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IMPROVEMENT OF DISTRICT ROAD MAINTANANCE MANAGEMENT SYSTEM BY INCORPORATING VALUATION FOR ENHANCING AVAILABILITY PERFOMANCE OF ROAD INFRASTRUCTURE.

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ABSTRACT

This paper presents the result on Factors affecting, District Road, Maintenance Management System, Availability Performance, and Road Infrastructure. Road as one of the infrastructures used to transport goods from one place to another can be evaluated on its depreciation like other assets. Roads that follow under Tanzania Rural and Urban Roads Agency (TARURA) are categorized into three: Collector, Feeder and Community roads. TARURA uses Roads Maintenance Management System (DROMAS) as management system for maintenance of its road network. The existing system used by the agency remark the software used to collect, store, analyze and deliver some information regarding to Road maintenance management system. However, it lacks some few necessary issues including Valuation and deprecation of Road in which in one way or another if included with help to improve the system.

S/N	Specific objectives	Input	Data collection tools/methods	Data analysis tools/methods	Output
1	To identify factors/shortcomings that affect the current District Road maintenance management system for the availability performance of Road infrastructure.	Identification of shortcomings based on the current Road Maintenance Management System for enhancing availability performance of the Road infrastructure	Interviews, viewing the system, questionnaires, literature review and viewing the system	Computer software package (SPSS V.20)	Factors/shortcomings that affect current road management System by incorporating valuation for enhancing availability performance of road infrastructure
2	To develop a mathematical model for a road maintenance management system for the availability performance of road infrastructure	Identified factors affecting the current road maintenance management system	Literature review, online questionnaires	Statistical Package for Social Science version 20	The mathematical model for Road maintenance management system for availability performance of road infrastructure
3	To improve district road maintenance management system by incorporating valuation for enhancing availability performance of road.	Data collected from road sites	Road maintenance management system criteria	Statistical Package for SocialScience version 20	Management system tool by incorporating valuation for enhancing availability performance of road infrastructure

The results obtained will be used to improve the existing system (DROMAS) by incorporating valuation to valuated the Road value at specific time (T)

Key words: Improvement Of District Road maintenance Management System by Incorporating Valuation for Enhancing Availability Performance of Road Infrastructure

INTRODUCTION

Study area is TARURA Kinondoni district, which is responsible for maintaining Road network with total Km 1665.28, but due to Budget limitation, they are able to maintain only around 200km out of 1665.28km, which is equal to 12%.

In the last few years, the Road Maintenance Management System has grown from a small laboratory system to an organizational system which can be relied upon **(Wienker et al., 2016).** Transportation infrastructure assets are expensive to build and more costly to maintain to meet the public expectation and hence require to focus on preventive maintenance lather reactive maintenance to ensure these assets are in operation all the time and safely. Road asset management serves as a key tool to maintain existing assets in a way that better and efficiently operates all the road assets within the network.

Between 2010 and 2012, PO-RALG conducted a research project on alternative and improved district road maintenance systems in East Africa. The study indicated that more than 60 per cent of road maintenance systems need improvement.

The research carried out under the GEM project for community access partnership (ReCAP), including TARURA Agency, showed a few examples of sustainable rural road asset management programs currently operational in sub-Saharan Africa. Systems focus on preparing and implementing annual work programs for maintenance rather than adhering to long-term strategic plans. It will be also recognized that Governments tend to pay more attention to the construction of new roads rather than the maintenance of existing infrastructure. Many countries still need to develop a culture of prioritizing maintenance. However, this is based only on reactive maintenance and does not mention anything about Preventive maintenance(Sultana et al., 2013).

Contrary to popular belief, Transportation asset management (TAM) from the USA has existed in some form since the very beginning of Federal-Aid legislation. While the concept has evolved significantly through the years, the underlying philosophy remains the same: to improve infrastructure condition (Maintenance) and preserve it under the transportation system through cost-effective and strategic operation and maintenance with data-driven investment decisions. In recent times, clear and specific policies mandating aspects of asset management have proved to be catalysts of the development of these systems, encouraging their implementation. Nevertheless, this process has not been without dealing with Preventive maintenance of Road Assets **(Wienker et al., 2016)**.

In Tanzania, the road network is one of the most considerable community assets and is predominantly government-owned. The agencies responsible for maintaining, operating, improving, replacing and preserving this asset in Tanzania are Tanzania Roads Agency (TANROADS) and Tanzania Rural and Urban Roads Agency (TARURA). TANROADS are responsible for Trunk and Regional roads, whereas TARURA is responsible for all District and Community Roads

However, a significant research gap remains unaddressed in the literature, which pertains to the absence of a structured road valuation system. This research gap is particularly

crucial as it directly influences the allocation of maintenance funds and the prioritization of road infrastructure projects. The absence of a road valuation system has resulted in situations where severely deteriorated roads are overlooked, while less critical ones receive maintenance funding rather than being considered for reconstruction or rehabilitation. Consequently, this study aims to bridge this critical gap by developing and implementing a comprehensive road valuation framework within the District Road Maintenance Management System. The ultimate objective is to optimize resource allocation and enhance the accessibility and performance of road infrastructure.

The main objective of this study is Improvement of district road maintenance management system by incorporating valuation for enhancing availability performance of road infrastructure.

In order to achieve the general objective following are the specific objectives of this research

i. To identify factors that affect current District Road maintenance management system for availability performance of Road infrastructure.
ii. To develop a mathematical model for district road maintenance management system for availability performance of road infrastructure
iii. To improve district road maintenance management system by incorporating valuation for enhancing availability performance of road infrastructure

A research methodology used was a systematic, theoretical analysis of the method applied to describe the measures used to conduct research that helped to have good results. This explains study areas, research design, study population, and sampling distribution. It also elaborates methods, tools and techniques to be used in data collection and analysis (Queiroz and Kerali, 2010)

The results of this research presents improvement of maintenance management system by incorporating valuation for enhancing availability performance of road infrastructure. The system was based on the findings obtained and the developed maintenance management model. The developed system will help the authority to improve availability performance of the road maintenance.

2. METHOD AND MATERIALS

2.1. DETERMINATION OF SAMPLE SIZE

The study area for this research is TARURA Kinondoni, located in the Kinondoni district, chosen for its regular road maintenance activities and its role as an agency overseeing road network management in the country. The primary objective of the study is to enhance the performance of road infrastructure availability within the district by incorporating valuation into the road maintenance management system. The research design employs both qualitative and quantitative methods, with qualitative research focusing on perceptions and issues related to the current road management system in TARURA, while quantitative methods analyze response frequencies and percentages to assess road maintenance performance trends.

Sampling methods include random and stratified techniques, with a sample size of 68 technical staff from TARURA. Data collection methods encompass interviews, questionnaires, literature reviews, and system observations. Primary sources involve

interviews and questionnaires, while secondary sources include literature reviews

from various documents and sources. Research instruments include surveys, interviews, and questionnaires, with data analysis conducted using Microsoft Access, SPSS, and Statistical Process Control (SPC) tools for qualitative and quantitative data analysis, respectively.

2.2. DATA COLLECTION METOD

Data were collected through Interviews, viewing thesystem, questionnaires, literature review and viewing the system, Literature review, online questionnaires.

2.3. DATA ANALYSIS AND TESTING METHODS

i. Analysis was done by using Computer software package (SPSS V.20)
ii. Statistical Package for Social Science version 20 and
iii. Statistical Package for Social Science version 20

3. RESULTS

3.1 Respondent Characteristics

The analysis revealed that the majority of the respondents were between 27 to 32 years old (36.8%), followed by 33 to 39 years old (29.4%). The majority of respondents were (61.2%) and held a bachelor's degree (61.8%). The majority of the respondents held the position of an Engineer (55.9%) or Technician (35.3%). In terms of experience, the majority of respondents had more than 5 years of experience (78.0%).

These findings provide valuable insights into the demographic and professional characteristics of the TARURA workforce in the Dar es Salaam region. The results can be used to inform human resource planning and development strategies, including recruitment, training, and retention efforts.

Table 3.1: Respondent Characteristics (n=68)

VARIABLE	RESPONSE	FREQUENCY	PERCENT (%)
Age of response	20 to 26 years	12	17.6
	27 to 32 years	25	36.8
	33 to 39 years	20	29.4
	40 to 46years	5	7.4
	47 to 53 years	3	4.4
	54 years and above	3	4.4
		68	**100.0**

Gender of respondents	Male	41	61.2
	Female	27	38.8
		68	**100.0**
Level of education	Diploma	24	35.3
	Bachelor degree	42	61.8
	Master's degree	2	2.9
		68	**100.0**
Job position	Engineer	38	55.9
	Technician	24	35.3
	Economist	6	8.8
		68	**100.0**
Year of experience	1 to 2 years	3	4.4
	3 to 4 years	12	17.6
	More than 5 years	53	78.0
TOTAL		**68**	**100.0**

3.2 Analysis of Relative Importance Index for the Indicators of Road Valuation

The Relative Importance Index (RII) is a metric used in road valuation for road maintenance to determine the significance of various indicators. The RII assigns numerical values that represent the weightage or importance given to each criterion. These values provide valuable insights into the relative importance of different factors in road valuation for maintenance purposes.

One of the most critical factors in road valuation is the Pavement Condition, which holds the highest RII value of 0.819 as per *Vanduhe (2012) formula calculation*. This indicates that the condition of the road pavement is extremely important in the road maintenance process. Well-maintained pavements are crucial for providing a smooth and safe driving experience, reducing the risk of accidents and vehicle damage.

The Ride Quality Type follows closely with an RII of 0.842. This indicator emphasizes the importance of evaluating the quality of the road surface and its impact on the comfort and satisfaction of road users. A high RII value for this indicator highlights the consideration given to ensuring a smooth and enjoyable driving experience.

Traffic Volume and Congestion hold an RII of 0.772. This indicator takes into account the level of traffic flow and congestion on the road. It acknowledges that roads with higher traffic volumes or congestion may require additional maintenance efforts and investments to mitigate congestion-related issues and ensure smooth traffic flow.

The Cost-Effectiveness indicator has an RII of 0.558, signifying the significance of evaluating the economic feasibility and efficiency of maintenance strategies. It emphasizes the need to assess the costs involved in maintaining roads and selecting

cost-effective approaches that maximize the value of investments.

The indicator of Functional Classification holds an RII of 0.500. Functional Classification considers the intended purpose and importance of a road within the overall transportation network. It highlights the significance of maintaining roads that serve critical functions such as major highways, arterial routes, or access roads to important facilities.

Drainage and Water Management, with an RII of 0.838, reflects the importance of addressing water-related issues on roads. Proper drainage systems are crucial to prevent water accumulation, which can lead to pavement deterioration and safety hazards.

Structural Capacity, with an RII of 0.680, emphasizes the importance of evaluating the structural integrity and load-bearing capacity of roads. This indicator highlights the need to ensure that roads can accommodate the expected traffic volumes and vehicle loads without experiencing structural failures.

The Maintenance Block Log indicator has an RII of 0.761, representing its significance in road valuation for maintenance purposes. This criterion likely refers to the history or record of maintenance activities performed on the road, including any blockages or disruptions that required attention.

Length and Width of Road have a relatively lower RII value of 0.688. While still considered important, this indicator suggests that the length and width of the road are not as critical in the road valuation process compared to other factors. It implies that factors such as pavement condition and ride quality type have a more significant impact on road maintenance considerations.

Lastly, the Environmental Impact indicator holds the lowest RII value of 0.643. Although still relevant, this criterion suggests that environmental considerations may have a relatively lower weightage in the road valuation process for maintenance purposes compared to other factors. However, it is important to note that environmental impact assessments are increasingly being recognized as crucial in road maintenance projects to ensure sustainable practices.

In general, the RII values assigned to each indicator provide valuable insights into their relative importance in road valuation for road maintenance. These values guide decision-makers in prioritizing and allocating resources effectively to address critical factors such as pavement condition, ride quality, traffic volume, cost-effectiveness, functional classification, drainage, structural capacity, maintenance block log, length and width of roads, and environmental impact.

4 .DISCUSION OF RESULT

4.1 Identified Indicators for Enhance Valuation of Road Infrastructure by District Road Maintenance system (DROMAS)

The analysis of the survey results conducted to identify indicators for enhancing road infrastructure valuation by DROMAS has yielded valuable insights into the opinions of participants regarding various indicators. One key indicator discussed is Volume and Congestion. A significant majority of 52 respondents (76.5%) expressed their agreement with the use of Volume and Congestion as indicators for road valuation in terms of maintenance. These respondents firmly believe that Volume and Congestion offer valuable insights and should be taken into consideration when assessing road maintenance needs. This finding aligns with the study conducted by Chandak et al. in 2018, which emphasized the importance of considering volume and congestion in road infrastructure valuation.

However, it's worth noting that there were also 2 respondents (2.9%) who strongly disagreed, and another 2 respondents (2.9%) who simply disagreed with using Volume and Congestion as indicators. Their perspective may be rooted in the belief that other indicators are more relevant or that different aspects of road valuation should take precedence.

Turning to the indicator of Pavement Condition, a substantial number of respondents, 39 (57.4%), strongly agreed with using Pavement Condition as an indicator for road valuation in terms of maintenance. They are of the opinion that the condition of the pavement plays a critical role in determining the value of a road concerning its maintenance needs. Additionally, 17 respondents (25.0%) expressed agreement with this proposition, albeit not as strongly as the previous group.

On the other hand, there were four respondents (5.9%) who disagreed, and eight respondents (11.8%) who strongly disagreed with using Pavement Condition as an indicator for road valuation in maintenance. These individuals argue that pavement condition alone might not be sufficient or appropriate to evaluate the value of roads in terms of maintenance and suggest that additional factors should be considered for a more comprehensive assessment. This perspective finds support in the studies conducted by Montoya et al. in 2019 and Branco in 2017.

Regarding the indicator of Ride Quality, a majority of respondents, 41 (60.3%), strongly agreed with using Ride Quality as an indicator for road valuation in maintenance. They believe that the ride quality experienced by road users is a crucial factor in determining the value of a road concerning maintenance needs. An additional 17 respondents (25.0%) expressed agreement with this proposition, though not as emphatically.

Conversely, four respondents (5.9%) disagreed, and six respondents (8.8%) strongly disagreed with using Ride Quality as an indicator for road valuation in maintenance. These individuals believe that ride quality alone may not provide a comprehensive assessment of a road's maintenance needs and suggest that additional factors should be taken into account for more informed maintenance decisions. This perspective is in line with the findings of Branco's 2017 study.

Moving on to the indicator of Structural Capacity, a significant number of respondents, 36 (52.9%), expressed agreement with using Structural Capacity as an indicator for road valuation in maintenance. They recognize the importance of assessing the structural capacity of roads when determining their value concerning maintenance needs. Additionally, 11 respondents (16.2%) strongly agreed with this proposition, emphasizing the significance of evaluating a road's ability to withstand anticipated loads and stresses.

On the other hand, there were twelve respondents (17.6%) who disagreed, and nine respondents (13.2%) who strongly disagreed with using Structural Capacity as an indicator for road valuation in maintenance. These individuals argue that Structural Capacity alone may not provide a comprehensive assessment of a road's maintenance needs and advocate for considering additional factors, such as pavement condition or ride quality, for more informed maintenance decisions. Interestingly, this perspective contradicts the findings of Chandak et al.'s 2018 study, which indicated a lower number of significant respondents considering structural capacity as a vital indicator for road valuation.

Lastly, regarding the indicator of Drainage and Water Management, a significant number of respondents, 28 (41.2%), strongly agreed with using Drainage and Water Management as an indicator for road valuation in maintenance. They recognize the importance of proper drainage and effective water management in determining the value of a road concerning its maintenance needs. This finding aligns with the study conducted by Pacaiova and Glatz in 2015, which highlighted the strong consideration given to drainage and water management by engineers during road evaluation.

CONCLUSION AND RECOMMENDATIONS

Conclusion:

The analysis of the survey results on indicators for enhancing road infrastructure valuation by DROMAS has provided valuable insights into the diverse opinions of participants. These insights reveal a range of perspectives on key indicators such as Volume and Congestion, Pavement Condition, Ride Quality, Structural Capacity, and Drainage and Water Management.

Recommendations:

Based on these findings, it is recommended that road infrastructure valuation processes consider a multi-faceted approach that takes into account a combination of these indicators. While each indicator has its merits and enjoys varying levels of support, a comprehensive assessment should incorporate Volume and Congestion, Pavement Condition, Ride Quality, Structural Capacity, and Drainage and Water Management. This approach ensures a more thorough evaluation of road maintenance needs and aligns with the diverse perspectives of stakeholders.

Furthermore, it is advisable to conduct additional research to explore the reasons behind the varying degrees of support and disagreement for these indicators. This will help refine the road valuation process and ensure that it effectively addresses the maintenance requirements of different road segments and regions. Collaboration with experts and stakeholders in the field of road infrastructure is also essential to develop a robust and inclusive road valuation framework.

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