Socioeconomic Outcomes of Sustained Road Maintenance in Tanzania: *A Theoretical Social Economic Policy Model*

Abstract

Tanzania has established the Road Fund Board, (RFB) to ensure sustainable financing of road maintenance interventions in order to preserve and sustaining condition of road networks. The RFB disburses these funds to roads agencies and monitor utilization of the funds to ensure *Value for Money* in the road maintenance works. The sustainable financing maintenance has led to visibly improved road network condition; which in turn has brought positive social economic outcomes, (SEOs) to road users through lower vehicle operating costs, improved access, improved comfort, mobility and safety. However, these SEOs of the sustained road maintenance have not been systematically evaluated with the purposes to inform policy formulation and decision-making processes especially for improvement and maintenance of rural roads.

This paper attempts to design and formulate a methodology (*theoretical mode*l) for evaluating the socio economic outcomes *(Y*) of road sustained financing (*X*) and road maintenance, (Z) in Tanzania. The paper proposes the theoretical social economic model aiming at identifying, selecting and determining a set of appropriate indicators for evaluation of outcomes of road maintenance and development for research methodology and approach. The theoretical social economic policy model introduces the sustained road financing and maintenance performances concepts; presents theoretical social economic model that provides an indicative application and the quantitative data model.

Key Words: Sustained Road Maintenance

1.0.Introduction

1.1. Background

Road transport is the mode of transport most used for cargo and passenger transport in Tanzania. Over 80 percent of passengers and cargo use road transport. In general, road infrastructure plays vital role by providing mobility for the efficient movements of people and goods. By linking producers to markets, workers to jobs, students to schools and the sick to hospitals, roads are vital in promoting sustainable socio-economic development. It guarantees timely, safe and efficient transport for cargo and passengers and consequently lower costs of doing business, (Haule, 2005).

To sustain these benefits, well-planned and consistent implementation of road maintenance programs must follow road improvements. Without regular maintenance, roads can rapidly fall into disrepair, preventing realization of the longer-term socio-economic outcomes of road improvements, such as increased agricultural production and growth in school enrolment.

Up to 1990s, most part of road network in Tanzania had deteriorated to poor condition due to lack of systematic and well-planned road maintenance programs. Inadequate institutional systems and funds were the main cause of lack of proper road maintenance, (Haule 2005). As a result, there was huge economic losses due to losses of road asset value due to deterioration, increased transportation costs and limited access to social and economic centres.

To address the above challenges, the Government established the Roads Fund and Roads Fund Board in the year 2000 under the Roads and Fuel Tolls Act, CAP 220. The main objective of the establishment was to ensure sustainable and adequate financing of road maintenance interventions in order to preserve and sustaining condition of road network, (Road Fund Board, 2007).

The main responsibility of the Board is to manage the Fund by mobilizing funds for roads maintenance, disburse the funds to Roads Agencies and monitor utilization of the funds to ensure value for money in the road maintenance works. For the past five years, the Board has managed to collect and disburse average of TZS 793.5 billion annually to finance road maintenance programs. The sustainable financing of road maintenance has led to visibly improved road network condition. Prior to the establishment, only about 15 percent of National roads and 10 percent of District roads, respectively, were in good condition compared current about 88 percent for National roads and 56 percent of the District Roads, (Road Fund Board, 2007 and *various issues*).

Improvement of road condition has brought positive social economic outcomes to road users through lower vehicle operating costs, improved access to hospitals, schools, and markets; improved comfort, mobility and safety. However, these socio-economic outcomes of the sustained road maintenance have not been systematically evaluated with the purposes to inform policy formulation and decision-making processes especially for improvement and maintenance of rural roads.

1.2.An evaluation study on socio-economic outcome of road maintenance

It is the mandate and responsibility of the Road Fund Board to conduct an evaluation study on socio-economic outcome of road maintenance in Tanzania, (Semboja *et al*, 2025). The overall objective of the evaluation assignment is to build capacity of the Board to manage effectively and efficiently utilization of Roads Fund resources through informed decision-making processes with the view to maximize socio-economic outcomes from road maintenance works.

This paper attempts to design and formulate a methodology (*theoretical mode*l) for evaluating the socio economic outcomes *(Y*) of road sustained financing (*X*) and road maintenance, (Z) in Tanzania developed, (Semboja *et al*, 2025). The paper will propose the theoretical social economic model aiming at identifying, selecting and determining a set of appropriate indicators for evaluation of outcomes of road maintenance and development for methodology and approach of conducting the evaluation.

1.3.The Objective of the Paper

The government aims at evaluating and establishing socio-economic outcomes of maintenance of roads in Tanzania with the view to inform decision-making processes related to sustainable financing and management of road maintenance. The objective of this paper is to [1] design and formulate a methodology (i.e., *theoretical mode*l) for evaluating the socio economic outcomes *(Y*) of road sustainable road financing (*X*) and road maintenance, (Z) in Tanzania and [2] indicate empirical model determining a set of appropriate socio economic outcome indicators (*Y)* established and justification of each indicator provided.

2.0.Sustained Road Financing and Maintenance Performances Concepts

Section 2.0 reviews basic concepts related with sustainable road financing and maintenance performances. The current and expected future incomes and funding levels in Tanzania will be strong pressures for the road maintenance expenditure on national and local roads, (Haule, 2005; Baporikar, 2016 and Semboja, *et al,* 2005). In effect, the RFB has seen the benefit in moving beyond a summary of the known generic impacts of maintenance, to establish the nature and magnitude of the impacts that might be expected on national and local roads in Tanzania. Such knowledge would provide a useful contribution to future policy decision-making by all levels of government, (Ellie Gould, *et al* 2013). The concept and justification of the socio economic outcomes (*Y*) of road sustained financing (*X*) and road maintenance, (*Z*) are aspired and founded on the [1] UN- sustainable development goal (SDG-2030)-Goal 9; [2] the Agenda 2063 of Africa for an Integrated Africa, and [3] the Tanzania Development Vision 2050 envision for the Integrated Logistics. The paper uses and focuses on the SDG-2030-Goal 9 on a strong assumption that others are variants of the UN-Systems, (Semboja, *et al,* 2005).

2.1. Sustainable Road Maintenance Funds

The concept of Sustainable Road Maintenance Funds, (*Z)* refers to adequacy and reliability of funding to meet planned current and future needs of the road's infrastructure, (Haule 2005 and Benmaamar 2006). Sustainability requires that the fund must meet all costs for maintenance of

current needs of network, extension / quality improvement, asset replacement; the costs for maintenance must be recovered fully from road users with no subvention from central government and there must be efficient and effective use of resources, i.e., the value for money. Revenues incremental to the budget, coming from charges related to road use and channeled directly to the Road Fund bank account. The road network is extremely valuable and thus RFB is expected to invest maintenance funding in a way that returns maximum benefit to road users, (Benmaamar, 2006 and Ellie Gould, *et al* 2013).

2.2. The Socio-Economic Outcomes of Sustained Road Maintenance

The road access is a key determinant of poverty reduction in developing nations. Haule (2005 and Bogale, 2016) noted that roads have a direct impact on the welfare of the rural poor in Tanzania. The process of poverty reduction is embedded in a broad range of socio-economic activities to which roads and services provide intermediate inputs. It known that there is a marked decline in the income of households living at a distance of more than 5 km from a good road. It is important to note that the distance to the nearest good road also provides a measure of national physical integration. The further the household lies from a good road, the less likely it would be to have access to markets or other economic and social facilities and opportunities. Isolation is a key indicator of poverty, (Bogale, 2016).

Poor roads and the resultant inability to transport people and goods, limit the facilitating role of transport in both production and consumption activities. The link and impact lie in the fact that improved transportation leads to improved accessibility to economic and social opportunities by reducing transport costs. It also ensures increased agricultural productivity, opens up room for participation in non-agricultural activities through time saving, improves accessibility to education and health services, and it links rural communities to the rest of the economy. Maintenance works in rural areas have proven to be an important source of income and distribution of wealth. In the case of urban areas, the quality of transportation and other types of infrastructure appear to play a significant role in reducing inflation, because transportation costs have been found to be a significant component in the total cost of foodstuffs, affecting the survival of urban dwellers, (Haule, 2005, Johansson, 2004 and Bogale, 2016).

Without physical access, rural communities face much greater obstacles in obtaining health, education and other social services, (Donnges *et al*, 2007). In addition, their ability to take advantage of surplus crop production and of employment opportunities is severely constrained. Roads are a key element in the provision of physical access, (African Union Commission and African Union Development Agency - NEPAD. 2022 and Elisther *et al*, 2023).

2.3.UN- The Sustainable Development Goal (SDG-2030)

This paper uses the concept of the sustainable development goal (SDG-2030)-Goal 9 as about building resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. The first target of this goal 9 is to develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all, (UNDESA, 2024).

Development and maintenance of physical infrastructure are key to rapid economic growth and poverty reduction. Production costs, employment creation, access to markets, and investment depend on the quality of infrastructure, especially transport. Road transport is the most widely used means of transportation in Africa. The fragmentary nature of the railway system and the limitations imposed on the scope of inland water transport by geographical factors mean that transport of people and freight by rail and inland waterways has to be supplemented, usually by road transport over long distances, (Wasike, 2001 and Haule, 2005).

The basic objective of road maintenance is implicit in the word itself. It is done to ensure that the road that has been constructed, or improved, is maintained in its original condition. It is accepted that over the life of the road it will deteriorate due to factors with which maintenance activities cannot deal. Nevertheless, maintenance is intended to slow down this deterioration and should begin on the first day after the road improvement works are completed, (Gould *et al,* 2013).

In practice the effect of regular and timely maintenance is to increase the life of the road by putting off the date at which it needs to be reconstructed. This has several benefits, the prominent being that it stretches the period over which the benefits of the investment made are available and therefore provides a higher rate of return on the initial investment. Maintenance puts off the date when large investments have to be made to reconstruct the road. As the yearly cost of maintaining a road is a small fraction of the investment cost, the economic logic for effective preventative maintenance is undeniable. It can be argued that the construction of roads, whilst consuming large amounts of money, is of limited importance if there is no effective maintenance system.

The situation is particularly critical with unsealed roads, which is the case for the majority of rural roads in the Asia and Pacific region. Whilst the cost of rural road maintenance is small relative to the asset value, it is crucial that maintenance is carried out on a timely and regular basis. Consequently, it is a recurrent activity and needs to be financed as such. The funds allocated to it should relate to a maintenance plan which defines those roads in a maintainable condition and defines a recurrent cost for the network. Unfortunately, road maintenance is often viewed as a set of projects to be carried out on roads which, because of lack of maintenance, have deteriorated to a state where they need re-construction, (Elisther *et al,* 2023). The problems of rural road maintenance are not uniquely related to finance. There are technical issues related to the lack of planning and the lack of information on the state of the road network. There are also major institutional factors relating to the lack of clear responsibility at different decentralised levels for maintenance planning, budgeting and implementation, (Semboja, *et al,* 2005).

2.4. Sustainable Road Maintenance: Why and who benefits?

We consider a sustainable road as a road that is built to reduce the environmental impact of transportation, (Baporikar, 2016). It usually involves using materials such as asphalt and concrete, which are made from natural materials like fly ash, limestone, and shale. The principal objectives of sustainable road maintenance is to keep roads open, reduce rates of deterioration and extend the life of the road network, reduce vehicle operating costs and improve the speed, frequency, safety and convenience of private and public transport. When maintenance is provided it also generates employment opportunities and additional market prospects for the local construction industry, (Audit Commission 2011 and Johansson, 2004).

The purpose of sustainable road maintenance is to ensure that the road remains serviceable throughout its design life. Maintenance is important because it (Haule, 2005):-[1] prolongs the life of the road by reducing the rate of deterioration, thereby safeguarding previous investments in construction and rehabilitation, [2] lowers the cost of operating vehicles on the road by providing a smooth-running surface; [3] keeps the road open for traffic and contributes to more reliable transport services and [4] sustains social and economic benefits of improved road access.

The first purpose is primarily in the interest of the responsible government authorities. The last three are of more general interest to the inhabitants of the area traversed by the road and to the vehicle operators, (Gould *et al,* 2013). Regular maintenance of roads is critical to the economic vitality of a country. In particular, a focus on rural road maintenance is needed when planning and operating a large transport network, as they are often deemed less important than paved roads and highways. When rural roads are neglected, it can cause a detrimental imbalance, with negative effects on the socioeconomic development and political participation of rural population.

Also, the aim of maintenance is to ensure that the road remains serviceable throughout its design life. Maintenance is important because it: Prolongs the life of the road by reducing the rate of deterioration, thereby [1] safeguarding previous investments in construction and rehabilitation, lowers the cost of operating vehicles on the road by providing a smooth-running surface, [2] keeps the road open for traffic and contributes to more reliable transport services and [3] sustains social and economic benefits of improved road access. The first purpose is primarily in the interest of the responsible government authorities. The last three are of more general interest to the inhabitants of the area traversed by the road and to the vehicle operators, (Bogale, 2016).

3.0. Theoretical Social Economic Model

Section 3.0 presents the theoretical social economic model, (Semboja, *et al,* 2005). The theoretical model will identify, select and determine a set of appropriate indicators for evaluation of outcomes of road maintenance and development for methodology and approach of conducting the evaluation.

3.1. System Theory

3.1.1. System Defined

The link between financial system (*Z*), road maintenance, (*X*) and social economic development, (*Y)* may be comprehended with comprehensive system- framework, (Semboja, *et al,* 2005). Figure 1 summarizes the system as a group of interacting or interrelated elements, (*Z, X & Z)*) that act according to a set of rules to form a unified whole. A system, surrounded and influenced by its environment, is described by its boundaries, structure and purpose and is expressed in its functioning. Systems have several common properties and characteristics, including structure, function(s), behavior and interconnectivity, (Von Bertalanffy Ludwig 1950 and Baporikar, 2016).

There are natural and human-made (designed) systems, (Mike, 2000). Natural systems may not have an apparent objective but their behavior can be interpreted as purposeful by an observer. Human-made systems are made with various purposes that are achieved by some action performed

by or with the system. The parts of a system must be related; they must be "designed to work as a coherent entity" otherwise they would be two or more distinct systems.

Most systems are open systems and exchanging matters with their respective surroundings; like a car, lorry, bus, truck, a driver, road, or earth. *Open systems* have input, transformation and output flows, representing exchanges of matter, or information with their surroundings. A closed system exchanges efforts, but not matter, with its environment; like a computer or the project biosphere. An isolated system exchanges neither matter nor energy with its environment. A theoretical example of such a system is the universe, (Von Bertalanffy Ludwig 1950).

3.1.2. Process and Transformation Process

An open system can also be viewed as a bounded transformation process, that is, "*a black box*" that is a process or collection of processes that transform inputs into outputs. Inputs are consumed; outputs are produced, (Von Bertalanffy Ludwig 1950). The concepts of input, transformation and output here are very broad. For example, an output of a bus transport service is the movement of people from departure to destination. A system comprises multiple views. Human-made systems may have such views as concept, analysis, design and implementation, deployment, structure, behavior, input data, and output data views. A system model is required to describe and represent all these views. A systems architecture, using one single integrated model for the description of multiple views, is a kind of system model, (Von Bertalanffy Ludwig 1950).

3.1.3. Subsystem

A *subsystem* is a set of elements, which is a system itself, and a component of a larger system. The main *elements* they have in common are the components that handle input, scheduling, spooling and output; they also have the ability to interact with local and remote operators. A subsystem description is a system object that contains information defining the characteristics of an operating environment controlled by the system, (Von Bertalanffy Ludwig, 1950). The data tests are performed to verify the correctness of the individual subsystem configuration data and they are related to a single subsystem in order to test its specific application, (SA).

3.1.4. Economic Management and Engineering Systems

Figure 1 shows an economic system as a social economic entity (*institution)* which deals with the investments production, distribution, and consumption of goods and services a particular society, (Mike, 2000). The economic system is composed of institutions (TANROADS, TARURA, ministries, private sector firms and others), activities (e.g., investments, financing, construction, production, consumptions and savings), sectors (e.g. agriculture, industry and services) their relationships to resources, such as capital, labour power, finances and the convention of property. It addresses the problems of economics, like the allocation and scarcity of resources, (Baporikar, 2016).

In engineering a physical system is the portion of the universe that is being studied (of which a thermodynamics system is one major example), (Thomé, 1993). Engineering, also has the concept of a system referring to all of the parts and interactions between parts of a complex project. System

engineering is the branch of engineering that studies how this type of system should be planned, designed, implemented, built, (constructed) and maintained, (Thomé, 1993).

In other management sciences human organizations are viewed as management systems of interacting components such as subsystems or system aggregates, which are carriers of numerous complex business processes and organizational structures, (Bogale, 2016).

3.1.5. Multidimensional System

A multidimensional system, in a general sense, is a system that involves, interacts or considers multiple independent variables or dimensions, rather than just one, (Mike, 2000). This concept applies across various fields, including mathematics, signal processing, and data analysis.

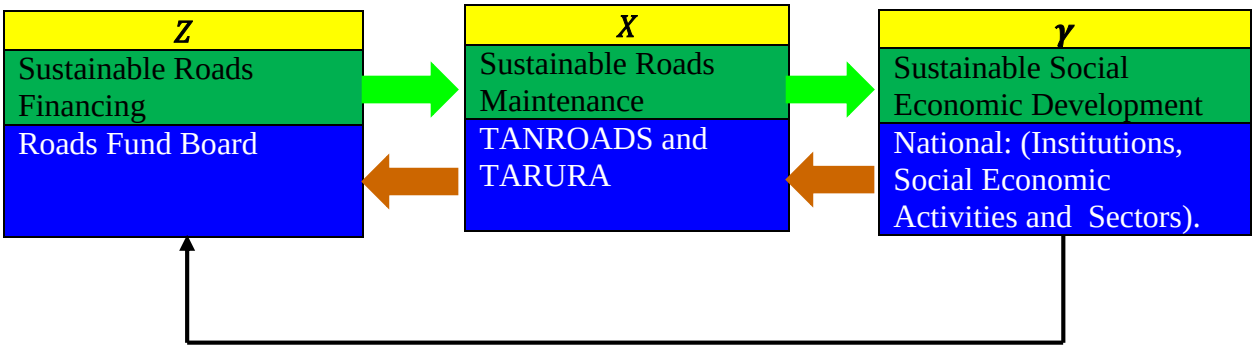
In mathematical system theory, *a multidimensional system or m-D system* is a system in which not only one independent variable exists (*like time*), but there are several independent variables, (Chiang, 1984). A state-space model is a representation of a system in which the effect of all "prior" input values is contained by a state vector. In the case of an *m*-d system, each dimension has a state vector that contains the effect of prior inputs relative to that dimension. The collection of all such dimensional state vectors at a point constitutes the total state vector at the point. A multidimensional system, in a general sense, is a system that involves or considers multiple independent variables or dimensions, rather than just one. This concept applies across various fields, including mathematics, signal processing, and data analysis, (Chiang, 1984).

3.2. Connectional Framework

Figure 1 summarizes a comprehensive system consisting of three subsystems (or boxes). These are linked or connected as follows;

$$
\begin{array}{lccc}
 & Z & \Leftrightarrow & X \\
 & X & \Leftrightarrow & Y \\
* & , & , & , \\
 & \therefore Z & \Leftrightarrow & Y
\end{array}
$$

Figure 1: Conceptual Framework



The Roads Fund Board (RFB) among other mandated functions, it has to monitor the use of the funds disbursed to TANROADS, TARURA or other agencies for the purposes and objectives of the fund, (RFB, 2020). The RFB is responsible to monitor the use of every single cent disbursed to roads agencies in order to ensure that all the provided funds are used for the intended purposes. Since the Board funds all roads maintenance and development projects, it has to ensure that the funded projects achieve the value for money as much as possible, (Road Fund Board, 2015/6 to 2023/2024). *Let us now consider and define major policy variable as follows;*

Z as sustainable road financing system, Sustainable Road Maintenance Funds, refers to adequacy and reliability of funding to meet planned current and future needs of the road's infrastructure. In accordance with the Road and Fuel Tolls Act Cap 220 (Revised edition 2019) which established the Roads Fund, at least 90 percent of money deposited in the Fund should be used for maintenance and emergency repair of classified roads and related administrative costs in Tanzania Mainland, (Semboja, 2019)

X as sustainable road maintenance systems. The principal objective of sustainable road maintenance is to keep roads open, reduce rates of deterioration and extend the life of the road network, reduce vehicle operating costs and improve the speed, frequency, safety and convenience of private and public transport.

Y as sustainable social economic developments that include [1] ending poverty in all its forms everywhere; [2] ending hunger, achieve food security and improved nutrition and promote sustainable agriculture; [3] ensuring healthy lives and promote well-being for all at all ages; [4] ensuring inclusive and equitable quality education and promote lifelong learning opportunities for all; [5] achieving gender equality and empower all women and girls; [6] ensuring availability and sustainable management of water and sanitation for all; [7] promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all; [8] building resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation; [9] make cities and human settlements inclusive, safe, resilient and sustainable; *and* [10] ensure sustainable consumption and production patterns, (UNDESA, 2024). *We can paraphrase the above relations *, Figure 1 and systems as follows*

$$* \qquad X = g(Z)$$

$$** \qquad Y = f(X)$$

$$*** \qquad \therefore \; Y = f(g(Z))$$

Above relations suggest that we have a comprehensive system and subsystems reflecting how social structures (*X &Y*) interacting and influencing each other. In turn *Y* is effected by *Z,* (UNDESA, 2024). The social economic systems have inputs (*factors*), processes, (*transformation)* and products (*output, outcome and impact*) sub-systems. These social economic systems (*Z, X* and *Y*) are dynamic, bounded and affected by policies, laws, norms, ethics, sentiments and other factors. Social-economic outcomes encompass the effects on individuals, communities, and societies, encompassing areas like agriculture, industry, services, and overall well-being, (African

Union Commission and African Union Development Agency - NEPAD. 2022) and UNDESA, 2024).

3.3.The Road Fund Board - SEO-SRM-2025-Model

We will now use above concepts and definitions provided in sections 3.1 and 3.2 to consider and propose the theoretical model to be used to evaluate socio-economic outcomes, (SEO) of sustainable road maintenance, (SRM) in Tanzania with the view to inform decision-making processes related to financing and management of road maintenance as the Road Fund Board-SEO-SRM-2025-Model, (José Papí, *et al*, 2007).

3.3.1. Assumptions and Conditions

Because of the complexity of evaluation of socio-economic outcomes of road maintenance, it necessary for us, when designing and formulating policy models, to reduce the complexity of the problem by either simplifying the problem or constraining it by making restrictive assumptions and conditions. *The following are main policy model assumptions and conditions;*

A. Tanzania is a democratic nation with valid constitution, national development vision, mission and policies, plans, programs and projects as some vital methods of providing, controlling, effecting and executing sustainable road maintenance financing and socio-economic development policies, plans, programs and activities.
B. There are existences of effective laws, regulations, institutional frameworks and road maintenance financing and strategic socio-economic development policy objectives, strategies and line of activities.
C. National governments, regional, global development partners and all stakeholders have same and consistent national social economic development policies, opinions, or at least not conflicting interests concerning sustainable road maintenance financing systems.
D. These are many, integrating open and small economies; *and*
E. We have sustainable road maintenance financing systems, activities, and all markets are global and easy to move, enter and exit.

These assumptions and conditions guarantee existence of solid sustainable road maintenance financing and socio-economic development systems aiming self-sufficiency in the basic requirements; ownership, management and operation of desired systems for the benefit of current and the future social economic generations at national, regional and global levels.

3.3.2. The SEO-SRM-2025- Model Foundation

The SEO-SRM-2025- Model is founded and uses appropriate socio-economic outcome indicators established, justified and adopted by the United Nation Systems; (URT, 2024 and UNDESA, 2024). This is the 2030 Agenda for Sustainable Development, adopted by all United Nation (UN) members in 2015, created 17 world Sustainable Development Goals (SDGs). The aim of these global goals is "*peace and prosperity for people and the planet*" – while tackling climate change and working to preserve oceans and forests. The SDGs highlight the connections between the environmental, social and economic aspects of sustainable development. Sustainability is at the

center of the SDGs, as the term sustainable development implies, (URT, 2024; UNDESA, 2024 and African Union Commission and African Union Development Agency - NEPAD. 2022).

The SDGs are universal, time-bound, and legally non-binding policy objectives agreed upon by Un-governments (José Papí, *et al*, 2007). They come close to prescriptive international norms but are generally more specific, and they can be highly ambitious. The overarching UN program "2030 Agenda" presented the SDGs in 2015 as a "supremely ambitious and transformative vision" that should be accompanied by "bold and transformative steps" with "scale and ambition".

Caution must be taken when adopting and using these SDG Indicators. There are cross-cutting complex issues and synergies between the different goals. On the other hand, critics and observers have also identified trade-offs between the goals, such as between ending hunger and promoting environmental sustainability. Furthermore, concerns have arisen over the high number of goals (compared to the eight Millennium Development Goal), leading to compounded trade-offs, a weak emphasis on environmental sustainability, and difficulties tracking qualitative indicators.

The global effort for the SDGs calls for prioritizing environmental sustainability, understanding the indivisible nature of the goals, and seeking synergies across sectors. The SDGs are emphasizing inclusiveness in the national context and also in global governance. For the national context this means a focus on marginalized groups that are affected by exclusion and inequalities. For the global context, inclusiveness means a special emphasis on the least developed countries.

3.3.3. Major UN-Sustainable Development Goals-2030

The lists of targets and indicators for each of the 17 SDGs was published in a UN resolution in July 2017, (UNDESA, 2024). Each goal typically has eight to 12 targets, and each target has between one and four indicators used to measure progress toward reaching the targets, with the average of 1.5 indicators per target. The targets are either outcome targets (circumstances to be attained) or means of implementation targets. The latter targets were introduced late in the process of negotiating the SDGs to address the concern of some Member States about how the SDGs were to be achieved. Goal 17 is wholly about how the SDGs will be achieved, (UNDESA, 2024).

Indicators serve as the key policy tools for decision-makers to track progress towards the SDG targets. Therefore, they have a decisive impact on SDG implementation, as well as the ultimate determination of whether the world is closer to realizing the SDGs by 2030. National and local governments use the indicators to measure own progress towards sustainable development, which they report in their voluntary national and local reviews. The indicators are now widely deployed at all levels of sustainability governance, (African Union Commission and African Union Development Agency - NEPAD. 2022 and UNDESA, 2024).

3.3.4. Endogenous Variables / or Policy Target Variables

The model attempts to identify, define and formalize these sustainable road maintenance financing and socio-economic development areas and issues are follows. We define sustainable road maintenance financing and socio-economic development as a compatible system, as composed of a set of parts or subsystems that interact to achieve a common goal, (Y), (Ellie Gould, *et al* 2013).

There exists independent but interlinked parts or subsystems, (Y_i), comprises of the sustainable road maintenance financing and socio-economic development systems, (José Papí, *et al*, 2007).

3.3.5. The Overall Sustainable Development Goals (SDG), (Y)

Let us denote the socio-economic development as identified and selected sustainable development goals (SDG-2030) and evaluation model, whereby we define our overall or total or main target/ policy objectives as endogenous variable, (URT, 2024 and UNDESA, 2024), *Y* as;

$$1 \qquad Y = \varpi_1 Y_1 + \varpi_2 Y_2 + \varpi_3 Y_3 .+ \varpi_4 Y_4 + \varpi_5 Y_5 + \varpi_6 Y_6 + \varpi_7 Y_7 + \varpi_8 Y_8 + \varpi_9 Y_9 + \varpi_{10} Y_{10}$$

Where *Y* is the "*desired overall*" sustainable development goal (SDG-2030) as defined in sections 3.1, 3.2 and the *following ten endogenous variables are selected and considered as socio-economic outcomes of maintenance of selected roads and thus the specific target variables / policy objectives, (URT, 202*4 and UNDESA, 2024):

Y1, as the SDG-Goal 1: End poverty in all its forms everywhere;
Y2 as the SDG-Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture;
Y3, *as* the SGD-Goal 3: Ensure healthy lives and promote well-being for all at all ages;
Y4 as the SGD -Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all;
Y5, *as* the SGD- Goal 5: Achieve gender equality and empower all women and girls;
Y6 as the SGD- Goal 6: Ensure availability and sustainable management of water and sanitation for all;
Y7 as the SDG-Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all;
Y8 as the SDG-Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation;
Y9 as the SDG-Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable; *and*
Y10 as the SDG-Goal 12: Ensure sustainable consumption and production patterns

Whereby the general parameters and weights defined and restricted as follows:

$$0 \leq \varpi_i \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_i = 1$$

The data for these variables; will be collected, managed and analyzed by sex, age, employment status, and geographical location (urban/rural). The total sum of the SDG goals namely *Y*, is social economic development as a multifaceted approach that seeks to improve the economic well-being and quality of life for a national, regions and district residents. It involves strategic initiatives aimed at fostering growth, enhancing competitiveness, and creating a vibrant, resilient economy, (URT, 2024 and UNDESA, 2024),

The multifaceted social economic may also refer to the complex and interconnected nature of social and economic variables, ($Y_1, Y_2, \ldots, Y_{10}$) encompassing numerous factors and challenges that influence people's lives and well-being, (José Papí, *et al,* 2007). Multi-faceted socio-economic

progress refers to the overall development and improvement of various aspects of society and economy. It involves the simultaneous growth and advancement of different factors such as education, health, infrastructure, employment, and income, (URT, 2024; African Union Commission and African Union Development Agency - NEPAD. 2022 and UNDESA, 2024),

3.3.6. Y_1-SDG Goal 1: No Poverty

SDG-Goal 1; $\boldsymbol{Y_1}$ is to "*end poverty*" in all its forms everywhere. Achieving SDG 1 would end extreme poverty globally, (URT, 2024 and UNDESA, 2024), Equation 2 outlines specific poverty reduction outcome indicators.

$$2 \quad Y_1 = \varpi_{11}Y_{11} + \varpi_{12}Y_{12} + \varpi_{13}Y_{13} + \varpi_{14}Y_{14} + \varpi_{15}Y_{15}$$

Whereby we define specific poverty reduction outcome indicators as follows;
Y_{11} as eradication of extreme poverty for all people everywhere, currently measured as people living on less than US$2.15 a day;

Y_{12} as reducing at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions;

Y_{13} as implementing nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable;

Y_{14} as ensuring that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance;

Y_{15} as building the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters;

Whereby the specific parameters and weights defined and restricted as follows;

$$0 \leq \varpi_{ij} \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_{ij} = 1$$

3.3.7. Y_2-SDG Goal 2: End Hunger, Achieve Food Security and Improved Nutrition and Promote Sustainable Agriculture.

The Y_2-SDG Goal 2, that is, $\boldsymbol{Y_2}$ focuses on ending hunger, achieve food security and improved nutrition and promote sustainable agriculture, (URT, 2024 and UNDESA, 2024). Equation 3 outlines the specific sustainable agriculture outcome indicators as follows;

$$3 \quad Y_2 = \varpi_{21}Y_{21} + \varpi_{22}Y_{22} + \varpi_{23}Y_{13} + \varpi_{24}Y_{24} + \varpi_{25}Y_{25}$$

Whereby we define these specific sustainable agriculture outcome indicators as follows;

Y_{21} as ending hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round

Y_{22} as ending all forms of malnutrition, including achieving, by 2030, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons

Y_{23} as doubling the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment

Y_{24} as ensuring sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.

Y_{25} as maintaining the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed.

Whereby the specific parameters and weights defined and restricted as follows;

$$0 \leq \varpi_{ij} \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_{ij} = 1$$

3.3.8. Y_3-SDG-Goal 3: Ensure Healthy Lives and Promote Well-Being for All At All Ages

Y_3-SDG-Goal 3 that is ***Y_3;*** focuses on ensure healthy lives and promote well-being for all at all ages, (URT, 2024 and UNDESA, 2024). Equation 4 defines sustainable health and promote well-being outcome indicators.as follows'

$$4 \quad Y_3 = \varpi_{31}Y_{31} + \varpi_{32}Y_{32} + \varpi_{33}Y_{33} + \varpi_{34}Y_{34} + \varpi_{35}Y_{35}$$

Whereby we define this specific sustainable health and promote well-being outcome indicators as follows;

Y_{31} as reducing the maternal mortality ratio to less than 70 per 100,000 live births.

Y_{32} as ending preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under 5 mortalities to at least as low as 25 per 1,000 live births.

Y33 as ending the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases.

Y*34* as reducing by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being.

Y35 as reduce / halving the number of deaths and injuries from road traffic accidents.

Whereby the specific parameters and weights defined and restricted as follows;

$$0 \leq \varpi_{ij} \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_{ij} = 1$$

3.3.9. Y4-SDG-Goal 4: Ensure Inclusive and Equitable Quality Education and Promote Lifelong Learning Opportunities for All

Equation 5 specifies SDG Goal 4, that is ***Y4***; of ensuring inclusive and equitable quality education and promote lifelong learning opportunities for all, (URT, 2024 and UNDESA, 2024). Equation 5 outlines main inclusive and equitable quality education outcome indicators as follows;

$$5 \quad Y_4 = \varpi_{41}Y_{41} + \varpi_{42}Y_{42} + \varpi_{43}Y_{43} + \varpi_{44}Y_{44} + \varpi_{45}Y_{45}$$

Whereby we define these main inclusive and equitable quality education outcome indicators as follows;

Y41 as ensuring that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes

Y42 as ensuring that all girls and boys have access to quality early childhood development, care and preprimary education so that they are ready for primary education.

Y43 as ensuring equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university

Y44 as substantially increasing the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship

Y45 as eliminating gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations

Whereby the specific parameters and weights defined and restricted as follows;

$$0 \leq \varpi_{ij} \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_{ij} = 1$$

3.3.10. Y_5-SDG-Goal 5: Achieve Gender Equality and Empower All Women and Girls

Equation 6 articulates SDG-Goal 5, that is, ***Y_5;*** of achieving gender equality and empower all women and girls, (URT, 2024 and UNDESA, 2024). Equation 6 outlines main gender equality and empower all women and girl's outcome indicators as follows;

$$6 \quad Y_5 = \varpi_{51}Y_{4\backslash 51} + \varpi_{52}Y_{52} + \varpi_{53}Y_{53} + \varpi_{45}Y_{54} + \varpi_{55}Y_{55}$$

Whereby we define this main equality and empower all women and girls outcome indicators as follows:

Y_{51} as ending all forms of discrimination against all women and girls everywhere
Y_{52} as eliminating all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation

Y_{53} as eliminating all harmful practices, such as child, early and forced marriage and female genital mutilation

Y_{54} as recognizing and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate

Y_{55} as ensuring women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life.

Whereby the specific parameters and weights defined and restricted as follows;

$$0 \leq \varpi_{ij} \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_{ij} = 1$$

3.3.11. Y_6-Goal 6: Ensure Availability and Sustainable Management of Water and Sanitation for All

Equation 7 defines *Y_6* as SDG-Goal 6 of ensuring availability and sustainable management of water and sanitation for all, (URT, 2024 and UNDESA, 2024). Equation 7 outlines main sustainable management of water and sanitation outcome indicators as follows;

$$7 \quad Y_6 = \varpi_{61}Y_{6\backslash 61} + \varpi_{62}Y_{62} + \varpi_{63}Y_{63} + \varpi_{64}Y_{64} + \varpi_{65}Y_{65}$$

Whereby we define these main sustainable managements of water and sanitation outcome indicators as follows;

Y_{61} as achieving universal and equitable access to safe and affordable drinking water for all

Y_{62} as achieving access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

Y_{63} as improving water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

Y_{64} as substantially increasing water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

Y_{65} as protecting and restoring water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

Whereby the specific parameters and weights defined and restricted as follows;

$$0 \leq \varpi_{ij} \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_{ij} = 1$$

3.3.12. Y_7-Goal 8: Promote Sustained, Inclusive and Sustainable Economic Growth, Full and Productive Employment and Decent Work for All

Equation 8 defines SDG-Goal 7, that is, Y_7 of promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, (URT, 2024 and UNDESA, 2024). Equation 8 outlines main inclusive and sustainable economic growth outcome indicators as follows;

$$8 \quad Y_7 = \varpi_{71}Y_{71} + \varpi_{72}Y_{72} + \varpi_{73}Y_{73} + \varpi_{74}Y_{74} + \varpi_{75}Y_{75}$$

Whereby we define main inclusive and sustainable economic growth outcome indicators as follows;

Y_{71} as sustaining per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries,

Y_{72} as achieving higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors,

Y_{73} as supporting productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services,

Y_{74} as promoting sustainable tourism that creates jobs and promotes local culture and products,

Y75 as encouraging and expanding access to banking, insurance and financial services for all.

Whereby the specific parameters and weights defined and restricted as follows;

$$0 \leq \varpi_{ij} \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_{ij} = 1$$

3.3.13. Y8-Goal 9: Build Resilient Infrastructure, Promote Inclusive and Sustainable Industrialization and Foster Innovation.

Equation 8 articulates SDG-Goal 9, that is. ***Y8;*** of building resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation, (URT, 2024 and UNDESA, 2024). Equation 9 outlines main inclusive and sustainable industrialization and foster innovation outcome indicators as *follows;*

$$9 \quad Y_8 = \varpi_{81}Y_{81} + \varpi_{82}Y_{82} + \varpi_{83}Y_{83} + \varpi_{84}Y_{84} + \varpi_{85}Y_{85}$$

Whereby we define these main inclusive and sustainable industrialization and foster innovation outcome indicators *as follows*;

Y81 as developing quality, reliable, sustainable and resilient infrastructure, including national, regional and trans border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all

Y82 as promoting inclusive and sustainable industrialization and, significantly raise industry's share of employment and gross domestic product, in line with national circumstances,

Y83 as increasing access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets

Y84 as upgrading infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with taking action in accordance with their respective capabilities

Y85 as enhancing scientific research, upgrade the technological capabilities of industrial sectors; encouraging innovation and substantially increasing the number of research and development workers, and public and private research and development spending.

Whereby the specific parameters and weights defined and restricted as follows;

$$0 \leq \varpi_{ij} \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_{ij} = 1$$

3.3.14. Y_9-SDG-Goal 11: Make Cities and Human Settlements Inclusive, Safe, Resilient and Sustainable.

Equation 10 articulates ***Y_9*** as SDG-Goal 11 of making cities and human settlements inclusive, safe, resilient and sustainable, (URT, 2024 and UNDESA, 2024). Equation 10 outlines main human settlements inclusive, safe, resilient and sustainable outcome indicators as follows;

$$10 \quad Y_9 = \varpi_{91}Y_{91} + \varpi_{92}Y_{02} + \varpi_{93}Y_{93} + \varpi_{94}Y_{94} + \varpi_{95}Y_{89}$$

Whereby we define these main human settlements inclusive, safe, resilient and sustainable outcome indicators *as follows*

Y_{91} as ensuring access for all to adequate, safe and affordable housing and basic services and upgrade slums

Y_{92} as providing access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons

Y_{93} as enhancing inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries

Y_{94} as strengthening efforts to protect and safeguard the world's cultural and natural heritage

Y_{95} as significantly reducing the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.

Whereby the specific parameters and weights defined and restricted as follows;

$$0 \leq \varpi_{ij} \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_{ij} = 1$$

3.3.15. Y_{10}-SDG -Goal 12: Ensure Sustainable Consumption and Production Patterns

Equation 11 articulates SDG- Goal 12 that is ***Y_{10}***; of ensuring sustainable consumption and production patterns, (URT, 2024 and UNDESA, 2024). Equation 11 outlines main sustainable consumption and production patterns outcome indicators *as follows*

$$11 \quad Y_{10} = \varpi_{101}Y_{101} + \varpi_{102}Y_{102} + \varpi_{103}Y_{103} + \varpi_{104}Y_{104} + \varpi_{105}Y_{105}$$

Whereby we define these main sustainable consumption and production patterns outcome indicators *as follows;*

Y_{101} as achieving the sustainable management and efficient use of natural resources

Y102 as halving per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses

Y103 as achieving the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment

Y104 as substantially reducing waste generation through prevention, reduction, recycling and reuse

Y105 as ensuring that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature

Whereby the specific parameters and weights defined and restricted as follows;

$$0 \leq \varpi_{ij} \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_{ij} = 1$$

3.4. RFB – SEO – SRM - 2025 - Model Determination

Box 3.1 summarizes the RFB-SEO-SRM-2025-Model. The RFB- SEO-SRM-2025-Model is determined according to mathematical modelling rules since we have eleven relations; 1 - 11, to determine the values of eleven endogenous policy evaluation target variables, *Y*, ***Y1, Y2, Y3, Y4, Y5, Y6, Y7, Y8, Y9, and Y10.*** In turn these determine efficiency, effectiveness and equity of the system. The final use of the RFB- SEO-SRM-2025 framework is to form a clear policy judgment on whether *Value for Money* has been secured during road maintenances in the area under examination, (Haule, 2005 and José Papí, *et al,* 2007). It will determine the criteria against which performance will be assessed by agreeing what optimal arrangements for the system under scrutiny would look like (Road Fund Board, 2008). 'Optimal' is hereby defined as the most desirable possible given expressed, restrictions or constraints during sample time, (Baporikar, 2016).

Table1 The RFB-SEO-SRM-2025-Model

1	$Y = \varpi_1 Y_1 + \varpi_2 Y_2 + \varpi_3 Y_3 . + \varpi_4 Y_4 + \varpi_5 Y_5 + \varpi_6 Y_6 + \varpi_7 Y_7 + \varpi_8 Y_8 + \varpi_9 Y_9 + \varpi_{10} Y_{10}$
2	$Y_1 = \varpi_{11} Y_{11} + \varpi_{12} Y_{12} + \varpi_{13} Y_{13} + \varpi_{14} Y_{14} + \varpi_{15} Y_{15}$
3	$Y_2 = \varpi_{21} Y_{21} + \varpi_{22} Y_{22} + \varpi_{23} Y_{13} + \varpi_{24} Y_{24} + \varpi_{25} Y_{25}$
4	$Y_3 = \varpi_{31} Y_{31} + \varpi_{32} Y_{32} + \varpi_{33} Y_{33} + \varpi_{34} Y_{34} + \varpi_{35} Y_{35}$
5	$Y_4 = \varpi_{41} Y_{41} + \varpi_{42} Y_{42} + \varpi_{43} Y_{43} + \varpi_{44} Y_{44} + \varpi_{45} Y_{45}$
6	$Y_5 = \varpi_{51} Y_{4\backslash 51} + \varpi_{52} Y_{52} + \varpi_{53} Y_{53} + \varpi_{45} Y_{54} + \varpi_{55} Y_{55}$

7	$Y_6 = \varpi_{61}Y_{6\backslash 61} + \varpi_{62}Y_{62} + \varpi_{63}Y_{63} + \varpi_{64}Y_{64} + \varpi_{65}Y_{65}$
8	$Y_7 = \varpi_{71}Y_{71} + \varpi_{72}Y_{72} + \varpi_{73}Y_{73} + \varpi_{74}Y_{74} + \varpi_{75}Y_{75}$
9	$Y_8 = \varpi_{81}Y_{81} + \varpi_{82}Y_{82} + \varpi_{83}Y_{83} + \varpi_{84}Y_{84} + \varpi_{85}Y_{85}$
10	$Y_9 = \varpi_{91}Y_{91} + \varpi_{92}Y_{02} + \varpi_{93}Y_{93} + \varpi_{94}Y_{94} + \varpi_{95}Y_{89}$
11	$Y_{10} = \varpi_{101}Y_{101} + \varpi_{102}Y_{102} + \varpi_{103}Y_{103} + \varpi_{104}Y_{104} + \varpi_{105}Y_{105}$

4.1.Indicative Application and Results of the SEO-SRM-2025- Data Model

4.2. Data Methods, Approaches and Analysis

4.2.1. Data and Information Collection and Management

The *Quantitative Data Model* will be formulated based on the above SEO-SRM-2025 model which is an evidence-based investigation to evaluate and report on whether economy, effectiveness and efficiency has been achieved in the use of road funds (Road Fund Board, *2008 and various issues*). Based on the *SEO-SRM-2025 Quantitative Model*, data and information will be collected, managed and analyzed by the RFB Task Force Team, (Road Fund Board, 2015/6 to 2023/2024). The RFB Task Force Team composed of road engineers, social economists and consultants will use various research survey methods to collect data and information including meetings; desk study and field survey for verification, and measurements.

The field research survey methods will also involve visiting identified construction sites with the purpose of verifying the quality of road maintenance works, (RFB, 2020). This is comprised of [1] visual assessment to check quality of riding surface shoulders; cross falls and super elevation and existence of cracks, potholes, ruts and the existence of corruption; [2] field measurements to assess dimensional accuracy of but not limited to carriageway; shoulders and drainage structures and [3] field/laboratory tests, during site inspection, the auditors must conduct some confirmatory tests to assess the compliance of road pavement layers with design specifications. In this method the important parameters include covers; field density and thickness for base courses; TFV (dry and wet) for base and surface dressing wearing courses; thickness of pavement layers; grading of aggregates; binder content as well as rebound hammer for structural element, (RFB, 2020).

4.2.2. The SEO-SRM-2025 Data Analysis

The RFB Task Force Team will evaluate the socio-impacts of roads maintenance projects from those RFB funded projects, (Road Fund Board, 2015/6 to 2023/2024). It must be based on rigorous preparatory process, guided by a standard research methodology with its associated tools and template, (RFB, 2020). The process is framed around a set of core social economic indicators and involves multi-stakeholder participation at different stages of the preparation of the evaluation. This includes data validation and a review of the quality of the narrative reports by the Task Force

Team and the RFB Management. The collected data and information will be organized, managed and analyzed using computer software including Statistical Package for Social Science (SPSS), STATA and MS Excel and other relevant analytical software seems to be viable for the assignment.

Data analysis will involve statistical investigation of performances or behaviour of endogenous or policy target SDG-2030 variables during the sample period or over time (Chiang, 1984). It will involve taking time derivatives of all policy target variables. The time derivative is a derivative of all functions with respect to time, usually interpreted as the rate of change of the value of the function. The derivatives of functions or real variables measure the sensitivity to changes of the functions (outputs) values with respect to changes in their arguments (input values) (Chiang, 1984). For example, the derivative of the position of a moving object with respect to time is the object's velocity. This measures how quickly the position of the object changes when time advances, (Robinson, 1982).

This theoretical note articulates its corresponding non-parametric Quantitative SEO-SRM-2025 model and shows its model determination, use and results of the SEO-SRM-2025 model. The Quantitative SEO-SRM-2025 model to be developed will be consistent with existing approaches commonly used by public and private organizations to monitor and evaluate performance-based work. The quantitative model procedures to be adopted in the framework to evaluate each component are based on mathematically valid techniques. These procedures are associated to the four evaluation research phases or activities: {*Input, Data Collection, Data Analysis, and Reporting*}. The proper implementation of these procedures and techniques provides reliable assessments of the sustainable road maintenance contractor's performances. The procedures and techniques to be adopted will be associated to the complete ex-post evaluation processes, through all stages or phases; from the planning stage through the reporting of results from the data and policy analysis, (Road Fund Board, 2015/6 to 2023/2024).

Descriptive statistics such as frequency distribution, means, and percentages will be generated and used to analyze the quantitative data using *SPSS Version 26* with the aid of Excel Spread Sheet in Microsoft Office 2021 and data will be presented systematically in terms of tables, charts, graphs, numerals and description. *E View Version 12* will be also used to analyze the relationship between variables in social impact characteristics.

Robust non-parametric techniques will be developed to address the specific needs in the ex-post evaluation SEO-SRM-2025 Model. The implementation of Quantitative SEO-SRM-2025 Model will be the most important adopted technique that makes the proposed SEO-SRM-2025 Model to be very practical and reliable. The proposed framework presents several contributions to the body of knowledge. *These contributions can be classified in two categories*.

The first major contribution of this evaluation will be the clarification and formalization of those main components or elements that define the SEO-SRM-2025 framework. The SEO-SRM-2025 Model responds to the need of RFB to perform comprehensive and reliable assessments of the economy, efficiency and effectiveness of performance-based specification roadway maintenance system. The implementation of performance-based specifications in road maintenance in Tanzania is relatively new and current guidelines to monitor this type of initiative are considered are part of second-generation reforms in the road sector in the country. For this reason, the proposed SEO-

SRM-2025 Model can be categorized as unique and a major asset to the performance-based road maintenance arena in developing economies.

The second major contribution corresponds to formalizing the link between on one hand economy, efficiency and effectiveness theories and other hand the non-parametric SEO-SRM-2025 model. This paper provides the RFB in Tanzania not only with non-parametric valid procedures to estimate economy, efficiency, and effectiveness accrued as a result of the implementation of performance-based specifications, but also proved methodologies to evaluate the ex-post impact. Since there are no known previous studies in Tanzania addressing these issues; the methodologies presented can be categorized as the most comprehensive attempt until now to evaluate the social economic efficiency of the RFB initiatives in the road maintenances in the country.

References

African Union Commission and African Union Development Agency - NEPAD. 2022. AUC & AUDA-NEPAD Second Continental Report on the Implementation of Agenda 2063. AUC & AUDA-NEPAD, Midrand, South Africa,

Audit Commission (2011). Going the distance: Achieving better value for money in road maintenance. Local government report, May 2011. Audit Commission, London.

Baporikar, N. (2016). Infrastructure development as a catalyst for social-economic advancement. *International Journal of System Dynamics Applications (IJSDA), 5(4), 101-113.*

Benmaamar Mustapha, (2006):' *Financing of Road Maintenance in Sub-Saharan Africa - Reforms and progress towards second generation road funds'*, SSATP Discussion Paper No.6 -- Road Management & Financing Series, World Bank, Washington, USA.

Bogale, B.D., (2016) "Socioeconomic impacts of road development in Ethiopia: case studies of Gendewuha- Gelago, Mile–Weldiya and Ginchi-Kachisi Roads", (Doctoral Thesis), Department of Geography, University of South Africa,

Chiang, A.C. (1984) "Fundamental Methods of Mathematical Economics". 3rd Edition, McGraw-Hill, Singapore.

Donnges, Ch.; Edmonds, and G.; Johannessen, B. (2007): *Rural Road Maintenance - Sustaining the Benefits of Improved Access (SETP 19)*; Bangkok, International Labour Office,

Ellie Gould, Chris Parkman and Thomas Buckland, (2013): "*The Economics of Road Maintenance"* The Royal Automobile Club Foundation for Motoring Ltd Foundation; 89–91 Pall Mall; London SW1Y 5HS,

Elisther K. Ndyalusa and Casmir Fabian Kitula (2023 Assessment of Social-Economic Impact of Road Construction Projects in Conserved Areas: Evidence from Ngorongoro Conservation Area Authority in Tanzania, *Accountancy and Business Review Vol. 15(2), pp. 36-45,*

Johansson, S., (2004) "*Socio-economic impacts of road condition on low volume roads*", Roadex II Northern Periphery, Report being part-financed by the European Regional Development Fund, 2004.

José Papí, Brendan Halleman, Tom Antonissen, Francesco Falco, and Berta Vizcarra-Mir, (2007): *The Socio-Economic Benefits of Roads in Europe*" IRF Research Council (2007):" European Union Road Federation (ERF); International Road Federation (IRF) – Brussels Programme Centre; Avenue Louise 113; B-1050 Brussels (BELGIUM)

Haule J.O. (2005)" Financing Roads in the United Republic of Tanzania: Challenges and Strategies"; *Transport and Communications Bulletin for Asia and the Pacific No. 75, 2005*

Mike C. Jackson; (2000): "*Systems Approaches to Management*". London, England: Springer

RFB (2020). Roads Fund Board Monitoring and Evaluation Manual. Dodoma, Tanzania

Road Fund Board (2015/6 to 2023/2024); "*The Annual Progress Reports 2016/17-2023/24 and Roads Fund Board Financial Release to Implementing Agencies*", Roads Fund Board; Ministry of Works, Communication and Transport; Njedengwa Investment Area, Block D, Plot No. 3, P.O. Box 993, Dodoma.

Robinson; John Bridger (1982) Energy backcasting A proposed method of policy analysis, *"Energy Policy; Volume 10, Issue 4, December 1982, Pages 337-344*

Semboja Haji Hatibu, (2019); Formalization of the Value for Money Model Used the Roads und Board in Tanzania. A paper to be published in the *Tanzanian Economic Review, Vol. 9 No. 1, July 2019: 1–24*

Semboja Haji Hatibu (2024), "The Multidimensional Tourism Carrying Capacity Model for Zanzibar": *Asian Journal of Economics, Business and Accounting, Volume 24, Issue 1, Page 63-80, 2024; Article no. AJEBA.110648 ISSN: 2456-639X.*

Semboja Haji Hatibu, David Kwesiga and Amosi Pangani, (2025);"An Evaluation of Socio-Economic Outcomes of Sustained Road Maintenance in Tanzania"; Proposal for Internal Consultations, With the Road Fund Board Management; The United Republic of Tanzania Ministry of Works and Transport Roads Fund Board, Dodoma, Tanzania

Thomé, Bernhard (1993). *Systems Engineering: Principles and Practice of Computer-based Systems Engineering.* Chichester: John Wiley & Sons. ISBN-0-471-935552-2

Wasike, Wilson S.K. (2001) "*Road Infrastructure Policies in Kenya: Historical Trends and Current Challenges*"; Infrastructure and Economic Services Division; Kenya Institute for Public Policy Research and Analysis; KIPPRA Working Paper No. 1

United Republic of Tanzania (2024); "*The Tanzania Development Vision 2050*: Draft Version; Presidents Offices, Planning and Investments, Government City, Mtumba, 1 Barabara ya Ardhi, P. O. Box 104, 40403 DODOMA.

UNDESA (2024):" *The Sustainable Development Goads 2030*": The Division for Sustainable Development Goals (DSDG) in the United Nations Department of Economic and Social Affairs (UNDESA) acts as the Secretariat for the SDGs, United Nations Statistics Division; Development Data and Outreach Branch; New York, NY 10017

Von Bertalanffy Ludwig. (1950). "An Outline for General Systems Theory." *British Journal for the Philosophy of Science 1(2).*