The Use of Partial and General Equilibrium Approaches and Multi-Criteria Decision Analysis to Prioritise Investments in the Public Sector.

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Persisting triple challenge of unemployment, poverty and inequality in the post-apartheid regime coupled with limited resources and/or budget constraints has remained a complex hurdle constraining development in South Africa, particularly the Eastern Cape. The multi-conflicting goals that Government seeks to achieve require the use of specific planning and prioritization tools. The use of partial and general equilibrium approaches in decision-making regarding investments in catalytic projects is often being criticized for its biasedness towards quantitative aspects, leaving the qualitative issues unattended. This paper proposes an integrated multi-criteria model that combines both the "partial and general equilibrium approaches" (PGEA) and "multi-criteria decision analysis" (MCDA), as a tool that policy-makers could use, firstly, to allocate resources efficiently and effectively in order to achieve optimal outcomes; secondly, to ensure a scientific method is used for option appraisal and prioritization of investment projects or programmes; lastly and more importantly, to assess the macro-economic benefits, social impacts, environmental implications and financial gains associated with the investment. The paper reviews literature on the use of PGEA and MCDA. It provides empirical applications with specific emphasis on investments in the Eastern Cape. The results show how the use of the integrated model contributes towards efficient and effective resource allocation. It also show how adequate option appraisal of key investment projects lead to desired outcomes.

Key words: Partial and General Equilibrium Models; Multi-Criteria Decision-Making, project appraisal, project prioritisation, impact analysis. Supply and Use Table (SUT), Social Accounting Matrix (SAM), Input Output (IO), Computable General Equilibrium Model (CGE-Model), Cost-Benefit Analysis (CBA), Social Return on Investment (SROI), Multi-Criteria Decision Analysis (MCDA)

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1. Introduction

1.1 Background

Twenty years into democracy, South Africa is still confronted by multiple and conflicting challenges of rising unemployment, poverty and inequality (Helepi, 2013:1). Despite the fact that challenges are being diagnosed, in many cases, prioritisation is intuitive and thereafter hazardous with unpredictable consequences. The existence of conflicting goals and criteria to base the decision of selecting projects that yield optimal outcome poses a serious dilemma to commissioners and policy-makers (Stewart, Joubert, Scott and Low, 1997:5). For example, the traditional economic policy objectives of stimulating investment and industrialisation with the aim to create jobs, often conflicted with environmental goals of reducing carbon emissions (Andre and Cardette, 2009:2). Policy makers should aim to design *efficient policies* which seeks to achieve the best possible outcome of certain policy objectives with the minimum possible cost in terms of other objectives (Andre and Cardette, 2009:2).

This paper suggests a multi-criterion approach where project appraisal combines economic efficiency (optimal allocation of resource), equity (impact distribution aspects), sustainability (environmental aspects), financial efficiency (return on investment), and compatibility (alignment with other goals and policy objectives) as decision criteria.

The use of partial and general equilibrium approaches (PGEA), such as, Supply and Use Tables (SUTs), Social Accounting Matrix (SAM), Input Output, and Computable General Equilibrium (CGE) models has gained the terrain in decision-making regarding major investments and their economy-wide impacts (Austroads, 2005:3). However, these models belong to one family of PGEA and they are often being criticized for their biasedness towards quantitative aspects, leaving the qualitative issues unattended. A second family of model, referred to as "Multi-criterion approaches" (MCA) includes Cost Benefit Analysis (CBA), Social Return on Investment (SROI) and Multi-Criteria Decision Analysis (MCDA). These are decision-making tools that accommodate both quantitative as well as qualitative aspects (Mendoza, Prabhu, Sakadri and Pernomo: 1999:15). However, they do not provide economy-wide impacts. Therefore, this paper proposes an integration of both the "partial and general equilibrium approaches" (PGEA) and "multi-criteria approch" (MCA), as a single tool that policy-makers could use, firstly, to allocate resources efficiently and effectively in order to achieve optimal outcomes; secondly, to ensure a scientific method is used for option appraisal and prioritization of investment projects or programmes; lastly and more importantly, to assess the macro-economic benefits, social impacts, environmental implications and financial gains associated with the investment.

1.2 Aim and questions the paper seeks to address

The aim of this paper is firstly to shows the use, advantages and limitations of the SUTs, IO, SAM, and CGE models and how they are interlinked. Secondly, it also shows the use, advantages and limitations of the CBA, SRI, MCDA models and how they are interlinked. Thirdly, it shows how the two set of models (PGEA and MCA) can be integrated into one single model. In certain instances, the paper provides empirical applications of the tools with specific emphasis on investments in the Eastern Cape.

The benefit of integrating PGEA and MCA is to widen both the type of appraisal and the impact range. Depending on the nature of the problem at hand, different types of appraisal, including: economic appraisal, institutional appraisal, financial appraisal, social appraisal, and environmental appraisal are feasible (Adler, 1987: 3-4). Similarly, the impacts from investing in a specific project are wide-ranging, including those related to the generation and distribution of income, alignment with policy goals and objective (Schutte, 1983:7-8). The robustness of the combined model and its capacity to generate micro-economic impact, macro-economic impact, impact on other regions, and economy-wide impacts are an additional advantage (Austroads, 2005:16).

The questions that an integrating model based on PGEA and MCA can address are listed below.

1. What informs the choice and design of government policy and initiatives? How government initiatives impact on household of different race, profession, income groups, and on the economy as whole?
2. How public and private projects are appraised and what informs the choice of the project that yield optimal outcome? For a particular project/program or investment, how are economic impact, cost-benefit, social return on investment, environmental impact, social and financial impact assessed?
3. What determines the robustness of a policy or strategy? Are government policies pro-poor? Are they addressing income inequality and contributing to job creation?
4. What input and resource (sector input, skill level) are required to achieve the desired level of GDP growth? Which sectors need to be stimulated to yield optimal economic growth and create more jobs?
5. How external shocks; such as oil price increases, drought, and 2010 soccer world cup and how internal structural changes affects households of different background and the economy as a whole? For example, how does an additional R1 in the fiscus impact the regional economy as a whole and how it affect people of different income groups? The question is whether that 1R will reach the targeted group of households?

In the process of developing a combined model, additional information is generated which is often used to strenghten economic analysis as recommended by the world bank. The world bank's handbook on economic analysis of investment operations suggests that a good economic analysis should answer the following questions: (1) What is the objective of the project?; (2) What will be the impact of the project?; (3) Are there any alternatives to the project? If so how would costs and benefits of the alternatives to achieve the same goal compare to the project in question?; (4) Is there economic justification of each separable component of the project?; (5) Who gains and who loses if the project is implemented?; (6) What is the fiscal impact of the project?; (7) Is the project financially sustainable and what are the risks involved?; and (8) Are there any other externalities? What is the environmental impact of the project? (Belli, P., 1996)

1.3 The need for both PGEA and MCDA models

Currently, all provinces in South Africa have an Input Output Model which was developed by the Development Bank of South Africa together with Connigarth (DBSA, 2006). Other provinces have in addition to the IO model developed either a SUTs, or a SAM and very few provinces use CBA and SRIO. It is quite inconvenience to rely on one tool/model. For example, the input output alone will not address qualitative impact. It provides very limited social, environmental and financial impacts. Similarly, the CBA and SROI models have no capacity to capture economy-wide impacts. It is against this background that this paper suggest the integration of both PGEA and MCDA in order to capture both qualitative and quantitative impacts.

1.4 How is the integration done?

The 2008 System of National Accounts (2008 SNA) and the 1995 European System of National Account (1995 ESA) consider Supply and Use Tables (SUTs) as the corner-stone of the National Account. Statistics South Africa has implemented the 2008 SNA and has compiled a manual that shows how to convert a SUTs into an Input Output framework (Stats

SA, 2012: 5). The IO becomes a building block of the Social Accounting Matrix (SAM). The SAM is used to construct the CGE (See Annexure 2), making the integration of the partial and general equilibrium approaches possible. Partial and General Equilibrium models (PGEM) are developed for the SUTs, IO, SAM and CGE for qualitative impact analysis. Each model is unique and it has a specific type of problem it addresses.

Similarly, CBA can be converted into SROI. Both the CBA and SROI are input to the MCDA. The Multiple MCDA is designed to incorporate results from PGEM together with the results from the Cost Benefit Analysis (CBA) and Social Return on Investment. In this way, both the MCDA and PGEA are integratable as one model to provide for a wider range of qualitative and quantitative impact and economy-wide impacts. (Conningarth Economists, 2013)

2. Methodology

The multiple criteria analysis is an appropriate tool used in an environment with infinitely variable alternatives, multiple challenges, budget constraint, finite number of options, multiple conflicting goals and policy objectives, and endless wish list of possible projects. Most policy decisions are concerned with the question of prioritisation and project appraisal, and how to come up with efficient policies. The methodology here is to identify an optimal design for the option, guided by multi-criteria methods, bearing in mind that the optimisation is subject to specific constraints, such as budget, cost, technology, etc.

Following Anderson, Sweeney, and Williams (1997), the methodology seeks to identify from all the infinite possible combinations of values of a set of decision variables, X_j, a set which maximise a given linear objective function while also obeying a set of constraints which restrict the combinations of X_j values that are admissible (Anderson, Sweeney, and Williams, 1997) also (DCLG,209:112-113).

Maximise

$$\sum_{j=0}^{n} a_j \, x_j \tag{1}$$

Subject to

$$\sum_{j=0}^{n} a_{ij} \, x_j \leq b_i \; (i = 1, \dots, m) \;\; and \;\; x_j \; \geq \; 0 \; (j = 1, \dots, n) \tag{2}$$

Where,

x_j are decision variables (variables over which the decision-maker has control)

aj are numerical parameters whose relative values reflect the relative contributions of changes in each of the decision variables to achieving the overall aims

$\sum a_j x_j$ is the objective function. It expresses the decision maker's overall goal/objective as a function of the decision variables

$\sum a_{ij} x_j \leq b_j$ are the functional constraints. They express how the values of the x_j are limited by the operating environment in which the decision maker finds himself

Xj ≥ 0 are non-negatively constraints, requiring that the x_j do not take negative values

2.1 MCDA methods

Different MCDA methods have been developed. They all share the same goal since they are all concerned with the problem of assessing a finite set of alternatives, based on a finite set of conflicting criteria, by the decision-maker. The question is then how to select the appropriate MCDA method.

Hanne (1999) pointed out three important aspects that should be taken into account when selecting a MCDA method in a real-world decision context, namely; characteristics of the problem at hand, the method requirements and the decision making requirements. For example, if the problem has *a continuous* set of alternatives, it can be categorised under *Multi-Objective Decision Making*, whilst if the problem has a *discrete* set of alternatives, it falls within the category of *Multi-Attribute Decision Making* (Márcia, Dalila and Teresa, 2013: 5). Therefore, the nature of the problem at hand informs the choice of the MCDA method to be applied. The most common MCDA methods are briefly discussed below:

- *Multi-Objective Decision Making* (MODM): is one of the most popular MCDA approaches used in the public sector in cases where Government is interested in simultaneously maximising growth, minimising environmental damage, minimising unemployment, minimising poverty and inequality, maximising revenue, and so on.

- *Multi-Attribute Utility Approach (MAUA):* This multi-criteria method is used for rational choice under uncertainty (Keeney, 1972: 37-50). For example, the utility of investing in "*Umzimvubu Water Dam*" in the Eastern Cape-South Africa may depend on a future rate of climate change, hence there is uncertainty about what future will be.

- *Analytical Hierarchy Process (AHP)* was originally devised by Saaty (1980). This method has proven to be one of the more widely applied MCA methods. It is extraordinary elegant in its simplicity for addressing and analysing discrete alternative problems with multiple conflicting criteria. AHP process is the methodology used to solve problems at the strategic level (Saaty 1980:5). This method consists of "*pairwise comparisons"* which are done by responding to the question: How important is criterion A relative to criterion B; criterion A relative to criterion C? After getting responses, then you allocate both weights for criteria and performance scores for options on the different criteria.

- *The Linear Additive Models (LAM)* also refered to as simple additive weighting (SAW) is widely used in the public sector for decision-making. In this method, various impacts for each alternative on a specific project are weighted using numerical values called criteria weights. The weighted criteria are then summed up to derive a single value for each alternative by which the alternatives are ranked (Voogd, H.,1983). In general the basic form of simple additive weighting (SAW) method is

$$S_i = \sum_{j=0}^{n} c_{ij}\, w_j \qquad (3)$$

Where

S_i is the appraisal score for alternative i,

c_{ij} is the score of alternative i with respect to criteria j

w_j is the weight of criteria j. It implies that the higher the value of S_i the higher is the rank. If we have n criteria, then we will have weight vector (W) shown in the equation 4.

$$W^t = (w_1, w_2, \ldots\ldots w_n) \qquad (4)$$

and

$$\sum_{j=0}^{n} w_j = 1$$

According to Chen and Hwang (1992), the main difficulty in applying linear additive model in public sector project appraisal is in determining criteria weights (w_j).

- Other MCDA methods are: (1) Goal Programming (GP): This method is mostly useful in financial planning because many financial criteria can be expressed in terms of goals (Chanes, Cooper and Ferguson, 1955). (2) Fuzzy method is used for integer or binary, stochastic or fuzzy decision variables (van Laarhoven and Pedrycz, 1983). (3) Outranking Methods (OM); In this method, there must be enough arguments to decide that option A is at least as good as Option B, while there is no overwhelming reason to refute that statement (Roy and Vanderpooten, 1996).

- In CBA, there are three techniques used for economic evaluation:

1. Internal Rate of Return: (IRR): $\Sigma\, b_j/(1 + r)^j - \Sigma c_j/(1 + r)^j = 0$ (5)
Selection criteria: 0nly projects with an IRR higher than the social discount rate will be accepted.
2. Net Present Value (NPV). The NPV = $\Sigma\, b_j/(1 + r)^j - \Sigma c_j/(1 + r)^j$ (6)
Selection criteria: NPV should be positive.
3. Discount Benefit Cost Ratio (BCR). The BCR = $(\Sigma\, b_j/(1 + r)^j)/(\Sigma c_j/(1 + r)^j)$ (7)
Selection criteria: BCR should be higher than one.

Where,

$b_0, b_1, \ldots, b_n$ are the project benefits in years 0, 1, 2, …, n
$c_0, c_1, \ldots, c_n$ are the costs in years 0, 1, 2, …, n, and
I is the social discount rate, then the present value of the benefits is given by $b_0/(1 + i)^0 + b_1/(1 + i)^1 + \ldots + b_n/(1 + i)^n$ and the present value of the costs are given by $c_0/(1 + i)^0 + c_1/(1 + i)^1 + \ldots + c_n/(1 + i)^n$

2.2 PGEA methods

There are two main categories under PGEA: the partial equilibrium approach and the general equilibrium approach. The partial equilibrium approach such as the SUTs, IO and SAM is based on the Leonthief multipliers developed by Wassily Leontief (1905-1999) for which he received a Nobel Memorial Prize in 1973. It provides different types of multipliers against which impacts analysis are derived. *The Type I multipliers* measure the direct and indirect effects, while *Type II multipliers* measure the induced effect. In analysing the multipliers, it is important to specify which one to use. The nature on the problem at hand determine whether to use Type I and Type II demand-side multipliers or to use Type I and Type II supply-side multipliers. (Defourney and Thorbecke 1984: 111-136).

In order to widen the range of impact, the Leontief multipliers are derived at seven different levels. These levels are:

- Initial impact: it captures the initial capital investment of the project.
- First round impact also referred to as first order effects
- Direct impact: The direct impact is the sum of the initial and first round impacts.
- Indirect impact: Indirect effects result from changes in sales by suppliers to the directly-affected businesses
- Total impact: This is the sum of the direct and indirect impacts.
- Induced impact: Induced effects are further effected resulting in spending by households
- Economy-wide impact: This is the sum of the direct, indirect, and induced effects.

These Leontief multipliers are used for running simulations for partial equilibrium models (SUT, IO and SAM),

Annexure two shows how the SUT can be converted into IO; how the IO is converted into a SAM; and how the SAM is converted into the CGE. The SAM provides a record financial transactions of goods and services of a particular country (or region) in a form of matrix for a particular period, generally a year. For accounting purposes, the entries made in rows represent incomes or receipts, whilst the entries made in columns represent outlays or expenditures (Pyatt and Round, 1985). This accounting practice is also adopted by the United Nation's System of National Accounts (68 SNA, 93 SNA and 2008 SNA) as well as the 1995 European System of Accounts (1995 ESA).

Robinson and EL-Said (2000) define a SAM as a matrix *T* in which the transactions with elements *Ti,j* represent payment from column account *j* to row account *i*. Following the conventions of double-entry bookkeeping, the total receipts (income) and total expenditure of each actor must balance. That is, for a SAM, every row sum *Yi* must equal the corresponding column sun *Yj:*

$$Y_i = \sum_j T_{i.j} = \sum_J T_{j.i} \quad \text{and} \quad Y_j \sum_j T_{i.j} = \sum_J T_{j.i} \qquad (8)$$

Where,

Y_i is total receipts of account *i*

Y_j is the total expenditures of accounts *j*.

T_{ij} and t_{ji} represent the transactions recorded in the column accounts and in the row accounts respectively. These transactions are consistent and interlinked in a single accounting framework called the SAM.

From Equation 8, it is possible to derive the main structure of the economy. This is obtained by dividing each cell entry in the SAM matrix by its respective column total which leads to a SAM technical coefficient matrix, *A* shown in equation 9

$$A_{i.j} = \frac{T_{i.j}}{y_j} \qquad (9)$$

By definition, all the column sums of *A* must be equal to 1, so the matrix is singular. Since column sums must equal row sums, it also follows that (in matrix notation):

$$y = Ay$$

The genesis of the SAM and its related accounting methods for economic activity is generally associated with a french man called Mr. F. Quesnay who compiled the first "Tableau Economique" in the 18th century. This concept of recording economic activity in a matrix was further pioneered by Sir Richard Stone (1954) in his article entitled "Input-Output and the Social Accounts". More than 20 years later, Pyatt and Thorbecke (1976) improved the input output framework to include what is currently known as Social Accounting Matrix. Since then, SAMs have been worldwide used for various policy analysis, but more specifically to study income distribution (Pyatt and Roe, 1977; and Keuning, 1996), regional economic development (Cardenete, 2004), growth strategies in developing economies (Pyatt and Round, 1985; Robinson, 1986; and Vos and Jong, 2003), income multipliers (e.g. Stone, 1981; Pyatt and Round, 1985; and Santos, 2004), and socio-economic, technological, environmental issues (Resosudarmo and Thorbecke, 1996; Khan, 1997; Duchin1, 1998; and Alarcón and others, 2000).

There is a difference between a partial equilibrium and general equilibrium models: Partial equilibrium models have fixed prices and variable quantities. For example in partial equilibrium models, output, number of people employed can change but the wage prices cannot change, it remains fixed. Also in partial equilibrium models, the level of sector details is more. For example, the South African SUT has over 176 commodities compared to 27 commodities in the CGE model.

General equilibrium models have fixed quantities but allows prices of certain parameters such as capital and labour to change. The analytical power of CGE for policy analysis is gained by allowing price variation among inputs. Hence, this approach is better equipped to evaluate policy shocks whose impacts are expected to be complex i.e. with potential to capture a much wider set of economic impact, to build scenarios, and assess the robustness of a specific policy.

The CGE model draw data from the SAM (Austroads, 2005:3). The development of a CGE model, the programming and calibration of the model is time consuming. Annexure 3 provides simplified CGE model equations for both a static model and for dynamic model.

3. Definition, use, advantage and limitations, applications, simulations and results

This section presents very briefly the use, advantages, limitations, and where possible empirical applications, simulations and results of the SUTs, SAM, IO, CGE, CBA, SRI and MCDM models. We are not suggesting that all 7 models should be used simultaneously in one project, but a combination of two or more depending on the nature of the problem at hand. For example, when investigating the impact of the contracting a new road, a combination of SAM, CBA and MCDA will suffice.

For Partial Equilibrium model, this paper uses the Eastern Cape economic model developed by Quantec (2011). The model comprises 43 sectors, 11 multipliers (which show impact on Output, employment, GDP, GFCF, households, wages, intermediate import, GOS, taxes, and capital stock), and 5 impact levels (initial, direct, indirect, induced and economy-wide) (See Annexure 4). The paper also adapt the CBA and MCDA compiled by Conningarth Economist (2013) used for project appraisal with the aim of revealing the macro-economic benefits, social impacts, environmental implications and financial gains associated with the project or investment.

3.1 Supply and Use Tables and Input Output Tables

3.1.1. Definition, use, advantage and limitations of SUT and IO Models

The Supply and Use Tables provide a record of economic data in a matrices format which shows how supplies of different kind of goods and services originate from domestic industries and imports and how these supplies are allocated between various intermediate input and final demand, including exports (Eurostats, 2008: 21). The SUTs have an advantage of accommodating detailed sectors. It can even be disaggregated from industry level to product level.

SUTs Models are used for sector analysis, investment choices, industrial strategy, trade strategy, investment analysis (Kavese and Seedat, 2004:21). Impact analysis can be done at product level. The applications of the SU-Tables are designed to achieve the following purposes (Eurostats, 2008: 65):

- To identify industries and sectors with high comparative and competitive advantages,
- To determine inter-industry impacts through multipliers,
- To assess backward and forward linkages,
- To assess the number of jobs sustained through infrastructure projects,

- To initiate analyses with the GDP estimates at Regional level (GDP-R) rather than the obsolete concept of Gross Geographic Product (GGP),
- To provide the foundation upon which the social accounting matrix and related macro-economic models are developed, and
- To quantify the monetary flow of goods and services within the regional economy in a comprehensive provincial accounting system.

The IO framework completes the SUTs framework by offering an alternative approach to display information contained within the SUTs. The use, benefit and limitation of the SUTs are also applicable to the IO framework. The IO framework offers extensive analytical ability in both the product by product and industry by industry frameworks (Stats SA, 2012: 8). The industry by industry IO model allows for analysis that aims to examine tax structures and reforms, the effect of monetary and fiscal policies. The product by product IO model allows for analysis that aims to examine sector policy such as: industrial policy, energy policy, environmental policy, etc.

There is a difference between SUTs and IO tables: The SUTs are industry-by-product matrices using both industry and product classifications. SUTs comprises two separate tables, one describing the use of commodities and the other describing the supply of commodities. However, I-O tables are either produced as a product-by-product, or an industry-by-industry matrix (not mixed). An I-O table has both supply and use data in a single matrix, using either industry or product classifications in the rows and columns (Stats SA, 2012: 8).

Both the SUT and IO models have in common the following limitations. Firstly, both models do not perform impact analysis on demographic variables such as (Gender, race, age groups, occupation, and income groups). This limitation is handled in the SAM. Secondly, in the SUTs and IO models, prices of capital and labour remains fixed. This limitation is relaxed in the CGE model. Thirdly, the SUTs and IO are quantitative models. This limitation is relaxed in both the SROI and MCDM models.

3.1.2 SUT and IO models: Simulations and results

First simulation: Assume that in 2010, policy-makers in the Eastern Cape set a target of 5% real GDP growth for 2015. Pertinent strategic questions here are: (1) what level of input and/or output do economic sectors need in order to reach that target? (2) What level of skills does the province require to achieve and sustain that growth? (3) How do we promote a pro-poor and jobless growth policy and to what extent will the new economic growth reach the targeted beneficiaries? SUT and IO models are equipped to answer question one. Questions 2 and 3 are best handled in SAM and CGE models.

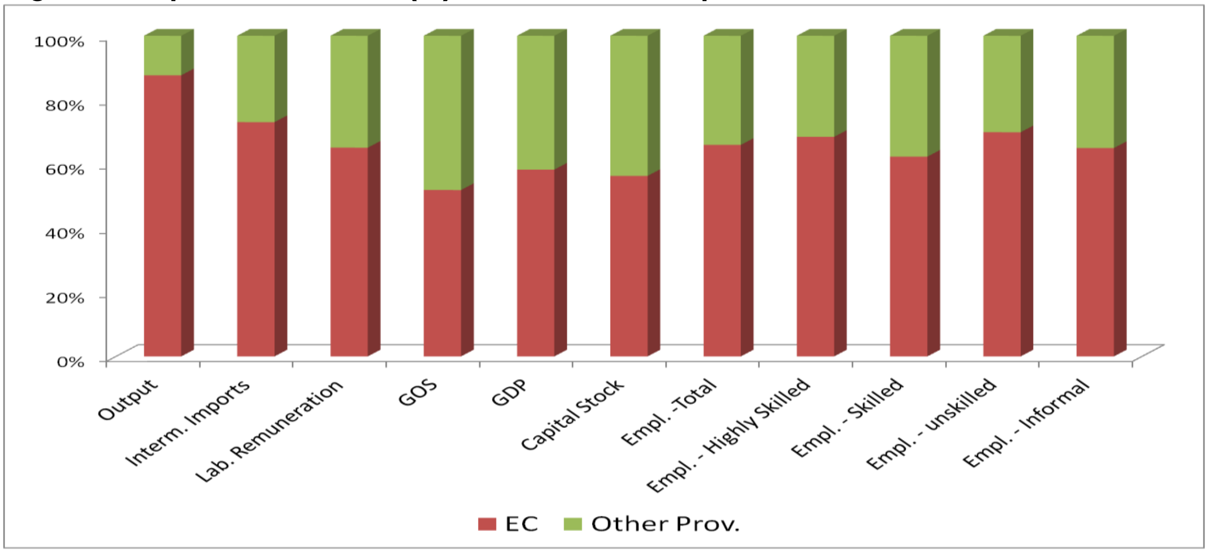
The first step is to estimate the level of output for 2015. We use the SUTs/IO models' technical coefficients to assess the sector input required to achieve that target. Between 2010 and 2015, Rm 19 561 sector GVA is needed to reach 5% growth in 2015 and sector input required is shown below.

Agriculture	383
Mining	20
Manufacturing	3 388
Electricity	187
Construction	518
Trade	2 711
Transport	1 758
Finance	4 542
Government	6 049
Total (Rand million)	**19 561**

The second simulation concerns the auto sector. The Eastern Cape economy is driven by the automotive sector. Assume that households or exports demand for automotive products increased by R1 million. What will the impact of that increase in the auto-sector be, firstly in the Eastern Cape economy, and secondly on the rest of the country? Annexure 4 shows the demand-side multipliers, also known as backward multipliers, for a hypothetical R1 million final demand spending on products of the automotive sector in the Eastern Cape. These multipliers take into account the effects of increased spending by other sectors, but not the effect of direct and indirect imports that will result from such an increase in final demand (Kavese 2012:23). The simulation results show that total output will increase by Rm 2.77, labour remuneration by Rm 0.24, Gross Operating Surplus by Rm 0.19, GDP by Rm 0.43, intermediate input by Rm 0.46, and there will be 3.7 jobs created of which (0.38 highly skilled, 1.31 skilled, 1.32 unskilled and 0.74 informal).

Figure 1 shows how the impact is distributed between the Eastern Cape and the rest of the country

Figure 1: Impact distribution (%) in the Eastern Cape automotive sector



Source: Own calculation derived from the Eastern Cape IO model, 2012

The results show that when the final demand in the Eastern Cape automotive sector increases by R1 million, the output impact is split at 90% in the Eastern Cape and 10% in the rest of the country, whereas, the GDP impact is 60% in Eastern Cape and 40% in the rest of the country; and for the GOS impact, it is half in Eastern Cape and half in the rest of the country. Figure1 also shows the share of jobs that will be created. The total employment impact is 70% in Eastern Cape and 30% in the rest of the country. Employment spilt is shown by skills levels (highly skilled, skilled, unskilled and informal).

3.2 . Social Accounting Matrix and Computable General Equilibrium models

3.2.1. Definition, use, advantage and limitations of SAM and CGE Models

SAM is a well-equipped tool for analyzing the socio-economic impact of any government project. It is a database that provides a snapshot picture of the economy in one year, showing, among other things, how income is generated, how it is distributed among different households, and how different households spend their income (Pyatt and Round, 1985).

SAM models have been used to study income distribution and redistribution (e.g. Pyatt and Roe, 1977; and Keuning, 1996), regional development (e.g. Cardenete, 2004), growth strategies in developing economies (e.g. Pyatt and Round, 1985; Robinson, 1986; and Vos and Jong, 2003), decomposition of activity multipliers that shed light on the circuits comprising the circular flow of income (e.g. Stone, 1981; Pyatt and Round, 1985; and Santos, 2004), as well as a combination of social, technological and environmental issues (e.g. Resosudarmo and Thorbecke, 1996; Khan, 1997; Duchin1, 1998; and Alarcón and others, 2000).

In South Africa, SAMs are used to build economy-wide macroeconomic models explicitly designed to analyze the distributional impacts of policy change, that is, the effects on employment, incomes and poverty of different household groups. The uniqueness of this economic model is its capacity to show to what extent (i) a social or economic policy, (ii) an infrastructure project, (iii) a public or private investment, and (iv) any other public and private initiative affects people of different (i) gender, (ii) race, (iii) income group, (iv) regions, (v) professions. It also shows at regional level how public and private interventions impact on various institutions and economic sectors. That makes it uniquely apt tool to analyze government's policies and strategies aimed at addressing broad development challenges.

The SAM has limitations. Firstly, it assumes full employment. Secondly, the prices of capital and labour are fixed. Following the basic principles of the walrasian equilibrium as in Scarf and Shoven (1984), Ballard et al. (1985) or Shoven and Whalley (1992), these limitations can be addressed in the CGE model which allows changes in capital and labour.

The CGE is an extension of the SAM. Therefore, the CGE has the potential to capture a much wider set of economic impact than the SAM; to evaluate the implementation of a policy reform as well as the distributive effects within the economy at different level of disaggregation. That unique nature makes CGE approach a cutting-edge tool for public design and implementation (Lofgren, Hans, Harris and Robinson, 2002). CGE models are a standard tool of empirical analysis, and are widely used to analyze the aggregate welfare and distributional impacts of policies whose effects may be transmitted through multiple market.

3.2.2 SAM and CGE models: Simulations and results

To address the challenge of poverty and inequality, it is imperative to have a model (such as SAM) that shows how income is generated and distributed. The SAM and CGE are well structured to respond to questions of pro-poor growth and the extent to which new economic growth reaches the targeted beneficiaries as well as the skills needed to achieve a specific target. Therefore, the next section provides two simulations: the first one addresses the question of how to ensure income reached the targeted audience and the second simulation answers the question of employment by skills needed to achieve a specific policy target.

Simulation 1: To what extent does the income generated in the Eastern Cape reaches the targeted social group such as African households in low income class? For the purpose of this paper, income group 1 to 4 is classified as low class, income group 5 to 9 is classified as middle class and income group 10 to 12 is classified as high income class.

The results from the SAM model show that almost half (47.04%) of the province's income ends up in the hands of Whites, while the share received by Africans is 38.13%. It also shows that the gap between the low class and the high class is very wide. The low class receives 5.58% of the province's income while the high class enjoy 70.06%. The middle class enjoy almost a quarter of the province's income (See Table1).

Table 1: Generation and distribution of income in the Eastern Cape.

Income group	African	Coloured	Indian	White	TOTAL	TOTAL
Income 1	0.12	0.07	0.00	0.12	0.32	**5.58** **Lower class**
Income 2	1.36	0.09	0.00	0.08	1.53	
Income 3	1.13	0.19	0.01	0.04	1.37	
Income 4	2.05	0.24	0.02	0.07	2.37	
Income 5	2.11	0.92	0.03	0.15	3.21	**24.36** **Middle class**
Income 6	1.99	0.68	0.07	0.18	2.92	
Income 7	3.95	0.50	0.12	0.35	4.91	
Income 8	4.01	0.79	0.32	0.75	5.87	
Income 9	4.26	1.34	0.58	1.27	7.44	
Income 10	4.20	1.51	0.86	3.89	10.46	**70.06** **Upper class**
Income 11	4.83	1.54	1.03	7.54	14.95	
Income 12	8.91	2.09	1.05	32.60	44.66	
TOTAL	**38.92**	**9.94**	**4.09**	**47.04**	**100.00**	**100.00**

Source: Own calculation derived from the EC SAM model

From Table 1, it becomes evident that income is unevenly distributed in the Eastern Cape Province. The gap between the poor and the rich is wide. Hence the challenge of poverty and income inequality is apparent. The wealth of the province is still in the hands of the few rich households and not yet reaching the majority (largely of the population) in the lower income groups. This is also an indication that pro-poor growth in the province remains out or reach.

The beauty of the EC SAM model is that it provides both multipliers on the demand side and on the supply side. For example, for a specific project, it is possible to assess impacts in two directions: input required from other sectors and output generated to other sectors; as well as the number of jobs created by each sector and employment required by skill level.

Simulation 2: Given a specific target to achieve, it is possible to determine the employment required by skill, by occupation and by sector in order to reach a specific target. Using the earlier example that targeted 5% growth in 2015, Simulations results from the EC SAM model shows employment requirement by skills as follows: 10.3% from highly skilled labour, 35.0% from skilled labour, 34.9% from unskilled labour and 19.8% from the informal sector. Annexure 4 provides the number of jobs created for every R1m increase for final demand in the auto sector.

3.3. Definition, use, advantage and limitations of Cost Benefit Analysis and Social Return to Investment

3.3.1. Cost Benefit Analysis

CBA is a tool that considers a range of benefits and costs, and translates them into monetary terms by using appropriate unit valuation factors derived from actual cost or willingness-to-pay estimates (Weisbrod, 2011:3). The CBA originated when economists started to link the theory of consumers' surplus with the net gain to communities resulting from government spending projects (Mullins, Mosaka, Green, Downing& Mapekula, 2007:1).

According to Dockel, Mirrilees and Curtayne (1991:3), there are different types of CBA: the narrow CBA, broad CBA; classical CBA, traditional CBA; economic CBA and social CBA. The conventional school of thought favours the narrow CBA while the decision-making school of thought supports the broad CBA. The economic CBA focuses mainly on the objective of efficiency (optimal allocation of resources). The social CBA, in addition to economic efficiency, also considers aspects such as equity effects and externalities (Brent, 1996: 5). The discussion in this section is related to the broad CBA which is mainly used by policy decision-makers.

Cost Benefit Analysis is a useful approach for anyone required to do option appraisal, allocation of resources, and evaluation of projects or programmes. It is essential in setting out the cost and benefits associated with different options, and making hard choice between them. It is an important tool for policy decision-makers, used for drawing up strategic business cases and reduce inefficiencies. Final decisions are based on whether there is a net benefit or cost to the service or programme (IPC, 2011: 2-3).

The advantages of CBA are numerous: A CBA support option appraisal, makes hidden costs and benefits explicit, and allows the selection of projects that are financially viable and feasible.

CBA is often criticised that it does not adequately take into account non-monetary impacts. CBA rarely gives proper recognition to qualitative and non-market factors, such as equity, quality of life. It over-relies on the quantitative data. It uses shadow prices and surrogate prices that are often overestimated or underestimated (Mullins D., Mosaka D., Green A., Downing R., & Mapekula P., 2007: 36).

Other shortfalls of CBA were identified by the Institute of Public Care (IPC, 2011: 2-3):

- Valuation techniques are imperfect and loaded with assumptions. The parameters and any underlying assumptions about costs, benefits, risks and discount rates need to be clearly defined and transparent.
- Information on costs, benefits and risks is rarely known with certainty, especially when one looks to the future. This makes it essential that sensitivity analysis is carried out, testing the robustness of the CBA result to changes in some of the key numbers.

In the CBA, what are the criteria used to select viable projects? Suppose:

- $b_0, b_1, \ldots, b_n$ are the project benefits in years 0, 1, 2, …, n
- $c_0, c_1, \ldots, c_n$ are the costs in years 0, 1, 2, …, n, respectively, and
- i is the social discount rate, then the present value of the benefits is given by $b_0/(1 + i)^0 + b_1/(1 + i)^1 + \ldots + b_n/(1 + i)^n$ and the present value of the costs are given by $c_0/(1 + i)^0 + c_1/(1 + i)^1 + \ldots + c_n/(1 + i)^n$

The following three criteria are used for project appraisal (Mullins D., Mosaka D., Green A., Downing R., & Mapekula P, 2007: 40-41):

- Internal Rate of Return (IRR)
  $\Sigma\, b_j/(1 + r)^j - \Sigma c_j/(1 + r)^j = 0$
  Only projects with an IRR higher than the social discount rate will be accepted.
- Net Present Value (NPV)
  $NPV = \Sigma\, b_j/(1 + r)^j - \Sigma c_j/(1 + r)^j$
  Only projects with positive NPV are accepted.
- Discount Benefit Cost Ratio (BCR)
  $BCR = (\Sigma\, b_j/(1 + r)^j)/(\Sigma c_j/(1 + r)^j)$
  The BCR should be higher than one for the project to be considered as viable

After assessing the three criteria above, project-evaluators usually perform a so-called "*sensitive analysis*". This process aims to establish the sensitivity of a project's outcome to changes in a limited number of key input variables. This is done by selecting one key parameter which is capable of affecting significantly the results of the CBA in order to determine impact scenario for the project and these possible result outcomes are ranked high, medium and low for each of the parameters selected for the sensitive analysis (Mullins D., Mosaka D., Green A., Downing R., & Mapekula P., 2007: 44).

3.3.2 Social Return on Investment (SROI)

Social Return on Investment has emerged internationally as a viable approach to measuring the extent to which social impacts are being achieved. It has its roots in cost-benefit analysis. SROI philosophical intent is to promote a strong focus on positive social impacts. SROI is about value rather than just money. The SROI ratio represents the social value created for each R1 invested, rather than an actual financial return (CVAC, 2012: 12). SROI expressly relates input to impact. It seeks to examine the relationships between input and outcomes, or activities and outcomes, and by doing so, it fills a vacuum which previously existed in social sector evaluation framework (CVAC, 2012: 8). It incorporates social, environmental and economic costs and benefits, and helps institutions to understand better the economic value that they create by assigning a monetary value to all these factors (Liam B., Kevin B., 2009:8).

Historically, SROI emerged when Government funding to sector in the form of grants grew significantly and organisations were unable to adequately account for the social impact realised through the grants (Millar & Hall, 2012:4). In the 1990s, government and investors become interested to know (1) how to measure the success of their endeavour; (2) whether the grants/funds were achieving intended outcome; (3) how to make informed decision about the ongoing use of resource; and (4) what was the social value for each R1 invested (CVAC, 2012:9). In 2000, Robert Enterprises Development Fund (REDF) extended the cost-benefit analysis to calculate the social return on investment to the long terms grants given to institutions that run businesses for social benefit (Millar & Hall, 2012:4).

Since then, the SROI approach has been intensively used by a range of organisations, including public and private sector, policy decision-makers, investors, commissioners and funders.

A SROI analysis is useful in many ways: It can be used as a tool for strategic planning, for communicating social impact, attracting investment, and/or making investment decisions. Moreover, the tool identifies common ground between what the institution wants to achieve and what its stakeholders want to achieve. In this way, it helps to maximise social value through meaningful involvement of stakeholders in service design (CVAC, 2012: 10).

Projects are appraised using social return on investment ratio. The process starts by discounting the projected value over time. Having calculated the present value of all the "benefits" that the project offers, the next step consists of deducting the inputs (investments) to arrive at the Net Present Value (NPV) as shown in the following formula:

NPV is equal to Present Value of benefits minus the value of Investment
Two SROI ratios can then be calculated: the initial SROI ratio and the net SROI ratio.

SROI ratio is obtained by dividing the discounted value of benefits by the total investment:

$$\text{SROI} = \frac{\text{Present Value}}{\text{Value of input}}$$

Net SROI ratio is obtained by dividing the NPV by the value of the investment.

Net SROI = Net Present Value
Value of input

$$\text{Net SROI} = \frac{\text{Net Present Value}}{\text{Value of input}}$$

Assume the answer from the Net SROI ratio is R2.5. How is this ratio interpreted? It means there is R2.5 for every 1R invested.

After calculating the ratio, it is important to do a sensitivity analysis which assesses the extent to which the results would change for every change in the assumptions made in the previous stages. The aim of the sensitivity analysis is to test which assumptions have the greatest effect on the model; or which changes have a significant impact on the overall model. Hence, sensitivity analysis help in identifying potential priority areas. In other words, if the model show sensitivity to changes in a particular parameter, this is an indication that one may prioritise investment in system to manage that particular parameter. There are a number of online tools that are available to help researchers with SROI (See www.thesroinetwork.org).

The Strengths of the SROI includes its capacity (1) to improve the case for funding and investment by creating a wider interpretation of "return on investment" and provides a better understanding of value for money; (2) to develop public policy when social value is important by involving engagement and commitment from a wider range of stakeholders; and (3) to supplement CBA by incorporating both potential negative and positive outcomes so that corrective actions can be taken and that the impact of change is assessed.

The limitations and weaknesses of using SROI include (1) the difficult to translate some benefits and outcomes into a monetary value. There are benefits that are very important but they cannot be monetised; for example, improved family relations or increased self-esteem are outcome not easy to associate with monetary value (Arvidson, 2010:3). (2) The need for multi-skilled capacity. SROI is both time and resource-intensive. (3) If an institution seeks to monetise its impact, without having considered its stakeholders, there is a risk of choosing inappropriate indicators. As a result, the SROI calculations can be of limited use and miss the real difference that a service makes to people's lives.

3.4 Definition, use, advantage and limitations of Multi-Criteria Decision Analysis

Decision-making done intuitively and prioritisation made hazardous can result in unpredictable consequences. Multi-criteria analysis is a decision-making tool for multi-criteria type problems associated with multiple and conflicting goals (Stewart, Joubert, scott & Low, 1997:5). The tool seeks to address complex problems that have a mixture of monetary and non-monetary objectives by outlining monetary values for costs and benefits purposes and non-monetary items that have major importance. It provides a structured process for determining both the criteria by which a range of options will be assessed, and the relative importance of each of the criteria. This enables a single preferred option to be identified. The judgement of the decision-making team in establishing explicit objectives and criteria, scoring, weighting, and ranking is a critical feature (Belton V., & Stewart, T.J., 2002: 79-80). The MDCA uses outranking method; a concept where one solution outranks another if it is at least as good as the other in most respects, and not too much worse in any one respect (Ralph, E., Steuer, Paul N.A., 2003:502)

The DCLG manual identifies eight stages or steps of compiling a classical MCDA. (DCLG, 2009: 50). These are: (1) Establish the decision context; (2) Identify the options to be appraised; (3) Identify objectives and criteria; (4) Scoring: assess the expected performance of each option against the criteria; (5) Weighting: assign weights for each of the criterion to reflect their relative importance to the decision; (6) Combine the weights and scores for each option to derive an overall value; (7) Examine the results; and (8) Conduct a sensitivity analysis.

The manual (DCLG, 2009:10) supports good decisions and suggest that objectives be clear and "*SMART*" that means Specific, Measurable, Agreed, Realistic, and Time-dependent. Options that contribute to the achievement of objectives must be identified. These options may range from broad policies to specific programs. After completing the MCDA, a final decision must be taken. In Government, the final decision is sometime taken by Ministers. This is supported by Nijkamp who argues that political choices should be made by politicians and not by their model builders or other advisors" (Nijkamp and Spronk 1984: 285).

The MCDA can be used to identify the single most preferred option; to prioritise or rank options; to clarify the differences between options; to indicate the best allocation of resources to achieve objectives. The Institute of Public Care (IPC 2011: 11) have identified advantages and disadvantages associated to MCDA.

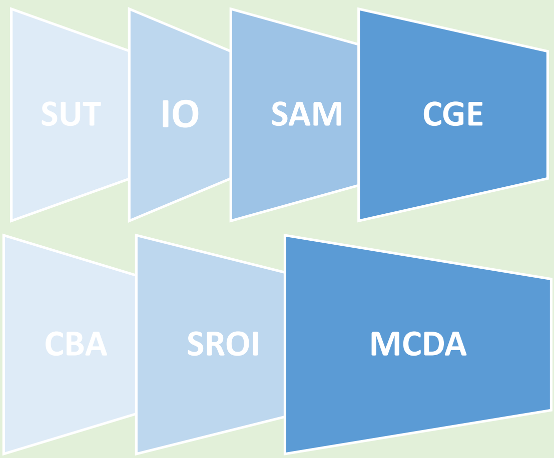
The advantage of the MCDA is that it incorporate a wider range of criteria (social, financial, political, ethical, economic and environmental). It provides a systematic approach to appraising options with a wide range of quantifiable and non-quantifiable impacts. The choice of objectives and criteria are open and explicit to analysis and the choice of options, criteria, and weighting are very flexible (IPC 2011: 11).

The weakness associated with the MCDA is the subjectivity embedded in the decision makers' own choices of objectives, criteria, weights and assessment of achieving objectives. The weighting and scoring may be bias and hard to derive (IPC 2011: 11).

4. Integrated model that combines general equilibrium approaches and multi-criteria decision analysis

This section provides a modelling system that applies a broad range of criteria (financial, economic, political, social, and environmental) to analyse the impact of changes in the allocation of resources to various investments or infrastructure projects. As shown in the diagram below, the proposed model suggests an integrated multi-criteria model that combines both the "partial and general equilibrium approaches" (PGEA) and "multi-criteria decision analysis" (MCDA), as a tool that policy-makers could use, firstly, to allocate resources efficiently and effectively in order to achieve optimal outcomes; secondly, to ensure a scientific method is used for option appraisal and prioritization of investment projects or programmes; lastly and more importantly, to assess the political, macro-economic benefits, social impacts, environmental implications and financial gains associated with the investment.

Multi-criteria analysis: an integrated model for impact analysis



Main indicators	Overall weight
1. Social & demographic impact	0.30
2. Economy-wide impact	0.30
3. Financial impact	0.15
4. Environmental impact	0.15
5. Political & Institutional impact	0.10
TOTAL	**1.00**

Source: Adopted from Kavese k., 2004

The modelling process starts by constructing the SUTs then integrate it into the IO, thereafter integrate the IO into the SAM and finally integrate the SAM into the CGE (See Annexure 2). In this way, a complete partial and general equilibrium models are produced. The next step consists of including the CBA and the SROI into the MCDA to provide a complete multi-criteria decision models. The Multi-criteria approach will then combine the two set of models and apply five broad criteria groupings for assessing impacts. To complete the modelling process, a weight has allocated to each of the 5 criteria in the diagram above. From the diagram above, the integrated model shows that social and economic impact carries equal weight of 0.30 each; the financial and environmental impact also carries equal weight of 0.15 each, and political impact has a small weight. These weight can be reviewed depending on the goal and objective that the project or investment seeks to achieve.

These 5 criteria are also subdivided in sub-criteria or indicators and weights are assigned to each sub-criteria. The value of each sub-criteria is derived from either the PGEA or MCDA models. The 5 measurable criteria and sub-criteria are discussed below.

1. **SOCIAL & DEMOGRAPHIC:** From the SROI model, the impact of the project or investment will include: social return on investment, social return ratio, net social return ratio, and payback period. From the SAM model, the economy-wide through the multipliers will be provided. Other social and demographic impacts include the impact of the investment/project on people of (1) different income class (for poverty and inequality policy analysis); (2) difference population group; (3) different profession (for labour policy analysis); (4) different age group (for youth policy analysis); (5) different gender (for women and gender policy analysis), etc…

2. **ECONOMY-WIDE IMPACT**: From the SUT and IO models, the economy-wide impact through the multipliers are provided, namely output multipliers (impact on economic sectors); employment multipliers (number of jobs that the project creates or sustains); GDP multipliers (impact on economic growth); GDFI multipliers (impact on investment); Wages multipliers (impact on income, poverty and inequality); taxes multiplier (fiscal policy analysis) as shown in annexure 4 and annexure 5. From the SAM model, social and demographic impacts listed in the previous paragraph are provided. From the CGE model, impact of changes in tariff, taxes, and prices could be simulated. Other macro-economic benefits of the project, economic ratio, forward and backward analysis are provided.

3. **FINANCIAL IMPACT**: Project appraisal and feasibility study are part of the CBA. The financial efficiency provided by the CBA are measured through three criteria, namely: (1) the Net Present Value (NPV) to show the sum of all discounted net benefits over the economic project life; (2) the Internal Rate of Return (IRR) to show the discount rate the present values of cost and benefits are equal, and (3) the Benefit Cost Ratio (BCR) shows the benefits of the project for every Rand spent. The model can be extended to show also the net discounted value and the net benefit-investment ratio

4. **ENVIRONMENTAL IMPACT**: From the MCDA model, environmental impacts are provided to show positive and negative externalities and their impact on economic development are provided, aspects of land use and water use, ecological characteristics of site and its surroundings, net carbon emission impacts, commercial and industrial impacts; access to lack of access to natural resources. From SROI model, social environmental impacts are provided, such as social upliftment and their overall impact in the community.

5. **POLITICAL AND INSTITUTIONAL IMPACT**: The MCDA model shows the effect that tribal, traditional and other local leadership have on the project. It also show how various stakeholder influence (or/and) are influenced by the project. Other impacts relate to

aspect of livelihoods, displacement of people and assets, aspect of cultural and traditional resources and their impact on rural development;

This integrated MCA model has the capacity of handling complex information in a consistent and systematic way. It establishes preferences between options by referring to an explicit set of objectives agreed by the decision-makers who agreed on selected measurable criteria to assess the extent to which objectives have been achieve.

For example, if Government objectives is to address the multiple and conflicting triple challenge of unemployment, poverty and inequality while simultaneously ensuring sustainable economic growth that is harmless to the environment, then project appraisal and resource should be allocated to the investment that score high in these criteria.

5. Conclusion

This paper has considered policy making as a multi-criteria problem. It suggested the use of suitable multi-criteria techniques combined with some structured economic models in order to achieve efficient policy, optimal policy making and appropriate policy recommendations.

The fact that twenty years into democracy, South Africa is still confronted by multiple and conflicting challenges of rising unemployment, poverty and inequality can be an indication that prioritation in many cases was either intuitive or hazardous with unpredictable and unintended results. Hence, this paper proposed a multi-criterion approach where project appraisal combines economic efficiency (optimal allocation of resource), equity (impact distribution aspects), sustainability (environmental aspects), financial efficiency (return on investment), and compatibility (alignment with other goals and policy objectives) as decision criteria. This is achieved through the integration of partial and general equilibrium models (such as Supply and Use Tables, Input Output model, Social Accounting Matrix, and Computable General Equilibrium model) with Multi-criteria decision making models which in this paper incorporated the Cost-Benefit Analysis and Social Return on Investment models. The definition, use, advantage and limitation of these models were presented.

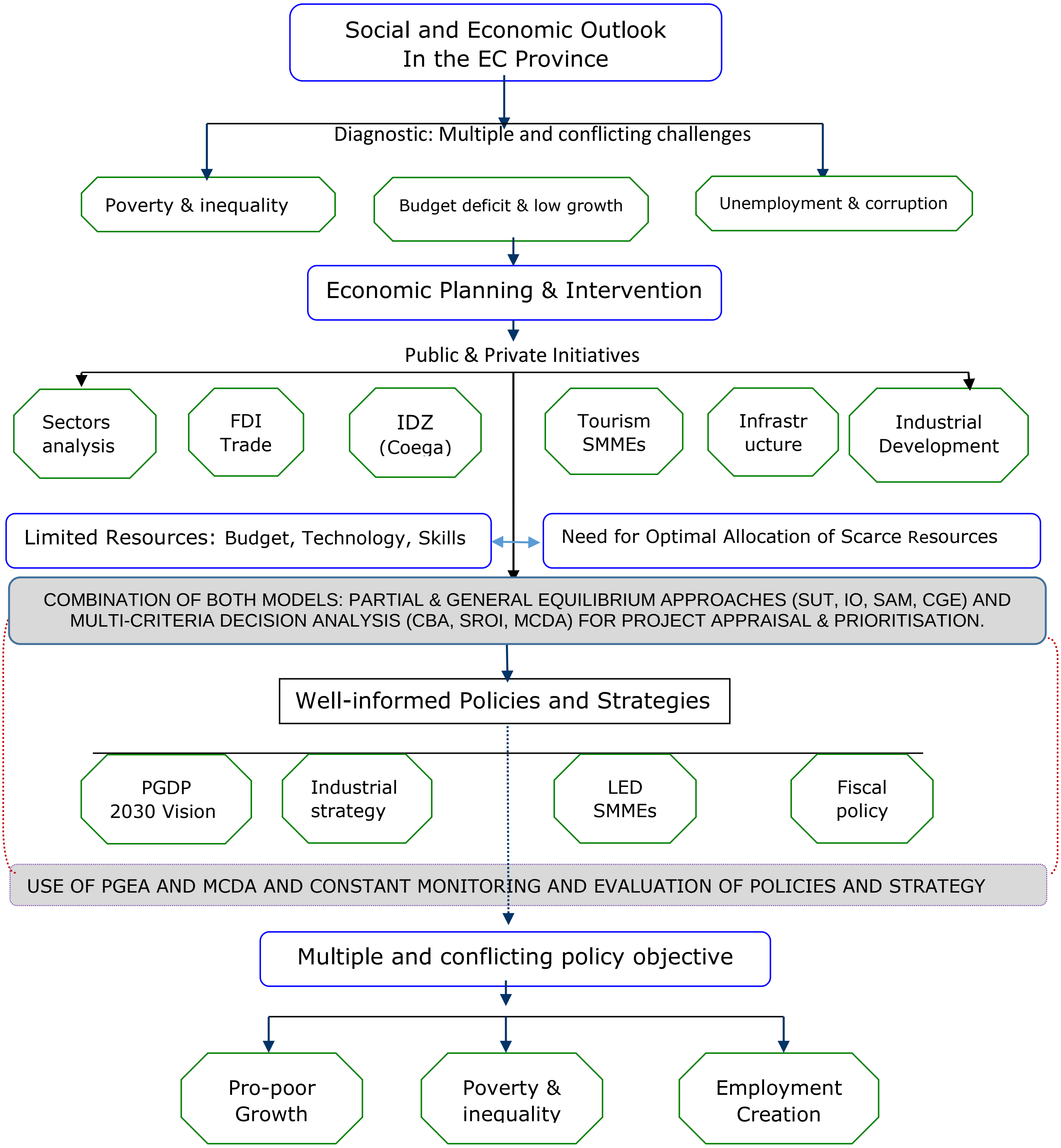
The result shows that for every R10 generated in the Eastern Cape Economy, R3.9 went to Africans, R1.0 went to Coloureds, R0,4 went to Indians and R4.7 to Whites. It shows that the income generated in the province has not reached the targeted social group such as African households in low income class. The wealth of the province is still in the hands of the few rich households. Whites who constitutes 5% of the total population receive 47% (almost half) of the province's income and Africans who account for 85% of the total population receive 39% of the province's income. The income is unevenly distributed and the gap between the poor and the rich is wide. The result also shows that for every R10 generated in the Eastern Cape Economy, R7 went to upper class, R2 went to the middle class and R1 to the lower class. This is one of the reasons why poverty and inequality in the Eastern Cape have persisted.

Pro-poor growth can be seen as a multi-criteria problem in which government can use its policy instruments to pursue different conflicting policy objectives, namely to address poverty and inequality and to create jobs for unemployed people. To achieve government objective, commissioners in the public sector and decision-makers should ensure that no policy, programme or project is adopted without first conducting an option appraisal, a process that identifies the best option that will deliver the desired outcome. An effective option appraisal will include setting objectives, generating options and deciding on the best option.

The contribution of this paper is the integration of partial and general equilibrium model with the multi-criteria decision making to achieve effective option appraisal. This will allow policy makers to design efficient policies which seeks to achieve the best possible outcome of certain policy objectives with the minimum possible cost in terms of other objectives.

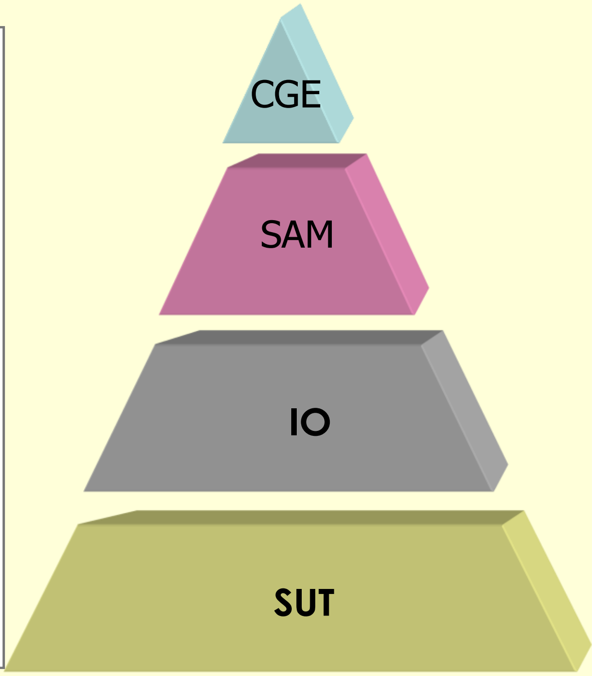
Annexure 1:

Diagrammatic representation of research and policy planning process



Annexure 2: Four stages for regional economic models

- **SUTs**: Supply and Use Tables
  - ✓Industries + Commodities
  - ✓Intermediate Consumption
  - ✓Final Demand and GVA
- **IO**: Input Output Tables
  - ✓Industries by Industry
  - ✓Intermediate Consumption
  - ✓Final Demand and GVA
- **SAM**: Social Accounting Matrix
  - ✓Supply and Use Tables
  - ✓Generation & Allocation of Income
  - ✓Capital, Trade, and
  - ✓Institutions
- **CGE**: Computable General Equilibrium Model



Annexure 3: Simplified CGE model equations

Static model equations

Production	$Q_{srt} = \alpha_{srt} \prod_f a_{frt} \cdot F_{fsrt}^{\delta_{fsr}}$		**(1)**
Factor returns	$W_{frt} \cdot \sum_s F_{fsrt} = \sum_s \delta_{fsr} \cdot P_{st} \cdot Q_{srt}$		**(2)**
Income	$Y_{hrt} = \sum_{fs} \theta_{hf} \cdot W_{frt} \cdot F_{fsrt}$		**(3)**
Consumption	$P_{st} \cdot C_{hsrt} = \lambda_{hsr} \cdot P_{st} \cdot H_{hrt} + \beta_{hsr} \cdot (1 - v_{hr}) \cdot \left(Y_{hrt} - \sum_{ss} \lambda_{hsr} \cdot P_{st} \cdot H_{hrt} \right)$		**(4)**
Investment	$P_{st} \cdot I_{st} = \rho_s \cdot \sum_{hr} v_{hr} \cdot Y_{hrt}$		**(5)**
Labor market	$\sum_s F_{fsrt} = L_{frt}$	*f is labor*	**(6)**
Capital market	$\sum_{rs} F_{fsrt} = K_{ft} \quad and \quad W_{frt} = W_{fr't}$	*f is capital*	**(7)**
Product market	$\sum_{hr} C_{hsrt} + I_{st} = \sum_r Q_{srt}$		**(8)**

Dynamic equations and links to the demographic model

Population	$H_{hrt} = \sum_{pga} H_{hpgart} \quad \text{where} \quad H_{hpgart} = sh_{hpgar} \cdot \frac{DH_{pgart}}{dh_{pgar}}$		(9)
Labor supply	$L_{frt} \approx \sum_{a} L_{pgaart} \quad \text{where} \quad L_{pgaart} = sl_{pgaart} \cdot \frac{DL_{pgaart}}{dl_{pgaar}}$	*f is labor*	(10)
Labor productivity	$e_{frt} = e_{frt-1} \cdot (1 + \gamma_{frt}) \quad \text{where}$		
$\gamma_{frt} \approx \mu_{pgar} \cdot [(1 - DP_{pgart}) + 0.5 \cdot (DP_{pgart} - DA_{pgart}) + 0.2 \cdot DA_{pgart}]$		*f is labor*	(11)
Technical change	$\alpha_{srt} = \alpha_{srt-1} \cdot (1 + \varphi_r)$		(12)
Capital supply	$K_{ft} = K_{ft-1} \cdot (1 - \pi) + \frac{P_{st-1} \cdot I_{st-1}}{\kappa}$	*f is capital*	(13)

Simplified CGE model variables and parameters

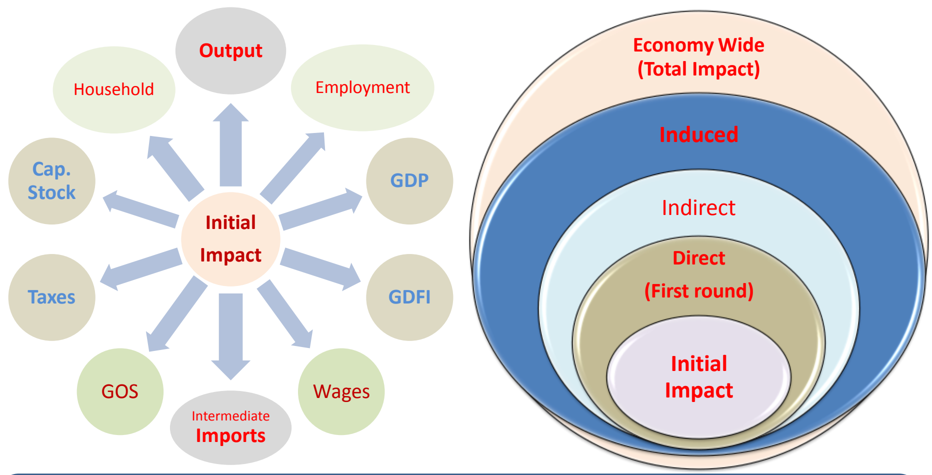
Subscripts model			**Endogenous variables in CGE**
f	Factors	*C*	Household consumption demand quantity
r	Regions	*F*	Factor demand quantity
s	Sectors	*I*	Investment demand quantity
t	Time periods	*K*	National capital supply
p	Population group (race)	*L*	Regional labor supply
g	Gender	*M*	Male and Female
a	Age cohort	*P*	Commodity price
o	Occupation group	*Q*	Output quantity
Exogenous parameters		*W*	Average factor return
α	Total factor productivity (production shifter)	*Y*	Total household income
β	Household marginal budget share		Own calculation from Stats SA
γ	Factor-specific productivity growth rate	*DH*	Population projection
δ	Factor input share parameter	*DL*	Labor supply projection
ε	Factor-specific productivity (input shifter)	*DP*	Productivity
θ	Household share of factor income	*DA*	Predicted full-blown AIDS
κ	Base price per unit of capital stock		prevalence rate **Base-year (2002) stock**
λ	Per capita subsistence consumption quantity	*sh*	**estimates**
φ	Hick's neutral productivity growth rate	*sl*	Household population profile (household survey)
π	Capital depreciation rate	*dh*	Labor force profile (labor survey)
ρ	Investment commodity expenditure share	*dl*	Population profile (demographic model)
σ	Exogenous factor supply growth rate		Labor force profile (demographic model)
υ	Household marginal propensity to save		
μ	Exogenous labor productivity growth rate		

Annexure 4: Impact in the Eastern Cape economy: assuming that households or exports demand for automotive products increased by R1 million

Multipliers per R1 million final demand in Eastern Cape and foreign activity	Initial Impact	First Round	Direct Impact	Indirect impact	Direct and Indirect Impact	Induced Impact	Economy-wide Impact
Output/ sales at basic value	1.0000	0.3970	1.3970	0.8710	2.2680	0.5026	2.7706
Intermediate Imports	0.1437	0.1299	0.2736	0.1441	0.4177	0.0444	0.4622
Labour Remuneration	0.0388	0.0358	0.0746	0.0864	0.1610	0.0844	0.2454
Gross Operating Surplus	0.0189	0.0172	0.0361	0.0662	0.1023	0.0887	0.1910
GDP at basic values	0.0566	0.0521	0.1087	0.1533	0.2620	0.1756	0.4376
Capital Stock	0.0939	0.0850	0.1789	0.2709	0.4498	0.3465	0.7963
Employment (Total number)	0.3801	0.3503	0.7304	1.3468	2.0772	1.6820	3.7592
Employment Highly Skilled	0.0585	0.0533	0.1118	0.1306	0.2424	0.1439	0.3864
Employment Skilled	0.2048	0.1866	0.3914	0.4321	0.8235	0.4902	1.3137
Employment Unskilled	0.1168	0.1086	0.2254	0.4643	0.6897	0.6235	1.3132
Employment Informal	0.0000	0.0018	0.0018	0.3198	0.3216	0.4243	0.7459

Annexure 5

Specification of the Model's Multipliers



43 sectors: Agriculture, Mining, Food, Textile, Wood, Petroleum & chemicals, Metals, Machinery & Equipment, Electrical machinery, Radio & TV instruments, Transport equipment, Furniture, Electricity, Water, Water, Construction, Wholesale & retail trade, Catering & accommodation, Transport, Communication , Finance & insurance, Business services ,Community services, Government , etc...

Bibliography

Adler, H.A., 1987. Economic appraisal of transport projects: A manuel with case studies (Revised and expanded edition). EDI Series in economic development. Baltimore and London: Published for the World Bank by the Johns Hopkins University Press.

Anderson, D.R., Sweeney, D.J., Williams, T.A. 1997. An introduction to Management Science, 8th edition, West publishing company. Saint Paul, Minnesota.

Andre F.J. and Cardenete M.A. 2009. Efficient economic and environmental policies combining multicreteria techniques and general equilibrium model. Working paper WP Econ 09.08

Austroads, 2005. Guide to Project Evaluation: Introduction to project evaluation. Sydney. Australia: Austroads Incorporated.

BALLARD, C. L. ET AL. (1985). A General Equilibrium Model for Policy Evaluation. University of Chicago Press, Chicago.

Belli, P. 1996. Handbook on Economic Analysis of Investment Operations. Washington, DC:
World Bank

Belton V., & Stewart, T.J., 2002. Multiple citeria Decsion Analysis: An integrated approach. Beston-Dordrecht, London: Kluwer Academic Publishers

Breisinger C., Thomas M., and Thurlow J. 2009: Social Accounting Matrix and Multiplier Analysis - An Introduction with Exercises

Brent, J.R., 1996. Applied Cost Benefit Analysis Cheltenham: Edward Elgar. Boston-London: KluwerAcademic Publishers

Chen, S.J. and Hwang, C.L.,1992. Fuzzy Multiple Attribute Decision Making – Methods and Applications, Springer-Verlag, Berlin.

Charnes, W.W., Cooper, R.O., Ferguson, 1955. Optimal estimation of executive compensation by linear programing, Management Science 1 (8) (1955) 138-151.

Conningarth Economist, 2013. The Need for a Multi Criteria Decision Making Model: Approach to assessing /analyssing the projects and programmes. Unpablish document. Pretoria, South Africa.

Eurostat – Eurostat Manual of Supply, Use and Input-Output Tables, 2008

DCLG,2009. Department of Communities and Local Government, London: Multi-Criteria Analysis, a Manual. www.communities.gov.uk

Dockel, J.A., Mirrilees, R.I.,& Curtayne,P.C., 1991. Cost Benefit Analysis in Project Evaluation: A note recalling first principles, Paper presented at the Annnual Transport Convention (ATC), Pretoria.

Hanne, T,1999. Meta decision problems in multiple criteria decision making, Kluwer Academic Press; Boston.

Helepi, P. 2013. Public Service Leadership for a Developmental State in South Africa: some preliminary thoughts Public Service Commission, South Africa

Institute of Public Care IPC, 2011. Three Techniques to support Option Appraisal and Evaluation. Briefing paper, Oxford Brookes University.

Kavese, K., Seedat E.D., 2004. Regional Economic Analysis With Supply And Use Tables: A Model For KwaZulu-Natal. Provincial Treasury, Province of KwaZulu-Natal, South Africa

Kavese, K., (2012). Eastern Cape automotive sector analysis: an economic model for policy and investment development. Unpublished document, ECSECC, Eastern Cape, RSA

Keeney, R.L., 1972. An Illustrated Procedure for Assessing Multi-Attribute Utility Functions. Sloan Management Review Fall, (37-50).

Liam B., Kevin B., 2009. A guide to Social Return on Investment. Cabinet Office, Office of the Third Sector. United Kingdom, 2009.

Lofgren, Hans, Herris R.L., and Robinson S., 2002. A standard Computable General Equilibrium (CGE) in GAMS, Microcomputers in Policy Research, Vol 5, International Food Policy Research Institute.

Márcia O., Dalila B. M., and Teresa P., 2013. Multicriteria Decision Making: A Case Study in the Automobile Industry. FEP working paper, 483. EFP Economic Management.

Millar & Hall, 2012. Social Return on Investment (SROI) and Performance Measurement. In Public Management Review, DOI:10. 1080/14719037

Mullins D., Mosaka D., Green A., Downing R., & Mapekula P., 2007. A Manual for Cost Benefit Analysis in South Africa with specific reference to Water Resource

Development. Second edition (Updated and revised). Conningarthe Economists. Water Research Commission-WRC Report No. TT 305/07, Pretoria – RSA.

Nijkamp, P. and Spronk, J. (1984). Perspectives of Macroeconomic Conflict Analysis. In M. Despontin, P. Nijkamp and J. Spronk (Eds.), Macro-Economic Planning with Conflicting Goals. Proceedings of a Workshop at the Vrije Universiteit of Brussels

Roy,B. and Vanderpooten, D. 1996. The Europeean School of MCDA: Emergence, basic features and current work. Journal of Multi-Criteria Decision Analysis, 5 pp 22-37

SHOVEN, J.B., WHALLEY, J. (1992). Applying General Equilibrium. Cambridge University Press. New York.

Stewart, T.J., Joubert, A, Scott, L., and Low, T. 1997. Multi-creteria decision analysis: procedures for consensus seeking in natural resource management. WRC Report no 512/1/97, Pretoria, South Africa.

Schutte, I.C. 1983. Manual on the Economic Evaluation of Transport project: Part 1-Principles and Procedures, CSIR draft manual K64. Pretoria: National Institute for Transport and Road Research, CSIR.

Ralph, E., Steuer, Paul N.A., 2003. Multiple Criteria Decision Making combined with Finance: A Categorised bibliographic study. European Journal of Operational Research. 150 (2003) 496 – 515

Statistics South Africa, 2012 (a): The status of the input-output tables for South Africa, Discussing document DO404, 2014, National Account. Pretoria, South Africa, 2012

Van Laarhoven, P. J. M. and Pedrycz, W. (1983). A fuzzy extension of saaty's priority theory. Fuzzy Sets and Systems, 11(1-3):199–227.

Voogd, H.,1983. Multicriteria Evaluation for Urban and Regional Planning, Pion, 207 Brondesbury Park, London.

Weisbrod D. 2011. Incorporating economic impact metrics in transportation project ranking and selection processes. Paper presented to the Annual Conference of the Transportation Research Board. Boston, MA: Economic Development Research Group.

www.socialventures.com.au: Social Return on Investment: lessons learned in Australia. Paper prepared by Social Ventures Australia Consultants, CVAC 2012. www.thesroinetwork.org