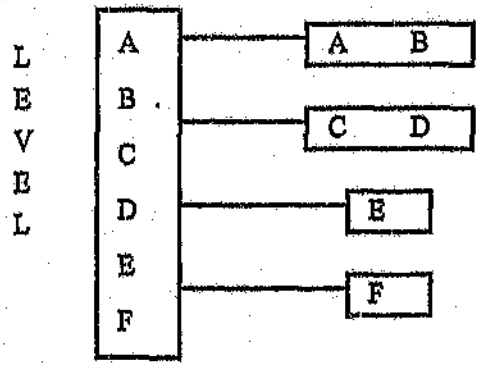


Figure 2.4 Single category/Multi level.

Figure 2.4 shows a single category multi level situation. A and B have the highest rating in the category but the difference between these two is not significant.

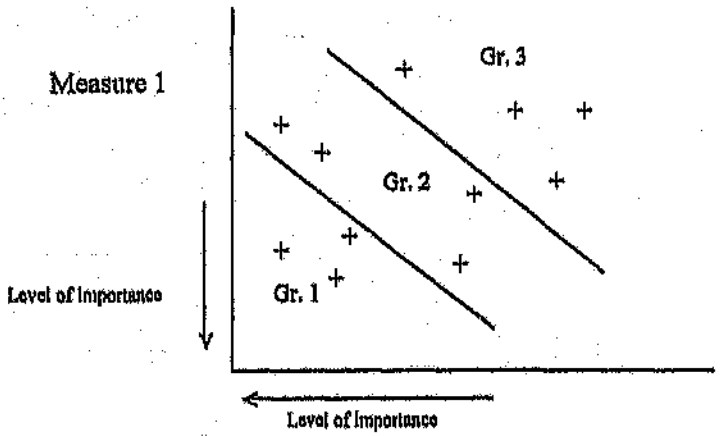


Figure 2.2 Two Measure Evaluation.

The relative importance of the two measures is reflected in the slope of the lines separating the sub groups.

The method of sub-setting described by Harness and Sinka is a multi level/multi category system. The generalised diagram of this is shown in Figure 2.3.

The levels are shown on the vertical scale and the categories are shown on the horizontal scale.

In first subset C has many more vehicles in the peak hour than the other projects A, B, D, E, F and G.

The next factor is the number of accidents, the difference in accident statistics for projects A, B, D, E and F is small while project G has very few accidents and so is put into a lower category.

The third category considers the present road surface condition. The condition of the road surface of projects B and D is much worse than projects A, E or F.

The final category is the cost of the projects. In this example project B is more cost effective than project D, F is more cost effective than project E which in turn is more cost effective than project A.

The final listing comes out as C, B, D, F, E, A and G. With this methodology the relative importance of different types of category needs to be ranked. Then the projects are split into subgroups according to the most important priority measure.

Before the categories can be ranked the relative importance of the categories must be clearly understood.

If some of the measures have a similar importance trade off curves must be developed to combine the measures. Figure 2.2 shows how two measures may be combined to subgroup projects.

category can only be placed approximately into a small number of groups. Also the projects in each group will have the same priority.

These group or subsets can also be divided into additional smaller groups using different criteria.

The method is best illustrated by a simple example using the flow diagram shown in figure 2.1.

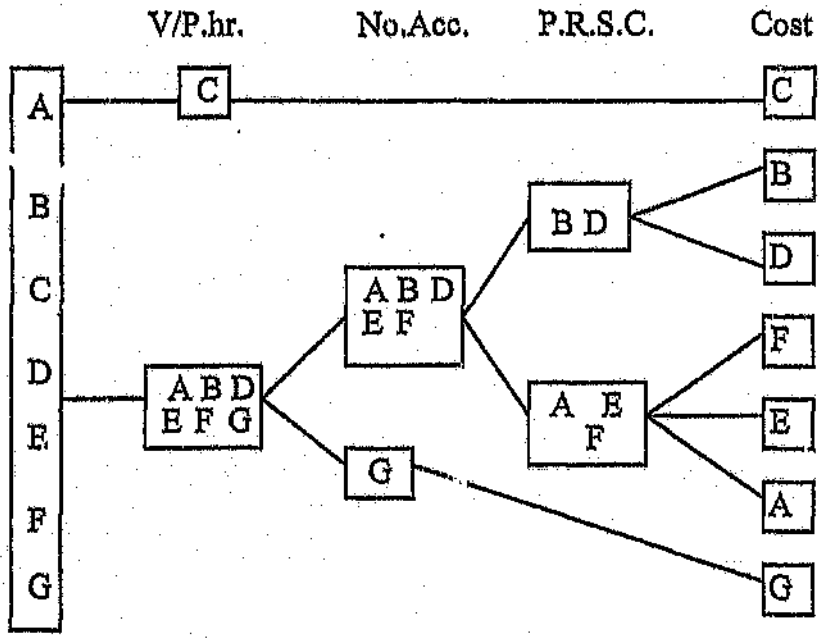


Figure 2.1 Flow Diagram of Successive Sub-setting.

In Figure 2.1 four categories are defined, vehicles per peak hour, number of accidents, present road surface condition and project costs.

of; arbitrary assumptions concerning the interrelationship of the measures of achievement of individual objectives, the aggregation of benefits and costs referring to different objectives and finally, the use of indices which cannot be understood in terms of a single unit of measurement and so is difficult to interpret.

The major advantage of the goals achievement method is that it compares, in a structured manner, the qualitative aspects of different projects or plans.

There are several disadvantages to the system:

The large combination of groups and goals may cause non conformity in the weighting.

Lichfield (1970) has criticised the method for its complexity in terms of the groups understanding of the issues especially in relation to transportation projects.

There is also the problem of goal selection.

2.3.4. Successive Sub-setting

The methodology of successive sub-setting was developed by Harness and Sinka (1984) to overcome the problem which is sometimes experienced by sufficiency rating methods of not giving sufficient highlight to the importance of each category. The method assumes that the best project for each problem has been established and can take into account subjective and low accuracy data.

It also assumes that due to the limits of accuracy for measuring impacts of the improvement these cannot be measured precisely and that the projects in each

α, β, γ, and δ are descriptions of the goals. These are given the relative weights of 2, 3, 5, and 4.

Various groups of people or sectors are selected as a, b, c, d, and e. These groups are relevant to the cost and benefits and a relative weight is given by the groups either to the goals as a whole or for each individual goal. The letters A to N are the cost and benefits that can either be in monetary units, non-monetary units or qualitative terms, the dash (-) indicates that no cost or benefit is accrued to that group from the plan.

It should be noted that a group may suffer both costs and benefits from a particular plan.

The cost and benefits are recorded in each cell by the parties who are affected.

The summation sign indicates that for certain goals the summation of the costs and benefits are meaningful and useful.

Hill proposes two ways of measuring the qualitative goals, a nominal scale which classifies and numbers the entities, and an ordinal scale which ranks the entities.

Hill also proposes two methods of comparing the effectiveness of alternative plans. The first is to present the whole goals-achievement account to the decision makes so that they are presented with the achievements of the objectives with respect to the weights of the goals for the entire community.

The second method combines the weights of the goals and their incidence is assigned to the measures of achievement of the objectives. The weighted indices are then summed and the preferred plan is that with the largest index. Hill states that this second method, although providing a comparison of plans, is subject to the criticisms

In the methodology the goals are set and their relative value established, the objectives are then defined. The consequences of each action is assessed in terms of these objectives and the incidence of the benefits and costs of each action measured in terms of achievement of the goals.

The relative weight of each population group is established. These weights reflect the community's valuation of the various objectives and incidents of benefits and costs. It is important that the sectors of the public who are affected by the courses of actions are identified.

The weights applied to the incidence of objectives are the communities' distribution of the benefits relating to the objective. So the aggregated incident weights represent the communities concept of equity or fairness.

The tabulation of the analysis is shown in Table 2.3.

Goal description:		α			β			γ			δ	
Relative weight:		2			3			5			4	
Incidence	Relative weight	Costs	Ben.	Relative weight	Costs	Ben.	Relative weight	Costs	Ben.	Relative weight	Costs	Ben.
Group a	1	A	D	5	E	-	1		N	1	Q	R
Group b	3	H		4	-	R	2		-	2	S	T
Group c	1	L	J	3	-	S	3	M	-	1	V	W
Group d	2	-		2	T	-	4		-	2	-	-
Group e	1	-	K	1		U	5		P	1	-	-
		Σ	Σ					Σ	Σ			

Table 2.3 Goals Achievement Matrix (from Hill 68).

Project selection is the final stage of the Sweet procedure, when the projects are sorted in order of their value for money rating.

The procedure has several advantages these are, it screens the projects to provide a subset of the more worthwhile projects (Wilmot 1984). The system procedure presents value of benefits less the costs and so is similar to the net present value system used for economic analysis. The procedure is easy to use, and inexpensive but Sweet recommended that it should only be used as a first stage analysis.

Wilmot (1984) also identified a major draw back of the system in that it is too coarse to be acceptable by most decision makers for the allocation of moneys.

2.3.3. Goals Achievement Matrix

This methodology was developed by Hill in 1966. Is also based upon the balance sheet concept of Lichfield (1960). The method measures the extent that different actions achieve set goals.

In this way benefits show progress towards the goals and costs represent retrogression from the goals. Where quantitative units are used both cost and benefits should use the same units and where no measurable units are used benefits represent progress towards the qualitative state whilst dis-benefits perform the same as cost in that they detract from the qualitative state.

Hill states that this differs from the traditional concept of costs and benefits as costs have traditionally been defined as land, labour and capital resources, here they are defined as goods and services used for the establishment, maintenance and operation of the project, whilst benefits are the value of immediate products, or services, resulting from the courses of actions for which the costs were incurred.

Other issues.

a) Value for Money.

To obtain the value for money of a project the cost of each project is assessed as to whether it offers above or below average value for money. The assessment of value for money is undertaken on a statistical basis. To do this analysis a cost norm for the proposed projects, within an order of benefit, is estimated and the cost of each project within the order of benefit is compared with this norm.

The cost norm is defined as the standard cost of providing a given level of benefit. In practice this is estimated by taking the average costs (or estimated cost) of the projects within a benefit order e.g. the cost of all the projects having three high order benefits in the problem severity/success rating/level of benefit table are averaged. This gives the cost norm. The projects within a level of benefit are put in order of the value for money below:

Rating	Criteria
Very good	Less than half of the norm.
Above average	Less than the norm.
Average	Similar to the norm.
Below average	Worse than the norm.
Poor	More than twice the norm.
Rejected	Projects offering negligible benefit are dropped from detailed consideration.

b) Project Selection.

The benefit provided by a project is the product of the degree of problem relief achieved and the severity of that problem. The benefits are given a high, medium, low or negligible index rating so that if a project completely solves a high rated problem the success rating is high, if partially solved a rating of medium is given and if barely solved a low rating is given.

An example of weights is shown in Table 2.2

Order of Problem	Problem Severity	Success Rating	Level of Benefit
High order problems	H	H	H
	H	M	L
	H	L	L
Medium order problems	M	H	M
	M	M	L
	M	L	-
Low order problems	L	H	L
	L	M	-
	L	L	-

Table 2.2 Estimation of Benefits (From Sweet 1986)

As stated above, H indicates high, M indicates medium, L indicates low and - indicates negligible effect.

After the three criteria have been rated on a scale of zero, low, medium or high importance, the value for money is assessed and the projects are put into priority order on the basis of their value for money.

A summary of how Sweet addresses the three criteria follows.

a) Problem Severity.

Sweet purported that the problem severity relates to both the intensity of the problem, and the number of persons affected by it. So problem severity is assessed by subjectively classifying the problem into either high, medium or low importance on the basis of the problem severity and the number of people affected.

b) Success Rating.

It is assumed that all the projects have a degree of success in solving the problems or they would not have been considered. The assessment of the degree of success each project is expected to have is done in exactly the same way as the problem severity assessment, that is, it is allocated a high, medium or low rating. A high rating indicates that the problem has been solved, a medium rating indicates a particular solution of approximately 50% and a low rating indicates a small but significant solution of about 20%. Any detrimental effects are indicated by a negative sign e.g. -H would mean a high detrimental effect.

The problem severity and success rating are used to calculate an index of benefits.

c) Estimating Benefits.

Three teams are established to provide weights for the categories and criteria. The teams are:

(a) The study team: this consisted of Core City officials and the consultant.

(b) The technical team: this consisted of engineers, planners and traffic officers from the constituent Local Authorities.

(c) The decision-making team: this consisted of town clerks, chairpersons of management committee, representatives from the Transvaal Provincial Administration, the Department of Transport and the East Rand Development Board.

A ten-point scale questionnaire is used for rating, with the study team providing initial values which serve as a guide for the technical team. The technical team then finalise the weights of the project criteria and prepares initial weights for the category and sub-category weights for the guidance of the decision-making team. The decision-making team finalise the weights of the categories and sub-categories and establish the weights applicable to the different socio-economic population groups.

The study team develops performance groups for each criteria. This is done subjectively using the limiting values of the criteria and what is acceptable as a low and high rating. The range is between 0 and 10.

Using information obtained from the weighting, a priority index is calculated using the following formula using three levels: categories, sub-categories and sub-sub-categories. The formula used for calculating the index is:

(i) Improvement or rehabilitation projects.

(ii) New construction projects.

These categories are further subdivided into seven sub-categories of:

(a) Car and truck.

(b) Bus.

(c) Combi-taxi.

(d) Rail.

(e) Pedestrian.

(f) Motorcycle.

(g) Bicycle.

These sub-categories are further divided into specific types of projects.

Two sets of criteria were then developed for the specific types of projects these are:

Problem severity criteria.

Project performance criteria.

The methodology has six basic steps (Wilmot 1985).

(a) If many projects are to be prioritised (say, in excess of twice the available budget) then the Sweet procedure is used to clarify the projects into categories (This procedure has now been dropped due to the coarseness of the Sweet procedure).

(b) The projects are classified into different categories. The categories include projects that are evaluated using similar criteria and for which relative importance of the criteria are similar.

(c) The assistance of decision makers is employed to assign importance ratings to the criteria in each category and to the categories themselves.

(d) Each project is rated on the criteria relevant to it.

(e) The ratings are then multiplied by the weightings of the criteria and categories and the results are summed to obtain a number representing the priority of the project as determined from the quantitative criteria. The values are normalised to account for the different number of criteria possible for different projects.

(f) The final category weights are established by the decision making teams. Note is taken of the values suggested by the technical group. The decision making teams are also used in the final stage of the analysis when subjective evaluation of the benefits matrix was required in arriving at the final priorities.

The projects are divided into two categories:

A traffic demand index is calculated from information obtained from the transportation analysis.

$$\text{Traffic Demand Index} = M_{2000} \times \left(\frac{V}{C}\right)_{2000:1985} \times \frac{C_{1985}}{M_{1985}}$$

The traffic demand index is obtained in the following manner.

where M_{2000} = is the morning peak hour traffic on the link for the year 2000 on the 2000 network.

$(V/C)_{2000:1985}$ = is the volume/capacity ratio on the link is the peak hour demand in the year 2000 is assigned to the 1985 network. If the link does not exist in 1985 an equivalent link is selected.

C_{1985} = is the peak hour count on the link in 1985.

M_{1985} = is the modelled peak hour traffic on the link, or equivalent, in the 1985 network.

The projects are then sorted in descending order of traffic demand index to provide a priority list.

2.4.5. East Rand

The East Rand Metropolitan Area commissioned a study in 1984 to investigate priority assessment procedures. From that study a methodology was developed.

These are, in priority order:

Priority 1. Public transport projects

(a) First priority: small public transport projects. These are projects costing less than R200 000 and with a completion period of one year or less. They include such items as lay-byes and shelters.

b) Second priority: Large public transport projects, these would include such items as bus termini.

Priority 2. Traffic control projects

(a) First priority: Large traffic control projects. These include area wide traffic control systems.

(b) Second priority: Transport Systems Management (TSM). The term here is used to indicate small projects such as intersection improvements. They are considered together as a group.

Priority 3. Road construction projects

These projects are motivated by their network effects and an economic analysis. This analysis is performed using a DELTRAN model (De Leuw Cather 1983)

The road projects are only accepted to the priority list if they provide an increase in capacity on the DELTRAN network analysis.

(iii) New projects are added to the list in a particular priority position.

The methodology is applied in the following manner:

(a) An initial priority list is prepared by the Core City taking subjective account of the following factors

- the volume/capacity ratio
- the economic worth of the project, usually in the form of internal rate of return
- the availability of the final design
- political factors
- how well the project fulfills the transport goals of the area
- network contribution
- equity and fairness.

(b) The list is considered by the decision makers and amended as necessary.

2.4.4. Durban

The Durban Metropolitan Authority have divided their projects into two categories:

(a) On-going projects - these are projects on which money has been spent in the previous financial year

(b) Future projects - these are projects which are scheduled to start in the current financial year.

Each of these categories is further divided into three sub-categories:

The maintenance, minor works and public transport works are not generally given a priority except as follows:

(a) Priority is given to those projects which improve or promote public transport. The DOT manual on the cost/benefit analysis of public transport projects (DVV 1985) is occasionally used to evaluate some public transport projects.

(b) Minor works are funded on a first-in-first-out basis. All these minor projects should contribute to the transport goals of mobility, reasonable costs, minimum side effects and convenience.

(c) Projects are furthermore funded in such a way that equity and fairness to the various Local Authorities is achieved.

Road projects are given a priority by the following method:

(a) Each Local Authority gives a priority to the projects in their area. The priority method is the choice of the Local Authority and the Core City assumes that it reflects the needs and preferences of the local community. These priorities are reviewed every six months by the Core City.

(b) All the road projects are collated in priority order by the Core City. This new list consists of updating the existing priority list by the following method:

    (i) When a project has been completed or postponed it is deleted from the list.

    (ii) Any changes in priority order between projects are taken into account.

2.4.3. Cape Town

The Cape Town Metropolitan Authority goes through a detailed project identification procedure during which the project is identified as:

Maintenance.
Road project (the route does not include a bus route).
Road project (the route includes a bus route).
Commuter parking.
Other parking.
Bus terminus.
Modal transfer project.
Minor transport project.

Minor transport projects are projects such as pedestrianisation and bicycle projects. (CAPMET 1990).

The projects are assessed under four major headings:

a) Maintenance. These projects only receive Provincial moneys.

b) Minor works, including minor public transport projects.

c) Major public transport projects.

d) Road projects.

This order of project categories is also the priority order to which subsidies are allocated.

CRITERIA	WEIGHT
Level of service	57
Road Classification	13
Traffic volumes	8
Traffic growth	3
Reduction of accidents	13
Reduction of accident rate	6
TOTAL	100

Table 2.4 The Bloemfontein Criteria and Weights.

A subjective scoring system has been developed which allows each project to be rated out of 10 for each of the criteria.

The scores of each criteria for the projects are multiplied by the weight. The weighted scores are then totalled for each project. The projects are then sorted in decreasing order.

Only projects having a capital cost of more that R500 000 undergo an economic analysis. The items taken into account in this economic analysis are, construction costs, maintenance costs, operating costs, accident costs and time costs.

Some of the smaller local authorities are allocated moneys for projects which do not qualify for money, according to the prioritisation methodology, in an attempt to gain equity in funding.

2.4.2. Bloemfontein

The methodology used by the Bloemfontein Metropolitan area divides the implementation projects into two categories, namely; public transport projects and private transport projects (Bloemfontein 1990).

The public transport projects are not given a priority but are given preference over any private transport projects.

The road projects are given a priority.

A utility analysis methodology, recommended by the Department of Transport (1980), is used. Initially fourteen objectives relating to Bloemfontein were selected and pre-determined weights were supplied to these objectives. These weights were adjusted to take into account the fact that public transport projects were not included.

Criteria were selected for the measurements of each objective. When there was more than one criteria for an objective, the weight of the objective was distributed between the criteria.

Over a period of time, following discussions and testing, the fourteen objectives were reduced to six. These six were given weights according to the totals of their partial weights.

The criteria and weights are shown in Table 2.4.

2.4 Methods Used in the Metropolitan Areas of South Africa.

2.4.1. Introduction

There are eight metropolitan authorities in the republic, namely:

Bloemfontein.
Cape Town.
Durban.
East Rand.
Johannesburg.
Port Elizabeth.
Pietermaritzburg.
Pretoria.

The methodology used by these metropolitan authorities for giving a priority to their transportation projects is looked at in detail. The Johannesburg methodology is the last to be studied.

In 1980 the Department of Transport issued the 'Guidelines and requirements for the preparation of an Urban Transport Plan'. Since then these guidelines have been interpreted in a different way by each of the Metropolitan areas.

The Committee of Urban Transport Authorities (1990) commissioned Jordaan and Joubert to conduct a study into the different methods of priority assessment used by the Metropolitan Authorities. Much of the following work of this chapter is based on their report. Where the information is unclear the Core City officials of the area were contacted directly.

a) That the sensitivity is controlled by the order in which factors are chosen for sub-setting.

b) There is no need for the determination of weight in the basic form.

c) Inaccurate and subjective data can be used.

d) It is flexible and easy to use.

e) An in-depth knowledge of how the data were collected is not needed.

f) The iterative nature of the process facilitate the analysis of many projects.

Shaffer and Fricker (1987) have highlighted several disadvantages of the methodology they are:

a) Because of the subjective or approximate basis of the data, inaccuracy and inconsistency among the decision makers can occur.

b) The weighting of categories of similar importance is difficult and in the opinion of the author of this dissertation, poorly explained in the literature.

c) If a project scores badly in the first subset it cannot regain the ground it has lost no matter how well it scores in other categories.

d) It is hard to rate different types of transport projects as the major category for say a road project may not be the same as that of a public transport project.

		PUBLIC TRANSPORT PROJECTS	%	PRIVATE TRANSPORT PROJECTS	%
1979	000'R	1645,5	21	6301,8	79
	No	11	27	29	73
1980	000'R	4786	27	12767	73
	No	16	21	62	79
1981	000'R	2443	13	15641	87
	No	N/A		N/A	
1982	000'R	3035	46	6558	54
	No	N/A		N/A	
1983	000'R	Information not available			
	No				
1984	000'R	116	2	9478	98
	No	3	12	21	88
1985	000'R	2050	21	7741	79
	No	3	11	24	89
1986	000'R	6670	24	20873	76
	No	16	25	49	75
1987	000'R	16085	31	35650	69
	No	20	36	35	64
1988	000'R	13405	15	79299	85
	No	27	21	102	79
1989	000'R	8575	11	68822	89
	No	33	40	49	60
1990	000'R	23928	21	927[illegible]0	79
	No	22	28	57	72
1991	000'R	20490	16	108615	84
	No	30	36	53	64

Table 2.8 Analysis of Types of Projects 1979 to 1991.

first identified as projects of importance to the metropolitan area. This identification is arrived at by either the historic inclusion of the project in the Concept 2000 document (JOMET 1984) or from approval given by the Technical Liaison Committee (TLC) for the area.

2.5.2. Analysis of Past Usage

The proposed expenditure on proposed public and private transport projects, during the period 1979 to 1991, is shown in Table 2.8. The amounts shown are for projects which were approved by the TLC as being of metropolitan significance.

It can be seen that a very high percentage of the submitted projects and proposed expenditure was related to private transport projects, although approximately 70% of trips to the Johannesburg Central Business District (CBD) during the morning peak period are by public transport.

The significance of this 70% is realised when it is noted that the allocation of priorities is to the morning home based work trips and that the Johannesburg CBD, although only 60% of its potential available floor area is used, at present attracts more than 10 times the number person trips than the next major trip attractor in the metropolitan area.

The final project score is determined by multiplying the project total by the project urgency factor.

The projects are then given a priority from the resultant number in descending order.

2.4.9. Summary

With the exception of Durban the methods used are utility analysis with varying numbers of criteria. This utility analysis is usually in the form of a sufficiency rating. Durban gives a priority to its projects by giving each project a traffic demand indices based on economic analysis. Durban also attempts to assess in detail the effects of the traffic volumes on the network.

Many of the Metropolitan authorities allocate a portion of money to all the local authorities in the area even if the local authority does not have a project above the monetary cut of line on the priority list. This may indicate a perceived need to firstly, fund small projects which with the present rating systems would not score very highly and secondly, to ensure that the smaller local authorities show interest in the workings of the Metropolitan areas and continue to support the system of strategic transport planning.

2.5 The Johannesburg System.

2.5.1. Introduction

The projects which are put on the annual priority list are selected from the first year of the five year implementation programme. This implementation programme forms part of the Interim Transport Plan and is updated on an annual basis. The projects are

Criteria	Wt
Importance of providing this service.	5,1
Statutory requirements.	3,7
Degree of commitment.	2,8
Safety of the community.	3,0
Direct income benefit for the Council.	1,7
Avoidance of Council expenditure.	1,6
Cost benefit to the public.	2,0
Community benefits.	2,9
Quality of the environment.	1,4
Educational or training benefit.	1,8
Leisure value.	1,7
Informational value.	1,0
Necessity for higher rates.	-1,0
Necessity for additional personnel or equipment.	-1,0

Table 2.7 Pretoria Criteria and Weights.

The criteria are scored for each project. These scores are then weighted from the table and totalled. A project urgency factor is applied as follows:

- If the project starts during the second year for which the assessment is made the factor is 2.

- For every year that the project could be delayed deduct 0,1

3. Projects on which funds have been spent already, in priority order.

4. New projects on which no expenditure has yet been made, in priority order.

The system used for priority assessment of metropolitan projects in groups 2, 3 and 4 above is the same as that used by Pretoria City Council.

Once the project has been assessed as falling into one of the major groups it is further allocated to one of three sub-groups. These sub-groups are:

1. Those projects for which a contract has been signed or a tender accepted.

2. Those projects that have historically been accepted by the Pretoria City Council as a continuous responsibility.

3. General projects, which are to be given a priority.

The general projects are given a score on a 5-point scale for 14 criteria. These criteria are each given a weighting as shown in Table 2.7.

Assessment Factor	Measurement Criteria	Wt.
Traffic congestion.	V/C during peak hour.	25
Economic efficiency.	Veh. running cost savings per unit construction cost.	25
Accessibility.	Savings in daily passenger travel time.	20
Road Condition.	Pavement Management System condition index.	18
Social Environment.	Residents benefiting minus adversely affected residents.	13

Table 2.6 Port Elizabeth Assessment Factors.

2.4.8. Pretoria

The Pretoria Metropolitan Area has divided it's projects into four major groups. These groups in descending order of priority are:

1. Special projects for which no priority is assigned.
2. High priority projects. These are projects that:

   (a) Supply highly effective capacity.

   (b) Optimise existing facilities.

   (c) Provide facilities essential to the functioning of the system.

   (d) Facilities for modes not reli t on external energy sources.

The non-road projects, which comprise minor works and *ad hoc* capital works, are given a subjective priority rating based on the ranking of existing projects in the 1989/90 Transport Plan Amendment and the urgency of the new projects.

The committed road projects are funded before any new road projects.

The remaining road projects are given a priority as follows:

1. Five assessment factors have been developed which have been given a weighting by the Technical Liaison Committee (TLC). These factors were selected to reflect the goals, objectives and policies of the PEMET Transport Plan.
   The weighting was undertaken on an individual basis by members of the TLC, distributing 100 points between the assessment factors.

2. Each road project is scored out of 10 for each of the assessment factors. These scores are then normalised by awarding 10 to the highest scoring project.

3. The score is then multiplied by the weighting assigned to each factor and the factor scores are then totalled to give a priority rating index.

4. The projects are then ranked in descending order according to this index.

The factors along with their weighting are shown in Table 2.6

A high score is allocated 5 points, a medium score is allocated 3 points, a low score is allocated 1 point and a not applicable is allocated 0 points.

The project is then assessed against three major objectives which are rated in priority order. These objectives are such items as safety. Each of these objectives contains five sub-objectives, these sub-objectives are such items as, 'the reduction of accidents'.

The projects are then rated in this same high, medium, low and not applicable way against eight criteria which reflect the project significance and six criteria which reflect the project impact.

The scores are added for each project to obtain an initial total score. To this total is added two bonus points for each non-zero score in the first set of objectives and one bonus point for each non-zero score in the second set of objectives. The projects are then ranked in descending order of their total score.

2.4.7. Port Elizabeth

Port Elizabeth Metropolitan Area has divided it's projects into five groups (PEMET 1990) these are:

- Planning and administration.
- Infrastructure maintenance.
- Expropriation and demolition.
- Minor works.
- Capital works.

This allocation process is iterative as some of the projects may initially be allocated more than the maximum allowable subsidy as set down by the DOT or Natal Provincial Administration (NPA) as set out in Table 2.5.

Type of Project	DOT %	NPA %
Road	60	10
Public Transport	60	20
Signal	50	10

Table 2.5 Percentage Subsidies of Projects.

Priority ranking for (c) above is undertaken as follows. An 'Implementation Assessment Form' is completed for each project which gives details of the project.

From this information the project is rated against four goals:

(i) Mobility.

(ii) Convenience.

(iii) Reasonable cost.

(iv) Minimal side effects.

The rating is done on the basis of high, medium, low or not applicable.

2. Road projects.

3. Public transport projects.

The available subsidies are divided amongst these groups as follows:

Low budget projects, 10%.
Road projects, 30%.
Public transport projects, 60%.

Group 1 low budget projects are not given a priority ranking and to date all projects in this group have received subsidy. Any moneys over go to the other two groups.

The moneys are allocated to the road projects and public transport projects as follows:

(a) 25% of the money is divided equally between all the proposed projects.

(b) 25% of the available money is divided proportionally to the project cost.

(c) 50% of the money is allocated between the three highest ranked projects on the following basis:

- 50% to the first ranked project.
- 30% to the second ranked project.
- 20% to the third ranked project.

$P_{I_{min}}$ = the smallest priority value obtained among the set of projects being reviewed.

$P_{I_{max}}$ = the largest priority value obtained among the set of projects being reviewed.

The resulting priority indices for the projects are normalised between the range of 0 and 10. A benefit matrix is then developed for the top 30 implementation projects these are listed in descending order of the normalised priority indices, and subjective rating are provided for the following criteria:

(i) Degree of prior commitment.

(ii) Impact on system continuity.

(iii) Consistency with regional planning.

(iv) Socio-political desirability.

(v) The subjective importance rating that the relevant Local Authority gave to that project.

The rating is given as high, medium or low, as in the case of the Sweet procedure.

2.4.6. Pietermaritzburg

Pietermaritzburg Metropolitan Authority (PMBMET 1987/92) divide their projects into three groups:

1. Low budget projects which cost less than R50 000.

$$P_i = W_{ki} W_{gi} W_{hi} \sum_{s=1} W_s \left[\frac{\sum_{Ci=1}^{N_{csi}} R_{ci} W_{ci}}{N_{csi}} \right]$$

where, P_i = initial priority value for project

W_{ki} = weighting of category k for which project i is relevant

W_{gi} = weighting of sub-category g for which project i is relevant

W_{hi} = weighting of sub-sub category h for which project i is relevant

W_s = 6,9 for problem severity criteria or 6,5 for project performance criteria

N_{csi} = number of criteria in subsection s for which the project i is relevant.

R_{ci} = rating of criteria c for which project i is relevant

W_{ci} = weighting of criteria c for which project i is relevant

The PI's for all the projects are normalised to vary between 0 and 10 by calculating the priority index (PI) from:

$$PI_i = \left[\frac{P_i - P_{i\min}}{P_{i\max} - P_{i\min}} \right] \times 10$$

where,

P_i = priority value from the index formula above.

CHAPTER 3

DEVELOPMENT OF THE NEW METHODOLOGY

3.1 Introduction.

Figure 3.1 is an adaptation of Irick's flow chart and is considered more applicable to the Central Witwatersrand Area as it gives more flexibility within any one action. Some of the actions mentioned by Irick, such as Executive and Legislative review, are either not applicable to the structure of the Regional Services Council or can be included in such actions as financial control.

f) Concerning the availability of land, if it is mining or government land which will not be released the project cannot go ahead and so it should not have been put forward for assessment.

The main advantage of the methodology is its ease of application and it must be realised at the time of development, in 1977, there were no other rational methods in use in South Africa.

The system does not address public transport projects, Transport System Management (TSM) projects, maintenance projects, or continuity of funding.

With usage various problems have emerged:

a) The public transport aspects of road projects, only address the bus usage. Since the methodology was developed the Combi taxi has come to the fore as a major form of public transport.

b) The volume/capacity ratio does not have a time scale. There is no indication as to whether the present volumes should be used or future year volumes. This is especially relevant with the time benefit aspects for if the road is fully utilised soon after it is opened it means that it was under-designed.

c) The provision of a paved pedestrian facility is important but many of the poorer councils can only afford to provide a graded, grassed facility, and it may be dangerous on many major routes to have pavements.

d) Concerning relief to adjoining routes, many of the roads put forward for subsidy are the only access to the areas and so can provide no relief to other routes as there are no other routes.

e) If a road is built to the correct standards major maintenance need only be undertaken every 15/20 years and so disturbance to traffic flow is for a relatively short period. If on a major dual carriageway all the two-way traffic can be diverted down one carriageway when the road need maintaining, the facility was very over-designed in the first place.

indicate that an attempt was made to address the economy of the area by emphasising the need to get workers to their place of work during peak periods.

From the random nature of these weightings it can be assumed that they were arrived at in a subjective manner.

Existing Road Upgrade		New Road	
ECONOMIC			
Existing condition	17		
Maintenance	2	8	Maintenance
Traffic	36	30	Traffic
Land Available	4	10	Land Availability
Time Benefit	4	10	Time Benefit
SUB-TOTAL	63	58	
SAFETY			
Pedestrian Facility	6		
Accidents	13	10	Accidents
SUB-TOTAL	19	10	
PUBLIC TRANSPORT			
Usage	14	12	Usage
ENVIRONMENTAL			
Relief to routes	4	20	Relief to Routes
GRAND TOTALS	100	100	

Table 2.10 Weights Used in the JOMET System.

It can be seen from the table that nearly twice as much emphasis is put on the safety aspects of a road improvement project compared to a new road project and that five times as much emphasis is placed on the relief to routes aspect of a new road compared to that of a road improvement project.

(iv) Ease of maintenance - this is similar to the ease of maintenance item of improvement projects except that the allocation of points can range between 0 to 8.

(v) Accident expectation - this item reflects the way in which the new road relieves congestion on alternative routes and the type of route that has been relieved. The score is between 0 and 10.

(vi) Availability of land - up to ten points are allocated to this item and the assessment ranges from mining or Government land which will not be released, to the ground being available in full. The scores for this item range from 0 to 10.

(vii) Time benefit - this item which is allocated 0 to 10 points reflects the period of time to elapse before maximum benefit is gained.

Table 2.10 consolidates the scores and groups then under the general areas of, economics, safety, public transport and environment.

There is a cost/benefit analysis procedure proposed as an annexe to the methodology. The procedure only takes into account travel costs between two alternative routes and so could not be used for most of the projects that have been put forward for priority rating over the years.

There is no documentation available as to how the present weighting was arrived at but the weightings, along with the points allocation sheet and their application guides,

(viii) Time benefit - this is scored from 0 to 4 and reflects the period of time elapsed before the maximum benefit of the project is achieved.

b.) New Major Roads.

The assessment of new major roads is based on ... performance, this is measured by assessing the seven items listed below:

(i) Traffic loading - the points are allocated in proportion to the volume/capacity (V/C) ratio. The maximum points of 30 is allocated to a V/C ratio of 1. There is no indication as to whether the ratio should relate to future or present traffic volumes. It is assumed by Core City staff when assessing the projects that future traffic figures should be used.

(ii) Relief to adjoining traffic routes - this item is given a points weighting ranging from 0 to 20. These points are allocated according to percentage relief to adjoining routes with the maximum points being given to a relief of 58% or over.

(iii) Aid to public transport - the expected public transport usage is reflected in this item. The score ranges from 0 to 12. The first 9 points reflect the likely increase of buses and can be assessed either by the assessing the improvement of service or the expected bus volumes. The remaining three points are allocated to bus priorities or bus lanes.

increased bus accessibility which is allocated four points to a permanent bus lane.

(iii) Accident expectation - this item reflects the improvements to the road which will assist in the safety of the vehicle users and pedestrians. It includes such details as alignments, provision of central islands, and turning bays. The weighting is from 0 to 6.

(iv) Pedestrian facilities - the proposed future facilities for pedestrians are measured from 0 to 4. The score is based mainly on the provision of a paved sidewalks.

(v) Relief to adjoining roads - this item measures the relief to adjoining routes the score which ranges from 0 to 4 is allocated on a percentage of relief to these adjacent routes. The amount of relief can be assessed either from transportation studies or subjectively.

(vi) Ease of maintenance - the ease of maintenance is scored out of 2 points. The minimum value of zero is allotted to a single carriageway whilst two points are allocated to a dual carriageway of which half can be closed while maintenance is undertaken.

(vii) Availability of land - as the title implies this item measures the availability of land, from land which will not be released through to all the required land being available. The scores for this item range from 0 to 4.

categories the highest of which is allocated eighteen points.

(v) Geometric alignment - the condition of the alignment of the existing road is allocated three points from four categories.

(vi) Accident record - the average accident records are used to give an average equivalent accident number. The score ranges from zero to seven. With this system the types of accidents are allocated points:

fatal	10
serious	5
minor	2
no injury	1

(vii) Public transport rating - this item is based on the number of buses which use the route. The anticipated maximum number of buses is fifty in the peak hour in both directions. This maximum number is allocated six points.

The project performance items are:

(i) Level of service - this like traffic loading is based on volume/capacity ratio using peak hour, off-peak and intersection rating. The maximum points are eighteen.

(ii) Public transport measures -this item, which is allocated a maximum of eight points, ranges from no improvement, no points, through

b.) New road projects.

a.) Existing Road Projects.

The items to be considered when assessing the improvement of an existing road are divided into present condition and project performance.

The present condition items are:

(i) Pavement condition - this item is given a total score, or weighting as it is termed on the marking sheets, of ten points. The score is divided into six categories ranging from a road which has been reconstructed within the last four to five years to a carriageway which requires reconstruction.

(ii) Surface water drainage - the drainage is given a total score of four points from three categories. The minimum score of zero is given when there is adequate drainage and the maximum of 4 is given where there is standing water extending in the channels for more than 500 mm from the edge of the channel for some time after the rain has ceased.

(iii) Pedestrian facilities - this criteria is allocated two points and is measured in three categories from the situation where there is a sidewalk to where there is no pedestrian facilities.

(iv) Traffic loading - this item is measured in one of two ways either out of three categories which are allocated six points each and a project can fulfil all three categories or out of five

(iii) Second claim - public transport:

These are public transport project which have not received an allocation from the UTF funding in the previous financial year.

(iv) Second claim - private transport:

These are private transport projects which have not received an allocation from the UTF funding in the previous financial year.

Urban Traffic Control (UTC) systems are classified as first claim public transport projects.

One of the major problems with this classification, is that although a project in the fourth group may be given a significantly higher priority rating than any project in the second group there is very little chance of it ever receiving moneys.

2.5.4. *Present Priority Methodology*

The full documentation of the priority rating system is given in Appendix A

The present methodology, which is a sufficiency rating system, was developed by Carlisle and Webster in 1979. The system entails scoring the projects on rating sheets. Points are given for both problem severity and project performance. The projects are then ranked in descending order of the scores.

The private projects are divided into two:

a.) Existing road projects.

2.5.3. Present Distribution of Moneys

During 1988 it was decided by the TLC that the priority list be divided into four sections. These sections in priority order are:

(i) First claim - public transport.

(ii) First claim - private transport.

(iii) Second claim - public transport.

(iv) Second claim - private transport.

The definition of these sections is:

(i) First claim - public transport:

These are public transport projects for which money was allocated to and spent in the previous financial year. If the local authority does not spend all the moneys allocated to a project in this section, any moneys over may be spent on any other project the local authority has within this category. This has the disadvantage that local authorities may spend minimal amounts on projects just to keep them in this category and then allocate the money to some other project.

(ii) First Claim - private transport:

These, like the first claim public transport projects, are termed on-going projects for which moneys were allocated and spent in the previous financial year. Also similar is the spending of minimal amounts on a project to ensure that it remains in this category.

It can also be seen that there was a sharp increase in anticipated expenditure from 1986. This may be because of the substantial increase in the Urban Transport Fund (UTF) from that time, as shown in Table 2.9.

YEAR	79/80	80/81	81/82	82/83
UTF	R3.78M	R4.53M	R5.03M	R3.37M
YEAR	83/84	84/85	85/86	86/87
UTF	0	R0.1M	0	R20.9M
YEAR	87/88	88/89	89/90	90/91
UTF	R21M	R23M	R18M	R11.77M

Table 2.9 UTF Available For JOMET Projects 1979/1991

Up to and including the 1985/86 financial year the public transport projects were slotted into the priority list on a subjective basis. The following year the list was divided into two sections, public transport and private transport. The public transport projects were not assessed in priority order but were allocated moneys from any available funding before the private transport projects. If the funding did not provide for all the public transport projects the moneys that were available were allocated on a *pro rata* basis.

With this preference to public transport projects the number of these projects appearing in the five year programmes, submitted by each of the constituent local authorities, increased significantly.

relevant aspects of the problem are selected and weighted according to their relevance to the area. Criteria are then developed to measure how well the project addresses the problem.

The NTPS(1984) identified eleven different issues pertaining to transport which may be looked at when assessing a project, these are:

a) Legal aspects.

b) Policy.

c) Practice, standards, norms and guidelines.

d) Engineering.

e) Finance.

f) Economic.

g) Social.

h) Environmental.

i) Achievement of objectives.

j) Strategic.

k) Political.

(ii) The road should have a design period of 20 years.

(iii) The expected usage, by the year 2005, should be 3000 person trips/lane during the peak hour. These levels of usage may be found from transportation studies or by using an annual compound growth rate of 2,2%.

(iv) Additional works, such as bridges, landscaping and storm-water facilities should be considered as part of the whole project and must be included in the estimate.

(e) Transport Systems Management (TSM) Projects.

(i) TSM projects, as their name implies, should be a system not *ad hoc* item such as individual signal timings, white lining or individual intersection improvements.

(ii) TSM projects must have had a study undertaken to assess the cost, person volumes, environmental impact and public attitudes, to the proposals before they can be considered as a project of metropolitan worth.

(iii) The expected usage, by the year 2005, should be 3000 person trips/lane during the peak hour. These levels of usage may be found using the same methods as in paragraph (d) (iii).

4.4 Second Stage Assessment.

The second stage assessment is a more detailed analysis of the problems which the projects address, and to what extent these problems have been solved. To do this,

authorities. From information gained during these discussions levels of usage for the different types of project were arrived at. The projects would be required to reach these levels before they went forward to the second stage of analysis.

The proposed levels are as follows:

(a) Taxi facilities:

More than 300 taxis should arrive and depart daily from the facility;
or more than 70 taxis should arrive and depart during the peak hour;
or more than 1000 passengers should be using the facility during the peak hour.

(b) Bus facilities:

More than 128 buses should arrive and depart daily from the facility;
or more than 30 buses should arrive and depart during the peak hour;
or more than 1000 passengers should be using the facility during the peak hour.

(c) Park and Ride facilities:

The facility should be more than 8 km away from the CBD it serves and there must be facilities for 100 cars or more.

(d) Road related projects:

(i) The minimum classification of road should be class 3 road, minor arterial/major collector, as defined in Appendix B1 of "Guidelines for the Provision of Engineering Services for Residential Townships," DCD (1983).

Each project or phase must be clearly defined as must contract goals, in terms of work and time.

Information on how the estimated costs were arrived at and a sketch plan, for each project or phase, must be provided.

Public transport projects must be divided into three types:

(i) Bus projects.
(ii) Taxi projects.
(iii) Park and Ride projects.

Maintenance projects will only be accepted if they form part of a TSM project.

A financial plan for the project must be supplied. This should show where the funds for the project will come from if the UTF cannot supply funds.

4.3 First Stage Requirements.

It was decided by the working group that until the new system had been tested the first stage rating, which was to have been a multi level system of sub-setting, should be a single level system.

The principal reason for undertaking transportation projects is to move people, especially during the peak period, so it was decided that the single category of the first stage analysis should reflect this.

Discussions were held with personnel who worked with the taxi associations, the bus departments, maintenance departments and road departments of the local

CHAPTER 4

PROPOSED METHODOLOGY

4.1 Introduction.

To develop and test the system for the area it became necessary to set up a working group. This group reported to the Technical Liaison Committee.

The author chaired this group.

4.2 Basic Principles.

The first undertaking was to lay down certain principles about the acceptance of projects for priority assessment, these were:

Each project must be a stand alone project. If the project is divided into phases, each of these phases must stand alone i.e. benefit is gained from a project or phase even if the project or phase does not continue.

Bridge projects will not be considered as stand alone projects or phases unless they are immediately usable with no further construction work necessary.

Each stand alone project or phase when completed, would not be considered as an on-going project when assessing the next phase.

The second stage analysis uses a sufficiency rating methodology. The issues which have an influence on transport, or transport has an influence on, are selected and weighted against each other. Assessment sheets which reflect these issues are developed.

The use of the first level will reduce the use of resources as described in item c. The remaining items from a to g will be addressed in the more detailed analysis of the second level.

With the weighting of the issues that are relevant to transport rather than the criteria which are used to assess these issues it will be easier to reflect any changes that society puts on these issues. This addresses items h, i, and k. The issues should also reflect the goals and objectives of the area to satisfy item j.

The first stage analysis, although using the Sweet principles of short listing the projects, does not use his methodology as it is agreed with Wilmot that the method is too coarse to be acceptable to the decision makers in the area.

It is proposed that, for the first stage analysis, a single category, single level form of sub-setting be use for each type of project i.e. private transport projects (roads), public transport projects, TSM projects and maintenance projects.

The category decided upon would be the most significant for that type of project, as selected by the decision makers in the area.

Once the amounts of money available is known, the projects whose accumulated value falls within the appropriate level, will undergo the more detailed analysis. The system is illustrated in Figure 3.2.

The vertical axis gives the accumulative value of the projects. In the illustration the available funds run out between levels 2 and 3. All the projects below the third level, i.e. levels 1 and 2 go forward for further analysis.

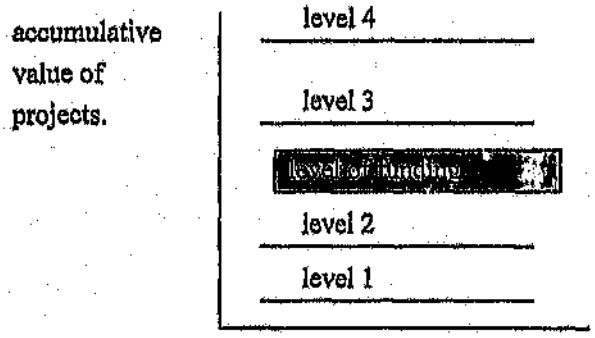


Figure 3.2 Project Levels relative to funding.

(h) Durability:

Any methodology must be durable that is, it must be able to stand up to changing situations.

(i) Flexibility:

The method must be flexible enough to be adaptable to any situation which surpasses the durability of the system.

(j) Goals and objectives:

The method must be in keeping with the goals and objectives of the area, as set out in the LUTSPLAN for the area.

(k) Weightings:

It is important to ensure that the correct weighting procedure is undertaken. The municipalities should be represented in proportion to their population.

3.4 The Proposed System.

To address the problems highlighted in 3.3 it is proposed that a two stage priority system be used.

The first stage is similar to the principles proposed by Sweet in that it short lists the projects to go forward to the second stage analysis.

The figures indicate that an enormous amount of resources in terms of time and money went into assessing projects which had little or no chance of receiving moneys.

Of the projects assessed only one third managed to score more than 75% of the marks available from the rating system.

(d) Environment:

The environmental lobby, which was negligible in the 1970's, is now a prominent force which must be addressed, in both the richer and poorer areas.

(e) Continuity of funding:

The continuity of funding of projects must be addressed, it is enormously expensive to re-start a project which has been interrupted through lack of funding.

(f) Public transport:

Approximately 70% of the work force, in the area, use public transport, including taxis, to get to work.

(g) TSM and maintenance:

With the present monetary constraints best use of existing facilities should be promoted by encouraging appropriately formulated TSM and maintenance projects.

The CWRSC area has some very pronounced problems, many arising from the large socio/economic gap between the wealthy, skilled, upper income, white population and the poor, unskilled, lower income, black population. These problems are;

(a) The lack of data:

In most of what were the white suburbs there are large amounts of reliable data available, but in many of what were the black areas there is little if any data on such items as accidents, income levels, environmental values, car usage or even population.

(b) The modal split:

There are large differences in modal split within the area. A peak hour traffic count in the northern suburbs gave a volume of 1200 vehicles. The modal split and occupancy statistics for the area gave a usage of 1900 persons, whilst a count of 1900 vehicles on Immik Road in Diepmeadow, when taking modal split and occupancy for this area into account, gave a person count of 25 000 persons during the peak hour.

(c) The lack of resources:

In the financial year 1991/92 local authorities requested subsidies, from the Urban Transport Fund for 82 projects, 31 of these were public transport project which were not given a priority. Of the remaining 51 projects, which were allocated a priority, only 4 (7,8%) received subsidy. The total moneys requested amounted to over R50M. The moneys received amounted to R10M.

From the assessment sheets of the present methodology it can be seen that only the peak period movements of motor vehicles on roads are addressed. This indicates that there are issues that are either poorly addressed or not addressed at all.

Some of these issues were highlighted in chapter 2. The full list is shown below:

(i) Public transport projects.

(ii) Transport Systems Management (TSM) projects.

(iii) Maintenance projects.

(iv) Continuity of funding.

Items which are poorly addressed by the present system are:

(i) The volume/capacity aspects.

(ii) Pedestrian facilities.

With these issues in mind it was decided that the present method because of inflexibility, could not be satisfactorily adapted to address these items and so a new system was required.

3.3 The Problems Of The Area.

All areas have problems some of which may be unique to that area. Any priority system should address these problems.

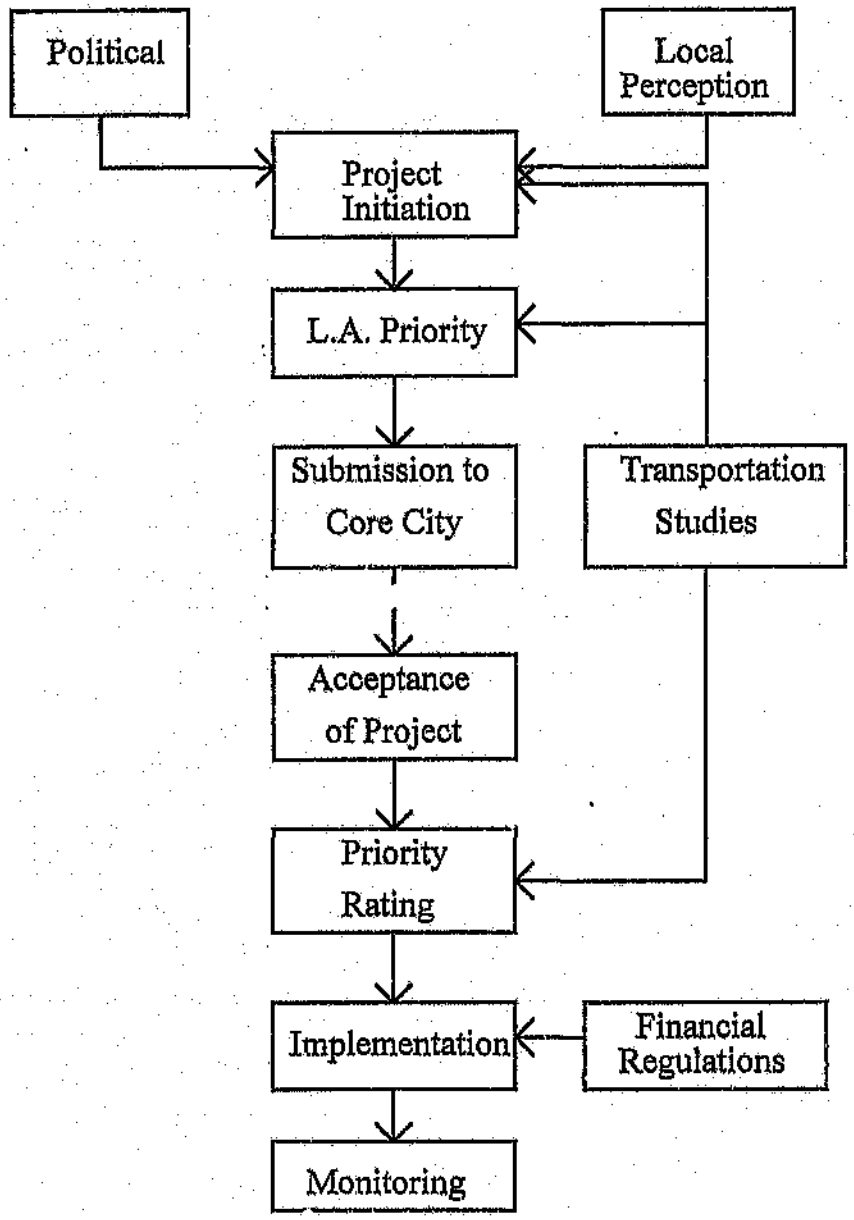


Figure 1.1 Project Programme Flow Chart-Central Witwatersrand.

3.2 Why A New Methodology ?

If the present method has been used for the past twelve years why develop a new system?

The aggregated weighting for the questionnaire was undertaken using an EXCEL spreadsheet. The results are shown in Table 5.1.

Question No.	Aggregated Weight
1	0,4526
2	1,7048
3	1,8369
4	0,8565
5	0,4375
6	0,3169
7	1,3919
8	1,6799
9	0,7493
10	3,1154
11	0,8553
12	1,6431
13	0,0101
14	1,1730
15	0,7930

Table 5.1 The Aggregated Weights.

A copy of the full spreadsheet is shown in Appendix D.

The population ratios, which were obtained from the Metropolitan Planning Department of Johannesburg City Council, are shown in Appendix E.

$$r_j = \prod_{i=1} r_{i,j}$$

that is: $r_j = r_{1,j}^{w_1} x r_{2,j}^{w_2} x r_{3,j}^{w_3} x, \ldots\ldots r_{n,j}^{w_n}$

this may be written:

$$\ln r_j = \sum_i w_i \ln r_{i,j}$$

or: $$r_j = \exp \sum_i w_i \ln r_{i,j}$$

This methodology is best illustrated by example:

L.A.	Relative Population	Pair Comparison Score
1	60% (.6)	1/3 (.3)
2	20% (.2)	3
3	20% (.2)	1/5 (.2)

$$= w_1 \ln r_{1,j} + w_2 \ln r_{2,j} + w_3 \ln r_{3,j}$$

$$= 0.6 (\ln 0.3) + 0.2 (\ln 3) + 0.2 (\ln 0.2)$$

$$= 0.6(-1.2040) + 0.2 (1.0986) + 0.2 (-1.6094)$$

$$= -0.7224 + 0.2194 - 0.3219$$

$$= -0.8245$$

so $r_j = \exp (-.8245)$

$= 0.4384$

The scores given to each comparison was based on a natural logarithmic scale.

From left to right the score as answered read; -2, -1, 0, 1, 2. For analysis it read; ln -2, ln -1, ln 0, ln 1, ln 2, which approximated to; 0,14, 0,3, 1, 3, 7.

Johannesburg officials completed the questionnaire independently of each other. Before analysis these results needed to be combined to give a unified score for each comparison.

To do this the following method was adopted;

If r_j is the unified weighting for j then,

$$r_j = \exp \frac{\sum_n \ln r}{n}$$

where r is the individual weighting,
and n is the number of answers.

The scores from each local authority were weighted according to the residential population of that local authority.

So letting $P = \sum P_i$

where P_i is the population of the local authority (LA) i, then,

$$w_i = \frac{P_i}{P}$$

To aggregate these weightings let r_{ij} be the ratio for issue j for L.A. i, then the weighted aggregate ratio for j will be:

5.4.6. Randburg

The Town Engineer, the Deputy Town Engineer and the Assistant Town Engineer from the roads and storm water division, discussed the issues and arrived at a combined set of results.

5.4.7. Roodepoort

The Deputy City Engineer completed the questionnaire.

5.4.8. Sandton

The Deputy Town Engineer completed the questionnaire.

5.4.9. Soweto

The Senior Assistant Engineer and the Assistant Engineer completed the questionnaire individually and then arrived at a combined set of results.

5.5 Analysis.

It can be seen from inspection, that the set out of the matrix shown in Appendix C does not conform to the set out shown in 5.3. This non-conformity was to give a more random nature to the questionnaire.

Before any analysis could be undertaken the questions were arranged so as to conform to the 5.3 lay-out, e.g. comparison 7 reads D - B whilst for analysis it should read B - D.

After several minor changes the questionnaire took the format shown in Appendix C.

The response to the questionnaire by each local authority, is described below:

5.4.2. Alexandra

The questionnaire was completed by the city engineer, using advice requested from one of his assistants.

5.4.3. Diepmeadow

In the absence of the city engineer his assistant along with the Chief Traffic Officer and Engineering Advisor, completed the questionnaire individually discussed their answers and arrived at a single combined set of results.

5.4.4. Dobsonville

The Town Clerk, and two of his assistants submitted a combined set of results.

5.4.5. Johannesburg

The questionnaire was completed by four City Council officials, the acting Director Metropolitan Planning, the acting Deputy Director Metropolitan Planning, the acting Assistant Director Metropolitan Planning (road planning and traffic engineering) and the Chief Professional Officer (public transport).

Their individual results were combined into a single set by the method shown in 5.5.

$$\frac{n^2 - n}{2}$$

where n is the number of issues to be weighted.

In the methodology the number of issues is 6 and the number of questions is 15.

The pair comparisons are shown below:

A-B	A-C	A-D	A-E	A-F
	B-C	B-D	B-E	B-F
		C-D	C-E	C-F
			D-E	D-F
				E-F

Where :

A is problem solution.

B is economic.

C is environmental.

D is financial.

E is social.

F is problem severity.

5.4 Application.

5.4.1. Introduction

The questionnaire was first tested using core city staff.

A_1	A_2	A_3	A_4	A_5	A_6
B_1	B_2	B_3	B_4	B_5	B_6
C_1	C_2	C_3	C_4	C_5	C_6
D_1	D_2	D_3	D_4	D_5	D_6
E_1	E_2	E_3	E_4	E_5	E_6
F_1	F_2	F_3	F_4	F_5	F_6

1 is the most and 6 is the least relevant question.

The format for the questionnaire was:

A_5	F_4	E_3	D_2	C_1	B_6
B_5	A_4	F_3	E_2	D_1	C_6
C_5	B_4	A_3	F_2	E_1	D_6
D_5	C_4	B_3	A_2	F_1	E_6
E_5	D_4	C_3	B_2	A_1	F_6
F_5	E_4	D_3	C_2	B_1	A_6

This arrangement of the questions was to ensure that the respondent was orientated into the field of transportation and that no issue dominated the questions.

As the purpose of this questionnaire was only orientation the answers were not analysed.

In the second questionnaire, which was used to analyse the weightings, each issue was compared with every other issue.

The number of questions needed to accomplish this is given by the formula:

A level of inconsistency of up to 0,8 is acceptable.

The system is shown by example:

If A = 20B and B = 20C then A should = 400C.

If A actually = 380C, it is acceptable.

If A actually = 350C, it is not acceptable.

This method was used in preference to the usual linear scale method of weighting as with a linear scale it is normal to give a weighting to an issue by comparing it with the issue that has just been given a weighting not against all the other issues.

The linear method questionnaire was, however, used to orientate the respondents to transport related matters.

5.3 Questionnaires.

Two questionnaires were used. The first, as stated above, was to orientate the respondent to transportation related projects.

The second was used for the weighting of the different issues.

An example of the first questionnaire is shown in Appendix B.

The basis of this questionnaire is that the questions are divided into six sets, one for each issue. The matrix of the questions is shown below:

CHAPTER 5

WEIGHTINGS

5.1 Introduction.

The different issues of a project; financial, economic, social, environmental, problem severity and problem solution, need to be given a weighting which reflects their importance to the area. To ensure that the methodology is flexible the method of obtaining these weightings should be such that it can be revised as and when required.

To ensure that the method is equitable the total weighting should be a composite of the individual weighting of each local authority in proportion to its population.

The weighting was undertaken initially by council officials from the constituent local authorities of the metropolitan area who are involved with the transportation projects, in the area.

5.2 Methodology.

The method selected for finding the weights was the Analytical Hierarchical Process (AHP) (Saaty 1978). With this method each issue is compared against every other issue.

Inconsistencies in comparisons are measured against an acceptable value. If this value is not met the questionnaire will need to be reassessed.

mode of transport. The 1989 public transport study of the Greater Soweto area found that 30 000 people used taxis to commute to work, yet there was only one official taxi rank in the area, and even that facility had no exclusive taxi infrastructure.

Projects should seeks to redress this discrepancy.

(f) Economic.

There has been extensive work done on time costs and vehicle running costs in the area. These costs are used extensively in the transportation models used in the area.

Care must be taken to ensure that the relevant economic benefits are addressed and that duplication does not occur in the allocation of costs and benefits.

The selection of a project because of political reasons or because it is felt all local authorities in the area should receive something so as to give them ownership of the system should not be allowed. If it is thought necessary to use these forms of selection, and it is very likely that political influences will influence the selection of projects, they should form part of the financial control requirements.

stage at which the project is at, i.e. whether the project has been started and if it has at what stage is the construction at. Another indication of commitment is whether the local authority would undertake the project if there were no regional funds available. It is also important that a financial plan has been prepared so that the assumptions used in the costing of the project can be assessed and to assist in the monitoring of the project.

(b) Environmental.

Most transportation projects have an effect on the environment in some way. This issue should reflect the effects of the project on the environment within the community and whether all practical measures have been taken to protect the environment.

(c) Problem Severity.

This issue addresses the present condition of the existing facility. In some cases there may at present be no facility, this should also be taken into account. The existing safety aspects of a facility should also be reflected.

(d) Problem Solution.

This should reflect whether problems identified in the justification of the project have been addressed. This will include safety problems that were identified.

(e) Social.

There is at the moment a large discrepancy in the facilities available to the different economic strata in the area.

It is usually the poorer sectors which use public transport for commute to and from work as they are economically unable to afford to use a private car. The available public transport facilities are insufficient for and do not reflect the numbers using this

The working group studied these issues and selected four as being relevant to the implementation projects in the area. These four are:

i) Financial.

ii) Economic.

iii) Social.

iv) Environmental.

Items; a) Legal, b) Policy, c) Practice, standards, norm and guidelines, d) Engineering, i) Achievement of objectives and j) Strategic, are external items which it must be assumed the projects have conformed to before they were submitted to the TLC for approval. Item k) Political, which may have a major influence on the promotion of projects, should not form part of this priority assessment methodology.

Two additional issues were included by the working group as being relevant to the area. These were:

Problem Severity.

Problem Solution.

The working groups interpretation of the issues is shown below.

(a) Financial.

The financial aspects of a project are concerned with the financial commitment that the relevant local authority has to the project. An indication of this commitment is the

level to which funding will reach. These levels, for the last five years, are indicated to the left of the table

By comparing the highlighted projects with the extent of the funding it can be seen that the first stage analysis encompasses all of the projects that would have received moneys using the detailed analysis of the second stage method.

Next, the weightings arrived at in Chapter 5 are applied to the issues. The first project, the Western Bus Terminus in Roodeport, is shown in detail below.

	Issue	A	B	C	D	E	F	T
Ro 43 Bus Term. West	Unweighted	10	10	10	10	8	10	5
	Weighted	11.2	26.2	17.1	11.6	19.04	10.2	95.34

The weighting factors used are:

A - Financial	1.12
B - Environmental	2.62
C - Prob. Severity	1.71
D - Prob. Solution	1.16
E - Social	2.38
F - Economic	1.02

The full weighted list is shown in Table 7.3. The full scoring details are shown in Appendix G.

47	Jo 13 Wemmer Pan Road	40.5
48	Ro 56 Fairlands	40.5
49	Jo 89 Mary Fitzg,ld Taxi	40.5
50	Jo 69 Crownwood Road	40
51	Ra 16 Bond Street	40
52	Ra 14 Oak Avenue	39.5
53	Ro 102 Peter Road	39
54	Ra 15 Hans Strydom Drive	39
55	Ra 42 Pretoria Avenue	37
56	Ra 12 Jacaranda Street	35.5
57	Jo 36 A3	35.5
58	Ra 8 President Fochc Drive	35.5
59	Sa Boulting Avenue	35
60	Ra 6 Hendrik Verwoerd Drive	34.5
61	Jo 39 Club Street	32.5
62	Sa Katherin/Graystone Int.	32.25
63	Sa 5th Avenue Sandown	31
64	Jo 32 D.F.Malan Avenue	27.5
65	Jo 81 Jan Smuts Avenue	25

Table 7.2 The Un-weighted priority list

The projects which would have been put forward from the first stage analysis, which was based on the requirements listed in section 4.3, are highlighted in bold. An important consideration in deciding the cut-off point for further analysis is the

24	Ro 54 Corlett Drive	45	
25	Dm 10 Dube-Meadowlands Taxi	45	The project to which fundi
26	So 21 Ikwesi Taxi	44.5	would have reached in the
27	Jo Anderson Street	44.5	financial year 1989/90
28	Jo 57 Faraday Bus/Taxi Term.	44	The project to which fundi
29	Ro 46 Mare Road	44	would have reached in the
30	So 12 Old Potch. Road	43.5	financial years 1986/89
31	Ro 26 Ontdekkers Road	43.5	
32	Jo 66 Comaro Road	43.5	
33	Ra 43 Mangaan Road	43.5	
34	So 16 Komo Street	43.5	
35	Dm 3 Vincent	43.5	
36	Ro 32 Jim Fouche Phase 2	43	
37	Ro 34 Wilgerood Phase 2	42.5	
38	Ro 37 J.G.Strijdom Phase 2	42	
39	Jo 7 P73-1	42	
40	Ro 5 Hamburg Phase 2	42	
41	Jo 87 London Road	41.5	
42	Ra 25 Ysterhout Road	41.5	
43	Ro 7 Hoofd Road	41	
44	Jo 84 A5	41	
45	Ro 100 H.Potgieter/W.Nicol Rd.	41	
46	Jo 82 M2	40.58	

Position	Project name and number	Score.	
1	Ro 43 Western Bus Term.	58	
2	Jo 52 Long Dist. Taxi	55	
3	Jo 90 Eldorado Bus/Taxi Term.	53	
4	Dm 7 Immik Drive	52.5	
5	Ro 17 Westlake Phase 1	51.5	
6	Jo 72 Lenasia Rose Av.	51.5	
7	Dm 9 Barogwanath Bus Term.	50	
8	Jo 28 Noord St. Bus Term.	50	
9	So 23 White City Taxi	49.5	
10	Jo 16 S.W. Bus-way	49.5	
11	Jo 58 Soweto Highway	49	
12	Ro 40 Westlake Phase 2	47.5	
13	Do 2 Indinglilizi Taxi	47.5	
14	Jo 48 Newtown Bus Term.	47	
15	Ro Gordon Road Phase 2	46.5	
16	Do 1 Jonas Taxi	46.5	
17	Jo 50 Westgate Bus Term.	46	
18	Ro 101 Van Wyk Rd. West	46	
19	So 22 Maruti Taxi	45.5	The project to which money
20	Ra 3 River Road	45	would have reached in the
21	Ra 1 Republic Road	45	financial year 1991/92
22	Ro 9 Maraisburg Road	45	
23	Ra 38 Taxi/Bus Facility	45	

For the purposes of this paper all the projects put forward in the 1992/93 financial year were analysed in detail so that an assessment of the level reached by the projects that would have been put forward for the first stage analysis can be made.

During September 1991 each of the constituent local authorities in the area was visited and the relevant assessment sheets completed with the assistance of local authority officials for each project. No problems were encountered.

Johannesburg did have sufficient information to put forward a TSM project but decided not to.

The un-weighted assessment sheets of each project were totalled and these totals were then put in priority order.

The un-weighted list of projects is shown in Table 7.2.

Jo 50 Westgate Bus Term.

Jo 52 Long Dist. Taxi

Jo 57 Faraday Bus/Taxi Term.

Jo 58 Soweto Highway

Jo 66 Comaro Road

Jo 72 Lenasia Rose Av.

Jo 90 Eldorado Bus/Taxi Term.

Ra 1 Republic Road

Ra 3 River Road

Ra 38 Taxi/Bus Facility

Ra 43 Mangaan Road

Ro Gordon Road Phase 2

Ro 101 Van Wyk Rd. West

Ro 17 Westlake Phase 1

Ro 26 Ontdekkers Road

Ro 40 Westlake Phase 2

Ro 43 Western Bus Term.

Ro 46 Mare Road

Ro 54 Corlett Drive

Ro 9 Maraisburg Road

So 12 Old Potch. Road

So 16 Komo Street

So 21 Ikwesi Taxi

So 22 Marafi Taxi

So 23 White City Taxi

Table 7.1 Projects that the First Stage Analysis Would Put Forward for further Analysis.

CHAPTER 7

APPLICATION

7.1 Introduction.

The system was applied to the project list put forward for the 1992-1993 financial year.

7.2 The Lists of Projects.

A first stage analysis of all the projects using the requirements set out in Chapter 4 was undertaken. The projects which would have been put forward for further analysis are shown, in alphabetical order of the towns or cities, in table 7.1.

Dm 10 Dube-Meadowlands Taxi

Dm 3 Vincent

Dm 7 Immik Drive

Dm 9 Baragwanath Bus Term.

Do 1 Jonas Taxi

Do 2 Indingilizi Taxi

Jo Anderson Street

Jo 16 S.W. Bus-way

Jo 28 Noord St. Bus Term.

Jo 48 Newtown Bus Term.

The public transport address the aspects of passenger comfort and safety.

The park and ride projects look at the security and convenience of the facility.

6.6 Social.

The assessment sheets reflected firstly the income levels of the community being served by the facility and secondly, the extent to which the facility serves public transport, as public transport users are predominantly a captive clientele.

6.7 Economic.

As stated in chapter 4 care must be taken not to duplicate the economic analysis undertaken by any modelling work on the different projects. Account must also be taken of the disadvantages of economic analysis highlighted in chapter 2, especially the costs involved in data collection.

The method decided upon by the committee was to divide the capital cost of the stand alone project or phase by the increase in capacity that the project will provide during the peak hour. This will give a rand/person ratio for each project.

When the rand/person ratio had been calculated they were then normalised between the range 0 to 10.

6.4 Problem Severity.

The measure of need of a project is given by the severity of the problem. The assessment sheets were divided into three sections:

Private transport projects including TSM projects.

Public transport projects.

Park and ride p. ,ects.

The assessment sheets for private transport should reflect the present provision of pedestrian safety measures in areas that have a high incidence of accidents and the present usage of the facility.

The assessment sheets for public transport should reflect the safety and comfort of passengers and look at the present provision of safety railings and toilets.

The measures for park and ride look more to encouraging the use of such facilities, by the provision of guards and security fencing. Safety, at present, does not appear to be an issue which needs to be addressed as there have been no pedestrian/vehicle accidents at any of the park and ride facilities in the area.

6.5 Problem Solution.

These assessment sheets should reflect whether an attempt has been made to address the deficiencies highligh by the problem severity issue.

The private transport should included such measures as alignment and visibility, the provision of central islands and pedestrian walkways.

To accommodate this resolution it is proposed that in the first year of the new methodology, all projects are rated against each other. In subsequent years the projects that have received moneys from the region in the previous year are rated separately from the other projects.

Three other conditions should be imposed.

A financial plan must be formulated for each project outlining such items as how the cost of the project was arrived at, how the project will be financed if funding from the region is not available in the first or subsequent years of the project, and a list of the major target dates of the project so that progress reports may be systematically made on the project.

At least 50% of the allocated subsidy must be used during the financial year. This must be on the project as described in the financial programme. If not, the project will not be considered as having continuity of funding as described above.

Moneys must not be transferred between projects. If any moneys have not been used on a project they must be reallocated in the region as per the priority list.

6.3 Environment.

The environmental issue is not only whether the project will increase pollution in terms of air, noise, or vibration but should include a wide range of environmental issues. These are whether communities are severed, whether traffic is attracted away from residential areas, and whether an attempt has been made, in the design of the facility, to keep it in sympathy with the surrounding area, especially if there is no alternative to the proposed project.

CHAPTER 6

ASSESSMENT SHEETS

6.1. Introduction.

Assessment sheets needed to be developed which reflected the different issues. These needed to have a scale against which projects could be scored relative to each other.

Expert advise was sought for the development of these sheets from highway engineers, highway maintenance engineers, public transport engineers, accountants and land use planners in the area.

The maximum score is arbitrary but for ease of calculations the maximum score for each issue was selected as ten.

The assessment sheets are shown in Appendix F.

6.2 Financial.

The assessment sheets for the finance, were developed to demonstrate the financial commitment that the local authority were prepared to accept.

The regional council considers continuity of funding so important that it has taken a resolution to ensure that any project which has received regional funds in the previous financial year has preference over projects which have not received funding.

The results from the spread sheet were used as input data for the AHP programme, which gives a weighting to each issue and the level of inconsistency of the comparisons.

5.6 The Results.

The AHP programme was run on the Johannesburg Metropolitan Planning Department computer.

The results of the analysis are shown in Table 5.2.

ISSUE	WEIGHTING
Environmental	2,62
Social	2,38
Problem Severity	1,71
Problem Solution	1,16
Financial	1,12
Economic	1,02

Table 5.2 The Weights of the Issue.

The level of inconsistency was 0,8. This is an acceptable level.

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POSTSCRIPT

The methodology was accepted by the Central Witwatersrand Techni l Liaison Committee at it's meeting on 25 October 1991.

The resolution at the meeting recommended that the methodology be accepted for priority assessment of transportation projects in the region.

Until the level of funding can be anticipated with a greater degree of confidence, it is thought that the criteria for the first stage cut off should remain the same.

The setting up of a working group to agree on the methods of measuring the relevant issues of a transport project is important as it ensures that all the important transportation issues pertaining to the area were included in the methodology and reduces any personal bias. The working group members were drawn from both the public and private transport sectors so ensuring that a diversity of views were represented.

The methodology is durable enough to allow for the future inclusion or exclusion of any issue which increases or decreases in import.

The flexibility of the system means that the weightings can easily be changed by repeating the questionnaire process but the number of issues analysed should be kept to as few as possible as the number questions in the questionnaire increases geometrically.

If there is a reassessment of the weightings all the local authorities must participate.

To ensure the technical credibility of any assessment procedure it should not promote projects because they are politically correct, nor should it include projects just so that all the participating authorities receive something. It may be felt that it is necessary to do these things but they should form part of the financial control not part of the priority process.

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If there is a reassessment of the weightings all the local authorities must participate.

To ensure the technical credibility of any assessment procedure it should not promote projects because they are politically correct, nor should it include projects just so that all the participating authorities receive something. It may be felt that it is necessary to do these things but they should form part of the financial control not part of the priority process.

The scoring sheets are given a uniform score of 10 and the issues are given a weighting which reflects both the weighting that the local authority officials of each area give to them and the population of their respective areas.

The method used to give the weighting is the Analytical Hierarchical Process.

The methodology was used to assess all of the projects submitted for funding during the 1992/93 financial year. All the projects were assessed to see if the dual methodology would give a reasonable reduction in the number of projects for detailed analysis whilst ensuring that all the projects that would have received funding are included in the detailed assessment.

From chapter 7 it can be seen that the number of projects put forward for further analysis would have been reduced by 47%.

In the unweighted priority list the cut off line of the first assessment falls between projects 32 and 36. All the projects that have received funding in the past would have been included for further analysis.

From the weighted list it can be see that the out off line falls generally between projects 29 and 42. One project which would not have gone forward for further analysis moved to number 23 on the list. All the projects that would have received funding in the past would have gone c for further analysis.

The available moneys, for the 1992/93 year resulted in less than 23% of the projects receiving UTF funding and using the first stage assessment all projects receiving moneys would have been put forward for the second stage assessment.

8.4 The Pr... ...Methodology.

The proposed methodology has two stages. The first stage uses a single category, single level successive sub-setting technique to select projects which go forward to the second stage assessment which uses a sufficiency rating technique.

The sub-setting technique addresses the major transportation strategy of the area which is to transport people to their place of work during peak periods and so uses the person trips during peak periods as its category and the proposals set out in chapter 3 as it's levels.

The second stage sufficiency rating technique looks at and assesses the project in a logical fashion.

The scoring sheets reflect the issues of:

Financial
Economic
Social
Environmental
Project Severity
Project Solution

The score sheets are easy to understand and easy to complete.

It is necessary for completion of these sheets to be undertaken by one person to ensure continuity of scoring.

With this in mind it is important that the decision on the type of assessment must be undertaken by persons with an appreciation of the different methods.

Each of the eight metropolitan areas in the Republic use a different method. This indicates that there is not necessarily one ideal methodology that can or should be used.

The system outlined in this dissertation provides a method of measuring different issues pertaining to transport projects.

8.3. Priority Assessment : CWRSC Area.

The problems pertaining to the CWRSC area were highlighted in cha[illegible]

These problems are:

The lack of data.
The lack of resources.
The durability of the method.
The flexibility of the method.
Weightings of the different categories.
The different modal splits in the region.
The increase in environmental awareness.
The continuity of funding of projects.
The inclusion of TSM and maintenance projects.
The addressing of the goals and objectives in the area.

CHAPTER 8

CONCLUSIONS

8.1 Introduction.

The conclusions fall into two groups, those dealing with the priority assessment in general and those dealing with the priority assessment of projects in the Witwatersrand area.

8.2 Priority Assessment : General.

It can bee seen from the literature survey that there are many different methods of priority assessment. Each of the metropolitan area in the republic has a different methodology.

This variety of methods does not necessarily imply indecision, but reflects the fact that each area has different needs, problems and values. This also indicates that there is no single panacea for giving priorities to projects.

Each area must be studied and an assessment made of it's need. A method or combination of methods for giving a priority to the projects can then be formulated.

Using the first stage analysis for the priority assessment would have reduced the number of project needed for the detailed analysis by 52%, a considerable saving in resources.

The listing arrived at appears to be reasonable. As expected the weightings have had an effect on the order of projects especially in raising the priority of the projects which provided facilities for the poorer sectors and were environmentally friendly, this was done whilst still addressing the other issues that are important to the area.

48	Jo 13 Wemmer Pan Road	68.06
49	Ro 32 Jim Fouche Phase 2	68.02
50	Ro 34 Wilgerood Phase 2	67.835
51	Ra 25 Ysterhout Road	65.48
52	Ra 12 Jacaranda Street	64.445
53	Ra 16 Bond Street	62.76
54	Ra 15 Hans Strydom Drive	61.39
55	Ra 14 Oak Avenue	61.3
56	Ra 6 Henrik Verwoerd Drive	59.85
57	Ra 42 Pretoria Avenue	58.86
58	Sa Katherin/Graystone Int.	58.767
59	Ra 8 President Foche Drive	57.2
60	Jo 6 A3	57.1
61	Sa Boulting Avenue	57.1
62	Jo 39 Club Street	54.73
63	Sa 5th Avenue Sandown	54.145
64	Jo 32 D.F.Malan Avenue	45.44
65	Jo 81 Jan Smuts Avenue	43.5

Table 7.3 The Weighted priority list.

As with Table 7.2, the projects which would have been put forward from the first stage analysis, which was based on the requirements listed in section 4.3, are in bold. All of these projects would have received funding.

24	Ro 101 Van Wyk Rd. West	75.16
25	Dm 3 Vincent Road	75.08
26	Jo 48 Newtown Bus Term.	75.02
28	Ro 26 Ontdekkers Road	74.38
29	Ra 3 River Road	73.61
30	Jo 87 London Road	73.42
31	Jo 89 Mary Fitzg,ld Taxi	73.21
32	Ro Gordon Road Phase 2	73.2
33	Ro 54 Corlett Drive	72..
34	Ro 9 Maraisburg Road	72.78
35	Ra 1 Republic Road	72.11
36	Ro 100 H. Potgieter/W. Nicol Rd.	71.94
37	Ra 43 Mangaan Road	71.38
38	Ro 56 Fairlands	71.3
39	Jo 82 M2	71.12
40	Ro 46 Mare Road	70.4
41	Jo 69 Crownwood Road	69.2
42	Jo 66 Comaro Road	68.7
43	Jo 84 A5	68.62
44	Ro 7 Hoofd Road	68.42
45	Ro 37 J.G.Strijdom Phase 2	68.36
46	Ro 102 Peter Road	68.24
47	Ro 5 Hamburg Phase 2	68.2

Project name and number

1	Ro 43 Western Bus Term.	95.34	
2	Jo 52 Long Dist. Taxi	92.1	
3	Jo 90 Eldorado Bus/Taxi Term.	91.63	
4	Jo 72 Lenasia Rd. Ave.	87.35	
5	So 23 White City Taxi	86.21	
6	Ro 17 Westlake Phase 1	84.24	
7	Dm 9 Baragwanath Bus Term.	83.20	
8	Jo 16 S.W. Bus-way	82.35	
9	Do 2 Indingilizi Taxi	81.88	
10	Jo 28 Noord St. Bus Term.	81.73	
11	Do 1 Jonas Taxi	81.63	
12	Dm 7 Immik Drive	81.15	
13	Dm 10 Dube-Meadowlands Taxi	80.78	
14	Jo 50 Westgate Bus Term.	80.56	
15	Ra 38 Taxi/Bus Facility	79.05	The project to which fundin
16	Jo 58 Soweto Highway	78.87	would have reached in the
17	So 12 Old Potch. Road	78.54	financial years 1986/92
18	So 22 Marafi Taxi	78.46	
19	So 16 Komo St. Taxi	77.31	
20	So 21 Ikwezi Taxi	75.84	
21	Ro 40 Westlake Phase 2	75.58	
22	Jo 57 Faraday Bus/Taxi Term.	75.32	
23	Jo 7 P73-1	75.18	

2. Improved Public Transport Measures

Grading

0. No improvement to Public Transport.

1. Promotes a Park and Ride route only.

2. Sufficient carriageway now available for future bus lane if required.

3. Improved passenger comfort.

4. Improved road enables increased bus accessibility.

5. Improved bus speeds and regularity in this or other roads.

6. Improved bus speeds and regularity to be maintained for many years in this or other roads.

7. Peak hour bus lane incorporated into scheme.

8. Permanent bus lane incorporated into scheme.

3. Accident Expectation

Grading

0. No noticable improvement in alignment, hazardous sections not improved.

1. Provision of a small bypass.

2. Provision of right turn bays, pedestrian crossings, improved signing and visibility.

3. Provision of median island without turning bays.

4. Provision of central island with right turn bays, some improvement in alignment.

5. Good alignment to design standards, central island with right turn bays, improved visibility.

Grading

0. Not a bus route

1. Park and Ride bus route only

2. 1-5 buses per peak hour in both directions

3. 6-10 buses per peak hour in both directions

4. 11-20 buses per peak hour in both directions

5. 21-50 buses per peak hour in both directions

6. Over 50 buses per peak hour in both directions

B. Improved Major Road

1. Level of Service

Again this can be divided into peak hour volume/capacity, off-peak hour volume/capacity and intersection rating to assist grading.

Grading

0-3 Full roadway not utilised, even in peaks, roadway overdesigned.

4-7 Benefit to a small number of motorists, volume very much less than capacity.

8-11 Roadway flowing full in peaks, reduction of hazards, intersections relieved.

12-15 Roadway fully utilised and intersections flowing nearly full but freely. Level of service C.

16-18 Roadway fully utilised, but large savings in travel times level of service D or E.

16-18 Volumes at capacity level during most of the day. Intersections loaded. Level of service E for 8 hours or more.

5. Geometric Alignment

Grading

0. Good geometric alignment commensurate with design speed.

1. Curvi-linear alignment, some interference caused by right turns.

2. Bad kinks in road, turnout bays to avoid right turners.

3. Several curves at sub-standard design speeds, poor sight distance, bad kinks and tendency for motorists to cut corners.

6. Accident Record

Taking average annual accident record, determine average equivalent accident number (EAN) over all the intersections and in-blocks in section considered. To determine the EAN accidents have to be weighted in the following way: Fatal accidents x 10, serious injury x 5, minor injury x 2, no injury x 1.

0. EAN of 0-2

1. EAN of 3-5

2. EAN of 6-8

3. EAN of 9-12

4. EAN of 13-17

5. EAN of 18-25

6. EAN of 25-39

7. EAN of 40 or more

7. Public Transport Rating

3-4 Standing water in channel extending more than 600 mm out from the edge of carriageway some time after rain has ceased.

3. Pedestrian Facilities

Grading

0 Paved sidewalk, allowance been made for pedestrians at intersections.

1. Sidewalk in poor condition, no pedestrian crossings at intersections.

2. No allowance made for pedestrians.

4. Traffic Loading

In order to aid evaluation the traffic loading can be divided into three categories each worth about 6 points.

1. Peak Hour Volume/Capacity

2. Off-Peak Hour Volume/Capacity

3. Intersection Rating

Grading (Total)

0-3 Peak hour volumes less than capacity, intersections clear each cycle.

4-7 Peak hour volumes at capacity but below capacity throughout most of the day, intersections flow freely.

8-11 Peak hour volumes at capacity, off peak volumes less than capacity, intersections sticking slightly with right turners etc.

12-15 Off peak volumes nearing capacity, intersections regularly not clearing due to turning movements blocking, public transport problems etc. Parking impeding flow.

Determination of Weightings

In order that schemes may be ranked on a common basis, below are recommended standards upon which individual road elements may be ranked.

A. Existing Major Road

1. Pavement Condition

Grading

0-1	Reconstructed or resurfaced with premix carpet within last four to five years.
2-3	Generally in good condition with good ridability. No surface distress evident.
4-5	Average surface conditions, with possibly some patching necessary.
6-7	General deterioration of surface with regular patching required.
8-9	Poor surface requiring to be resurfaced.
10	Carriageway in very poor condition requiring imminent reconstruction.

2. Surface Water Drainage

Grading

0	Carriageway profile and drainage dealing adequately with surface water during rain.
1-2	No water running in the channels more than 500 mm from the edge of carriageway while rain is falling, nor any standing water extending more than 500 mm out from the edge of carriageway soon after rain has ceased.

2. Draw up a short list of schemes in relation to finance available.

3. Carry out cost/benefit analysis on short list of schemes.

4. If cost/benefit calculations indicate a financial return above a stated level, then scheme moves into firm programme.

5. If scheme has poor cost/benefit return then it should be re-appraised to see if proposal being considered is of too high standard.

It should be noted that the cost benefit analysis does not reveal absolute financial benefits but compares benefits in relation to the competing schemes.

PROJECT PRIORITY ALLOCATION

This is a relatively simple method whereby different highway projects, on an overall programme, may be allocated a priority thus eliminating as far as possible subjective assessment.

To assess schemes readily, taking into account the majority of aspects which both promote and comprise highway improvements, a sufficiency rating schedule is completed giving an overall rating for each scheme. This then allows it to be ranked with other schemes from all over the Metropolitan area although they may differ in their concept.

The process entails grading of improvements by using a system of marking each itemised element of existing conditions and proposed design. Each element is allocated a weighting factor in accordance with its merit compared with other elements. Draft ranking sheets are attached as Annexure A for the two cases of an improvement to an existing highway and a completely new highway. The procedure is to ring the corresponding number in accordance with each item marked. The summation of all items then gives a 'score' for the project based on a highway needs principle.

After assessing all schemes in the programme, a final table can be prepared of relative project priority. The schemes can then be carried out in descending order until the budget allocation is reached. However, at this stage no financial assessment has been taken into account except indirectly where it is reflected in the weightings given in the rankings.

A full cost/benefit analysis on each scheme would be complex and time consuming and in view of the approximate construction costs that may only be available, to determine financial benefits in any great detail would be unnecessary. It is considered, nevertheless, that some form of cost/benefit exercise should be imposed in order to confirm that projects undertaken represent a fair financial return to the community. A simplified analysis is therefore carried out, taking into account travel costs only, on the schemes that, from the ranking table, come within the annual budget.

The operational stages of a project priority exercise are therefore:

1. Rank schemes in order of priority on a highway needs basis and proposed design.

METHODOLOGY FOR MAJOR ROAD PROJECT PRIORITY ALLOCATION

BY

T I CARLISLE AND J A WEBSTER

January 1979

FP 120.
FP R-0140-01-00-0379

APPENDIX A

Present Methodology

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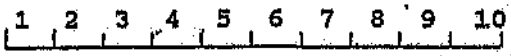
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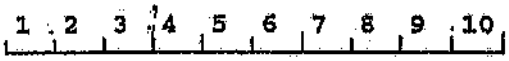
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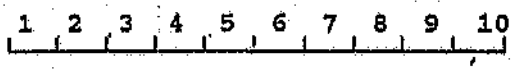
social upliftment of needy areas



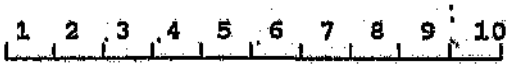
pavements are provided



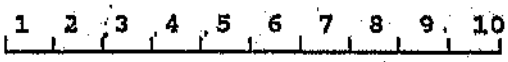
public opinion of a project



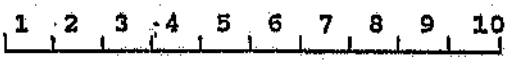
preservation of recreation facilities



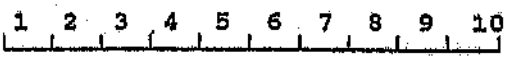
promotion of road projects



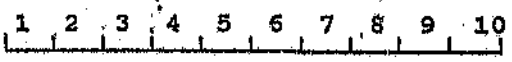
all local authorities get something



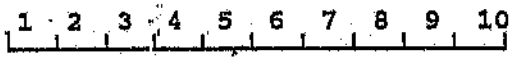
promotion of industrial areas



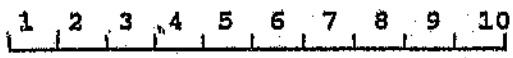
effect on residential areas



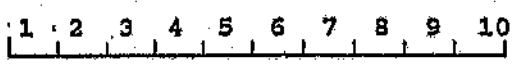
condition of existing facility, if any



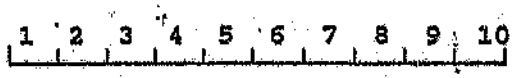
promotion of urban traffic control



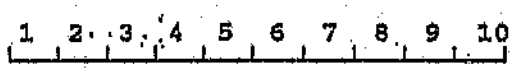
improvement of existing conditions



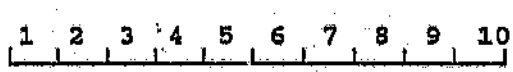
promotion of privatisation



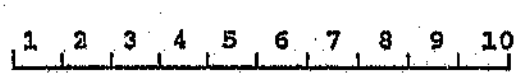
cost effectiveness



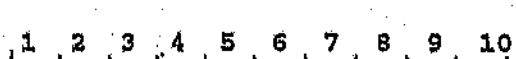
position of project on L.A priority list



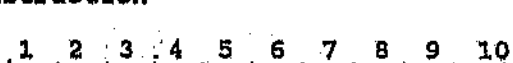
promotion of public transport



continuity of project



minimise social cost during construction



APPENDIX B

First Questionnaire

Information Required for Cost/Benefit Analysis

Length of improvement	L & L_o	From design and existing
Base year annual flow	q_o	Deduced from 1965/85 network and 1976 counts
Growth factor	g	ditto
Assessed flow	q	Base year flow x growth factor
Effective width	$w/(w-a)$	From design
Increased width	Δw	ditto
Base year speed	V_o	Deduced from 1965 network or 1976 measurements
Change in flow	Δq	
Change in speed	Δv	Formulae
Assessed speed	V	Formulae & base year speed

The change in speed is related to the change in flow and may be found from the following formulae. Please note that factors should be applied to convert from imperial to metric units.

Change in Speed/Change in Flow (Existing Roads)

Central Urban	$\Delta v = \frac{-\Delta q}{3(w-a)}$
Faster Urban	$\Delta v = \frac{-\Delta q}{4(w-a)}$
Rural	$\Delta v = \frac{-\Delta q}{6w}$

New Roads

Central Urban	$V = 31 - \frac{q + 430}{3(w-a)}$ or 24 m/hr whichever is less
Faster Urban	$V = 42 - \frac{q + 1000}{4(w-a)}$ or 35 m/hr " " "
Rural (single c/ways)	$V = 54 - \frac{q + 1400}{6w}$ or 45 m/hr " " "

Dual carriageways — Average speed assumed to be 46 m/h

Annexure B

Cost/Benefit Analysis

Simplified procedure taking into account travel costs only.

Construction Costs

As estimate.

Financial Benefits

Difference in cost of journey on proposed highway improvement and cost of journey on existing highway (i.e. Do nothing situation)

Basically annual travel costs are;

Annual flow x journey costs per vehicle per km x length of improved highway and journey costs are made up of the vehicle operating costs plus value of road users time.

Vehicle operating costs vary with speed and may be obtained from tables produced by National Institute for Transport and Road Research.

Road users time also varies with speed and may be represented by

$$\frac{\text{Length of improved highway}}{\text{average speed of vehicles}}$$

Costs per km may therefore be represented by

$$\frac{C}{\text{average speed of vehicles}}$$

Where C is the value of road users time in rand per hour.

A realistic figure will have to be assigned for C but accuracy is not necessarily essential as the same value will be taken for all schemes.

The most useful cost/benefit analysis is where the Internal Rate of Return is found which in effect gives an interest rate for the amount of money invested.

An accurate assessment requires the financial benefits to be calculated for ever year of expected life of the improvement which for this purpose may be taken as 20 years. However, in view of the simplified approach being taken, it will only be necessary to determine the benefits every five years and interpolate for the intervening years.

A draft standard form is attached for calculating benefits.

NEW MAJOR ROAD

SCHEME : _____

(Ring appropriate figure and total)

Element	Weighting	Good									Poor
Traffic loading	30	30	29	28	27	26	25	24	23	22	21
		20	19	18	17	16	15	14	13	12	11
		10	9	8	7	6	5	4	3	2	1 0
Relief to adjoining Routes	20	20	19	18	17	16	15	14	13	12	11
		10	9	8	7	6	5	4	3	2	1 0
Aid to public transport	12	12	11	10	9	8	7	6	5	4	3 2 1 0
Ease of maintance		8	7	6	5	4	3	2	1	0	
Accident expection		10	9	8	7	6	5	4	3	2	1 0
Availability of land		10	9	8	7	6	5	4	3	2	1 0
Time benefit is achieved		10	9	8	7	6	5	4	3	2	1 0

Note : Special factors appertaining to particular schemes may supersede above analysis

Overall rating _____/100

IMPROVEMENT TO EXISTING MAJOR ROAD

SCHEME _____

A. Existing Major Road (Ring appropriate figure and total)

		Weighting	Rating Poor ... Good
1.	Pavement Condition	10	10 9 8 7 6 5 4 3 2 1 0
2.	Surface Water Drainage	4	4 3 2 1 0
3.	Pedestrain Facilities	2	2 1 0
4.	Traffic	18	6 5 4 3 2 1 0
			6 5 4 3 2 1 0
			6 5 4 3 2 1 0
5.	Geometric Alignment	3	3 2 F 0
6.	Accident Record	7	7 6 5 4 3 2 1 0
7.	Public Transport Rating	6	6 5 4 3 2 1 0

Existing Major Road rating _____/50

B. Improved Major Road

	Element	Weighting	Good ... Poor
1.	Level of Service	18	6 5 4 3 2 1 0
			6 5 4 3 2 1 0
			6 5 4 3 2 1 0
2.	Public Transport Measures	8	8 7 6 5 4 3 2 1 0
3.	Accident Expectation	6	6 5 4 3 2 1 0
4.	Pedestrain Facilities	4	4 3 2 1 0
5.	Relief to adjoining routes	4	4 3 2 1 0
6.	Ease of maintance	2	2 1 0
7.	Availability of Land	4	4 3 2 1 0
8.	Time Benefit is achieved	4	4 3 2 1 0

Improved Major Road rating _____/50

Note : Special factors appertaining to particular schemes may supersede above analysis.

Overall Rating _____/100

2-3 Single carriageway - light traffic - no alternative route on which to deviate traffic.

4-5 Single carriageway - able to close half road and allow one-way traffic on other half.

6-7 Dual carriageway - heavy traffic - closure of one carriageway for maintenance and using the other half for two-way traffic would cause some congestion.

8. Dual carriageway - closure of one carriageway for maintenance and using the other for two-way traffic would not cause any congestion or;

where the whole road (either single or double carriageway) can be closed for maintenance purposes, the traffic being deviated via an alternative route.

5. Accident Expectation

A new route can be assumed to have been designed to correct safety standards and traffic will use this route instead of an ex ng alternative which due to possible inferior safety standards should hav reduction of accidents.

Grading

0 If new route serves a newly developed area and will not relieve existing roads.

1-2 New route relieves reasonably well designed alternative routes which are becoming congested.

3-4 New route relieves congested single lane roads.

5-6 New route relieves congested alternative ones with several priority junctions.

7-8 New route relieves use of minor roads not intended for through traffic.

9-10 New route relieves use of minor roads in a residential area.

The grading will also have to take account of the amount of relief to alternative routes and if they contain congested intersections with poor accident records.

1. Likely to become a Park and Ride route only.

2. Improved passenger comfort.

3. Improved bus accessability.

4.
5. Improve bus speeds and regularity both on overall bus route and other
6. roads.

7.
8. Improves bus speeds and regularity both on overall bus route and other
9. roads for many years.

10. Provision of substantial bus priorities other than bus lanes.

11. Provision of peak hour bus lane.

12. Provision of permanent bus lane.

As an alternative analysis or in conjunction with the above the grading can be found in relation to the predicted bus volumes.

2 Low bus volumes predicted

3

4

5 Medium bus volumes predicted

6

7.

8 High bus volumes predicted

9

4. Ease of Maintenance

Grading

0-1 Single carriageway - heavy industrial traffic - no alternative route on which to deviate traffic.

Assess ultimate benefit to be derived compared with benefit available immediately the improvement is completed. The score therefore to reflect period of time to elapse before maximum benefit is gained.

New Major Road

1. Traffic Loading

Traffic Loading is taken as:-

$$\frac{\text{Projected Volume During Peak Hour}}{\text{Theoretical Capacity}}$$ (Expressed as a percentage)

Projected volumes to be obtained from traffic assignment where possible otherwise by estimation. Theoretical capacity calculated from the Highway Capacity Manual (HRB Special Report 87).

Grading	Traffic Loading %	Grading	Traffic Loading %
0	0	16	51-53
1	1-3	17	54-56
2	4-6	18	57-60
3	7-10	19	61-63
4	11-13	20	64-66
5	14-16	21	67-70
6	17-20	22	71-73
7	21-23	23	74-76
8	24-26	24	77-80
9	27-30	25	81-83
10	31-33	26	84-86
11	34-36	27	87-90
12	37-40	28	91-93
13	41-43	29	94-96
14	44-46	30	97-100
15	47-50		

A higher score may be given than amount of relief indicated if major intersections in the vicinity will benefit from reduced congestion.

6. Ease of Maintenance

Grading

0. Single carriageway – no alternative route on which to deviate traffic.

1. Single carriageway – able to close half road and allow one-way traffic on other half.

Dual carriageway – heavy traffic – closure of one carriageway for maintenance and using the other half for two-way traffic would cause some congestion.

2. Dual carriageway – closure of one carriageway for maintenance and using the other for two-way traffic would not cause any congestion or;

where the whole road (either single or double carriageway) can be closed for maintenance purposes.

7. Availability of Land

Grading

0. Mining or Government land released.

1. Expropriation required, housing or buildings to be demolished.

2. Expropriation required, no major structural demolition necessary.

3. Servitudes already obtained, final transfer not yet taken.

4. Ground available, no expropriation or negotiation necessary.

8. Time Benefit is Achieved Weighting 0-4

6. Good alignment, grade separation, obvious improvements in safety features, access limited.

4. Pedestrian Facilities

Grading

0. No provision made for pedestrians.

1. Sidewalk relayed or smoothened - no noticeable improvement to pedestrian facilities.

2 Sidewalk rebuilt or in good condition. Some allowance for pedestrians at intersections.

3. Widened and improved sidewalks, no obvious pedestrian/motorist conflict points.

4. Wide, uncongested and even sidewalk, grade separation or special pedestrian considerations at intersections.

5. Relief to Adjoining Roads

This may be found by reassigning traffic movements by means of sophisticated computor programs from existing traffic network assignment. If this is not possible then subjective opinion based on extensive local knowledge of the area will be necessary.

Grading

0. No relief to adjoining roads.

1. 0 - 10% relief to adjoining roads.

2. 11 - 15% relief to adjoining roads.

3. 16 - 20% relief to adjoining roads.

4. Over 20% relief to adjoining roads.

APPENDIX E

Population and Ratios

Category		11		12		13		14		15	
Town	Weight (w)	Score (n)	ln.n x w	Score (n)	ln.n x w	Score (n)	ln.n x w	Score (n)	ln.n x w	Score (n)	ln.n x w
Alex.	0.0667	1.0000	0.0000	3.0000	0.0733	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000
Dep.	0.1120	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000
Dobs.	0.0216	3.0000	0.0237	3.0000	0.0237	1.0000	0.0000	3.0000	0.0237	3.0000	0.0237
Jhb.	0.3467	1.7232	0.1887	1.2298	0.0717	1.2836	0.0811	0.9924	-0.0026	0.9924	-0.0026
Ra.	0.0377	0.3300	-0.0418	3.0000	0.0414	3.0000	0.0414	0.1400	-0.0741	1.0000	0.0000
Ro.	0.0667	0.3300	-0.0739	1.0000	0.0000	3.0000	0.0733	0.3300	-0.0739	1.0000	0.0000
Sa.	0.0437	7.0000	0.0850	0.3300	-0.0484	3.0000	0.0460	0.3300	-0.0484	7.0000	0.0850
So.	0.3049	0.3300	-0.3380	3.0000	0.3350	0.3300	-0.3380	3.0000	0.3350	0.3300	-0.3380
Sum			-0.1663		0.4966		-0.0942		0.1695		-0.2319
exp			0.8533		1.6431		0.9101		1.1780		0.7930

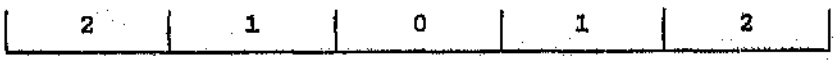
Category		6		7		8		9		10	
Town	Weight (w)	Score (n)	ln.n x w	Score (n)	ln.n x w	Score (n)	ln.n x w	Score (n)	ln.n x w	Score (n)	ln.n x w
Alex.	0.0667	0.1400	-0.1311	1.0000	0.0000	3.0000	0.0733	0.3300	-0.0739	7.0000	0.1298
Diep.	0.1120	0.3300	-0.1242	3.0000	0.1230	1.0000	0.0000	1.0000	0.0000	3.0000	0.1230
Dobs.	0.0216	1.0000	0.0000	3.0000	0.0237	3.0000	0.0237	3.0000	0.0237	0.3300	-0.0239
Jhb.	0.3467	0.2866	-0.4334	3.4815	0.4325	0.9924	-0.0026	2.1405	0.2639	3.2810	0.4098
Ra.	0.0377	1.0000	0.0000	3.0000	0.0414	3.0000	0.0414	0.3300	-0.0418	3.0000	0.0414
Ro.	0.0667	0.3300	-0.0739	1.0000	0.0000	1.0000	0.0000	0.3300	-0.0739	3.0000	0.0733
Sa.	0.0437	0.3300	-0.0484	3.0000	0.0480	3.0000	0.0480	0.3300	-0.0484	3.0000	0.0480
So.	0.3049	0.3300	-0.3380	0.3300	-0.3380	3.0000	0.3350	0.3300	-0.3380	3.0000	0.3350
Sum	1.0000		-1.1491		0.3307		0.5188		-0.2886		1.1364
exp	1.9333		0.3166		1.3919		1.6799		0.7493		3.1164

Category		1		2		3		4		5	
Town	Weight (w)	Score (n).	ln.n x w	Score (n)	ln.n x w	Score (n)	ln.n x w	Score (n)	ln.n x w	Score (n)	ln.n x w
Alex.	0.0667	0.3300	-0.0739	3.0000	0.0733	3.0000	0.0733	0.3300	-0.073'	0.3300	-0.0739
Dep.	0.1120	0.1400	-0.2202	3.0000	0.1230	0.3300	-0.1242	0.3300	-0.1242	1.0000	0.0000
Dobs.	0.0216	0.3300	-0.0239	0.3300	-0.0239	1.0000	0.0000	3.0000	0.0237	3.0000	0.0237
Jhb.	0.3467	0.7081	-0.1197	0.9924	-0.0026	0.7659	-0.0970	0.5730	-0.1931	0.8009	-0.0770
Ra.	0.0377	0.3300	-0.0418	3.0000	0.0414	3.0000	0.0414	1.0000	0.0000	0.1400	-0.0741
Ro.	0.0667	3.0000	0.0733	3.0000	0.0733	3.0000	0.0733	0.3300	-0.0739	0.3300	-0.0739
Sa.	0.0437	0.3300	-0.0484	0.1400	-0.0859	3.0000	0.0480	0.3300	-0.0484	3.0000	0.0480
So.	0.3049	0.3300	-0.3360	3.0000	0.3350	7.0000	0.5933	3.0000	0.3350	0.1400	-0.5995
Sum	1.0000		-0.7928		0.5335		0.6081		-0.1649		-0.8267
exp	2.7183		0.4526		1.7048		1.8369		0.8585		0.4375

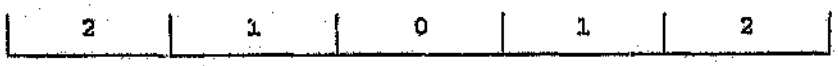
APPENDIX D

Calculations and Weightings

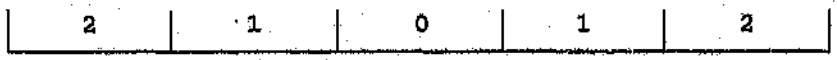
well being continuity of funding



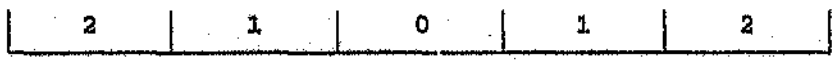
continuity of funding cost effective



improve existing facility well being



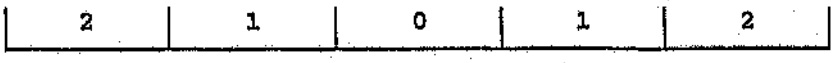
cost effective provide P.T. to poor area



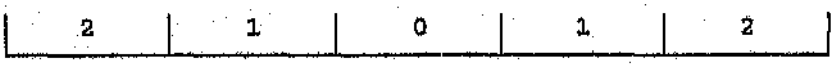
continuity of funding improve existing facility



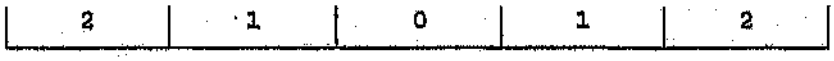
well being continuity of funding



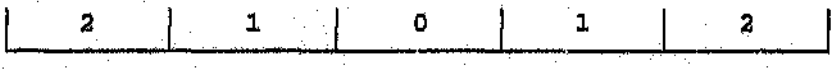
continuity of funding cost effective



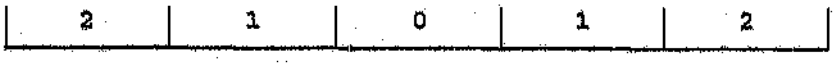
improve existing facility well being



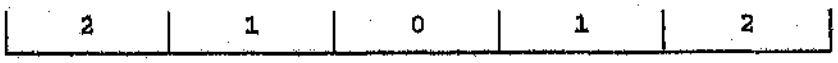
cost effective provide P.T. to poor area



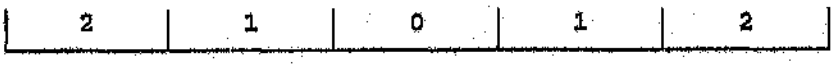
continuity of funding improve existing facility



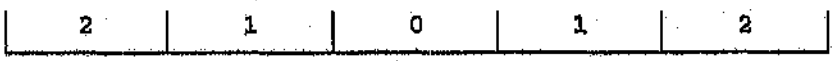
well being environmental impact



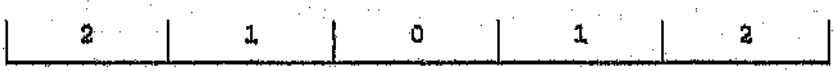
environmental impact provide P.T. to poor area



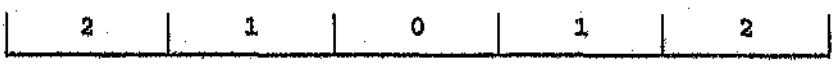
improve existing facility cost effective



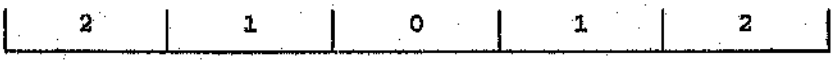
provide P.T. to poor area well being



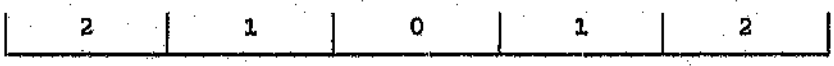
improve existing facility environmental impact



well being cost effective



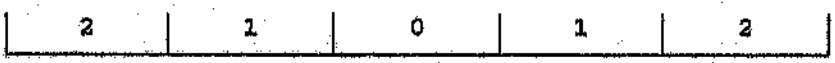
environmental impact continuity of funding



provide P.T. to poor areas improve existing facility



cost effective environmental impact



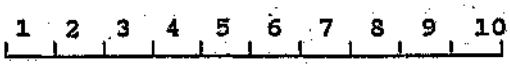
continuity of funding provide P.T. to poor areas



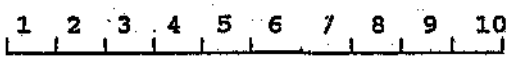
APPENDIX C

Second Questionnaire

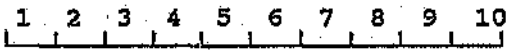
projects are built to recognised standards



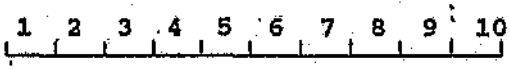
reinstatement of original condition of area after construction



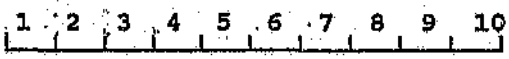
environmental impact.



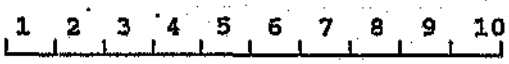
direct access between home and work



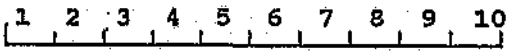
adequate precautions taken during construction



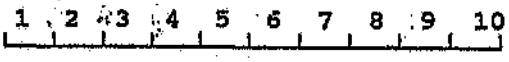
protection of historical buildings



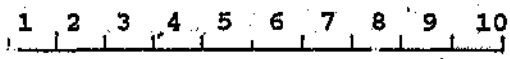
pe ians are separated from traffic



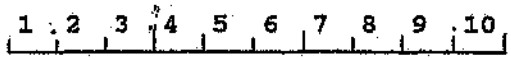
the safety aspects of a project



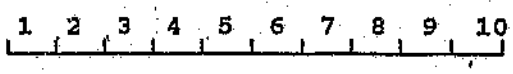
social upliftment of needy areas



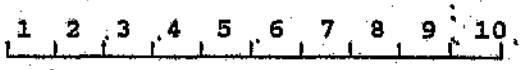
pavements are provided



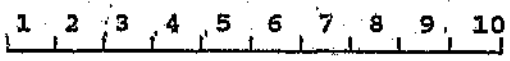
public opinion of a project



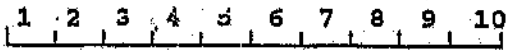
preservation of recreation facilities



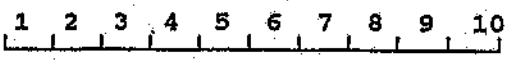
promotion of road projects



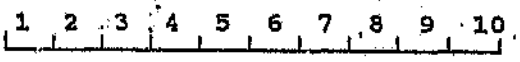
all local authorities get something



promotion of industrial areas



effect on residential areas



ECONOMIC

Cost of stand alone project.

Increase in capacity of Facility.

Method.
The capital cost is divided by the increase in capacity. When this was been done for all the projects the ratios are normalised between the range of 0 to 10.

SOCIAL

Which income group does the facility serve in terms of the regional LUTSPLAN?

		Allocation of points
1.	high income	1
2.	medium income	3
3.	low income	5

How does the facility serve public transport

1.	public transport facility	5
2.	dedicated public transport route	4
3.	major public transport route	3
4.	minor public transport route	2
5.	no significant amounts of public transport on the route.	1

Park and Ride Facility

1. A paved area will be provided	2
A paved area will not be provided	0
2. There will be a guard	2
There will not be a guard	0
3. There will be covered parking	2
There will not be covered parking	0
4. The facility will be fenced	2
The facility will not be fenced	0
5. The facility will be visible from a main road	2
The facility will not be visible from a main road	0

Public Transport Facility

1.	A hard stand for passengers will be provided	2
	A hard stand for passengers will not be provided	0
2.	Shelters will be provided	2
	Shelters will not be provided	0
3.	Safety rails will be provided	2
	Safety rails will not be provided	0
4.	Toilets will be provided	2
	Toilets will not be provided	0
5.	Accessibility will be improved	2
	Accessibility will not be improved	0

PROBLEM SOLUTION

Private Transport Facility

1. Alignment/visibility will be improved	2
Alignment/visibility cannot be improved	1
Alignment/visibility will not be improved	0
2. Central island will be provided/is provided	2
Central island cannot be provided	1
Central island will not be provided	0
3. A hard pedestrian path will be provided	2
A pedestrian path should not be provided (major arterial)	2
A pedestrian path will be graded	1
A hard pedestrian path will not be provided	0
4. A tarred road surface will be provided	2
The road will be reconstructed	1
The existing road surface will remain	0
5. No parking will be allowed on carriageway	2
Some parking will be allowed on carriageway	1
Parking will be allowed on carriageway	0

Park and Ride Facility

1.	There is a paved area for cars	0
	There are no paved areas for cars	2
2.	There is a guard	0
	There is not a guard	2
3.	There is covered parking	0
	There is no covered parking	2
4.	The facility is fenced	0
	The facility is not fenced	2
5.	The facility is visible from a main road	0
	The facility is not visible from a main road	2

Public Transport Facility

1.	There is a hard stand for passengers	0
	There is no hard stand for passengers	2
2.	There are shelters	0
	There are no shelters	2
3.	There are safety rails	0
	There are no safety rails	2
4.	There are toilets	0
	There are no toilets	2
5.	Accessibility to the facility is good	0
	Accessibility to the facility is bad	2

PROBLEM SEVERITY

		Allocation of points
Private Transport Facility		
1.	The alignment is good	0
	The alignment is bad	1
2.	There is a center island	0
	There is no center island	1
3.	There is a pedestrian walkway	0
	There is no pedestrian walkway	1
4.	The road surface is good	0
	The road surface is bad	1
	There is no road surface	2
5.	There are stormwater drains	0
	There are no stormwater drains	1
6.	The facility;	
	Does not exist	4
	Is at capacity	4
	Is .8 of capacity	3
	Is .7 of capacity	2
	Is .6 of capacity	1
	Is under .5 of capacity	0

.ximum capacity should be 3000 persons, 200 taxis or 50 buses lane, during peak hour

ENVIRONMENTAL

		Allocation of points
1.	A community will not be severed	2
	A community will be severed but additional link will be provided	1
	A community will be severed	0
2.	Air pollution will decrease	2
	Air pollution will remain the same	1
	Air pollution will increase	0
3.	Noise pollution will decrease	2
	Noise pollution will remain the same	1
	Noise pollution will increase	0
4.	Traffic will be attracted to new facility	2
	Traffic patterns will remain the same	1
	Traffic will intrude into residential areas	0
5.	The facility is in keeping with the environment of the area	2
	The facility is not in keeping with the environment of the area	0

FINANCIAL

		Allocat of poin
1.	Money is being spent on construction of the project at present, the project did receive subsidy during this year and money will be spent on construction during the next financial year.	10
2.	Money is being spent on construction of the project at present and money will be spent on construction during the next financial year.	7.5
3.	Money will be spent during the next financial year although the project is not yet under way.	5
4.	Depending on availability of additional funding outside the L.A., this project will proceed during the next financial year.	2.5

APPENDIX F

Assessment Sheets

Population ratios as at December 1989

Local Authority	Population (to the nearest thousand)	Ratios
Alexandra	157 000	0.0667
Diepmeadow	264 000	0.1120
Dobsonville	51 000	0.0216
Jhb.	818 000	0.3467
Randburg	89 000	0.0377
Roodepoort	157 000	0.0667
Sandton	103 000	0.0437
Soweto	719 000	0.3049

A Financial	1.12
B Environmental	2.82
C Prob. Severity	1.71
D Prob. Solution	1.16
E Social	2.38
F Economic	1.02

	A	B	C	D	E		
Ro 43 Western Bus Term.	11.20	26.20	17.10	11.60	19.04	10.20	95.34
Jo 52 Long Dist. Taxi	11.20	26.20	10.26	10.44	23.80	10.20	92.10
Jo 80 Eldorado Bus/Taxi Term.	5.60	26.20	15.39	10.44	23.80	10.20	91.63
Jo 72 Lenasia Rose Av.	8.40	26.20	15.39	8.12	19.04	10.20	87.35
So 23 White City Taxi	2.80	23.58	15.39	10.44	23.80	10.20	86.21
Ro 17 Westleke Phase 1	8.40	26.20	17.10	10.44	11.90	10.20	84.24
Dm 9 Soroguanath Bus Term.	8.40	20.98	9.41	10.44	23.80	10.20	83.21
Jo 18 S.W. Bus-way	8.40	20.98	8.56	10.44	23.80	10.20	82.35
Do 2 Indingilizi Taxi	2.80	20.98	13.68	10.44	23.80	10.20	81.88
Jo 28 Noord St. Bus Term.	11.20	20.98	5.13	10.44	23.80	10.20	81.73
Do 1 Jones Taxi	2.80	23.58	11.97	9.28	23.80	10.20	81.63
Dm 7 Immik Drive	8.40	26.20	6.84	9.28	20.23	10.20	81.15
Dm 10 Duba-Meadowlands Taxi	2.80	24.89	15.39	8.12	21.42	8.18	80.78
Jo 50 Westgate Bus Term.	11.20	26.20	6.84	2.32	23.80	10.20	80.56
Ra 38 Taxi/Bus Facility	5.60	26.20	5.13	8.12	23.80	10.20	79.05
Jo 88 Soweto Highway	11.20	18.34	11.97	8.12	19.04	10.20	78.87
So 12 Old Potch. Road	11.20	26.20	12.83	[illegible]	19.04	0.00	78.56
So 22 Marnfi Taxi	2.80	20.98	10.26	[illegible]	23.80	10.20	78.48
So 16 Komo Street	5.60	26.20	4.26	.28	23.80	8.16	77.32
So 21 Ikwusi Taxi	2.80	18.34	10.26	10.44	23.80	10.20	75.84
Ro 40 Westlake Phase 2	8.40	20.98	13.68	10.44	11.90	10.20	75.58
Jo 57 Fare-way Bus/Taxi Term.	11.20	20.98	6.84	2.32	23.80	10.20	75.32
Jo 7 P73-1	5.60	20.98	17.10	10.44	19.04	2.04	75.18
Ro 101 Van Wyk Rd. West	5.60	20.98	13.68	10.44	14.28	10.20	75.16
Dm 3 Vincent	2.80	20.98	13.68	10.44	19.04	8.16	75.08
Jo 48 Newtown Bus Term.	11.20	18.34	3.42	10.44	21.42	10.20	75.02
Jo Anderson Street	2.80	20.98	17.10	9.28	14.28	10.20	74.82
Ro 26 Ontdekkers Road	8.40	20.98	17.10	11.60	14.28	2.04	74.38
Ro 3 River Road	5.60	20.98	15.39	11.60	11.90	8.16	73.61
Jo 87 London Road	8.40	20.98	17.10	9.28	16.66	1.02	73.42
Jo 89 Mary Fitzgld Taxi	2.80	20.98	11.97	3.48	23.80	10.20	73.21
Ro Gordon Road Phase 2	8.40	20.98	13.68	10.44	9.52	10.20	73.20
Ro 9 Marl burg Road	5.60	20.98	13.68	10.44	11.90	10.20	72.78
Ro 54 Cr Drive	5.60	20.98	13.68	10.44	11.90	10.20	72.78
Ro 1 Rapubuc Road	5.60	20.98	15.39	10.44	9.52	10.20	72.11
Ro 100 H.Potgieter/W.Nicol Rd.	8.40	26.20	12.83	11.60	11.90	1.02	71.95
Ro 43 Mangaan Road	8.40	20.98	17.10	9.28	9.52	6.12	71.38
Ro 56 Fairlands	2.80	26.20	17.10	11.60	9.52	4.08	71.30
Jo 92 M2	8.40	20.98	17.10	9.28	14.28	1.02	71.13
Ro 48 Mare Road	5.60	20.98	13.68	10.44	9.52	10.20	70.40
Jo 69 Crownwood Road	5.60	20.98	17.10	11.60	11.90	2.04	69.20
Jo 66 Comaro Road	8.40	18.34	17.10	11.60	7.14	6.12	68.70
Jo 84 A6	8.60	18.34	17.10	11.60	11.90	4.08	68.62
Ro 7 Hoofd Road	5.60	20.98	13.68	8.12	11.90	8.16	68.42
Ro 37 J.G.Strijdom Phase 2	5.60	20.98	13.68	10.44	9.52	8.16	68.38
Ro 102 Peter Road	5.60	26.20	17.10	8.12	7.14	4.08	68.24
Ro 5 Hamburg Phase 2	5.60	20.98	10.26	9.28	11.90	10.20	68.20
Jo 13 Wemmer Pan Road	8.40	18.34	13.68	9.28	14.28	4.08	68.06
Ro 32 Jim Fouche Phase 2	5.60	20.98	13.68	10.44	7.14	10.20	68.02
Ro 34 Wilgerood Phase 2	5.60	20.98	11.12	10.44	9.52	10.20	67.84
Ro 25 Vaterhout Road	8.40	20.98	6.84	11.60	9.52	8.16	65.48
Ro 12 Jacaranda Street	5.60	26.20	12.83	9.28	9.52	1.02	64.45
Ro 16 Rand Street	5.60	13.10	17.10	9.28	9.52	8.16	62.76
Ro 15 Hi a Strydom Drive	8.40	18.34	8.55	8.36	9.52	10.20	61.38
Ro 14 Oak Avenue	8.40	18.34	10.26	8.36	7.14	10.20	61.30
Ro 6 Hendrik Verwoerd Drive	8.40	20.98	11.97	8.36	9.52	2.04	59.35
Ro 42 Pretoria Avenue	5.60	20.98	6.84	8.12	7.14	10.20	58.88
So Kutheria/Graystone Int.	5.60	23.58	3.85	10.44	14.28	1.02	58.77
Ro 6 President Fouche Drive	8.40	13.10	17.10	10.44	7.14	1.02	57.20
Jo 38 A3	8.40	10.48	17.10	11.60	9.52	0.00	57.10
So Boulting Avenue	5.60	20.98	6.84	10.44	7.14	6.12	57.10
Jo 39 Club Street	8.40	18.34	15.39	5.80	4.76	2.04	54.73
So 5th Avenue Sandown	8.40	20.98	5.98	8.28	9.52	0.00	54.16
Jo 32 D.F.Malan Avenue	8.40	20.98	0.00	9.28	4.76	2.04	45.44
Jo 81 Jan Smuts Avenue	5.60	18.34	3.42	8.98	7.14	2.04	43.50

APPENDIX G

Full Weighted List

Author: Conway Peter Joseph.
Name of thesis: Priority assessment of transportation projects in the Central Witwatersrand area of South Africa.

PUBLISHER:
University of the Witwatersrand, Johannesburg
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