

RESEARCH ARTICLE

Evaluation of the Social, Economic, Environmental and Security impacts (SEES) on the development of the Humming Bird Highway in Belize.**Dr. Romaldo Isaac Lewis (DBA)***Faculty of Management and Social Science, University of Belize, Belize, Central America***ABSTRACT**

The purpose of the research was to 1; Quantify the investment in resources (economic, materials, human, time and machinery) used for road rehabilitation hummingbird; 2. Evaluate the level of satisfaction or performance of the interested parties, being the road impact formulators, implementers and travelers; and the number 3. Determine if there are statistically significant differences between the interested parties' formulators, implementers and travelers on road rehabilitation. Regarding the performance of the Hummingbird highway rehabilitation project, according to the evaluation criteria, the relevance obtained an average of 2.98 or 74.5%, which indicates that the project was more than pertinent according to the expression of the interested parties. The effectiveness obtained an average of 2.95 or 74%, which indicates that the project was more than effective in achieving the planned objectives as expressed by the stakeholders. On the other hand, with respect to efficiency, the calculated value was 2.90 or 72%, which indicates that the project was executed in a more than efficient manner in terms of the use of resources according to the expression of the interested parties. For sustainability, the calculated value was 3.00 or 75%, which indicates that the project was more than sustainable in terms of execution according to how the interested parties expressed it. Finally, regarding the general average of the project, the calculated value was 2.96 or 74%, which indicates that the project rehabilitation of the Humming Bird highway was formulated and executed more than successfully.

The analysis revealed that the five stakeholder groups; formulators, implementers, entrepreneurs, travelers in private and public transportation, will significantly benefit from intangibles through efficient mobility and efficiently transport people and goods between municipalities and villages. Furthermore, during and after of rehabilitation, there will be social cohesion, capacity development, expansion /market introduction and exchange of experiences, as well as the participation of surrounding communities, which exceeds the investment costs (\$60,070,000) in the long term.

Keywords: Highway performance; Performance criteria; Road infrastructure: Humming Bird highway; Ex post evaluation; \$60,070,000; Cost Benefit Analysis; Stakeholders.

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1. INTRODUCTION

This justifies the need to design a comprehensive method to carry out evaluations on the road infrastructure projects that are currently being carried out in the country, and specifically, the Humming Bird highway that connects the City of Belmopán with the municipality of Dangriga. Due to the reason expressed above, a method was designed using the Humming Bird highway as an example, considering that it was completed three years ago. This The primary objective of the study is to design a model that incorporates the following; 1) Analysis satisfactory or performance of the interested parties (ASI), of the Social, Economic, Environmental and of Traffic, 2) Statistical analysis of the interested parties and criteria (AEIC) and 3. Cost Analysis- Benefit (ABC). This is important to mention, considering that the government must continue to monitor Carefully monitor the condition of the pavement to identify any rapid deterioration that may occur and determine the most economical remedy. The said evaluation will be a process that guarantees adequate planning, implementation, monitoring and closure of public investment projects. (Kati, K. and Ott, K. 2014, Pg. 7).

Currently, the ministry responsible for infrastructure works in the country does not have an evaluation method (Ex ante, During, Terminal and Ex post) that integrates various stakeholders to carry out the assessment of the development of the country's public civil infrastructure, as confirmed by the head of engineering at the Ministry of Infrastructure Development & Housing (MIDH). The fundamental reason is based on the fact that when international organizations, as well as the government of the day, finance projects, they never include funds for their evaluations and therefore they have always remained unassessed. (Bradley, L; Direct communication July 15, 2021).

The design, construction and maintenance, as well as policies and institutional features, cannot be quickly transferred to the countries of the region Central American. Therefore, the project design must incorporate a route of more realistic change, which may initially require less emphasis on standards international standards and implementation models, and more emphasis on gradually developing familiarity and confidence in international methods as expressed by the authors Blanco-Orozco, N; Arce-Díaz, E; Zúñiga-González, C. (2015, Pg. 4).

The continued absence of an Ex-post method to assess the social, economic, environmental and safety impacts of the road infrastructure in Belize, will leave a deficiency in the performance base on the criteria of relevance, efficiency, effectiveness, sustainability and impact of the projects. In addition, this will leave missing lessons learned from donors, formulators, implementers as well as the beneficiaries. Therefore, it is important to resolve this gap by considering the design of an expos evaluation method, which integrates the stakeholders in the Social, Economic, Environmental and Security (SEES) evaluation; to measure the impact they will bring to the beneficiaries.

In agreement with Mariana Gonçalves de Carvalho Wolff and Marco Antonio Farah Caldas (2018, Pg.

10), the implementation of the program seeks to translate the objectives into actions and through the performance of road administration, which has beneficial consequences for the whole of society. The mode of transport by road, for example, is recommended for door-to-door transport, especially in the case of fragments deliveries of products to the end customer.

According to Kati Kaare, Ott Koppel (2014, Pg. 213), Transportation planning recognizes the critical links between mobility and other societal goals. The Strategies supporting infrastructure investments generate substantial public interest because they are related to public expenses. The decision processes related to Transportation projects involve considerations of environmental, economic, technical and security, and are characterized by many actors and multiple objectives in the feasibility studies. This justifies the need to design a comprehensive method to carry out evaluations on the road infrastructure projects that are currently being carried out in the country, and specifically, the Hummingbird highway that connects the City of Belmopan with the municipality of Dangriga and the Thomas Vincent Ramos Highways in the country.

2. LITERATURE REVIEW

2.1 Evaluation of Road Infrastructure Projects

2.1.1 General principles of project evaluation

The general principles of project evaluation are foundations that guide the systematic analysis of an investment proposal or initiative, with the objective of determining its economic, financial, technical, environmental and social viability. These principles allow you to make informed decisions about whether or not to execute a project as outline below:

1. Economic rationality

The project must be evaluated from an economic point of view, seeking to maximize the efficient use of scarce resources. Costs and benefits must be compared over time.

2. Analysis of alternatives

You should not evaluate just one proposal, but compare different options (technological, location, scale, etc.) to select the most convenient one.

3. Comprehensive approach

The analysis must consider all relevant areas: technical, economic, financial, legal, social and environmental.

4. Time horizon

An appropriate time period must be defined for the evaluation, so that all relevant benefits and costs of the project are captured (project life).

5. Time value of money

It is recognized that a peso today is worth more than a peso tomorrow. For this reason, techniques such as net present value (NPV) and internal rate of return (IRR) are used.

6. Decision criteria

Projects are accepted or rejected based on certain indicators, such as:

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- a) Net Present Value (NPV)
 - b) Internal Rate of Return (IRR)
 - c) Benefit/Cost Ratio
 - d) Investment Recovery Period (Payback)

7. Risk and uncertainty

The risks that may affect the project must be identified and analyzed, applying tools such as sensitivity analysis, scenarios and simulations.

8. Social and environmental impact

The evaluation should consider the effects of the project on the community, the environment and other non-financial factors.

9. Consistency and objectivity

The analysis should be based on realistic assumptions, reliable data and a consistent methodology, avoiding subjective biases.

10. Sustainability

The project must be sustainable over time, not only economically, but also in social and ecological terms.

2.2 Types of project evaluation

In project evaluations, they are basically carried out in view of the Five Criteria of evaluation, but depending on the moment of the evaluation study, the perception of each topic is different. For example, in the ex-ante evaluation before starting a project, the "Relevance" can be examined based on the actual situation, but from the other points of view, the survey can only be carried out based on forecasts and perspectives. In an interim evaluation after the start of the project, "relevance" and "efficiency" can be evaluated based on the actual situation and performance, but "effectiveness" and "impact" can only be examined primarily at the end of the project in accordance with what is considered necessary and possible at that moment for the evaluation and that depends on the extent to which a medium-term effect has actually occurred. (Bakhtawar et al, 2018)

According to OCED (2016), the depth and focus of the examination of each of the five evaluation criteria may also differ depending on the characteristics of a project and the problems you face. For example, for small projects, it may not be appropriate to conduct the survey using expensive questionnaires, but using instead another simple method or if the party involved is aware of the efficiency issues as a problem for a project, it may be necessary to conduct the study with a stronger focus on examining efficiency.

2.2.1 Ex ante evaluation

The "ex-ante" evaluation includes the evaluations that are made on the processes or activities carried out in the pre-investment phase. Additionally, the evaluation serves to demonstrate the feasibility and viability of the project from three perspectives (financial, economic and social, and environmental). The results are used in the promotion phase, negotiation and financing in order to determine whether financial resources are allocated to the project. (Ramón Rosales, 2019, Pg. 31).

2.2.2 Evaluation During

According to Rosales, R. (2019, Pg. 32), The evaluation during is also called "about the "start-up"; it is carried out in the investment or execution phase. Its fundamental purpose is ensuring compliance with the execution objectives (specific execution objectives) of the project, that is, the achievement of each of the project deliverable. Furthermore, this is the evaluation to which greater importance is assigned, since its results have immediate consequences that cause modifications in the activities that are in course of execution. Additionally, in this phase there are three sub-processes, monitoring and control, evaluation and closing of the execution of the project, monitoring and control is what is carried out at activities of each of the project deliverable. These activities are carried out continuously throughout the phase, the evaluation can be carried out in two moments, one in the middle of the execution process, which is called the EMT mid-term evaluation. The Evaluations during are carried out in the middle of a project (in five-year projects, in the now about two and a half years have passed). Its purpose is to verify if the project It has been implemented smoothly and is on its way to producing effects. (OCED, 2016).

2.2.3 Terminal Evaluation

According to the organization, (JICA, 2010), final evaluations are carried out at the end of cooperation; They examine at a comprehensive level whether the project objective was achieved. As Consequently, relevance, efficiency and effectiveness are examined depending on the situation real and performance. Impact and sustainability are also examined based on performance and the status of activities up to that point, and also with respect to future trends and viability.

It is important to keep in mind that, although for impact and sustainability, they are the "perspectives" which will be judged in the final evaluation, the evaluation still has to identify the specific grounds for the trial to ensure that the sentence is not without merit basis. The evaluation results of the final evaluations are fed back mainly to operational departments and relevant government agencies and to the implementing agency in the partner country.

2.2.4 Ex post evaluations

According to Rosales, R. (2019, Pg. 33), there are two types of "expos" evaluation, which are carried out in any of the following moments: During the operation or operational phase of the project, whether at the beginning, middle or end of the phase: the "expos" evaluation of the operation or function. Each of these two types of evaluation has its own objectives and peculiarities; However, in general terms, the "expos" evaluation contemplates a careful examination of certain factors, including the quality of the goods or services that are produced or provided, the achievement of goals, the scope of the objectives, the solution of the problem, the satisfaction of the target group, the increase in production, etc., all of them linked to the living conditions of the objective beneficiaries direct objectives that are intended to be achieved through the project. The mentioned factors are measured based on parameters such as efficiency (appropriate use of resources), effectiveness (achievement of objectives in relation to the use of resources), the effects and impacts.

2.3 Difference between Ex Ante and Ex Post evaluation.

a. Ex ante phase (before execution)

It is the formulation and design stage of the project, where feasibility is analyzed and its implementation is planned. Includes:

1. Identification of the problem or opportunity.
2. Definition of objectives, goals and beneficiaries.
3. Feasibility study (technical, economic, social, environmental, institutional).
4. Preparation of the work plan, schedule and budget.
5. Ex ante evaluation: cost-benefit or cost-effectiveness analysis to decide whether it is advisable to execute the project.

b. Ex post phase (after execution)

It is carried out once the project is concluded, with a focus on evaluation and learning. Includes:

1. Evaluation of results (if immediate objectives were achieved).
2. Impact evaluation (medium and long-term effects on the population or context).
3. Sustainability analysis (if the benefits last over time).
4. Systematization of lessons learned and good practices.
5. Accountability to financiers, beneficiaries and actors involved.

2.4 Ex Post Evaluation

2.4.1 Definition and purpose

Ex post evaluation in project management is a systematic process that is carried out once the project is completed, in order to analyze its results, impacts and the way in which it was managed.

a. Definition

Ex post evaluation is the comprehensive review of a project after its execution and closure, which seeks to determine to what extent the stated objectives were achieved, how the resources were used and what effects (positive or negative) it generated in the organization, the beneficiaries and the environment.

b. Purpose

The main purpose of the ex-post evaluation is to learn from the experience to improve the management of future projects and verify the real value that the initiative generated. Its specific purposes include:

1. Measure results and impacts: determine if the expected benefits were achieved and what the long-term effects were.
2. Assess efficiency and effectiveness: analyze whether the resources invested were used appropriately in relation to the achievements.
3. Identify lessons learned: rescue good practices and errors to strengthen the management of future projects.
4. Be accountable: provide transparency to stakeholders (management, funders, community) about the achievements and relevance of the investment.

5. Evaluate sustainability: analyze whether the results are maintained over time, even after the project closes.

2.4.2 Methodological approaches

In project management, research methodological approaches quantitative, qualitative and mixed are applied as analysis, planning, monitoring and evaluation tools. Each approach provides different and useful perspectives depending on the type of project, its objectives and the type of information necessary for decision making.

a. Quantitative Approach

It is based on numerical and measurable data.

- ☐ Application in projects:
 1. Estimation of costs, times and resources.
 2. Risk analysis with statistical models.
 3. Performance monitoring with indicators (KPI, EVM – Earned Value Management).
 4. Structured surveys to measure customer satisfaction or impact.
- ☐ Advantage: Allows you to obtain objective, comparable results and project scenarios.
- ☐ Limitation: Does not explain in depth the perceptions, experiences or social factors behind the numbers.

b. Qualitative Approach

It focuses on deep understanding of experiences, perceptions and contexts.

- ☐ Application in projects:
 1. Identification of needs of users or communities (interviews, focus groups).
 2. Evaluation of the social or cultural impact of a project.
 3. Understanding of work dynamics in multidisciplinary teams.
 4. Study of success or failure factors from the perspective of those involved.
- ☐ Advantage: Provides rich and contextualized information to improve decision making.
- ☐ Limitation: Less generalizable results and with a certain level of subjectivity.

c. Mixed Approach

It combines both approaches (quantitative + qualitative), integrating the precision of numerical data with the depth of interpretation.

- ☐ Application in projects:
 1. Comprehensive evaluation of projects (e.g. measure economic impact with statistics and validate the perception of the beneficiaries).
 2. Organizational change management (surveys + interviews).
 3. Monitoring and evaluation of development or innovation projects.
- ☐ Advantage: Offers a holistic view, balancing objectivity and context.
- ☐ Limitation: Requires more resources (time, money, specialized personnel).

2.5 Advantages and limitations of Ex Post evaluation.

A. Advantages of Ex Post Evaluation

- Measures actual results – Unlike ex-ante (before) or mid-term evaluations, ex post deals with real data and outcomes, not projections or assumptions.
- Assesses long-term impacts – Can capture sustainability, unintended consequences, and lasting changes that may not be visible during implementation.
- Improves accountability – Provides evidence of whether the program/policy delivered on its promises.
- Learning for future projects – Lessons from successes and failures can inform the design of new policies or programs.
- More objectivity – Since the project has ended, political or operational pressures are usually reduced, leading to a more neutral assessment.

B. Limitations of Ex Post Evaluation

- Time lag – By the time evaluation happens, it may be too late to improve the completed project itself.
- Attribution challenges – Difficult to separate the project's impact from other external factors (e.g., economic changes, political shifts).
- Data availability issues – Records may be incomplete, inconsistent, or unavailable years after project completion.
- High costs & complexity – Collecting long-term impact data and conducting field studies can be expensive and resource-intensive.
- Stakeholder disengagement – Beneficiaries, staff, or policymakers may have moved on, making it harder to gather feedback.
- Risk of bias in recall – If based on interviews or surveys, respondents may misremember or reinterpret past experiences.
- Limited immediate utility – Since the project is over, the evaluation is more about learning for the future than improving current operation.

Table No. 1; Evaluation criteria and Type of evaluation

Type / Criteria	Ex ante Evaluation	Monitoring	Mid Term	Final	Expos
Relevance	●	-	●	●	✓
Effectiveness	o	-	✓	●	
Efficiency	o	-	●	●	
Impact	o	-	❖	❖	●
Sustainability	●	-			

Source: JICA (2012)

- Examination based on the real situation and performance
- o Examination based on forecasts and perspectives
- Examination in accordance with what is judged necessary and possible for the evaluation
- A full exam is not yet possible or was completed in an earlier phase

a) **RELEVANCE**: Refers to the extent to which the objectives of a development intervention are consistent with the requirements of the beneficiaries, the needs of the country, the priorities and policies of the partners and donor countries. The evaluation of the project's relevance can be evaluated through the assignment of values to the criteria such as: Highly relevant (4), More than relevant (3), Relevant (2), Less than relevant (1) and irrelevant (0).

b) **EFFECTIVENESS**: Refers to the extent to which the objectives of the development intervention were achieved, or are expected to be achieved, considering their relative importance. In other words, effectiveness measures the extent to which an activity achieves its purpose, or whether this can be expected to happen based on the products. Implicit within this criterion of effectiveness is opportunity. The evaluation of the project's effectiveness can be evaluated in the following way through the assignment of values to the criteria such as: Highly effective (4), More than effective (3), Effective (2), Less than effective (1) Ineffective (0).

c) **EFFICIENCY**: Refers to a measure of how economic resources/inputs (funds, experience, time, etc.) are converted into results. Efficiency generally measures the outputs, qualitative and quantitative, achieved as a result of the inputs. This usually requires comparing alternative approaches to achieving a result, to see if the most efficient approach has been used. The evaluation of the project's efficiency can be assessed evaluated through the assignment of values to the criteria such as; Highly efficient (4), More than efficient (3), Efficient (2), Less than efficient (1) Inefficient (0).

d) **IMPACT**: This refers to the long-term positive and negative, primary and secondary effects produced by a development intervention, directly or indirectly, intended or unintended. In other words, these effects for a road project can be reflected in an increase in land value. However, there may be negative impacts for some residents who live near the highway. These include increased noise, pollution and aesthetic impacts. The evaluation of the project's impact will be assessed in the following way through the assignment of values to the criteria of Highly satisfactory (4), More than satisfactory (3), Satisfactory (2), Less than satisfactory (1) Unsatisfactory (0). If long-term impacts are uncertain, the rating may refer to probable impacts.

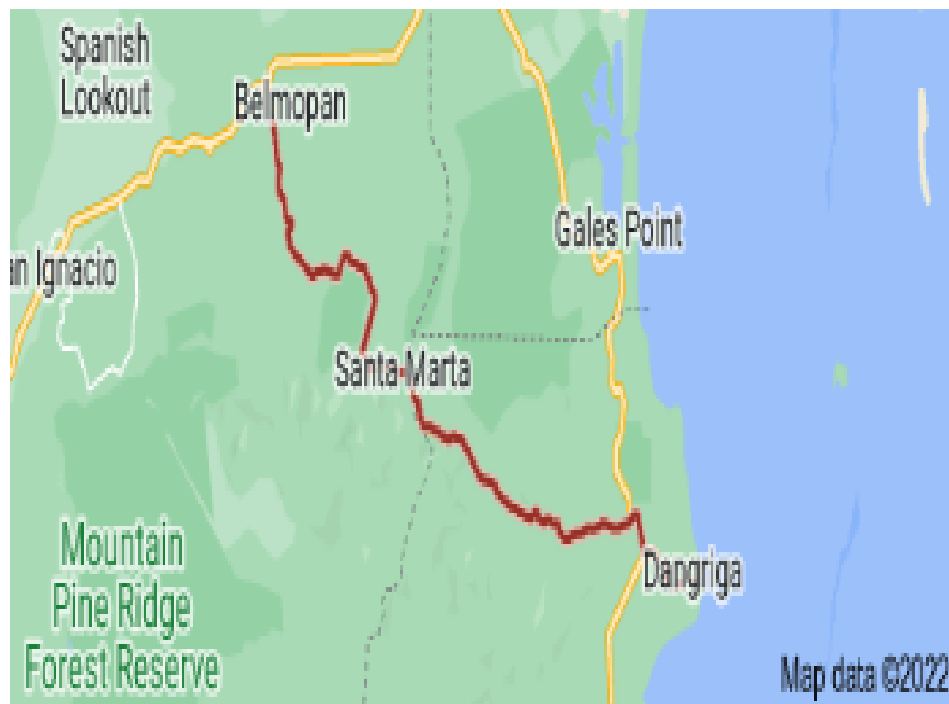
e) **SUSTAINABILITY**: Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs. In addition to natural resources, we also need economic resources. Sustainability is not just environmentalism. In other words, sustainability is a holistic approach that considers ecological aspects, social and economic dimensions, recognizing that everything must be considered together to find lasting prosperity. The evaluation of the sustainability of the project was evaluated as follows through the assignment of values to the criteria such as: Highly sustainable (4), More than sustainable (3), Sustainable (2), Less than sustainable (1), Unsustainable (0).

2.7 Location of the study

This study was conducted in Belize, Central America, where road infrastructure is currently under construction and remodeling. Belize as a country is the youngest, just 40 years of Independence recently as a nation, but making economic efforts to increase the level of productivity through the tourism industry, the export of mono crops such as Citrus, Banana, Sugar Cane and seafood (seafood).

The export of these items has been key to the growth of the Belizean economy as expressed according to data from the Belize Statistics Institute (SIB, 2021). Furthermore; this study will be carried out precisely on the Humming bird highway. It is a modern, paved, two-lane highway that opened in 1995. The Hummingbird Highway is approximately 55 miles (88 km) long and connects Belmopan, the national capital, with Dangriga on the southeast coast. The road itself offers a panoramic view of all the different landscapes of Belize.

Illustration No.1. Location of the Hummingbird Highway



The Hummingbird Highway passes through the northern part of the Mayan Mountains, crossing several picturesque rivers and passing citrus orchards before ending a short distance from the beach on the outskirts of Dangriga. It passes through several bridges along its route, which are double lanes. Because it is paved and well maintained, it is the fastest way to travel from the northern and western points of the country to the south eastern coast. From Belize City, the route southeast follows the Western Highway towards Belmopan in the center of the country and then the highway heads southeast until it reaches the outskirts of Dangriga on the coast. (Recuperated on September 2nd 2021: <https://www.hummingbird-highway-in-belize/>).

3. MATERIALES AND METHODS

3.1 Type of Research

This research employs a quantitative approach, which consist of an evaluation that applies the survey technique to the various stakeholders such as formulators, implementers, entrepreneurs, private transportation and public transportation travelers.

3.2 Objectives

3.2.1 General Objective

Evaluate the end results of the Humming Bird Highway project in social, economic, environmental and security dimensions, which is an ideal tool for future evaluations.

3.2.2 Specific Objectives

1. Define qualitative and quantitative techniques, as well as informant instruments and actors (Formulators, Implementers, Businesses and Travelers) to carry out the evaluation of the Humming Bird Highway.
2. Define and apply variables of interest for the study in the evaluation of each of the economic, social, environmental, and security dimensions.
3. Quantify the investment in resources (Economic, Material, Human, Time and Machinery) made for the rehabilitation of the Hummingbird highway.
4. Evaluate the level of satisfaction of the five stakeholders (Formulators, Implementors, Businesses, and Travelers in private and public transport).
5. Determine if there is a statistical difference in the level of satisfaction of the five stakeholders as mentioned above.

3.3 Sources of information

The primary sources of information were the data collected through surveys administered to people.

3.3.1 Stakeholders composition

- a) Formulators (Ministry of Economic Development)
- b) Implementors (Ministry of Infrastructure & Housing)
- c) Business in Dangriga
- d) Travelers in private transportation from Belmopan to Dangriga (Two ways)
- e) Travelers in public transportation from Belmopan to Dangriga (Two ways)

Table No. 2; Proportion, population and sample size of the stakeholders

Stakeholder	Proportion	Population	Sample size
Formulator	0.80	9	9
Implementors	0.80	9	9
Business	0.80	42	36
Traveler in private transport	0.80	62	50
Traveler in public transport	0.60	775	250
TOTAL		897	354

3.4 Evaluation instrument.

- a) A survey instrument was designed for each stakeholder group to collect the necessary information considering the limitation in visiting people to conduct a personal interview.

Surveys were distributed via email to the stakeholders (Formulators, Implementers, Businesses, and Travelers in private and public transport.

- b) Data were collected on the total costs of materials used, financial resources, Equipment, as well as the total amount of wages used in the execution of the rehabilitation of the highway.
- c) With the surveys that stem from the stakeholders, a descriptive analysis was carried out in order to determine the nature as well as the level of satisfaction based on the performance criteria as illustrated in the next slide. The results were presented in tables and graphs for their respective analysis and interpretation.

3.5 Bibliographic research

Finally, information was obtained from secondary sources through the use of books, articles, electronic journals from countries that have previously carried out studies of this nature through bibliographic research. Additionally, an evaluation matrix that relates each evaluation criterion to (Relevance, Effectiveness, Efficiency and Sustainability) was designed

3.6 Description Criteria

a) Relevance (20 pts)

The extent to which the objectives of a development intervention are consistent with beneficiaries' requirements, country needs, global priorities, and partners' and donors' policies. Are we doing the right things? What is the relevance or significance of the intervention regarding local and national requirements and priorities?

b) Effectiveness (15 pts)

The extent to which the development intervention's objectives were achieved, or are expected to be achieved, taking into account their relative importance. This could also be used as an aggregate measure of (or judgement about) the merit or worth of an activity, i.e. the extent to which an intervention has attained, or is expected to attain, its major relevant objectives efficiently in a sustainable fashion and with a positive institutional developmental impact.

c) Efficiency (15 pts)

A measure of how economically resources/ inputs (funds, expertise, time, etc...) are converted to results. Are the objectives achieved in a cost-efficient manner by the development intervention? How big is the efficiency or utilization ratio of the utilised resources?

d) Impact (30 pts)

The positive and negative, primary and secondary long-term effects produced by a development intervention, directly or indirectly, intended or unintended.

e) Sustainability (20 pts)

The continuation of benefits from a development intervention after major development assistance has been completed. The probability of continued long-term benefits. Are the positive effects sustainable? How is the sustainability or the continuity of the intervention and its effects to be assessed?

Table No. 3; Value, Criteria & sub criteria classification

VALUE/CRITERIA	RELEVANCE	EFFECTIVENESS	EFFICIENCY	SUSTAINABILITY	OVERALL
4	Highly relevant	Highly effective	Highly efficient	Highly sustainable	Highly successful
3	More than relevant	More than effective	More than efficient	More than sustainable	More than successful
2	Relevant	Effective	Efficient	Sustainable	Successful
1	Less than relevant	Less than effective	Less than efficient	Less than sustainable	Less than successful
0	Irrelevant	Ineffective	Inefficient	Unsustainable	Unsuccessful

Table No. 4; Criteria, classification, value, ratings & percentage

CRITERIA	CLASIFICATION	VALOR	RATINGS	PERCENTAGE
RELEVANCE	Highly relevante	4	3.21 a 4.00	81 a 100
	More tan relevante	3	2.41 a 3.20	61 a 80
	Relevante	2	1.61 a 2.40	41 a 60
	Less than relevante	1	0.81 a 1.60	21 a 40
	Irrelevante	0	0.0 a 0.80	0 a 20
EFFECTIVENESS	Highly effective	4	3.21 a 4.00	81 a 100
	More than effective	3	2.41 a 3.20	61 a 80
	Effective	2	1.61 a 2.40	41 a 60
	Less than effective	1	0.81 a 1.60	21 a 40
	Ineffective	0	0.0 a 0.80	0 a 20
EFFICIENCY	Highly eficiente	4	3.21 a 4.00	81 a 100
	More tan efficient	3	2.41 a 3.20	61 a 80
	Efficient	2	1.61 a 2.40	41 a 60
	Less than eficiente	1	0.81 a 1.60	21 a 40
	Ineficiente	0	0.0 a 0.80	0 a 20
IMPACT	Highly satisfactory	4	3.21 a 4.00	81 a 100
	More than satisfactory	3	2.41 a 3.20	61 a 80
	Satisfactory	2	1.61 a 2.40	41 a 60
	Less tan satisfactory	1	0.81 a 1.60	21 a 40
	Unsatisfactory	0	0.0 a 0.80	0 a 20
SUSTAINABILITY	Highly sustainable	4	3.21 a 4.00	81 a 100
	More than sustainable	3	2.41 a 3.20	61 a 80
	Sustainable	2	1.61 a 2.40	41 a 60
	Less than sustainable	1	0.81 a 1.60	21 a 40
	Unsustainable	0	0.0 a 0.80	0 a 20
AVERAGE	Highly sucessful	4	3.21 a 4.00	81 a 100
	More than sucessful	3	2.41 a 3.20	61 a 80
	Sucessful	2	1.61 a 2.40	41 a 60
	Less than sucessful	1	0.81 a 1.60	21 a 40
	Unsucessful	0	0.0 a 0.80	0 a 20

4. RESULTS AND DISCUSSION

4.1 Performance evaluation

Table No. 5; Criteria, weight, ratings & percentage

#	CRITERIA	WEIGHT	RATINGS	%
1	RELEVANCE	28.5		
2	EFFECTIVENESS	21.5		
3	EFFICIENCY	21.5		

4	SUSTAINABILITY	28.5		
OVERALL AVERAGE		100		

4.1.1 Policy formulators' performance evaluation

This evaluation project involved the participation of five stakeholder groups planners, implementers, business owners, and private and public transport travelers associated with the Humming Highway, which runs between Belmopan (the capital of Belize) and Dangriga (the district capital of Stann Creek). Four evaluation criteria were considered for this study: relevance, effectiveness, efficiency, and sustainability. The "impact" criterion was excluded because it is measured five years after implementation, and the highway was completed only three years ago. Consequently, the weighting percentages for the four evaluation criteria were distributed as shown in Table 5.

Table No.6; Summary performance by criteria of the policy formulators

#	CRITERIA	WEIGHT	RATINGS	%
1	RELEVANCE	28.50	2.91	73
2	EFFECTIVENESS	21.50	2.50	63
3	EFFICIENCY	21.50	2.60	65
4	SUSTAINABILITY	28.50	2.93	73
AVERAGE			2.74	68

Regarding Table 6, it is important to note that even though not all results were fully achieved or some minor negative outcomes occurred no significant shortfalls arose; overall, the expected results and impact will be achieved and sustained throughout the project's lifespan. Therefore, the project remains relevant, and both its planning and operations were efficient. Any negative impacts were minimal compared to the project's gains. The overall ratings were: Relevance 2.91, Effectiveness 2.50, Efficiency 2.60, and Sustainability 2.93, resulting in an overall average of 2.74 (or 68%). This indicates that the road rehabilitation project was highly successful.

4.1.2 Implementors' performance evaluation

Table No.7; Summary performance by criteria of the Implementers

#	CRITERIA	WEIGHT	RATINGS	%
1	RELEVANCE	28.5	3.17	79
2	EFFECTIVENESS	21.5	2.75	69
3	EFFICENCY	21.5	3.00	75
4	SUSTAINABILITY	28.5	3.00	75
AVERAGE			2.98	74

The weighted average for the four basic criteria Relevance (3.17), Effectiveness (2.75), Efficiency (3.00), and Sustainability (3.00) yields an overall average of 2.98, or 74%. This calculation can be interpreted to mean that the implementation process for the Humming Brid highway rehabilitation was carried out more than successfully by the implementing parties. Furthermore, the results indicate that the project remains relevant and that both its implementation and operations were efficient.

4.1.3 Businesses' performance evaluation

Table No.8; Summary performance by criteria of the Businesses

#	CRITERIA	WEIGHT	RATINGS	%
1	RELEVANCE	28.5	3.00	75
2	EFFECTIVENESS	21.5	3.60	90
3	EFFICEINCY	21.5	3.00	75
4	SUSTIANABILITY	28.5	2.88	72
AVERAGE			3.12	78

The weighted average for the four basic criteria Relevance (3.00), Effectiveness (3.60), Efficiency (3.00), and Sustainability (2.88) yields an overall average of 3.12, or 78%. This calculation suggests that the implementation process for the Hummingbird highway rehabilitation was carried out more than successfully by those who designed and implemented it. Furthermore, the results indicate that the project remains relevant and that both its implementation and operations were efficient.

4.1.4 Traveler in private transport performance evaluation

Table No.9; Summary performance by criteria of the Traveler in private transport

#	CRITERIA	WEIGHT	RATINGS	%
1	RELEVANCE	28.5	2.80	70
2	EFFECTIVENESS	21.5	2.88	72
3	EFFICENCY	21.5	2.67	67
4	SUSTAINABILITY	28.5	3.20	80
AVERAGE			2.89	72

The weighted average for the four basic criteria Relevance (2.80), Effectiveness (2.88), Efficiency (2.67), and Sustainability (3.20) yields an overall average of 2.89, or 72%. This calculation suggests that the rehabilitation of the Humming Bird Highway was implemented more than successfully by those who designed and carried out the project. Furthermore, the results indicate that the project remains relevant and that both its implementation and operations were efficient.

4.1.5 Traveler in public transport performance evaluation

Table No.10; Summary performance by criteria of the Traveler in public transport

#	CRITERIA	WEIGHT	RATINGS	%
1	RELEVANCE	28.5	3.00	75
2	EFFECTIVENESS	21.5	3.60	90
3	EFFICEINCY	21.5	3.00	75
4	SUSTIANABILITY	28.5	2.88	72
AVERAGE			3.12	78

The weighted average for the four basic criteria Relevance (3.00), Effectiveness (3.00), Efficiency

(3.25), and Sustainability (3.00) yields an overall average of 3.06, or 77%. This calculation suggests that the implementation process for the Humming Bird High way rehabilitation was carried out more than successfully by the project designers and implementers. Furthermore, the results indicate that the project remains relevant and that both its implementation and operations were efficient.

4.1.6 Overall stakeholders' participation performance evaluation

Table No.11; Overall summary performance by criteria of the stakeholders' participation

STAKEHOLDERS	RATINGS	%	CLASIFICACION
Formulators	2.74	68	More than successful
implementers	2.98	74	More than successful
Businesses	3.12	78	More than successful
Travellers in private transport	2.89	72	More than successful
Travelers in public transport	3.06	77	More than successful
General project average	2.96	74	More than successful

The overall performance average for the Humming Bird Highway rehabilitation project is shown in Table 140, which presents the weighted average ratings for each stakeholder group. The weighted averages obtained by the five stakeholder groups are as follows: Planners = 2.78, Implementers = 2.98, Business Owners = 3.12, Private Transport Travelers = 2.89, and Public Transport Travelers = 3.06; resulting in an overall project average of 2.96, or 74%. This calculation suggests that the process of formulating and implementing the Humming Bird Highway rehabilitation was highly successful. Furthermore, the results indicate that the project remains relevant and that both its implementation and operations were efficient.

4.2. Statistical Analysis of the Stakeholders and Criteria

4.2.1 Statistical Model

For every experimental design, there is a mathematical model that accounts for all independent and extraneous variables affecting the dependent variable. Below is the mathematical model for this randomized block experiment involving independent groups:

$$X_{ij} = \mu + \beta_i + \tau_j + \varepsilon_{ij}$$

Where X_{ij} = the score of the dependent variable for the subject under Criterion *i* receiving Treatment *j*;

μ = the population mean;

β_i = the effect of Block *i*;

τ_j = the effect of Treatment *j*;

ε_{ij} = the experimental error (i.e., the effect of all other extraneous variables).

For this model, it is assumed that ε_{ij} is normally and independently distributed with a mean of zero and a variance of σ^2 . The mean (μ) is constant.

4.2.2 Statistical Hypothesis

With a randomized block experiment, it is possible to test for block effects (β_i) and treatment effects (τ_j). Below are the null hypotheses (H_0) and alternative hypotheses (H_a) for each effect.

4.2.2.1 Null Hypothesis

H_{01} : $\tau_j = 0$; the effects of all treatments are equal.

H_{02} : $\beta_i = 0$; the effects of all blocks are equal.

4.2.2.2 Alternative Hypothesis

H_{a1} : $\beta_i \neq 0$; the effects of all blocks are not equal.

H_{a2} : $\tau_j \neq 0$; the effects of all treatments are not equal.

Table No. 12; Data of the stakeholders, criteria and results value

STAKEHOLDERS	CRITERIA	RESULTS
1	1	2.91
1	2	2.50
1	3	2.60
1	4	2.93
1	5	2.74
2	1	3.17
2	2	2.75
2	3	3.00
2	4	3.00
2	5	2.98
3	1	3.00
3	2	3.60
3	3	3.00
3	4	2.88
3	5	3.12
4	1	2.80
4	2	2.88
4	3	2.67
4	4	3.20
4	5	2.89
5	1	3.00
5	2	3.00
5	3	3.25
5	4	3.00
5	5	3.06

Table No. 13; ANOVA of the stakeholders, criteria and results value

Tests of Between-Subjects Effects

Dependent Variable: RESULTS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	219.111 ^a	9	24.346	539.743	.000
STAKEHOLDERS	.459	4	.115	2.542	.080
CRITERIA	.027	4	.007	.147	.962
Error	.722	16	.045		
Total	219.833	25			

a. R Squared = .997 (Adjusted R Squared = .995)

4.2.3 Decision rule:

If the F-value is greater than the significance level, reject the null hypothesis. For the stakeholder groups, the calculated F-value is 2.542, which exceeds the critical F-value (0.080); therefore, Alternative Hypothesis 1 is accepted. Consequently, there are significant albeit minimal differences in the effects produced by the stakeholder groups.

The following table illustrates Duncan's test of means, showing the mean values for stakeholders No. 3 (Businesspeople) and No. 5 (Public Transport Users). These groups yielded similar results within subset 2, yet outperformed the stakeholders in subset 1 specifically No. 2 (Implementers), No. 4 (Private Transport Users), and No. 1 (Formulators).

Table No. 14; Duncan's mean test for those interested**RESULTS**Duncan^{a,b}

STAKEHOLDERS	N	Subset	
		1	2
1	5	2.7360	
4	5	2.8880	2.8880
2	5	2.9800	2.9800
5	5		3.0620
3	5		3.1200
Sig.		.072	.096

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .037.

a. Uses Harmonic Mean Sample Size = 5.000.

b. Alpha = .05.

Regarding the criteria, the calculated F-value is 0.147, which is less than the critical F-value (0.962); therefore, Null Hypothesis 2 is accepted. Consequently, there are no significant differences among the criteria [Relevance, Effectiveness, Efficiency, Sustainability, and Weighted Average], as shown by Duncan's test of means, where the means fall within the same subset.

Table No.15; Duncan's mean test for the criteria

RESULTSDuncan^{a,b}

CRITERIA	N	Subset
		1
3	5	2.9040
2	5	2.9460
5	5	2.9580
1	5	2.9760
4	5	3.0020
Sig.		.519

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square (Error) = .045.

a. Uses Harmonic Mean Sample Size = 5.000.

b. Alpha = .05.

4.3 Cost Benefit Analysis**Table No.16; Cost Benefit Analysis of the rehabilitation of the Humming bird highway**

ASPECT	COST(\$BZ)	BENEFIT
Financial perspective	1. \$60,070,000	1. The estimated total cost of inputs (Study, Feasibility, Material, Human Capital, Machinery) for the rehabilitation of the highway was \$60,070,000). It is expected that the return on investment will be recovered through the payment of taxes in the long term.
	3. \$6,553,637	2. The estimated total cost for the four rehabilitation evaluations (Ex Ante, Mid-Term, Terminal, and Expos) was \$6,553,637, which is equivalent to 10.91% of the total rehabilitation cost, which is approximately \$1,638,409.25 per evaluation.
Marketing perspective		1. Creation of new evaluation systems that incorporate the participation of neutral beneficiaries as clients. 2. Creation of evaluation systems and personnel that will serve as a model for the evaluation of new or rehabilitated roads. 3. It allows estimating the current cost of evaluations of road infrastructure projects in the Belizean economy. 4. Allows for the design of new competitive strategic evaluation methods within the Belizean economy.
Social perspective		1. Effective and efficient mobility for the entire population between Municipalities and Villages. 2. It allowed the employment of vulnerable groups in both rural and urban areas. 3. Social cohesion between families and communities in rural and urban areas, in addition to the formation of a solid and committed team. 4. It allows the opportunity for development capacity and experiential learning as well as the creation of alternative livelihoods for family sustainability.
Learning and growth		1. Introduction of new processes/procedures for sustainable development. 2. Exchange of information between government entities, financial agencies and communities. 3. Serves as a laboratory for learning and experiential growth. 4. Opportunity for expansion in collaborative efforts for projects. 5. Opportunity for the construction and expansion of research projects.

5. CONCLUSION

5.1 Analysis of the performance of the stakeholders

The evaluation criteria as relevance obtained an average of 2.98 or 74.5%, which indicates that the project was more than relevant. The effectiveness obtained an average of 2.95 or 74%, which indicates that the project was more than effective in achieving the planned objectives. On the other hand, for efficiency, the calculated value was 2.90 or 72%, which indicates that the project was executed more than efficiently in terms of the use of resources. For sustainability, the calculated value was 3.00 or 75%, which indicates that the project was more than sustainable in terms of execution. Finally, regarding the general average of the project, the calculated value was 2.96 or 74%, which indicates that the Humming Bird highway rehabilitation project was formulated and executed more than successfully.

5.2 Statistical analysis of the stakeholders and the Criteria

Minimal statistical differences were found that caused an effect on the performance of the stakeholders since the calculated F is 2.542, which is greater than the Critical F (0.080). Therefore, Alternative hypothesis 1 is accepted. Since minimal statistical differences were found between the stakeholder groups, a Duncan means test was carried out, in which stakeholders No.3 Entrepreneurs and No.5 Travelers in public transport generated similar means but higher than those interested No.2 Implementers, No.4 Travelers in private transport and No.1 Formulators. On the other hand, no significant statistical differences were found in the effect caused by the criteria, since the calculated F is 0.147, which is less than the Critical F (0.964).

5.3 Cost Benefit Analysis (CBA) of the Rehabilitation

The analysis revealed that the five stakeholder groups; Formulators, implementers, entrepreneurs and, travelers in private and public transport, will benefit from the intangibles significantly through the efficient and effective mobility of people and goods between municipalities and villages. In addition, during and after the rehabilitation, there will be social cohesion, capacity building, market expansion/introduction and exchange of experiences, as well as the participation of the surrounding communities, which exceeds the investment costs (\$60,070,000) in the long term.

5.4 Lesson learnt

1. It is very important to have defined and direct strategic objectives that measure the effectiveness and efficiency of the results of any infrastructure project to give feedback to the corresponding department to make the necessary amendments to improve the process.
2. An evaluation model is required that incorporates the five stakeholder groups, the criteria and the design of the measurement instruments through an evaluation matrix.
3. The absence of policies and budget for the monitoring and evaluation of public infrastructure projects limits the obligation to bid the process publicly to increase the participation of capable people who could carry out the required evaluation.
4. Scoring each criterion allows the audit team, implementers, and stakeholders to see where strengths and weaknesses are in order to provide the necessary positive reinforcement for future improvement.
5. A performance evaluation of every high way must be conducted in order to guarantee that the

country is getting value for money and beneficiary are satisfied with the outcome of the infrastructure project.

6. RECOMMENDATIONS

6.1 Evaluation of the performance of the stakeholders

Performance evaluation analysis can be used to give individual feedback especially to formulators and implementers to improve relevance, effectiveness, efficiency, and sustainability in the planning process for recurrent or future projects. In addition, project evaluation is a step-by-step process of collecting, recording, and organizing information about project results, including short-term outputs and immediate and long-term results of the project (Raitzer, D.A.; Blöndal, N.; Sibál, J.; 2019, Pg. 58).

6.2 Statistical analysis of the stakeholders and the Criteria

Use the statistical analysis of the performance results of the criteria according to actors. According to Duncan's Mean Test, feedback from stakeholders No.3 Entrepreneurs and No.5 Travelers in public transport are the most important stakeholder group as they are independent and aren't a part of the planning group, nor is the implementation of the road infrastructure project.

6.3 Cost Benefit Analysis (CBA) of the refurbishment of the Humming bird Highway

even the results of the study carried out with the hummingbird highway, the Cost Benefit Analysis (CBA) is important to carry out both ex-ante and expos, both at the time of planning the evaluation and at the time of expos evaluation.

Table No.17; Recommendations Matrix, for the Line ministries (MED & MIDH)

Table No.17, Recommendations Matrix, for the Line ministries (MED & MIDH)

CRITERIA	RECOMMENDATION	STRATEGY	RESPONSIBILITY
RELEVANCE	1. Implement Evaluation Framework (Evaluation Instruments)	1. Adjust the instrument to the evaluation type that it needs (Ex-ante, Medium Term, Final Evaluation)	MIDH
	2. Budget for periodic performance evaluations of the highways	2. Conduct Ex ante, Medium Term, Final Evaluation	MED
EFFECTIVENESS	1. Define the specific time frame of the strategic objectives	1. Establish specific year to achieve outcomes	MED,
	2. Evaluate stakeholders contribution & participation	2. Use survey assessment to compile information	MED
EFFICIENCY	1. Evaluate and optimize (Maximize or Minimize) the resources (Human capital, Finance, Material, Time and Technology) use by the organization in all activity	1. Analysis of Cost Benefit Analysis(CBA) from four perspective (Financial, Marketing, Social, Internal & Learning & Growth).	MIDH, MED
SUSTAINABILITY	1. Design a financial strategy that will prepare, allow and adapt to internal and external economic shocks so that country can fulfil its mandate within the next twenty years to recover from the investment.	1. With in a comprehensive Strategic Plan, the Financial Plan should address the internal & external strategy to address these economic shocks.	MED
OVERALL	1. Considering that the projects remains relevant and its implementation as well as its operations were efficient. It is important to improve the weak areas for higher results in future evaluation.	1. Provide written feedback to the formulators & implementers of the areas that needs to be improve base on the evaluation.	MED, MIDH

MED = Ministry of Economic Development, MIDH = Ministry of Infrastructure Development & Housing

7. REFERENCES

1. Aldagheiri M. (2009); The role of the transport road network in the economic development of Saudi Arabia Department of Geography, Qassim University,
2. Aleksandra Krol-Badziak, Seyed Hassan Pishgar-Komleh, Stelios Rozakis, Jerzy Ksie, zak (2021), Environmental and socio-economic performance of different tillage systems in maize grain production: Application of Life Cycle Assessment and Multi-Criteria Decision Making. Journal of Cleaner Production. Vol. 278. Pg. 1 -13
3. Ahmad, T.; Thaheem, M.J. Developing a residential building-related social sustainability assessment framework and its implications for BIM. Sustain. Cities Soc. 2017, 28, 1–15.
4. Asian Development Bank, (2009); A performance Evaluation Report, Lao People's Democratic Republic: Rural Access Roads Project, Reference Number: PPE: LAO 2009-45, Project Number 30255; Loan Number: 1795-LAO(SF). Pg. 20-30
5. Bakhtawar, B.; Thaheem, M.J.; Arshad, H.; Qadeer, A. How to Embrace the Stakeholder in Public Private Partnership Decision-Making? A Theoretical Discourse. In Proceedings of the 34th Annual Conference, Belfast, Northern Ireland, 3–5 September 2018; Association of Researchers in Construction Management: Manchester, UK, 2018; pp. 373–382.
6. Berrada, A.; Loudiyib, K.; Zorkania, I.; (2016), Profitability, risk, and financial modeling of energy storage in residential and large-scale applications. Pg. 5-100
7. Blanco-Orozco, N; Arce-Díaz, E; Zúñiga-González, C. (2015), Comprehensive evaluation financial, economic, social, environmental and productivity of the use of sugarcane bagasse and fossil fuels for the generation of electrical energy in Nicaragua. Technology in March. Vol. 28, No. 4, December. Pages 94-107
8. Development Bank Environmental Safeguards Unit (VPS/ESG) TECHNICAL NOTE No. IDB-TN-739 December 2014, Pg. 11-33
9. Eckersten, S.; Balfors, B.; Gunnarsson-Östling U; (2021), Challenges and Opportunities in Early-Stage Planning of Transport Infrastructure Projects: Environmental Aspects in the Strategic Choice of Measures Approach. Sustainability 2021, 13, 1295.
10. Estache, A; (2010); A Survey of Impact Evaluations of Infrastructure Projects, Programs and Policies
11. Gichaga, F.J.; (2017), The impact of road improvements on road safety and related characteristics, Pg. 72-75.
12. Giunta, M. (2020); Assessment of the environmental impact of road construction: Modeling and prediction of fine particulate matter emissions. Build. Environ. 2020, 176, 106865.
13. Mariana Gonçalves de Carvalho Wolff 1 and Marco Antonio Farah Caldas (2018), "A Model for the Evaluation of Brazilian Road Transport: A Sustainable Perspective", Volume 2018; Article ID 5274789, Pages 1-13
14. JICA, (2010), Chapter 2 Issues in Ex-ante and Ex-Post Evaluations, Pg. 115-200
15. Jones, H., Moura, F., & Domingos, T. (2014). Transport infrastructure project evaluation using cost-benefit analysis. Procedia–Social and Behavioral Sciences, 111, 400–409. doi: 10.1016/j.sbspro.2014.01.073
16. Kati Kõrbe Kaare, Ott Koppel (2014), Performance indicators to support evaluations of roads investment, Department of Logistics and Transport, Tallinn University of Technology
17. Redwood, John (2012); Managing the Environmental and Social Impacts of Major Road Investments in Frontier Regions: Lessons from the Inter-American Development Bank's Experience, Inter-American Development Bank; Pg. 8 – 18
18. OCED, (2016); Reference guide on ex-post evaluation of competition agencies' enforcement decisions, Pg.1 – 100
19. Raitzer, D.A.; Blöndal, N.; Sibal, J.; (2019), Impact Evaluation of Transport Interventions, A

-
- review of the evidence; ASIAN DEVELOPMENT BANK (ADB), Pg. 10-65
20. Rodriguez Jean-P. (2020), The Geography of Transport Systems, Fifth edition, New York: Routledge, Pg. 45-60
 21. Santos, J.; Bryce, J.; Flintsch, G.; Ferreira, A. A comprehensive life cycle costs analysis of in-place recycling and conventional pavement construction and maintenance practices. Int. J. Pavement. Eng. 2017, 18, 727–743.
 22. Statistical Institute of Belize (SIB), (2021) Gross Domestic Product, July 2021, Published August 25th, 2021, Pg. 1-2
 23. Yang, L.; Van Dam, H.; Zhang, L.; (2020): Developing Goals and Indicators for the Design of Sustainable and Integrated Transport Infrastructure and Urban Spaces, Pg. 1-34
 24. Watkins, G.;(2014), Approaches to the Assessment and Implementation of Sustainable Infrastructure Projects in Latin America and the Caribbean Graham Watkins Inter-American
 25. Ziari, H.; Behbahani, H.; Amini, A, L.; (2015) A Framework for Economic Evaluation of Highway Development Projects Based on Network-Level Life Cycle Cost Analysis School of Civil Engineering, Iran University of Science and Technology, Pg. 1-15.