

**ASSESSMENT OF PERFORMANCE-BASED CONTRACT FOR  
MAINTANANCE MANAGEMENT OF DAR ES SALAAM BUS  
RAPID TRANSIT ROAD INFRASTRUCTURE**

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**MSc. in Construction Economics and Management Dissertation  
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RAPID TRANSIT ROAD INFRASTRUCTURE**

**BY**

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A Dissertation submitted to Department of Building Economics of the Ardhi University in Partial fulfillment of the Requirements for the Degree of Masters in Construction Economics and Management (MSc. CEM).

**Ardhi University**

**November, 2022**



**CERTIFICATION**

The undersigned certifies that has read and hereby recommends for acceptance by Ardhi University a dissertation entitled: **“Assessment of Performance-Based Contract for Maintenance Management of Dar es Salaam Bus Rapid Transit Road Infrastructure”** in a partial fulfilment of the requirements of the degree of Masters of Science in Construction Economics and Management of the Ardhi University.

.....

Qs. Dr. Geraldine J. Kikwasi  
*(Supervisor)*

Date:.....

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## **DEDICATION**

Firstly, I dedicate this research work to Alpha and Omega, the Almighty God whose grace guided me all along.

Moreover, to my parents Mr. Brian Lazaro Pallangyo and Mrs. Janeth Kopriano Urassa; my sister Victoria; my nephew Thomas Stephen and Grandmother Eliamulika Kopriano Pallangyo for their tireless prayers and encouragement throughout my years of studies. Thank you, my family, for always being supportive.

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To sum up, I thank all the great men and women of the stations and terminals under study for sparing their valuable time to response to the interviews.



## **ABSTRACT**

Road authorities in developing countries are striving to adopt the maintenance approach that could enhance improved maintenance condition and design life of the road's infrastructure that get affected by level of maintenance employed. The overall objective was to assess the application of the output and performance-based road contract on maintenance management of Dar es Salaam bus rapid transit road infrastructure. The specific objectives were: To examine the implementation of output and performance-based of road contract; secondly, to assess the challenges encountered by stakeholders in the implementation of maintenance contract; and examine user's perceptions on the maintenance condition of Dar es Salaam bus rapid transit road. Furthermore, the study sought to propose means in which the performance-based road contract could enhance smooth implementation of maintenance management of Dar es Salaam bus rapid transit road infrastructure.

This is qualitative study, that employed an exploratory cross-section case study design. The purposive sampling techniques were applied, while data were collected through document review, interviews and observation tools. Direct observation, structured and semi-structured interviews were employed to obtain primary data.

The findings show that cleanliness of road surface, functionality of road signs, marking and furniture contributed to non-compliance of contract. The study concluded that maintenance condition of parts of road sections was influenced by ineffective surveillance by authority and shortage of road's assets maintenance engineers. The knowledge generated from this study can be useful for maintenance management of other bus rapid transit facilities planned in Tanzania.

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**LIST OF ABBREVIATIONS AND ACRONYMS**

ADB	Asian Development Bank
BECCO	Bharya Engineering and Contracting Co. Ltd
BRT	Bus Rapid Transit
CBD	Central Business District
CREMA	Contracts for Rehabilitation and Maintenance
DART	Dar es Salaam Rapid Transit Agency
DSM	Dar es Salaam
IPC	Interim Payment Certificate
Km	Kilometers
KPIs	Key Performance Indicators
LRT	Light Rail Transport
MM	Maintenance Management
MO	Maintenance and Operations
NBS	National Bureau of Statistics
NOP	Notice of Performance
OPBRC	Output-and Performance-Based Road Contract
PBC	Performance-Based Contracts
PMMR	Performance-Based Management and Maintenance of Roads
SUMA JKT	Shirika la Uzalishaji Mali la Jeshi la Kujenga Taifa
TANROADS	Tanzania National Roads Agency
TBA	Tanzania Building Agency
TEMESA	Tanzania Electrical, Mechanical and Service Agency
TIMM	Transportation Infrastructure Maintenance Management
UDART	Usafiri Salama Dar es Salaam Rapid Transit
WB	World Bank





## **CHAPTER ONE INTRODUCTION**

### **1.1 Background of study**

Dar es Salaam city, the third fastest urbanized African city, with population geometrically increases approximately 2.4 million in year 2002 to 4.3 million in year 2012 and forecasted 7 million in year 2022 (NBS Tanzania, 2013). Urbanization has multiple consequence to urban atmosphere such as lack of affordable housing, rapid motorization as well as urban sprawl which accelerate demand for sustainable infrastructural development mainly road networks due to congestion, accidents, environmental degradation, parking pollution, stress, and noise pollution are the products of urbanization (Gwaleba, 2018). With rapid urbanization impact of modern cities, various transformation approaches adopted such as improving water and sewerage systems, power systems, access to modern transport systems like Light Rail Transport and Bus Rapid Transit (Wall, 2009).

The government of Tanzania planned to upgrade Dar es Salaam infrastructural system by improving city mobility through developing infrastructure such as roads by building BRT infrastructure in six phases since 2010's. The BRT phase one started as pilot project that covers 21.4 kilometers along Morogoro road, Kawawa road and Msimbazi street, which aims to improve city mobility, reduce congestion, traffic delays and frequent traffic accidents (Nkurunziza et al., 2012).

Dar es Salaam bus rapid transit (DSM BRT) system is preferred to alternative modes of transportation like Light Rail Transit (LRT) due to its cheaper initial construction, operation and maintenance cost. Then, dedicated bus lane that constructed on the median strip of the highway and finally it is safety, comfortable and off-board fare collection point that distinguish it from other informal public transport like daladala (Nasrin, 2015). Due to affordable cost, timesaving, safety and dependability characteristics, Dar es Salaam bus rapid transit (DSM BRT) has hastened commuters' access to their job and business locations in the central business district (Hidalgo and Gutierrez, 2013).

Given that infrastructure worth billions depleted through deterioration, others abandoned due to improper maintenance and finally restoration costs are higher due to untimely and ineffective maintenance, particularly in rapidly urbanized African cities like Dar es

Salaam, maintenance of existing infrastructure received greater attention than freshly developed systems.

The unsatisfactory maintenance condition of roads in developing countries is linked with method employed by road authorities to manage funds for maintenance of roads (Sultana et al., 2013). Poor maintenance conditions of public roadways influenced by maintenance approach employed and capacity of contracted practitioners as well. Despite the country's pride on newly constructed road, the country's development no longer measured by number of built public infrastructure a country has, their maintenance condition is what determines the country's growth and development (Rioja, 2012). Due to deterioration of infrastructure worth billions of dollars, the governments are responsible for depletion condition of most road projects, few years after successful annexation by users failed and abandoned due to improper maintenance. Restoration cost are expected up to five times greater than how would have been for timely and effective maintenance, incase no immediate measures taken to preserve (Clell and Asif, 1988).

Roads and highways maintenance performed under traditional contracting proved shortcomings like overheads, higher inspection costs, delays in project completion, cost escalation, high level of political interference and corruptions which influenced by payment method employed (Sultana et al., 2012). The reasons road authorities are striving to adopt contemporary maintenance methods (like OPBRC) is that; the contract is fixed sum whereby monthly payments for maintenance and management of road assets depends on contractor's output (Wirahadikusumah et al., 2015). The method proved success to road agencies in developing countries attaining service level and key performance indicators under fixed price contracts. Therefore, it is proffered method to road authorities for improvement of road conditions at reasonable costs (Mutai and Aila, 2018).

However, prior employing performance-based methods, there should be conducted detailed feasibility of contracted road, assessment of local industry capacity (authority, contractor or consultants), cost and quality of works. Others include establishing relationship between private sector (contractors and consultants) and road authorities by setting up performance specification, standard and expertise of private sector for succession of maintenance contract (Sultana et al., 2012).

Studies shows that output and performance-based of road contract (OPBRC) method is preferred for big projects with intense competition, extended duration and extension periods and long outsourced road section that encoumpass crack sealing, pothole repair and mowing activites. Cost analysis conducted by road authorities shows that outsourcing lengthy road segments under the output and performance-based of road contract (OPBRC) maybe adequately maintained (Anastasopoulos et al., 2010). Nevertheless, it is considered incomplete method of managing roads due to execution been based on contractors selfinterest that build-up strategic behaviour, performance measures been relied on unambiguous, unclear and immeasurable requirements (Schoenmaker and de Bruijn, 2016).

## **1.2 Problem Statement**

Usually, transportation infrastructure requires proper and satisfactory maintenance practices due to wear and tear over time and use, in order to attain expected design life, service level expected, safety to road users, vehicles and healthier environment. Study reveals popular method employed in road maintenance is traditional contracting, that linked to several challenges like overheads, inspection costs and delays in project completion, cost escalation and political interference due to direct involvement of road authority in conducting maintenance.

To address the aforementioned issues, road authorities throughout the world are attempting to use contemporary maintenance approaches like the output and performance-based of road contract (OPBRC), in order to enhance the quality of service offered, efficiency and cost-conscious attitudes while spending reasonable amount of money. The performance-based method like OPBRC expected to provide solutions even though not a cure to substandard maintenance and repair of road infrastructure. Although existing study had explored maintenance of road and highway projects under performance-based contract, there was little knowledge about maintenance management of pilot projects with unique physiognomies (such as BRT) under performance-based contract particularly in developing African countries. Therefore, this study explored on about the implementation of the output and performance-based of road contract, with a view to propose means in which smooth execution of maintenance management of Dar es Salaam bus rapid transit road infrastructure could be implemented.

### **1.3 Research Objectives**

#### **1.3.1 Main objective**

This study aims to assess the application of Output and Performance-based Maintenance of Roads Contracting on maintenance management of Dar es Salaam bus rapid transit phase 1 road infrastructure.

#### **1.3.2 Specific objectives**

- i. To examine the implementation of output and performance-based of road contracting on maintenance management of Dar es Salaam bus rapid transit road infrastructure.
- ii. To assess the challenges encountered by stakeholders on execution of maintenance management of Dar es Salaam bus rapid transit road infrastructure.
- iii. To examine bus rapid transit users' perception on maintenance condition of Dar es Salaam bus rapid transit road infrastructure.
- iv. To propose how output and performance-based of road contract could enhance smooth implementation of maintenance management of Dar es Salaam bus rapid transit road infrastructure.

#### **1.4 Research questions**

- i. How does output and performance-based of road contract is implemented in maintenance of Dar es Salaam bus rapid transit road infrastructure?
- ii. What are challenges encountered by output and performance-based of road contract stakeholders on maintenance management of Dar es Salaam bus rapid transit road infrastructure?
- iii. How does maintenance condition of Dar es Salaam bus rapid transit road infrastructure perceive by commuters?
- iv. How could performance of output and performance-based of road contract enhance maintenance management of Dar es Salaam bus rapid transit road infrastructure?

#### **1.5 Methodology**

This research employed an exploratory cross-sectional case study design that comprises of the following components. Firstly, the main objective of the study was to assess the maintenance management of Dar es Salaam bus rapid transit road infrastructure. The study started by reviewing the existing literature concerning the practices of network, pavement maintenance, the existing output and performance-based of road contract (OPBRC)

maintenance contract generally and within local road authorities. The summary of each document reviewed between years 2019 and 2020 respectively, were discussed within the relevant chapter dealing with each aspect.

The data collection techniques adopted for the research were document review of the output and performance-based of road contracting (OPBRC) related documents, interviews to practitioners (contractor and consultants) and physical observation with the aid of observation guide on the maintenance condition of Dar es Salaam bus rapid transit road infrastructure. The prior stage aimed to obtain general idea of the research problem and to recognize the knowledge gap, and then a comprehensive review on the studies related conducted in order to understand issues associated with the Dar es Salaam bus rapid transit (DSM BRT) road infrastructure. Then road agency and procured contractor who were purposively selected for interviews. The main aim of this phase was to identify from available contract documents the execution of maintenance contract and assessment of performance, through critical review of official contract documents then identification of the output and performance-based indicators compared with locally employed one under the output and performance-based of road contracting (OPBRC).

In the second phase of the research methodology, the verified related documents for maintainability and indicators enhanced the formulation of interview guide, then distributed to respondents during interview in order to examine and validate the proposed relationship between the constructs and observation guide.

### **1.6 Significance of the Study**

The findings will support a researcher to suggest strategies in which Dar es Salaam bus rapid transit (DSM BRT) road infrastructure under performance-based contracting could be enhanced, as well as enhancement of longevity of road infrastructure, preserve their maintainability or maintenance condition, reduce costs of maintenance and the community planned.

Secondly, generation of essential knowledge to Maintenance Managers, Engineers, Project Managers involved in maintenance of transportation infrastructure under output and performance based of road contracting (OPBRC) on performance and challenges.

Lastly, scholars aspiring to conduct more research on maintenance of roads and highways infrastructure under the output and performance-based contracting will use this study as a baseline for their works.

### **1.7 Scope and Limitations of the Study**

The focus of this study is on the maintenance management of Dar es Salaam bus rapid transit (DSM BRT) phase one road infrastructure, which consisted of road furniture and carriageway that owned by TANROADS Dar es Salaam region and maintained by private contractor (BECCO Contractors) under output and performance-based of road contract (OPBRC). The road under maintenance consisted of 21.4 kilometers total length and divided into nine (9) road sections depends on their physical characteristics and cross-sectional differences for easily execution of maintenance contract. It excludes terminals, intermediate and feeder station and traffic lights that owned and maintained by Dar es Salaam rapid transit agency (DART) and associated authorities.

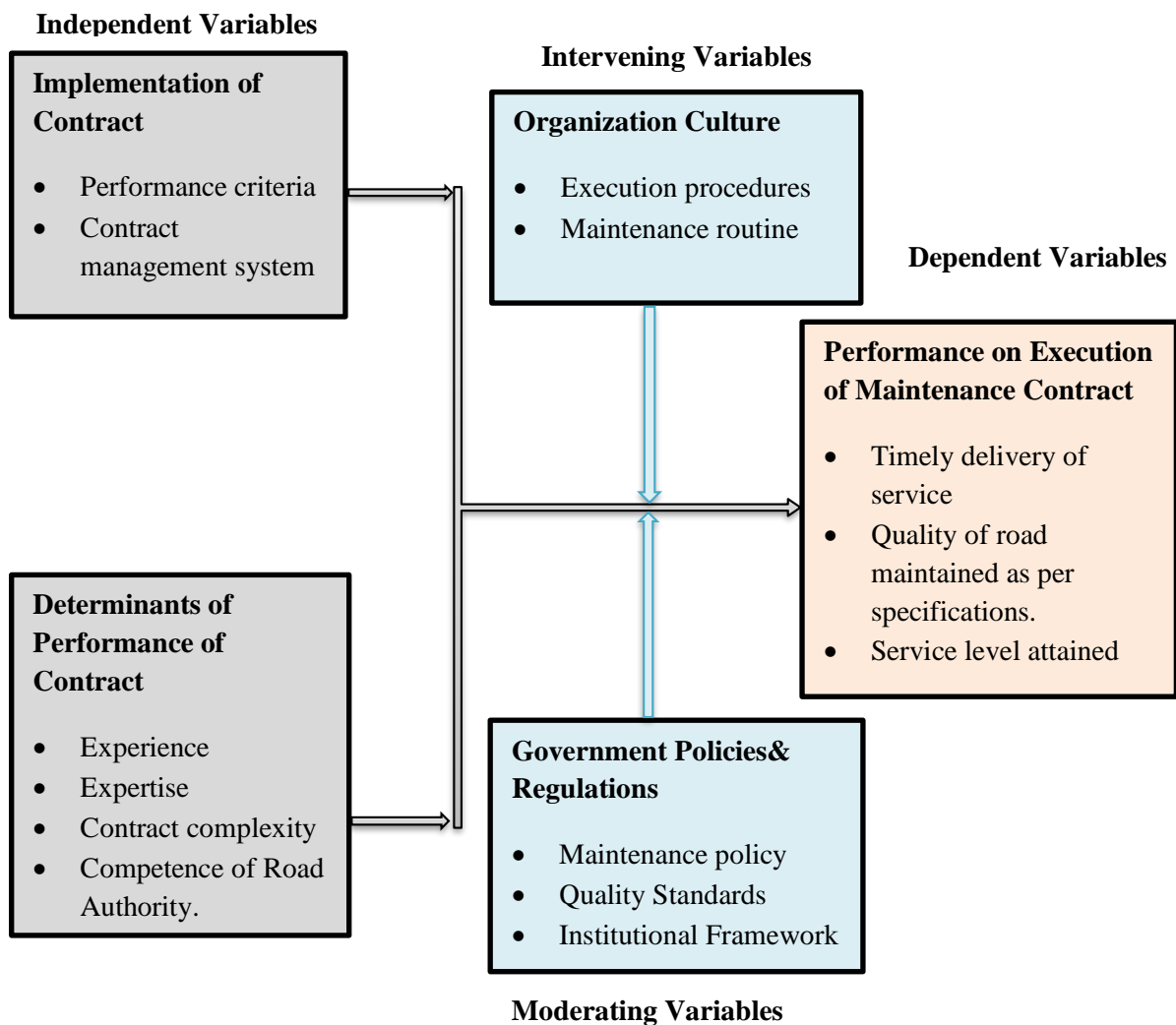
It is an intentional action to assess the application of output and performance-based of road contracting (OPBRC) on maintenance management of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure. This is because of the following reasons: Firstly, Dar es Salaam bus rapid transit (DSM BRT) system is a new project to Tanzania's context towards attainment of sustainable city transportation system that considered a pilot project to succeed in implementation of other bus rapid transit (BRT) phases.

### **1.8 Assumptions of the Study**

Assumptions are conditions taken and accepted as true without proof in relation to problems. The study assumes the sample selected represents the population under study area and instruments used for data collection are valid and reliable. The output and performance-based of road contracting (OPBRC) method promotes a more equitable alignment of risks and incentives among stakeholders.

## 1.9 Conceptual Framework

The conceptual framework of this study explains the concepts studied or investigated and includes key factors or variables investigated and the presumed relationship among them. It depicts the interaction of variables; dependent variable being level of performance on execution of contract, assessed in terms of service level, on time delivery of service and according to quality specification. Independent variables are the driving factors that determine the level of performance of contract developed based on the literature review. They include service level criteria, contract management system, experience and expertise of contractor, the complexity faced and competence of road authority in monitoring the maintenance contract (Gelderman et al., 2019).



**Figure 1.1 Conceptual Framework**

### **1.10 Chapter Summary**

The first chapter of this study has introduced the research and justification for doing the study. It contains the background information, problem formulation, research objectives and questions defined; scope and limitation of the study, significance and summary of methodology employed in the study. The next chapter intends to review the literatures related to the study on maintenance of roads under performance-based contracting like (OPBRC, PMMR etc.).



## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter provides a review of the literature on maintenance management of road infrastructure using either performance-based contracting or traditional contracting. The study highlights the key concepts related to existing studies.

#### **2.2 Maintenance**

Maintenance of road infrastructure consists of technical, administrative and management operations carried out throughout the asset's life cycle in order to maintain or restore it to a state where it can fulfill the needed function (Marquez and Gupta, 2006). For a long time, maintenance of road infrastructure perceived as value adding activity instead of spending on unavoidable expenses, by advocating maintenance culture that needs correct diagnosis of defect, remedial measures, and sound technical capacity to perform maintenance as well as management of resources (Olanrewaju and Anifowose, 2015). There has to be enhancement of maintenance control in order to achieve maintenance optimization, which considers maintenance policy, cost and reliability measures (Harral, 1987). The key to maintenance is to preserve assets, and not upgrade by conducting it regularly activities like minor repair and improvements of pavement, shoulders, slopes, drainage facilities and other properties to get the root of the problem and prevent having to do maintenance over and over again (Burningham and Stankevich, 2005).

#### **2.3 Maintenance management**

The combination of technical and administrative actions always contributes to protection and satisfactory operation of assets maintenance, such as cleaning, repairs and replacements that helps to retain value of assets, makes it useful and ensure longer life (Yuseni and Samad, 2013). The effective analysis detects most important problems and locating their potential solutions through identification of suitable procedures to adopt maintenance management. Furthermore, Marquez and Gupta (2004) declare that maintenance management consists of activities of management that determines the maintenance goals, tactics, responsibilities and implementation processes of plan, control, and supervision. The four dimensions in which operational objectives measure maintenance practices and performance measures include cost, quality, dependability and reliability.

## 2.4 Road maintenance

Maintenance of public roads are categorized as routine maintenance or periodic maintenance or urgent maintenance that contracted out in convectional contracts, performance-based contracts (PBC) and mixed or hybrid performance-based contracts. Routine maintenance, according to Burningham and Stankevich (2005), consists of small scale works carried out on a regular basis to ensure daily passability and safety of existing roads and to porevent premature deterioration. These activities include roadside verge cleaning and grass cutting, cleaning of silted ditches and culverts, patching and potholes repair.

The scope of periodic maintenance is more complex than of routine maintenance and conducted at regular long interval of about 8 years for paved road surfaces to preserve structural integrity of road through resurfacing, overlay, and pavement reconstruction activities using specialized equipment and skilled personnel (Anastasopoulos et al., 2010). Lastly, urgent or emergency maintenance are the one performed to repair defects that cannot be foreseen but require immediate attention like collapse of bridges, culverts, and di-siltation works (ADB, 2018).

*Table 2.1: Road maintenance contracts approaches*

<b>Contract Type</b>	<b>Scope</b>
Unit Price Contracts (Admeasured)	Contract provides unit rates for more items to execute and payment of based on quantities of works completed.
Lump Sum Contracts	Contractor invited to tender basis of drawings and specifications developed by road authority/ client, while contractor's responsibility remains to execute contract on agreed cost and payment depends on signed price for all total works.
Performance-based Contract (PBCs)	It uses performance level standards to evaluate road assets/ service provided under the contract, while the fixed payment issued incase performance level are met, or reduction for non-compliance.
Mixed or Hybrid PBCs	The contract made-up of elements present both in PBC and the unit price contracts, and payment approach rely on both features.

**Source:** Zietlow (2017).

## 2.5 History of performance-based contract

The performance-based contracts for roads infrastructure started in the late 1980's and early 1990's, firstly in British Columbia- Canada 1988 and then developed in Argentina in mid- 1990 about a thousand national roads kilometers referred to as Contracts for rehabilitation and maintenance (CREMA). In mid-1996, Uruguay adopted Performance-

based contract (PBC) for its national roads for initial rehabilitation, periodic and routine maintenance of five years and succeeded as well (Zietlow, 2017). Later in 1990's other Latin American countries such as Brazil, Chile and Colombia started using PBC in national roads maintenance. Other European countries include Australia in 1995 and New Zealand in 1998, while in Washington D.C in United States of America in 1996. Later, Asian countries and African countries started since 2000's under promotion of The World Bank (WB) and The Asian Development Bank (ADB) as well (ADB, 2018).

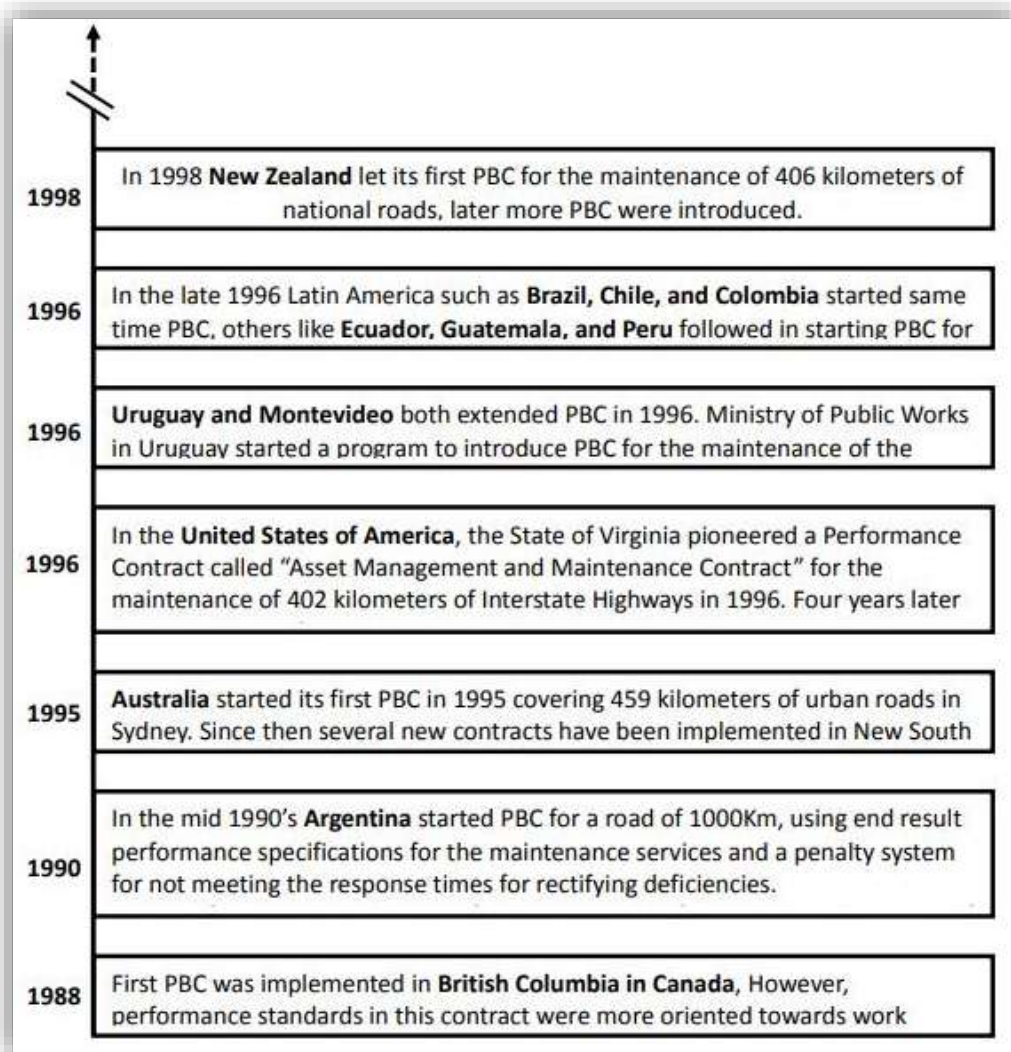


Figure 2.1: Evolution of PBC in developed countries. Source: adopted from Zietlow, (2017)

The use of performance-based contracts aims to save maintenance costs, increase stakeholder transparency, improve quality control and enforcement and improve overall road conditions and satisfaction (Sultana et al., 2013). Several challenges were experienced under traditional contracting method such as time and cost escalation,

unsatisfactory quality of works, no risk duty between the owner and contractor, overhead, inspection cost, political influence, corruption and delay in project completion (Zietlow, 2011).

## **2.6 Description of output driven contracts**

The performance-based contracts (PBC) were developed to encourage contractors undertake road maintenance responsibilities (including plan, design and implement maintenance activities) to carry the risks of efficiency of workforce and payment depending on the completed output rather than resources spent to deliver the output (Sultana et al., 2012). In addition, advantages expected once employed PBC contracting include (1) encourage innovation, (2) offers satisfactory service and (3) reduces corruption practice and misuse of public funds (The World Bank, 2017). Various terminologies used to describe the performance-based contracts depends on either developing or transitional countries (ADB, 2018).

The output and performance-based of road contracting (OPBRC) or Rehabilitation and maintenance contract (RMC) is the one that necessitates substantial capital works, with initial rehabilitation and periodic maintenance accounting for more than 30% of the overall contract price. Because of the predominance of bad road conditions, this is widely employed by underdeveloped countries. Apart from maintenance, Network Management Performance-based Contract or Performance-based Management and Maintenance of Roads (PMMR) needs no or minimal initial effort to bring roads to the appropriate service levels. Additionally, Micro enterprise performance-based contract a simple for routine maintenance on paved roads mainly applied to provincial and community-based roads.

The maintenance of public roads under performance-based contracts according to Hyman (2009) aims to (1) increasing efficiency and effectiveness of the management of road infrastructure in terms of value for money been spent for maintenance. (2) Enhancing the condition of the road networks for the benefit of the road users. (3) Promote continuous innovation in diagnostic and strategic planning and during the implementation phase. (4) Increase the traceability and quality of reporting during all the phases of the maintenance cycle for the benefit of stakeholders.

## **2.7 Key Difference between Traditional contracts and Performance-based contracts**

There following Table 2.2 shows the differences between traditional contracting method and performance-based contracting method identified from various studies.

*Table 2.2: The difference between Traditional contracts and Performance-based contracts*

<b>Traditional Contracts</b>	<b>Performance-based Contracts</b>
Risk is borne by road agency/ client who prescribe specifications, materials and construction method.	Risks transferred to contractor and bear basing on their expertise (Al-Kathairi and El Halim, 2014)
The selection process involves choosing a contractor who has the capability to assess the condition of the assets, selection of materials, work methods that suite work plan as well as monitoring of his own services (Sultana et al., 2012).	The selection process relies on the best value not necessary the lowest bidder due to risks of management responsibilities.
Contractor payment is determined by the physical works completed	Payment made on fixed price lump basis normally through uniform installments, determined by level of service attained (Zietlow, 2017).
The contract period is shorter and determined by contract/ project size	The duration of contract is longer and determined by complexity of contract (3-10years) (World Bank, 2017)
Competence of contractor to undertake management of risks is not priority because road authority bears them on decision of materials, methodology of execution of contract.	This contract type requires a well-matured contracting industry with capability to undertake longtime management of contract (Anastasopoulos et al., 2010).
Maintenance contracts period determined by scope of the project, and is not necessary to collaborate.	Comprehensive PBC often allows for formal collaboration between construction management firms and traditional road contractors (World Bank, 2017).
In traditional contracting joint venture of contractors is not necessary to enhance their capacity to execute the maintenance contract (Ambaw and Telgen, 2017).	PBC need a strong collaborating attitude on its initial stage of introduction (pilot project) due to lack of experience, procedures to assess performance indicators and monitoring of project.

## **2.8 Characteristics of performance-based contract**

The following are the features of output and performance-based of road maintenance contracts:

### **2.8.1 Performance indicators**

The performance-based contracting consists of clear and precise defined objectives and performance indicators in which performance of contractor assessed and the service quality criteria of maintenance works under the performance-based contract expected to be of better quality (Ambaw and Telgen, 2017).

Roughness, potholes, patching, rutting, cracking etc. are the key performance indicators (KPIs) used by the road authority to evaluate the contractor's performance during the implementation of an outsourced road maintenance under performance-based contract. Tables 2.3, 2.4 and 2.5 list the key performance indicators (KPIs) used in various nations throughout the world. The similarities based on assets maintained being on paved road, drainage system, road signs and markings has defined tolerance, measurement techniques and time permitted for attendance. Other components include information signs, warning sign, road marking and reflectivity of road markings and drainage elements (manholes, catch pits).

The great difference noted were coverage of contract for instance in Latin America covered gravel surface and measurements of sizes of defects and tolerance permitted are different depending on locality of contractual.

*Table 2.3: Performance indicators for PBC project in Latin America*

<b>Asset Class</b>	<b>Component</b>	<b>Performance Indicator</b>
Pavement	Potholes	No potholes
	Roughness (asphalt)	IRI<2.0(Argentina), IRI<2.8(Uruguay)
	Roughness (bituminous)	IRI<2.9(Argentina), IRI<3.4(Uruguay)
	Rutting	<12mm (Argentina), <10mm (Uruguay, Chile)
	Cracks	Sealed
Gravel surface	Potholes	No potholes
	Roughness	IRI<6(Uruguay) IRI<11(Chile)
	Thickness of gravel layer	10cm (Chile, Uruguay)
Shoulders	Potholes	No potholes
	Cracks	Sealed
	Joints with pavement	Vertical alignment<1cm (Chile, Uruguay)
Drainage system	Obstructions structures	No obstruction is allowed for free flow of water
Road signs and markings	Road signs	Complete and clean (Argentina, Chile, Peru)
	Road marking	Complete and visible (Argentina, Chile, Peru)
	Reflectivity of road markings	160mcd/lx/sqm (Argentina), 70mcd/lx/sqm (Uruguay)
Right of way	Vegetation, and foreign elements	15cm height (Argentina, Uruguay)

**Source:** adopted from ADB, 2018.

Table 2.4: Performance indicators in Australia

Asset	Outcome	Performance Target in % of Asset	Performance Indicator
Cross Pipes <36ft M <sup>2</sup> )	Structurally sound	95	<10% deteriorated barrel
	Open drains		>90% diameter open
	Joints intact		Joint intact
	Adequate capacity		End protection intact
	No erosion		No indication of structural problem allowed
Paved Ditches	Aligned	95	< 1" settlement
	Structurally sound		<25% spalled
	Clean		No obstruction to flow of water
Sidewalks and Ramps	Smooth	90	No settlement $>\frac{1"}{2}$
	Safe		No unsealed cracks $>\frac{1"}{4}$
	Sound		<25% spalled

Source: Adopted from Alyami et al, 2014

Table 2.5: Performance indicators of DSM BRT maintenance project

Asset	Component	Measurement	Tolerance Permitted
Pavement	Pothole	<10cm diameter, <2cm	3 Days
	Patching	depth	3 Days
	Cracks	<3mm wider <3mm wider	28 Days
Concrete Rigid Pavement (Surface Damage)	Surface Damage	≤5%	28 Days
	Vertical/ Lateral	≤3%	28 Days
	Movement	≤5%	20 Days
	Joint sealant		
Cleanliness (Pavement Surface & Shoulder)	safety related matters	-	2 Hours
	Non-safety related matters		3 Days
	Rutting diameter	<10	28 days
	Frequency	≤5%	
	Raveling within 1km Shoulder & Verge Maintenance	< 2%	28 Days
Road Signs and Road Safety	Information Sign, Warning Sign, Traffic Ruling Sign, Road Marking, Km Posts.	Visual inspection: clearly visible at night and in conformity with Tanzanian requirements.	≤14days
	Guardrails	Visual inspection	≤7days
Drainage System	Drainage elements i.e. manholes, catch pits etc.	No obstruction	Verified on regular basis during and after rain

Source: Adopted from DSM OPBRC, 2017

### **2.8.2 Risk Sharing**

Under traditional contracting, the design and specifications of project is finalized by the road authority, hence risk accountability goes to road authority. While the output and performance-based contract risks reduced by clearly defining obligations that enable stakeholders to deal with their risks (risks responsibilities), hence reduce the agency's liability even ensuring improved road maintenance condition of contracted road. Under outsourced road, agency bear a small part of risk caused by natural occasions like force majeure, political instability etc. unlike those caused by technical capacity and handled by parties (Sultana, 2012).

### **2.8.3 Duration**

The maintenance contracting under performance based contracting ranges from simple to comprehensive whereby simple contract covers single service in maintenance duties and takes short periods (several months to a year). Unlike comprehensive performance based contracting that covers full range of services needed for management of road and takes long period (5 to 10years) and up to 30years according to user's satisfaction (Anastasopoulos et al., 2010 and ADB, 2018).

### **2.8.4 Scope and assets covered by performance-based contract**

The scope of performance-based contract depends on contract complexity either simple contract or comprehensive contract that cover from only individual assets to all road assets within the given road corridor. Generally simple performance-based contract covers single service like mowing, maintenance of streetlights that signed for a short periods not exceeding a year. Comprehensive performance-based contract covers all road assets within carriageway includes full range of services required to maintain and manage road corridor like routine maintenance or periodic maintenance with duration ranges between three to ten years (Radovic et al., 2014 and World Bank, 2017).

## **2.9 Advantages of performance-based contracts for road maintenance**

This contemporary maintenance approach provides several benefits over other methods like traditional contracting, and the following advantages discussed as follows.

### **2.9.1 Cost saving**

Although studies are inconclusive as to how much money was saved on the same service level before and after using performance-based contracts, road authorities who used it were able to lower maintenance expenses. Areas experienced includes reduction in workload of agency's staff, safeguard against cost overruns, savings on rehabilitation works, improve



road safety and level of corruption due to fewer transactions conducted and identified in Tanzania (ADB, 2018). The cost reduction in Latin America has not yet reported so far since no cost comparison studies has been done, though road conditions have notably improved on roads that were maintained under the new contracting scheme (Zietlow, 2011).

*Table 2.6: Summary of Cost savings as recorded in Developed Countries.*

<b>Country</b>	<b>Costs Savings Percentage (%)</b>
Alberta, Canada	About 20%
Australia	10-40%
Brazil	15-35%
England	10%
Finland	18%
Holland	30%- 40%
Sweden	30%
USA	10-15%

**Source:** ADB, (2018)

### **2.9.2 Innovation**

This approach enables contractors to use sophisticated techniques in road network management while also encouraging the development of new talents in the existing sector through more efficient and effective means of accomplishing contractual goals. The longer contract terms enhance adoption of global technological advancement advantages by contractor accompanied by incentive to invest in the development of new products and techniques (Zietlow, 2017).

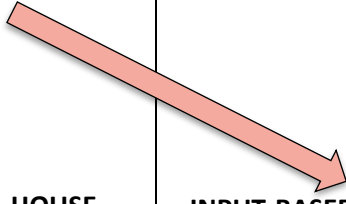
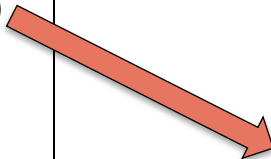
### **2.9.3 Users' satisfaction**

No recent studies have quantified results of improved users' satisfaction, but road users' appreciation of good road conditions and passable even during rainy season noticed in Chad. Likewise, increase rate of road users' satisfaction with service level delivered through reduced number of complaints recorded by road authority, saves on maintenance cost for their vehicles, road users appreciate the road maintenance condition better and safer roads with consistent conditions (Stankevich et al., 2005).

### **2.9.4 Risks management**

The road authority has managed to minimize risks by transferring them to contractor who merely bear them but aims to avoid cost overruns and change orders (Zietlow, 2017). Studies show that contractors understand risks better compared to road authority, hence willing to take them since outsourcing in a long-term aspects transfer risk burden.

Table 2.7: Risk sharing ideal

Risk to Public Sector	High				
	Low				
	Low	<b>Risk to Private Sector</b>		High	
		<b>IN-HOUSE</b> (Direct Labor)	<b>INPUT-BASED</b> (Unit rates)	<b>HYBRID</b> (Combination of input-based and output-based)	<b>OUTPUT-BASED</b> (Performance)

Source: adopted from Zietlow, (2017)

### 2.9.5 Improved level of service

The numerous studies reviewed show that implemented contracts under performance-based contract raised the standards of services beyond the previous services through enhancement of road safety and improved social outcomes by better access to business, market and employment areas (Sultana et al., 2012).

### 2.9.6 Value for money

The maintenance under performance-based contracts identified increase in the value for money by providing improved and better level of service at reasonable price, whereby the level of service provided meet the longterm expectations and tender price remains intact over the period of contract (Gericke et al., 2014).

### 2.9.7 Reduced administration

A reduction in administration cost while attaining better service level is an internal benefit to road agency due to input required from supervisory staff and contract administration staff reduced by changing roles from day to day surveillance to measurement of specified performance outcomes (ADB, 2018).

### 2.9.8 Expenditure certainty

Since the performance-based approaches are tendered on a single lump sum basis which subjected to price adjustment for performance achieved measured under key performance

indicators (KPIs), hence reduces the risks of cost overruns and budget blow outs (Anastasopoulos et al., 2010).

### **2.10 Disadvantages of applying performance-based approach**

Despite the merits gained by employing performance-based contracting in maintenance managements of roads, literatures discovered shortcomings of using this approach in maintenance of roads, as follows:

Al-Kathairi and El Halim (2014) study proved an increase in procurement process cost due to higher need for better understand of risks and necessity to incorporate quality aspects during tendering techniques due to performance based contract been new approach in developing countries.

Potential loss of agency control and flexibility especially during the financial trials of fluctuations and the contract has been fixed on the long-term commitments. In additional, risks associated with the development of works program have been transferred to the contractor, the agency loose assets management decision and less responsible in political requests for works to perform in certain areas (ADB, 2018).

Establishment of standard performance measures is complex and challenging, especially when there is lack of historic data to impact on the ability of tenderers to produce maintenance programs that will be correct in the future years. The development of key performance indicators are difficult task that require considerable knowledge and sufficient accuracy to allow reduction in risks, forecast asset value and determining possible remaining life of pavement (Gericke et al., 2014). Furthermore, reduction in competition is influenced by longevity of contract duration that reduce the size of market henceforth stress on small and medium size contractors, meanwhile competition should be observed for promotion of efficiency and value-for-money (Sultana et al., 2013).

Reduced ability to deal with changes during the contract life of performance-based contract despite many interfering factors like political instabilities, physical and environmental challenges, could increase cost to road agency in case of need to revise contract rates. Loss control and flexibility perceived as risk to road authority for funds

reallocation during fiscal constraint, reduction of standard of service provided by inadequately defined performance measures (Gericke et al., 2014).

### **2.11 Challenges in implementing performance-based contracts**

Previous study on performance-based contracts revealed so many advantages experienced by countries manage to adopt maintenance management of roads and highways. The challenges encountered during implementation of contract were not limited to the following.

Risks allocation; well discussed by Wirahadikusumah et al., (2015) that partnership in risks transfered between client and contractor should be identified and considered prior to adopting the contract approach. The performance based contract (PBC) requires equitable sharing of risks between client and contractor. Contractor usually takes some risks which relate to their expertise so that they will be able to properly assess the consequences and budget them into their tenders.

Procurement process of contractor involve prequalification of contractors to make sure that only sufficiently qualified tenders will proceed to the full tendering process in order to minimize the costs associated with tender preparation and evaluation. Organization of pre-bid seminars for prequalified contractors to make contractors familiar with the demands of the contract requirements (Zietlow, 2017).

Adequate skills and expertise within the road agency advocated by Shrestha et al., (2015) requires technical capacity of staff candidates to ease assessment to contractor and to determine the scope of works and service and the duration of the contract, to undertake a detailed road assets condition survey, design of tender documents and appropriate supervision arrangements.

Dependency on external source of funds buoyed by Zietlow (2017) that most funds went to road construction then modern road maintenance contracts like performance-based contract in developing countries failed due to insufficient local funding and underfinance of several pilot project under maintenance. Studies reveled that once road maintenance covered by performance-based contracts, might remain under performance-based contracting in order to guarantee minimum performance levels in the future.

## **2.12 Users' perceptions on performance-based contracting**

Findings from various scholars managed to grasp users' (passengers and drivers) and practitioners' (engineers, contractors and consultants) perceptions on maintenance conditions of roads and highways maintained under performance-based contracting. Beginning with reduced frequent claims on maintenance condition of road assets identified to most outsourced roads due to improved services offered by private contractor.

Improvement of service delivered identified by Sultana et al., (2012) that improved maintenance condition of road maintained influenced by timely response to defects like emergence events as agreed in the stipulated in general condition of contract (GN). Minimization of road users' maintenance cost identified that road user complaints on increase in maintenance cost minimized due to infrequent maintenance of their vehicles because of improved road condition.

## **2.13 Contributions from previous studies**

Various scholars discussed how the performance-based contracting has improved the service acquired on maintenance of roads and highways. The suggestions to improve the contemporary road maintenance approach (PBC, OPBRC, PMMR etc.) especially during transition period key recommendations developed from literature as follows.

Firstly, funding aspect determine the success of employed contract by having stable funding structure. Then encourage assessment of practitioners undertake the long-term financial risks to maintain large projects with strong competition, long duration and extension periods and long-outsourced road sections with maintenance of cracks, potholes and greenery (Andreski et al., 2006 and Anastasopoulos et al., 2010). The viability of industry prior implementation of performance-based contract could influence awareness and integrity hence improve contractor's performance (Manogaran et al., 2020).

A study on the experiences gained from client and contractor executed pilot project discovered unforeseen challenges happened during the course of the contract. Recommendations then raised including frequent assessment, monitoring and evaluation of network situation to enable risk identification and adjustment of key performance indicators to meet local environment (Jooste et al., 2009).

Inadequate time, learning curve and workload, financial shortfall, shortcuts and uncertainty about size and bonuses were the reasons behind the failures of performance-based contracts in Uganda to achieve the intended outcomes (Ssengooba et al., 2012). The best practice and knowledge sharing by road agencies enable contracting out maintenance under output and performance-based approach by encouraging involvement of private sector in system analysis, identification of options and formulation of transformation strategies enhance efficiency on management of contract (Andreski et al., 2006).

Successful performance of maintenance contracts depends on performance specifications and standards, experience of private sector, level of complexity of contract, identification of risks addressed and formulation of management (Sultana et al., 2012). A study conducted in Serbia shows that the road authority has experienced numerous advantages like cost saving, expenditure certainty, reduction of in-house workforce and improved conditions of contracted roads under their 5-years pilot project, despite the termination of contractor in the first year of implementation due to underperformance (Dadovic et al., 2014).

Several obstacles are facing developing countries' adoption of contemporary maintenance approach, key productivity constraints encountered by contractors and the associated mitigation measure addressed. Suggestions are to improve road management and achieve expected advantages through reduction of possible disadvantages raised (Ambaw and Telgen, 2017 and Sultana et al., 2013). In Malaysian industry, important mechanisms of identifying the challenges and develop strategies to adoption them from other countries addressed prior implementation of maintenance contract. The awareness improved maintenance status of their construction industry (Anwar et al., 2016).

The development of local capacity supports public road authorities and contractors undertaking maintenance management of roads through prediction of assets performance and optimize maintenance strategies for effective utilization (Al-Kathairi and El Halim, 2014). The key performance measures employed by agencies on assessment of contract performance as well as important physical attributes engaged as inputs to assess condition of road assets (Alyami et al., 2014).

The interrelationship of authority and contractor maintaining road under performance-based contracts, could enhance innovation through autonomy in their daily service operations. Lack of provided autonomy during contract execution has an influence on the

supplier- led innovation whereas outsourcers that are too closely are involved with outsourced service delivery restrict their suppliers from operating independently during contract execution and limiting innovation potential. The study demonstrates the bond between authority and contractor enhance innovation through self-sovereignty to act according to their best knowledge.

There is limited knowledge on the effects of using performance-based contracting on influencing the innovation (Sumo et al., 2016). Studies seek benefits associated with government support on the application of performance-based contracts, how reward system influence bus-operators to deliver minimum level of service required to satisfying community service obligations. The performance-based contracts found to maximize social surplus in public transportation provision within a given budget constraints. Competitive tendering found to be less appealing procurement method through the PBC approach, especially for securing the maximum social surplus of the community subsidy.

#### **2.14 Maintenance of Dar es Salaam bus rapid transit infrastructure**

Figure 1.2 described the development of Dar es Salaam bus rapid transit (DSM BRT phases) infrastructure system managed by TANROADS since 2012, when construction started then operation and maintenance of Dar es Salaam bus rapid transit (DSM BRT) infrastructure then divided into two categories. The first category owned and maintained by TANROADS Dar es Salaam regional office comprises the following Dar es Salaam bus rapid transit (DSM BRT) components:

- i. Road pavement constructed in concrete and asphalt
- ii. Road shoulders
- iii. Concrete pipe slopes
- iv. Open drainage systems
- v. Catch pit gratings
- vi. Manhole covers
- vii. Concrete kerbstones
- viii. Sidewalks and Roadside works
- ix. Gabions
- x. Waste vessels
- xi. Grass cutting, tree, shrubs and green areas
- xii. Over-all cleaning sand and general debris

The second category of Dar es Salaam bus rapid transit (DSM BRT) infrastructure owned and maintained by Dar es Salaam rapid transit agency (DART), comprises the following components buses, bus stations, intermediate stations, terminals, fences and passengers' bridges as presented in the Table 2.8.

*Table 2.8: Maintenance of Dar es Salaam BRT infrastructure*

<b>Agency</b>	<b>Infrastructure</b>	<b>Outsourced contractor</b>	<b>Responsibilities</b>
TANROADS- Dar es Salaam regional office	Road corridor and furniture	BECCO Contractors Ltd	Maintenance of 21.4km of Dar es Salaam bus rapid transit road infrastructure and furniture
Dar es Salaam rapid transit agency	Intermediate 29 stations, 3 feeder stations	Tanzania Building Agency (TBA-Dar es Salaam regional office)	Civil works to all intermediate stations, terminals and feeder stations
	pedestrian bridges 5 terminals& fence 1 depot	TEMESA- Dar es Salaam regional office  SUMA-JKT	Electrical works of DART stations and terminals  Cleanliness of DART stations, feeder stations, pedestrians' bridges and terminals

This study relied on the assessment of maintenance of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure owned by TANROADS Dar es Salaam regional office and maintained by private contractor. The agency applied the output and performance-based of road contracts (OPBRC) in maintaining its bus rapid transit (BRT) components. Private contractor who procured to implement maintenance duty that expected to offer several advantages like cost savings, certainty of expenditures of road authorities, reduction of agency's in-house workforce and customer satisfaction on road conditions (Stankevich et al., 2005).

The scope of maintenance contract of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure under output and performance-based of road contract (OPBRC) clearly elaborated in Part2 of contract document

For instance, Section Vii- Works and Services Requirements that shows project area and related boundaries under TANROADS Dar es Salaam regional office (Management and Maintenance of BRT under OPBRC Contract, 2017). The Dar es Salaam bus rapid transit (DSM BRT) road corridor phase one is about 21.4 km and divided into nine road sections depending on their physical design characteristics and different cross-sections.

Part 3: Section VIII- of General Condition of Contract (page 162) describes the scope of works and services to contractors' obligations as follows: (1) Design. (2) Execution of



works. (3) Performance of all services required; for keeping the road in accordance with service levels defined in the specifications, while respecting plans, procedures, specifications, drawings and codes as identified in the specifications. Furthermore, contractor's duties stretched to provision of supervision and engineering services, supply of labor, materials, equipment, construction utilities and supplies, temporary materials, structure and facilities as well (Maintenance and Management of Bus Rapid Transit under Output and Performance-Based of Road Contract, 2017).

### **2.15 Chapter Summary**

This chapter has discussed the contribution of various scholars' studies on maintenance of road and highway under output and performance-based contracting, through available literatures. General ideas and concepts relate to studies that researchers discussed include but not limited to evolution of PBC, experiences of practitioners, benefits, challenges and recommendations proposed to improve maintenance of road under output and performance-based contracting. The next chapter intends to discuss the methodology used to execute the research, including research design, sampling techniques, data collection methods and data analysis tools.

## **CHAPTER THREE RESEARCH METHODOLOGY**

### **3.1 Introduction**

The purpose of this chapter is to describe the steps involved in organizing the study to attain the research objectives. The chapter contains description of the research design, research population, sampling determination, data collection and analysis methodologies, data reliability and validity and ethical considerations are all included.

### **3.2 Research Design**

This study employed an exploratory cross-sectional case that suite in finding-out the prevalence of phenomenon, situation or problem and useful to obtaining an overall picture at a selected case, with little knowledge during studying (Kumar, 2011).

The exploratory study conducted aimed to explore this case with little information by conducting a study to endorse worthiness of study. The cross-sectional case study allows for the monitoring of variables in a specific case study in a single instance (Raimundo et al., 2018). The study on maintenance management of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure under output and performance based of road contract (OPBRC) is new and unique kind of project and approach implemented in Tanzania. This justifies the exploratory cross-sectional case design desires to establish a baseline and ground-mark for further studies.

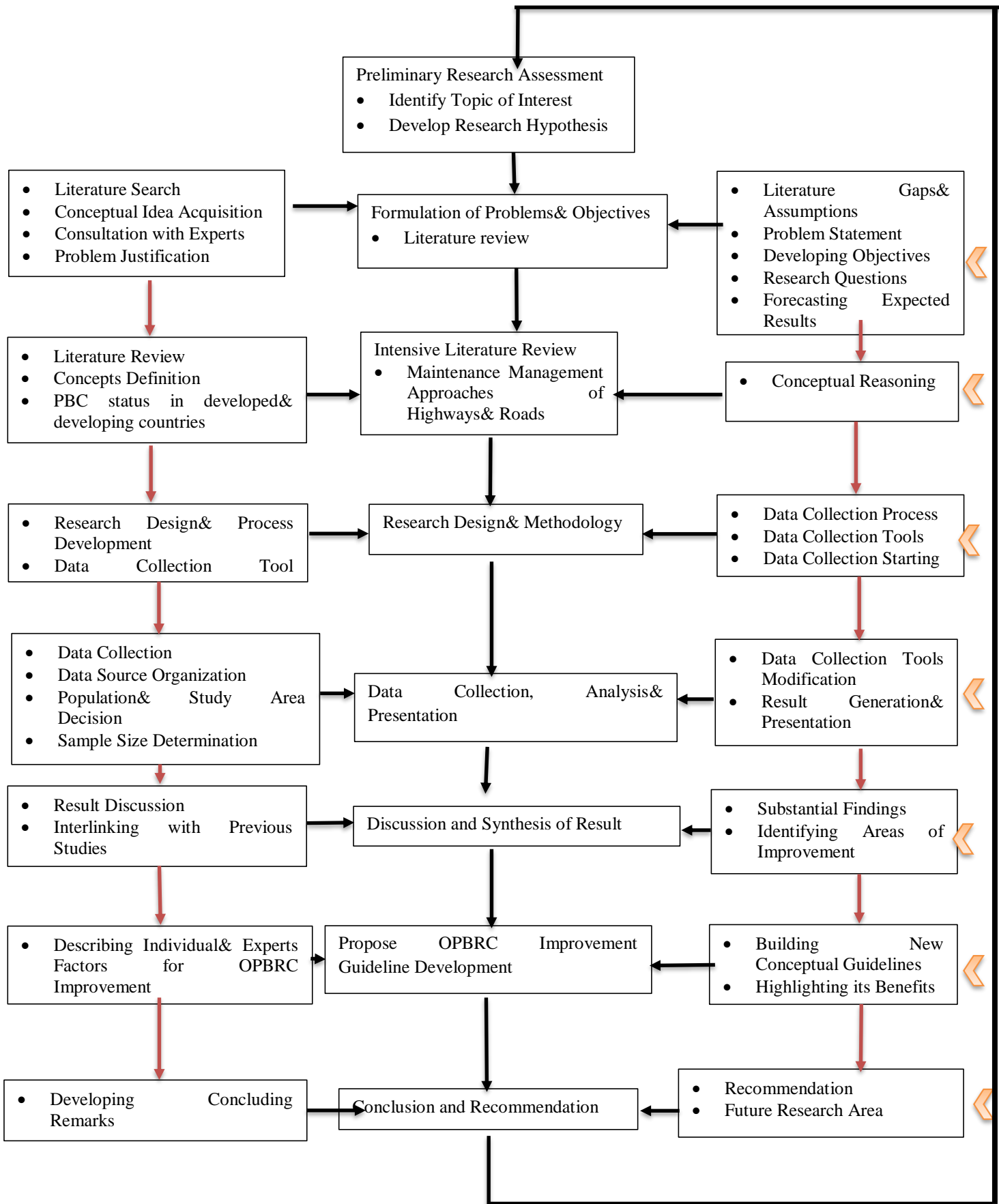


Figure 3.1: Research design of the study

### **3.3 Population**

The population of this study is finite population that comprises individuals using Dar es Salaam rapid transit agency (DART) road and those responsible in maintenance management of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure under output and performance based of road contract (OPBRC). They include project manager from road authority (TANROADS-Dar es Salaam regional office), road manager from private contractor and DART users includes drivers and commuters.

#### **3.3.1 Sampling design**

The sampling method employed for this study is purposive sampling and convenient sampling methods. The non-probability sampling approach used targets a specific set of people found to possess the known characteristics. The techniques and procedures adopted by researcher aimed to study about maintenance of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure from the people responsible for the project and generation of new insight through in-depth investigation from reliable and appropriate source (Merriam and Tisdell, 2016). For drivers and commuters the convenient sampling method were employed due to the availability at a given time and their illingness to participate in the research.

#### **3.3.2 Sample frame**

The sample frame of the study is made of finite population that includes maintenance departments involved in Dar es Salaam bus rapid transit (DSM BRT) road infrastructure under output and performance based of road contract (OPBRC) from public road authority (TANROADS-Dar es Salaam regional office), private contractor and Dar es salaam rapid transit agency (DART) users include passengers and drivers.

### **3.4 Sample size**

Sample size determination depends on the research design employed for instance the use of purposive sampling encounter difficulties in early stages of identifying sample size, but continuing use snowballing procedures until a saturation point reached then size were determined (Dawson, 2009).

*Table 3.1: The respondents' sample*

<b>Sample</b>	<b>Sampling Technique</b>	<b>No. Selected</b>
Project manager (from TANROADS Dar es Salaam regional office)	Purposive sampling Project manager responsible for the maintenance of BRT road under OPBRC contract, who represent client's side	01
Road manager (Becco Ltd)	Purposive sampling Road manager responsible for daily maintenance schedule representing contractor's office	01
DART drivers	Convenient sampling Employed DART drivers always using BRT components representing users' perceptions	15
DART passengers	Convenient sampling Commuters traveling using DART buses representing users' perceptions	20
Practitioners	Purposive sampling Senior maintenance practitioners under PMMR projects executed in 2000's in Tanzania regions, representing experts attitudes.	07

### **3.5 Research instruments**

This study employed three tools in collection of data namely; document review, interview and observation. The three mentioned tools enhance confidence of findings through triangulation. Triangulation promotes converging evidence from different sources and strengthen credibility of a study through collecting information from multiple sources using multiple techniques for verification of the same phenomenon (Yin, 2016 and Creswell & Creswell, 2018).

To understand the application of output and performance-based of road contract (OPBRC) on maintenance management of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure, data evaluation sheet for year 2019 and 2020 respectively were accessed and studied. Other contract related documents like OPBRC guideline, OPBRC maintenance contract, notice of operations, reminding letters, data evaluation sheets and monthly progress reports were reviewed with focus to assess the performance trend of a contractor.

#### **3.5.1 Document reviews**

The researcher manage to review various performance-based contract related documents like reminding letters, notice of operation, minutes of official meetings and montly progress reports with evaluation sheet and collect part of the general condition of contract. Document reviewed (data sheet, see appendix 6) provided the researcher with useful information that assisted to understand the roots causes of issues under study. This

enabled generation of interview guide and observation guide on maintenance condition of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure.

*Table 3.2: A list of documents reviewed for assessment of performance-based contracts*

<b>Documents Selected</b>	<b>Data Analyzed</b>
Contract document	Study on stakeholders' responsibilities on execution of contract
OPBRC Guideline by World Bank	Check on compliance of WB guidelines to Tanzania's context
Letter of reminders	Relationship between road authority and contractor on implementation of contract
Monthly progress reports& data sheet	Contract milestone report and evaluation report
Notice of Practice	Requests for execution of maintenance activities

### **3.5.2 Interview**

To understand maintenance management of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure under performance-based contract using purposive sampling technique, participants were chosen basing on their level of expertise, working area and roles in roads and highways maintenance sector (contractors and consultants). These includes Project Manager of Dar es Salaam bus rapid transit from (TANROADS Dar es Salaam regional office), Road Manager from procured private contractor and performance-based contracts maintenance experts who were purposively selected. On the other hand, convenient sampling applied to Dar es Salaam rapid transit agency (DART) users (like commuters and drivers), for inclusion because they were easily accessible and willingly to participate in the research at a given time. Two sets of interview questions were prepared based on findings from review of existing literature. One set of structured interview were prepared for professionals (project manager, road manager, contractor and consultants) and the second set to semi structured interview for DART drivers and commuters who are the users of this road infrastructure under study.

#### **Structured interviews**

The formal questionnaires were prepared and target population were selected basing on the experience, participation, working area and their role in the maintenance management as road authority, maintenance contractor and maintenance experts (Bordens and Abbott, 2011). This aims to share experience and collect expert's opinions on maintenance of pilot projects under performance-based approach on highways (previously PMMR pilot project Tanzania) and their perceptions towards maintenance of Dar es Salaam bus rapid transit road infrastructure under contract. In additional, output and performance based of

road contract (OPBRC) stakeholders such as road authority (TANROADS Dar es Salaam regional office), and procured contractor responded to questionnaires on maintenance status, challenges, adoption strategies and improvement tactics employed to improve their performance on maintenance management of Dar es Salaam bus rapid transit road infrastructure under performance-based contracting.

### **Semi-structured interviews**

This study employed semi-structured interview to DART users (commuters and drivers), whereby the approved interview questionnaires then was translated to vernacular language (Swahili) to enable respondents understand and communicate easily. The interview guide was prepared to keep an interviewee focus on the themes covered during the interview that need to be learnt that is flexible, accessible and allows style modification, pace and ordering of questions to raise the full responses in their own term (Qu and Dumay, 2011). The interview was conducted at Kivukoni, Kimara, Morroco and Gerezani terminals, several other intermediate bus stations (Kibo to Korogwe and Kisutu) to acquire users' perceptions regarding maintenance condition of Dar es Salaam bus rapid transit road infrastructure.

### **3.5.3 Observations**

This study employed participant observation, whereby it requires a researcher's participation to play a number of roles and techniques using five human's sense of organs for selection, recording and encoding, to unravel the complexity of a phenomena using observation guide (Creswell and Creswell, 2018). The observation guide (data evaluation sheet) assisted a researcher to take pictures and record videos, then clarifications from contractor on existing physical characteristics and maintenance conditions of the road infrastructure. For observation checklist for maintenance of BRT road infrastructure under OPBRC, see appendix 5.

### **3.6 Data analysis**

This study employed content analysis that involves consolidating, reducing, and interpreting what respondents said and what a researcher has seen and read in relation to study problem (Leavy, 2017 and Merriam and Tisdell 2016). In content analysis a systematic investigation of documented human communications or texts for understanding of the meanings that circulate in text. It involves sequential steps followed from specific to general and involve multiple levels of analysis such as organization and

preparation of data for analysis. The next is coding by organizing data through connecting chunks and writing words representing a category in the margins then generating descriptions and themes. The use of logical procedures explains and depict, compress, summarize and assess data depending on the collection tool used and writing up of results were all parts of the data analysis (Shamoo& Resnik, 2003 and Creswell& Creswell, 2018).

### **3.6.1 Analysis of interview**

Since qualitative interview aimed at gathering information about interviewee experience, views and beliefs, in which the researcher employed content analysis. Then analyzed through processes like data reduction for transcription, simplification and focus. The data presented by means of graphs to show relationships, similarities and verification that includes conclusion and explanation (Ryan et al., 2009).

### **3.6.2 Analysis of documentary reviews**

Document analysis is a systematic procedure for reviewing and evaluating study related documents (printed and electronic materials) in order to gain first-hand knowledge and generate meaning. It involves reading, understanding and interpretation process used for exploration of large amount of textual information to determine trends and pattern of words used, their frequency, their relationships and structure (Bowen, 2009).

This study employed inductive content analysis approach in organizing information into categories related to study, with a purpose to describe characteristics of documents content since no previous study conducted on maintenance of Dar es Salaam bus rapid transit road infrastructure (Mojtaba, 2013). The analysis of documents consisted of preparation part includes collection of data, making senses of the data and selection of unit of analysis. Then organization part involves open coding and creating categories. Lastly, abstraction part or research phenomenon that deals with reporting of results to reduce concepts (Thomas, 2006).

### **3.7 Ethical considerations**

A study by Bordens and Abbott (2011) says that ethical involves informing participants about the study and get consent to participate after been reviewed for safety, well-being, dignity and right of participants protected. The study activities observed ethics through ensuring privacy protection of respondents by not collecting personal identifiable



information to ensure confidentiality of ongoing maintenance contract and treatment of collected data with strict secrecy and assurance of data gathered could be useful for academic purpose only. Furthermore, the study was approved by the ethical review board of Ardhi university and received permission from TANROADS management and DART management.

### **3.8 Validity and reliability**

The accuracy of study with method measures what was intended to be measured through careful attention to study conceptualization and ways data were collected, analyzed, interpreted and presentation of findings that truly represents reality (Merriam and Tisdell, 2016). The questionnaires were validated through consultation with research supervisor and maintenance engineer. Respondents were given draft copies of questionnaires with the aim to critical examine the appropriateness of items, language used, instruments and arrangements.

The validity of the study enhanced by using triangulation, whereby multiple methods (interview, document review and observation) and multiple sources of data used to confirm findings. Findings gathered from respondents checked against what observed on site and read about in document reviewed. Reliability means the extent to which the research instruments yield consistent results under several repeated trials (Creswell and Creswell, 2018).

### **3.9 Chapter Summary**

This chapter has presented the methods used in conducting the study, by explaining the exploratory cross sectional research design adopted. Study population and sample frame and procedures used in designing instruments and collection of required data have been described. A combination of interview, document review and observation schedule assisted the researcher to collect both primary and secondary data. Content analysis was used in evaluating the value of the dependent and independent variables in the data set in respect to the objectives. Objectives related to implementation of maintenance contract of road infrastructure was analyzed by means of content analysis. The data related to challenges encountered by contract sides on execution of maintenance management was objective two, and analyzed by means of content analysis. The next chapter will cover data analysis, results and discussion of results.

## CHAPTER FOUR DATA ANALYSIS, RESULTS AND DISCUSSION

### 4.1 Introduction

This chapter describes how data was presented, analyzed and interpreted based on information obtained through document reviews, interviews and observations. Subtitles outlined in accordance to objectives of the study. Data collected from reviewing documents related to contract execution, observations of the real maintenance condition of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure and interviewing respondents on related maintenance condition.

### 4.2 Data collection

The structured interview was planned to 09 respondents, whereby 08 respondents were interviewed who are project manager, road engineer and maintenance experts. The response rate equals to 88% of the population, which suggest the appropriateness of the study, (Mugenda and Mugenda, 2003).

*Table 4.1: A table for structured interview conducted.*

<b>Respondents</b>	<b>Planned Interview</b>	<b>Actual Interview</b>
Project Manager	01	01
Road Manager	01	01
Maintenance Engineer/ Consultants	07	06
	09	08

For semi-structured interviews about 25 respondents were interviewed and responded well.

*Table 4.2: A table for semi-structured interview conducted.*

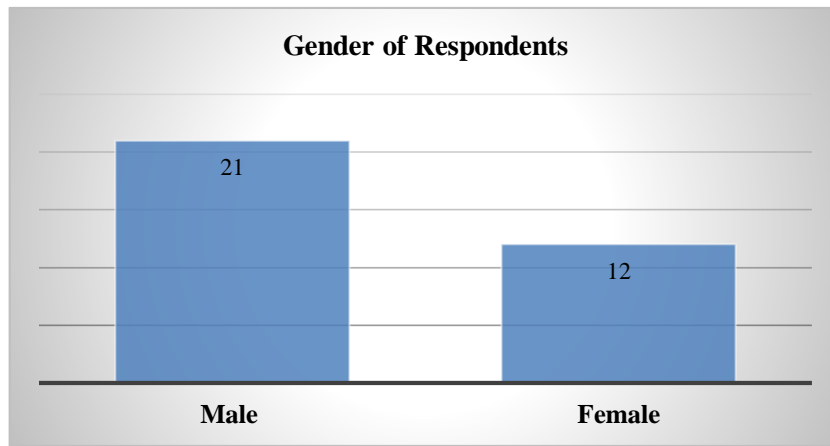
<b>Respondents</b>	<b>Interview Response</b>
Commuters	16
Drivers	09
	25

### 4.3 Data analysis

The primary data analysis started from the field prior intensive analysis basing on saturation occurs when continuing data produces no new information or insight into the phenomenon studied (Merriam and Tisdell, 2016).

### 4.3.1 Background of the respondents

This section discusses result relating to background of respondents, which includes gender and designation, whereby results presented in figure 4.1 and figure 4.2. From figure 4.1, the majority of respondents are male.



*Figure 4.1: Gender of respondents*

Results in figure 4.2 reveal that majority have experience of above 15 years followed by those experienced to range of 5 to 15 years.



*Figure 4.2: Professional experience of respondents*

### 4.3.2 Implementation of performance-based contract

The assessment of maintenance management of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure, evaluating existing documents that relate to execution of maintenance contract under performance-based approach. The issued and examined document include interim payment certificates, notice of operation and monthly progress

reports for the years 2019 and 2020. The amount of payment and penalty issued by authority to contractor's compliance in each road section per month, then were extracted from interim payment certificates which developed from data evaluation sheet (see appendix 6) for each road section. The findings collected from documents are presented in Table 4.3 to Table 4.9 are the summaries of each month progress of contract performed for the year 2019 and 2020. Equally, to table 4.3, column 4 and 5 presents annual non-complied kilometers in the given year 2019 and 2020 respectively. Column 2 for road section 1 has 5kms of road to be maintained per month, then column 3 presents 60kms presents (100%) compliance expected to be maintained per annum. Since the result of non-complied road kilometers in each road section varies, then were ranked from number (1-9) depending on the higher percentage (%) scores of non-compliance recognized.

Furthermore, first two higher ranked road section were chosen and in-depth study were conducted to recognize causative of non-complied road kilometers.

*Table 4.2: 2019 and 2020 annual non-compliance of road Kilometers for maintenance of BRT road*

Road Section	Kilometers maintained (km/month)	Kilometers complied (Kms/annum)	Kilometers Non Complied				Remarks (nr)	
			Kms per annum		Percentage per annum			
			2019	2020	2019	2020	2019	2020
Section 1	5	60	12.65	11.9	39.14%	39.14%	1	1
Section 2	0.5	6	0.12	0.102	0%	0.34%	9	9
Section 3	3.9	46.8	11.61	10.22	35.92%	33.61%	2	2
Section 4	1.46	17.52	2.044	2.3	6.32%	7.56%	4	4
Section 5	0.82	9.84	1.05	0.98	3.25%	3.22%	5	5
Section 6	0.88	10.56	0.267	0.2	0.83%	0.66%	8	8
Section 7	1.94	23.28	0.854	0.72	2.64%	2.37%	6	6
Section 8	2.57	30.84	2.981	3.431	9.22%	11.28%	3	3
Section 9	1	12	0.745	0.552	2.31%	1.82%	7	7
<b>TOTAL</b>	<b>18.07</b>	<b>216.84</b>	<b>32.321</b>	<b>30.405</b>	<b>100.00%</b>	<b>100.00%</b>		

Table 4.4 presents road section 1 (Magomeni Police Bus Station to Ubungu Bus Terminal) non-compliance scores that each month (January to December) 2019 score in

relation to service level (usability, durability, general and road safety), 1.15km of 5kms penalized January of 2019 and 0.95kms penalized as well out of 5kms maintained.

*Table 4.3: Road section1 (2019) annual non-complied road Kilometers*

Service Level	January	February	March	April	May	June	July	August	September	October	November	December	Total
Usability	0.4	0.45	0.5	0.5	0.45	0.45	0.4	0.35	0.35	0.3	0.3	0.3	4.75
Durability	0.5	0.5	0.5	0.45	0.45	0.45	0.4	0.4	0.35	0.35	0.4	0.35	5.1
Road Safety	0.2	0.15	0.15	0.15	0.15	0.15	0.15	0.2	0.2	0.2	0.2	0.25	2.15
General	0.05	0.05	0.08	0.07	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.65
	1.15	1.15	1.23	1.17	1.1	1.1	1	1	0.95	0.9	0.95	0.95	12.65

Table 4.5 presents each month (January to December) 2020 scores of road section 1 (Magomeni Police Bus Station to Ubungu Bus Terminal) that shows the growing non-compliance scores from contractor's performance led by durability, usability and road safety from 0.945kms out of 5kms in January to 1.01kms out of 5kms that penalized in that road section.

*Table 4.4: Road section1 (2020) annual non-complied road Kilometers*

Service Level	January	February	March	April	May	June	July	August	September	October	November	December	TOTAL
Usability	0.3	0.35	0.35	0.35	0.35	0.35	0.3	0.3	0.35	0.35	0.3	0.3	3.95
Durability	0.35	0.35	0.35	0.35	0.4	0.4	0.5	0.5	0.55	0.55	0.5	0.5	5.3
Road Safety	0.25	0.25	0.2	0.2	0.2	0.15	0.15	0.15	0.15	0.18	0.18	0.18	2.24
General	0.045	0.04	0.04	0.035	0.035	0.035	0.03	0.03	0.03	0.03	0.03	0.03	0.41
	0.945	0.99	0.94	0.935	0.985	0.935	0.98	0.98	1.08	1.11	1.01	1.01	11.9

Table 4.6 presents findings collected from IPC documents for road section 3 (Kibo Bus Station to Kimara Bus Terminal). The non-compliance scores found to vary by increasing and decreasing from January to December in 2020. Evaluation shows durability and usability contributed higher to non-compliance scores recorded during the study.

Table 4.5: Road section3 annual (2019) non-complied road Kilometers

Service Level	January	February	March	April	May	June	July	August	September	October	November	December	Total
Usability	0.35	0.35	0.35	0.3	0.3	0.38	0.35	0.4	0.35	0.35	0.35	0.35	4.18
Durability	0.5	0.5	0.45	0.45	0.45	0.45	0.4	0.4	0.4	0.35	0.35	0.35	5.05
Road Safety	0.2	0.2	0.2	0.15	0.15	0.15	0.15	0.17	0.15	0.13	0.15	0.15	1.95
General	0.05	0.03	0.03	0.05	0.02	0.02	0.02	0.05	0.04	0.04	0.04	0.04	0.43
	1.1	1.08	1.03	0.95	0.92	1	0.92	1.02	0.94	0.87	0.89	0.89	11.61

Table 4.7 reveals that in year 2020 (January to December), usability, durability and road safety contributed to non-compliance scores for the road section 3. The scores of penalties imposed is decreasing with an increase in contract execution's experience.

Table 4.6: Road section 3 annual (2020) non-complied road Kilometers

Service Level	January	February	March	April	May	June	July	August	September	October	November	December	Total
Usability	0.35	0.35	0.33	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.27	0.27	3.67
Durability	0.35	0.4	0.4	0.4	0.37	0.35	0.35	0.35	0.3	0.3	0.3	0.3	4.17
Road Safety	0.15	0.15	0.15	0.18	0.18	0.15	0.15	0.15	0.2	0.2	0.2	0.15	2.01
General	0.05	0.05	0.05	0.03	0.03	0.03	0.02	0.01	0.02	0.02	0.03	0.03	0.37
	0.9	0.95	0.93	0.91	0.88	0.83	0.82	0.81	0.82	0.82	0.8	0.75	10.22

Table 4.8 presents in details the contractor's non-compliance scores recorded in each key performance indicators evaluated to that particular road section 1 (Magomeni police bus station to Ubungo terminal) for the year 2019 and 2020. The result shows that cleanliness of road surface contributes about 21% of non-compliance in 2019 and 20% in year 2020, followed by functionality of road signs, marking and furniture then drainage system, which show greater non-compliance scores to set key performance indicators established.

Table 4.7: Road Section 1 non-compliance

Service Level Criteria	Compliance Criteria	Kms non-Complied per Annum (Km)		Perc. non-Complied per Annum (%)	
		2019	2020	2019	2020
Usability	Potholes	1.2	1.05	9%	9%
	Patching	0.8	0.35	6%	3%
	Cleanliness of road surface	2.6	2.35	21%	20%
	Rutting	0.01	0.01	0%	0%
	Incident response & emergency works	0.09	0.24	1%	2%
Durability	Cracking	1.2	1.55	9%	13%
	Multiple cracks	1	0.75	8%	6%
	Concrete rigid pavement surface damages	0.15	0.1	1%	1%
	Concrete pavement slab movements	0.01	0.01	0%	0%
	Concrete pavement joint sealant	0.35	0.25	3%	2%
	Raveling	0.01	0.01	0%	0%
	Loose pavement edges	0.02	0.01	0%	0%
	Drainage system	1.5	1.4	12%	12%
	Bridge routine maintenance	1.1	1.12	9%	9%
	Embankment and cut slopes	0.05	0.05	0%	0%
Road safety	Functionality of road signs, marking and furniture	2.18	2.24	17%	19%
General	Shoulder & verge maintenance	0.27	0.28	2%	2%
	Vegetation control	0.11	0.13	1%	1%
<b>TOTAL</b>		<b>12.65</b>	<b>11.9</b>		

Table 4.9 represents findings of road section 3 (Kibo Bus Station to Kimara Bus Terminal) among the volume of data collected and assessed from procured contractor and road authority's office then description of road sections rated or score higher non-complied kilometers from the data found in the contractor's office during document review. The evaluation of findings shows that in road section 1 (Magomeni police to Ubungu Terminal) cleanliness of road surface contribute to an average 20% of contractor's non-compliance in performance of contract. The second compliance criterion found to be functionality of road signs, marking and furniture that contributed to an average 18% for two years in non-complied kilometers, while drainage system has average 16.5% contribution to contractor's non-compliance.

Table 4.8: Road Section 3 non-compliance

Service Level Criteria	Compliance Criteria	Kms non-Complied per Annum (Km)		Perc. non-Complied per Annum (%)	
		2019	2020	2019	2020
Usability	Potholes	1.2	1.01	10%	10%
	Patching	0.2	0.1	2%	1%
	Cleanliness of road surface	2.5	2.3	22%	23%
	Rutting	0.01	0.01	0%	0%
	Incident response & emergency works	0.27	0.25	2%	2%
Durability	Cracking	2	2	17%	20%
	Multiple cracks	0.5	0.3	4%	3%
	Concrete rigid pavement surface damages	0.02	0.02	0%	0%
	Concrete pavement slab movements	0.01	0.01	0%	0%
	Concrete pavement joint sealant	0.2	0.12	2%	1%
	Raveling	0.01	0.01	0%	0%
	Loose pavement edges	0.01	0.01	0%	0%
	Drainage system	1.8	1.25	16%	12%
	Bridge routine maintenance	0.4	0.35	3%	3%
	Embankment and cut slopes	0.1	0.1	1%	1%
Road safety	Functionality of road signs, marking and furniture	1.95	2.01	17%	20%
General	Shoulder & verge maintenance	0.3	0.3	3%	3%
	Vegetation control	0.13	0.07	1%	1%
<b>TOTAL</b>		<b>11.61</b>	<b>10.22</b>		

The observation conducted with regard to observation guide (see Appendix 5) formulated from findings discovered during document review. The maintenance condition of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure was assessed in regard to service level criteria such as usability, durability etc. Furthermore, conditions of performance indicators like potholes, patching, cleanliness of road surface, road signs, markers and furniture, cracks and multiple cracks were recorded by means of photographs and videos for road sections 1 and road section 3. The existing maintenance condition was then presented in Figures 4.3 to 4.8 here below.





*Figure 4.3: (a) multiple cracks, (b) damaged bollards in BRT road*



*Figure 4.4: (a) Concrete road patch repaired with sand cement pavers, (b) damaged bollards and un-painted zebra crossing (markers) in BRT road.*



(a)



(b)

*Figure 4.5: (a) Vegetation grows in pavement, (b) rehabilitation of road cracks at Kibo bust station.*



(a)



(b)

*Figure 4.6: (a) and (b) Inspection chamber covered by vehicular tire in BRT road at DIT-Jiji bus station.*



*Figure 4.7: (a) and (b) the uncleansed road surface caused by informal wastes management and vendors' activities taking place along the BRT road infrastructure*



*Figure 4.8: (a) and (b) untimely response to defects increases the magnitude of defects on road shoulders*



*Figure 4.9: Di-siltation of Msimbazi River at Jangwani flood plain.*



*Figure 4.10: Pedestrians found crossing BRT road in non-zebra crossing area in Manzese.*

### **4.3.3 BRT road users' perceptions**

Table 4.10 presents bus rapid transit (BRT) road users' (passengers and drivers) attitudes towards maintenance condition of the Dar es Salaam bus rapid transit (DSM BRT) road infrastructure. Respondents were closely guided during the interview to focus on the need for the study mainly on maintenance condition of bus rapid transit road infrastructure

(BRT traffic lane, furniture etc.) in order to avoid possible misunderstanding and misinterpretation from other DART infrastructure like stations and terminals. The following table 4.10 shows assessed Dar es Salaam bus rapid transit (DSM BRT) components under performance-based contracting.

*Table 4.9: The users' perceptions on the following BRT components maintained under OPBRC contract*

Components of BRT Road Infrastructure	Maintenance Condition		
	Good n (%)	Average n (%)	Un-Satisfactory n (%)
Sidewalks	13 (52%)	05 (20%)	07 (28%)
Waste vessels	02 (08%)	04 (16%)	19 (76%)
Grass cutting, shrubs and green areas	23 (92%)	0 (0%)	02 (08%)
Overall cleaning, sand and general debris	14 (56%)	04 (16%)	07 (28%)
Road furniture (bollards)	15 (60%)	05 (20%)	05 (20%)
Road markers	15 (60%)	09 (36%)	01 (04%)
Road pavement condition	22 (88%)	03 (12%)	0 (0%)
Open drainage system	18 (72%)	05 (20%)	02 (08%)
Manholes covers	02 (08%)	04 (16%)	19 (76%)

Respondents satisfied with maintenance condition of bus rapid transit (BRT) components assessed, particularly out of 25 BRT users (drivers and commuters) interviewed more than 13 respondents were satisfied with good maintenance conditions, meanwhile waste vessels and manholes cover maintenance condition were not in good maintenance condition hence respondents were un-satisfied.

Furthermore, users' comments regarding the maintenance conditions of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure on are follows: Firstly, frequent floods and overflows at Jangwani plain caused by heavy rains in uplands area cause impassability of road, spread of muds and garbage on road surface, while destroying road furniture to un-maintainable state. The improper use of BRT road by users (pedestrians and motorists) cause accidents and destruction of BRT road furniture like bollards. Nevertheless, delays in attending or repairing of defects by contractor increases the size of defect or fracture of road furniture, pavement condition and drainage system hence inability or costly to restore it to required condition. Safety measures was observed by contractor on unrepaired areas or areas under maintenance at Kibo bus station, Kisutu bus station, Jangwani area and Baruti bus station, expose road users and maintenance crew to risks.

To sum up, absence of collection bins or trash bins was revealed by commuters to increase the uncleansed condition of BRT road surfaces and un-covered drainage system been stolen by passers-by or surrounding community hence hardship in management of wastes. The same, proximity of informal vendors' kiosks and BRT road structures cause inability to maneuver or diversion in case of emergency occasion or during attending road defects.

#### **4.4 Challenges encountered by contractor on execution of maintenance contract**

This study section presented findings gathered during the exploration of challenges encountered by stakeholders (road authority and contractor) during execution of pilot project on maintenance management of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure under output and performance-based of road contract approach.

##### **4.4.1 Challenges encountered during implementation of contract**

The procured contractor response shows that there are challenges faced contractor during implementation of maintenance contract (OPBRC pilot project contract) that includes:

To start with, encroachment of roadside walks and service lanes by informal vendors (machinga) throw garbage to road components like drainage systems hence increase hardship on attending daily cleanliness of road surface and affect surface water flows during the rainy seasons.

Secondly, hardship in maintaining some parts of road section due to existing road design condition like presence of median strip and mixed traffic lane at bus stations that cause inability to attend defects. At Jangwani area during rainy season, road closure occurred due to blockage of drainage channel allow for di-siltation; while at some point infrastructure become destroyed beyond unrepairable condition. Thirdly, heavy traffic hinders maintenance in some parts of road sections such as road section 3 (Kibo to Baruti bus stations) create difficulties in repairing of cracks and potholes due to intersection of traffic lanes at a very narrow road strip. On the other hand, less corporation from surrounding community such as vendors cause difficulties in controlling garbage and improper wastes control which cause blockage of drainage channels and uncleansed road surface.

Moreover, the design specifications obstruct fast reaction to problems such as concrete surface that requires enough curing days (21days) prior to reopening for normal traffic usage after repair. In addition, hardness of concrete bed constructed cause hardship to repair cracks with respect of contract condition (client's requirement) that instructed a patch to be in square or rectangular while ensuring continuous traffic flow, use similar materials specified to repair road defects (cracks, multiple cracks and potholes).

#### **4.4.2 Challenges encountered by the client during implementation of maintenance contract**

The road authority stated the challenges encountered on maintenance of Dar es Salaam bus rapid transit road infrastructure as follows:

- i. Floods problems at Jangwani area cause hardship to contractor's compliance in attending road sections during heavy rains that destruct road furniture and cause impassability.
- ii. Slow work progress executed by the contractor on attending road defects like cracks at road section 3 (Kimara Terminal to Kibo Bus Station), influenced by untimely response to event that are beyond tolerance permitted that decrease contract compliance scores.
- iii. Contractor's objectives that do not match with those of road authority. Despite being paid agreed rates to contract, road authority long-term objective is minimizing the whole life costs of assets that does not match with contractor's objectives who simply paid for repairing the defects as they occur while not necessary to contractor consideration on ways to minimize their recurrence.
- iv. The limited the staff capacity competence in management and monitoring of assets under output and performance-based maintenance contracts since Tanzania construction industry saturated with staff competent in engineering design, construction and not assets management.
- v. Untimely attendance to defects by contractor on repairing road defects events that increase the maintenance condition of Dar es Salaam bus rapid transit components.

#### **4.5 Enhancement of maintenance management of bus rapid transit road infrastructure**

Regarding perceptions of experienced maintenance practitioners with the aid of literature review, on enhancement of maintenance management of Dar es Salaam bus rapid transit

road infrastructure consider three contract phases of pre-contracting, contracting and post-contracting phases as follows.

*Table 4.11. The proposed maintenance management approaches to improve maintenance management of bus rapid transit*

Pre-Contracting Phase	Contracting Phase	Post- Contracting Phase
<ul style="list-style-type: none"> <li>•Build industry capacity interms of organizational structure and right skills to private sector</li> <li>•Conduct workshops and large group meeting to discuss issues of applicability of the sample bidding document</li> <li>•Conducting meeting with government agencies, contractors and consultants to identify issues to be adopted and mitigated once contract document developed</li> <li>•An exstensive training across the whole industry prior embracing upon a new contracting system</li> </ul>	<ul style="list-style-type: none"> <li>•Conduct regular training, seminars workshops to enhance capacity of practitioners</li> <li>•Conduct consortium approach to promote efficiency of contract implementation and supervision as well</li> <li>•Formation of decision supporting system for management of assets</li> <li>•Ensure timely attendance to defects and do not entertain backlog tendencies</li> <li>•Proper inspection and monitoring procedures</li> </ul>	<ul style="list-style-type: none"> <li>•Reviewing of industry structure and skills output</li> <li>•Review of specification and standards of maintenance guidelines and manuals</li> <li>•Reviewing of budgetary issues (budget allocation)</li> <li>•Analysis of maintenance milestone attained</li> <li>• Continuously improving local industry capacity</li> <li>•Review and recording of maintenance works</li> <li>•Propose areas of improvement for coming contracts.</li> </ul>

Though road agency has attained a number of advantages in maintenance management of bus rapid transit road infrastructure, respondents (practitioners and maintenance experts) had the following observations for improving the Dar es Salaam bus rapid transit (DSM BRT) road infrastructure under output and performance based of road contracting. By considering different stages of contract such as Pre-contracting, contracting and post-contracting phases.

Starting with pre-contracting phase, there should be check on industry capacity in terms of organizational structure of road authority (TANROADS) and check on right skills to private sector (contractors and consultants). Consultation between the government and industry participants in order to gain a thorough understanding of local conditions through workshops and meetings. Conducting research with government agencies, BRT stakeholders, contractors and consultants to identify specific issues require mitigation



once developing contract document and estimating the value of contract that best fit local capacity.

Contracting phase; regular training, seminars and workshops to improve capacity of practitioners. Adopting consortium approach to promote efficiency through problems solutions, decision supporting system for basic assets management concepts such as life cycle costing and ensuring assets management planning are in practice. The need for management board for jointly supervision and evaluation of contract to improve contract management and reduce disputes between parts. Emphasis on timely delivery of defects and no entertainment for backlogs. Another comment on proper procedures for implementation, monitoring and evaluation of maintenance activities was to enhance transparency and accountability. Correspondingly, suggested that there should be separation of emergency contract from main OPBRC allowing involvement of sub-contractors to enhance capacity building and remove monopoly of contractor in the field of performance-based contracts. Lastly, engagement of specialized maintenance contractors competent in road assets management alternative to major construction companies experienced in design and construction of new roads and not in routine maintenance activities.

The post-contracting phase should involve evaluation of milestone attained, conducted jointly by stakeholders of pilot project. These include reviewing the performance of organization structure, and skills of local practitioners involved in executing contract, reviewing of specifications and standard of maintenance guidelines and manuals, reviewing of budgetary issues (planned vs spent), analysis of maintenance milestone attained particularly on service level and assets conditions. Furthermore, continuously improvement to local industry capacity, review and recording of maintenance works and suggestions to improve the other coming contracts.

## **4.6 Discussion of Results**

The discussion of findings of this study in relation to each of the specific objectives compared with the literature review as follows.

### **4.6.1 Examination on implementation of maintenance contract**

The objectives were reviewed the maintenance condition of all nine-road sections of bus rapid transit and eighteen road components assessed. The study exposed that cleanliness

of the road surface, functionality of road signs, marking, furniture and drainage system contributed to non-compliance scores recorded and evaluated by road authority.

Generally, maintenance condition is good despite some parts of road sections three (3) that faced un-attended defects like multiple cracks. The findings show higher demerit points scored during evaluation influenced by: Contractor's inexperience on similar contract type (OPBRC). Also, road authority's incapacity to monitor contractor's performance. Studies suggest close monitoring of contract by road authority through joint inspection, informal inspection, training and seminars promote efficiency and effectiveness of contractor to implement contract by timely attending road defects (Sultana et al., 2012 and (Stankevich et al., 2005).

A study established that well trained staff both road authority's staff and contractor's staff increase their capacity to execute, monitor and manage maintenance contract. A similar notion supported by Jooste et al., (2009) that underperformance and mismanagement of pilot project output and performance based of road contract decrease with an increase in execution of contracts over time, experience and training, workshops and seminars offered to maintenance team.

Lastly, floods at Jangwani area during rainy season caused destruction of road components and temporary road closure. On the other hand, influence of surrounding community for instance encroachment of road sidewalks by informal vendors (machinga), improper wastes management by passers-by and passengers and trash bins been stolen caused incompliance of maintenance contract. Likely study by (Glas et al., 2019 and Stankevich et al., 2005) found that OPBRC maintenance contracts is associated with several risks like environmental risks, political risks, misbehavior risks etc. that has effects on compliance and performance of maintenance management contracts.

#### **4.6.2 Challenges encountered on execution of maintenance contract**

The study revealed that maintenance of Dar es Salaam bus rapid transit road infrastructure under output and performance based of road contract (OPBRC) approach is facing a number of challenges during implementation. They include.

Firstly, lack of technical capacity in terms of skills and expertise of both contractor and road authority executed OPBRC contract, reinforced by Al-Kathairi and El Halim (2014) study that contractor's technical capacity might cause errors in prediction of assets repairing, determining appropriate design and specifications, planning for maintenance intervention well performed under traditional method.

In addition, growing of unimpressed performance by contractor on attendance of road defects events as instructed by the contract influenced by the incompetence of self-control unit or department, and absence of morale. A similar scenario has been discussed by Sultana et al., (2012) on contractor's self-assessment, internal auditing of contractor, formal monthly inspection, informal inspection by road authority and users' complaints system.

The unsatisfactory performance reported due to road design challenges like presence of median strip and size of road at mixed traffic lane. This caused congestions during maintenance and inability to divert vehicles to service lane influenced by existing design (narrowness of BRT lane, median strip and mixed traffic lanes at road section 3). On the other hand, specifications of similar repairing materials requirements, as concrete requires curing period prior to opening the road for traffic. Or else hardness of maintaining (cutting and drilling reinforced concrete) while maintaining instructed shape of patches (rectangle or square shaped) affect contractor's attendance to road defects observed. Similarly, Jooste et al., (2009) found that technical failures encountered by maintenance contractors under performance-based contract greatly influenced by poor feasibility study conducted, and incompetent contractors that caused failure to plan for required maintenance in long-term contracts.

#### **4.6.3 BRT road users' perceptions on maintenance of Dar es Salaam bus rapid transit**

The perception of users (commuters) on maintenance condition of road infrastructure shows satisfactions of road pavement condition, greenery maintenance condition and waste vessels, unlike DART drivers mentioned road components like multiple cracks, manhole covers and road surface cleanliness.

The findings from interview conducted to respondent (road users) showed that they were satisfied with the maintenance condition of Dar es Salaam bus rapid transit (DSM BRT)

road infrastructure, despite the minor aspects that require more attention. This discussion made in relation to previous studies on performance-based approaches as follows.

Firstly, road users were satisfied with improved maintenance condition. This is similar to Sultana et al, (2013) who reported that satisfaction of maintenance condition of roads derived from outsourced road due to complaints on regular maintenance, costs of maintenance and the number of breakdowns recorded were small because of improved maintenance conditions of road.

The quality of materials (road paints) used to maintain such as marking road boundaries and zebra crossing easily fade away, henceforth need frequently repaint for passengers and passers-by safety. Additionally, repairing concrete lane requires enough curing period prior removing barriers. Likewise, the Jooste et al., (2009) shows key issues that caused the failure of performance-based contract in Chad was failure to take into account the lack of good materials intensified by unsuitable working methods and low quality equipment henceforth contractor fail to meet KPIs requirements (referred as technical failure).

Delay in attending road defects increases the magnitude of road defects like multiple cracks and road furniture destruction hence unsatisfactory maintenance condition of bus rapid transit road components. Additionally, unsatisfactory safety measures was observed on affected areas or areas under maintenance especially at road section 3, (Kibo bus station to Baruti bus station) and Jangwani area. Related discussion on performance monitoring by road authority on contractor's performance criteria and targets defined are met, timeliness of contractor's response to related events and safety procedures implemented to ensure minimal exposure to risk of accidents to road users and maintenance crew as well (Sultana et al., 2012).

#### **4.7 Enhancement of maintenance management of bus rapid transit road infrastructure**

Firstly, it recommended that assessment of industry capacity in terms of organizational structure of road authority (TANROADS) and check on right skills to private sector (contractors and consultants) could improve deliveries of the contract expected. Similarly, suggestion on the capability of practitioners in terms of working skills and finance studied

for assurance of local capacity, in case lack, then hired foreign experts for training (Manogaran et al., 2020 and Stankevich et al., 2005).

Moreover, by conducting regular and extensive training to contractors and consultants, could improve execution capacity of staff in performance-based contract works and all its whereabouts encourage involvement of multiple contractors during tendering hence fairness, competition and value for money. Similar observation suggests creation of necessity of using performance-based contract approach and handbook for local (Malaysian) construction industry standard minimizes technical failures, through annual seminars and workshops that assist on broaden knowledge and information to practitioners and obtain authentic knowledge (Anwar et al., 2016).

Nevertheless, outsourcing emergency contract from main output and performance-based of road contract during a pilot study could enhance capacity building of small and medium contractors, proper utilization of resources and remove monopoly of contractor in the field of performance-based contracts. The size and magnitude of emergency contract requires accumulation of resources, for instance at Jangwani flooding area where contractor devoted resources for di-siltation, while un-attending and unsatisfactory maintenance condition to road defects.

Correspondingly, Manogaran et al., (2020) study emphasize satisfaction with the number of contractors capable of carrying out road construction and maintenance works under performance-based approach to promote competition, fairness and value for money.

Contractor's integrity emphasis to overcome the challenges described caused by unfaithfulness attendance to contract. For instance, untimely response to road defects, unfaithfulness evaluation of the road maintenance condition for preparations of interim payment certificates and seriousness in attending defects due to assurance of payment a reasonable amount on each month even after being penalized. Correspondingly, Manogaran et al., (2020) study insists honest and strong moral principles to drive contractor on executing works as per specifications and requirements.

Finally, continuously improvement to local industry capacity, review and recording of maintenance works and suggestions to improve the other coming contracts. There should be assessment and evaluation of milestone attained, conducted jointly by stakeholders of

pilot project. These include reviewing the performance of organization structure, and skills of local practitioners involved in executing contract, reviewing of specifications and standard of maintenance guidelines and manuals, reviewing of budgetary issues (planned vs spent), analysis of maintenance milestone attained particularly on service level and assets conditions.

#### **4.8 Chapter Summary**

The challenges related to cleanliness of road surface, drainage system, functionality of road signs, marking and furniture, cracks and multiple cracks arise because of design and capacity. The next chapter draws conclusions of the study provide recommendations for action and suggest areas for further studies.

## **CHAPTER FIVE**

### **CONCLUSION AND RECOMMENDATIONS**

#### **5.1 Introduction**

This chapter presents conclusion drawn in from the study and the respondents' opinions that assisted the researcher to develop recommendations from the challenges identified and remarks suggested by professionals.

#### **5.2 Conclusion**

The study concludes that maintenance condition of Dar es Salaam bus rapid transit road infrastructure at several road sections are unsatisfactory. This is due to untimely attendance to road defects, floods problems at Jangwani and Msimbazi rivers, cleanliness of road surface, functionality of road signs, marking, furniture and drainage system are contributing challenges pronounced in the study area.

The study further found that road users (commuters and drivers) were satisfied with improved maintenance condition, though road defects were untimely attended, safety measures were not observed on affected areas and easily fade away of repainting materials need regular attendances.

Finally, the study suggests that in order to improve the maintenance management of Dar es Salaam bus rapid transit under performance-based contracts then engagement of specialized maintenance contractors and improvement of industry capacity through regular training, workshops and seminars to practitioners could improve industry capacity to implement the maintenance contract.

#### **5.3 Recommendations**

This study has several recommendations, which aims at enhancing the performance of maintenance management of Dar es Salaam bus rapid transit (DSM BRT) road infrastructure.

The study recommends the following:

- i. Road authorities should revise infrastructure development approaches and policy to allow for adoption of various development and operation approaches like Build, Operate and Transfer (BOT), Operate and Maintenance (MO), Design, Construct and Maintain Contracts (DCM), Build, Transfer and Operate (BTO) to enhance knowledge transfer from competent expertise at a reasonable cost.

- ii. Formation of consortium approach in pilot projects to facilitate the development of innovative project solutions like management of maintenance risks under OPBRC contract. Using specialized contractors and consultants in maintenance works could enhance competence in designing and building of new road infrastructure, as well design of maintenance plans, strategies, funds and policy in which they are competent.
- iii. Harmonization of stakeholders' objectives on maintenance management under output and performance based of road contracting (OPBRC) to minimize reoccurrence of defects and minimizing whole of life costs of road assets.
- iv. Assignment of emergency contract works to other contractor in order to enhance performance of maintenance particularly on pilot projects to enable commitment of resources on normal routine maintenance works instead of emergency works.
- v. Establishment of management board and decision support system for joint supervision and evaluation of ongoing contract and extensive training across the maintenance industry.

#### **5.4 Suggestions for Further Research**

The scope studied on maintenance management of bus rapid transit (BRT) road infrastructure phase one provide a necessity to conduct further studies. Further research should be on potential strategies for enhancement of performance of maintenance contract, effectiveness of private sector on maintaining roads infrastructure in developing countries.

- i. Further study should be on maintenance of DART infrastructure like terminals, stations and depot in order to achieve quality to modern BRT system.
- ii. Further study should focus on the lessons learnt from pilot PMMR projects conducted in early 2000's by TANROADS and their application on maintenance of DSM BRT.
- iii. More studies on post-contract achievement of pilot project has to conducted in order to identify the challenges and formulate means to overcome for fully employment of output and performance-based contracts.



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## **APPENDICES**

## **Appendix 1.**

### **Interview Schedule for Key Informants (highways Maintenance Experts under PMMR)**

This interview intends to gather data geared towards assisting Pallangyo, Frank B, with registration number HD/T.1385/2019, a Master of Science student in Construction Economics and Management (MSc. CEM) in the School of Building Economics, Ardhi University Dar es Salaam, for his research title “**Assessment of Maintenance Management of DSM BRT Road Infrastructure**”

**Declaration:** Information supplied herein are to be used only for academic purposes and will be treated with utmost confidentiality.

#### **A. GENERAL INFORMATION:**

- 1) Name/ Title of Respondent .....
- 2) Date of Interview.....
- 3) Experience on maintenance activities:
  - i. Less than 5years
  - ii. Between 5to 15 years
  - iii. More than 15years

#### **B. INTERVIEW QUESTIONS (1-8):**

- 1) What is your opinion on maintenance condition of Dar BRT road infrastructure?
  - i. Very Good
  - ii. Good
  - iii. Average
  - iv. Satisfactory
  - v. Unsatisfactory
- 2) How regular have you seen maintenance of Dar BRT executed?
  - i. Frequently
  - ii. Rarely
  - iii. Never Seen

3) How often, in your opinion, should a maintenance contractor using the OPBRC contracting examine the state of DSM BRT road infrastructure? (please put [√] against appropriate answer)

i. More than 5days/ week [ ]

ii. Between 3-5days/ week [ ]

iii. Less than 3days/ week [ ]

4) In your opinions, what are the common challenges encountered by contractor on maintenance management of pilot project under OPBRC contract?

Road section .....

.....

Road section.....

.....

Road section.....

.....

5) What measures should be taken by organization to overcome challenges faced and improve maintenance condition of road sections described above?

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6) Basing on your expertise, is there any means 'Road Authority/ Client' could enhance contractor's capacity to execute OPBRC contract on maintenance management of Dar BRT road infrastructure?

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7) What are your suggestions to improve performance on maintenance management of Dar BRT road infrastructure?

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## **Appendix 2.**

### **Interview Schedule for DART Road Users (drivers and passengers): ENGLISH VERSION**

This interview intends to gather data geared towards assisting Pallangyo, Frank B, with registration number HD/T.1385/2019, a Master of Science student in Construction Economics and Management (MSc. CEM) in the School of Building Economics, Ardhi University Dar es Salaam, for his research title “**Assessment of Maintenance Management of DSM BRT Road Infrastructure**”

**Declaration:** Information supplied herein are to use only for academic purposes and treated with utmost confidentiality.

#### **A. GENERAL INFORMATION**

- 1) Name/ Title of Respondent: .....
- 2) Date of Interview: .....
- 3) Place of interview: .....
- 4) Your Gender:
  - i. Male           ( )
  - ii. Female       ( )
- 5) Age Group:
  - i. 18-35 years       ( )
  - ii. 36-55 years     ( )
  - iii. above 55 years   ( )

**B. INTERVIEW QUESTIONS**

1) How regular do you travel in a week?

- i. Less than 2days/ week ( )
- ii. Between 2-5 days/ week ( )
- iii. More than 5days/ week ( )

2) What is your opinion on maintenance condition of the following DSM BRT road infrastructure? Please tick (√) against the given components.

Item	Maintenance condition		
	Good	Average	Unsatisfactory
Sidewalks			
Gabions			
Roadside works			
Waste vessels			
Grass cutting, shrubs and green areas			
Overall cleaning, sand and general debris			
Road furniture (bollards)			
Road markers			
Road pavement condition (concrete and asphalt)			
Reflective markers			
Road shoulders			
Open drainage system			
Catch pit gratings			
Manholes covers			

3) How regular have you seen maintenance activities carried-out on Dar BRT road infrastructure?

- i. Very Frequently ( )
- ii. Frequently ( )
- iii. Rarely ( )
- iv. Never Seen ( )

4) What are the challenges encountered by BRT road users due to insufficient maintenance of Dar es Salaam BRT road infrastructure?

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5) What is your suggestion on improvement of maintenance condition of BRT road infrastructure?

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**Appendix 3.****TAFSIRI YA LUGHA KISWAHILI KWA WATUMIAJI WA HUDUMA YA MWENDOKASI****Kwa abiria na dereva wa huduma ya mwendokasi:**

Lengo la mahojiano haya ni kupata ufahamu kwa mwanafunzi wa Shahada ya Umahili Pallangyo, Frank Brian mwenye namba ya usajili HD/T.1385/2019 katika Chuo Kikuu Ardhi –Dar es Salaam.

Kichwa cha utafiti wake ni **“Assessment of Maintenance Management of DSM BRT Road Infrastructure”**

**Ahadi:** taarifa zitakazo kusanywa katika Mahojiano haya ni kwa matumizi ya elimu tu, na yatatuzwa kwa usiri wa hali ya juu.

**A. TAARIFA ZA UJUMLA**

- 1) Jina/ Utambulisho wa Mhojiwa: .....
- 2) Tarehe ya Mahojiano: .....
- 3) Eneo la Mahojiano: .....
- 4) Jinsi ya Mhojiwa:
  - i. Mme ( )
  - ii. Mke ( )
- 5) Kundi la Umri:
  - i. Miaka (18-35) ( )
  - ii. Kati ya miaka (36-55) ( )
  - iii. Zaidi ya miaka 55 ( )



**B. MWONGOZO WA DODOSO**

- 1) Je, ni mara ngapi unasafiri katika miundombinu ya barabara ya mwendokasi katika wiki?
- i. Chini ya mara mbili (2) katika wiki
  - ii. Kati ya mara mbili hadi tano (2-5) katika wiki
  - iii. Zaidi ya mara tano (5) kwa wiki
- 2) Je, upi ni mtazamo wako kuhusu hali ya matengenezo/ ukarabati wa miundombinu ya barabara ya mwendokasi unaofanyika? Tafadhali weka alama ya vyema ( $\sqrt{\quad}$ ) katika mtazamo wako.
- i. Nzuri Sana
  - ii. Nzuri
  - iii. Wastani
  - iv. Inaridhisha
  - v. Hairidhishi Kabisa

Item	Hali ya Marekebicho		
	3. Nzuri	2. Kawaida	1. Hairidhishi
Barabara za watembea kwa miguu			
Usafi wa barabara za waenda kwa miguu			
Vyombo vya taka Waste vessels			
Ukataji nyasi, vichaka na bustani			
Ujumla wa usafi, mchanda na takataka			
Kingo za barabara			
Alama za barabarani			
Hali ya sakafu ya barabara ya zege na lami			
Mitaro ya majitaka na maji ya mvua			
Chemba za majitaka			

- 3) Je, ni kiasi gani umeona shughuli za matengenezo/ ukarabati katika miundombinu ya barabara ya mwendokasi ukifanyika?
- i. Mara kwa Mara
  - ii. Mara Chache

iii. Sijaona Kabisa

4) Je, ni zipi changamoto unakumbana nazo kutokana na uhaba wa maboresho katika miundombinu ya barabara ya mwendokasi?

.....  
.....  
.....  
.....  
.....

5) Naomba maoni yako kuhusu namna ya kuboresha matengenezo katika miundombinu ya barabara ya mwendokasi?

.....  
.....  
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.....

**Appendix 4.**

**Interview Schedule for Road Authority (TANROADS DSM)**

This interview intends to gather data geared towards assisting Pallangyo, Frank B, with registration number HD/T.1385/2019, a Master of Science student in Construction Economics and Management (MSc. CEM) in the School of Building Economics, Ardhi University Dar es Salaam, for his research title **“Assessment of Maintenance Management of DSM BRT Road Infrastructure”**

**Declaration:** Information supplied herein are to use only for academic purposes and treated with utmost confidentiality.

**A. GENERAL INFORMATION**

- 1) Name/ Title of Respondent .....
- 2) Date of Interview .....

**B. INTERVIEW QUESTIONS (1-8):**

- 1) How often do you conduct an inspection on maintenance condition of BRT road infrastructure? (please tick [] the appropriate answer)
  - i. More than 5days/ week [  ]
  - ii. Between 3-5days/ week [  ]
  - iii. Less than 3days/ week [  ]

- 2) What are the three top most challenging road sections discovered in execution of maintenance contract of Dar es Salaam BRT road infrastructure?
  - i. Road Section .....
  - ii. Road Section .....
  - iii. Road Section .....

- 3) In your opinions, what challenges encountered by contractor on maintenance of such road sections observed in execution of maintenance contract of Dar BRT road infrastructure?

Road section ...  
 .....  
 .....

Road section ...  
 .....  
 .....

Road section ...

.....

.....

.....

4) What measures taken by your organization to overcome challenges faced and improve maintenance condition on above described road sections?

.....

.....

.....

5) Put [√] on the appropriate space in each row, consider below listed ‘compliance criteria’, you are required to rate them basing on your experience how they affect your organization’s performance on maintenance of Dar BRT road infrastructure?

Service Level Criteria		Compliance Criteria	Very Strong	Strong	Moderate	Weak	Very Weak
			5	4	3	2	1
Usability	i	Potholes					
		Patching					
	ii	Cleanliness of road surface					
	iii						
	iv	Rutting					
v	Incident response & emergency works						
Durability	i	Cracking					
		Multiple cracks					
	ii	Concrete rigid pavement surface damage					
	iii						
	iv	Concrete pavement slab movements					
	v	Concrete pavement joint sealant					
	vi	Raveling					
	vii	Loose pavement edges					
	viii	Drainage system					
	ix	Bridge routine maintenance					
x							
	Embankment and cut slopes						
Road Safety	i	Functionality of road signs, marking and furniture					

<b>General</b>	i	Shoulder& verge maintenance					
	ii	Vegetation control					

6) Indicate reasons behind those ‘compliance criteria’ that rated (5-Very Strong, 4-Strong) on your assessment, what are the challenges to attain full compliance?

.....  
 .....  
 .....  
 .....

7) What strategies employed by your organization to improve the performance on execution of maintenance of BRT road infrastructure?

.....  
 .....  
 .....  
 .....

8) What are your suggestions to improve stakeholders’ performance on maintenance management of Dar BRT road infrastructure?

.....  
 .....  
 .....

**Appendix 5.**

Observational checklist for maintenance of BRT road infrastructure under OPBRC.

**Title: Assessment of Performance Based Contract for Maintenance Management of Dar es Salaam Bus Rapid Transit.**

Name of an Observer..... Road  
Section.....

Service Level Criteria	Compliance Criteria under Observation	Date of Observation			Remarks
		Dd	Mm	Yy	
<b>Usability</b>	Potholes				
	Patching				
	Cleanliness of road surface				
	Rutting				
	Incident response& emergency works				
	Cracking				
	Multiple cracks				
<b>Durability</b>	Concrete rigid pavement surface damage				
	Concrete pavement slab movements				
	Concrete pavement joint sealant				
	Raveling				
	Loose pavement edges				
	Drainage system				
	Bridge routine maintenance				
<b>Road Safety</b>	Embankment and cut slopes				
	Functionality of road signs, marking and furniture				
<b>General</b>	Shoulder& verge maintenance				
	Vegetation control				

## Appendix 6.

## MANAGEMENT AND MAINTENANCE OF BUS RAPID TRANSIT (BRT) ROAD INFRASTRUCTURE PHASE - 1 OF DAR ES SALAAM UNDER OUTPUT PERFORMANCE - BASED ROAD CONTRACT (OPBRC)

AE/001/2017/2018/DSM/W/54

Section 1: Magomeni Police Post - Ubungo Junction  
(6 + 100 - 11 + 600)Required Service  
Level

Very Good

Length of road at required  
service level (km)

5

Contract  
Month:October and  
November 2020)

SERVICE LEVEL CRITERIA	REQUIRED COMPLIANCE		ACTUAL COMPLIANCE								NON-COMPLIANCE		PAYMENT REDUCTION	
	Target	Km (1)	Compliance Criteria	6 + 100 - 7 + 100	7 + 100 - 8 + 100	8 + 100 - 9 + 100	9 + 100 - 10 + 100	10 + 100 - 11 + 100	11 + 100 - 11 + 600	Total Length compliant (required in Km) (2)	Length non-compliant (1-2) (3)	% Payment reduction (4)	Km (3x4) (5)	
				1	1	1	1	1	0.5					
1. Usability	100 %	5.0	10.2	Potholes						UNDER CONSTRUCTION				
				Number of potholes observed on Concrete lanes	0	0	0	0	0					
				Number of potholes observed on Asphalt lanes	1	0	1	0	1					

			<i>Results</i>	1	1	1	1	1	5	0	0%	0	
		10.3	Patching	3	3	2	2	2					
			<i>Results</i>	1	1	1	1	1	5	0	5%	0	
		10.9	Cleanliness of road surface	2	2	2	1	1					
			<i>Results</i>	1	1	1	1	1	5	0	10%	0	
		10.10	Rutting	0	0	0	0	0					
			<i>Results</i>	1	1	1	1	1	5	0	5%	0	
		10.17	Incident response & Emergency works	Y	Y	Y	Y	N	4	1	1%	0.01	
2. General	100 %	5.0	10.13	Shoulder & Verge maintenance	1	1	1	1	1	1			
				<i>Results</i>	1	1	1	1	1	5	0	5%	0
		10.19	Vegetation control	25	20	20	25	26					
			<i>Results</i>	1	1	1	1	0.9	4	1	1%	0.01	
3. Durability	100 %	5	10.4	Cracking	2	2	2	5	5				
				<i>Results</i>	1	1	1	0.8	0.8	3	2	5%	0.1



10.5	Multiple cracks	0%	0%	0%	0%	0%				
	<b>Results</b>	1	1	1	1	1	<b>5</b>	<b>0</b>	5%	<b>0</b>
10.6	Concrete rigid pavement surface damage	0%	0%	0%	10%	10%				
	<b>Results</b>	1	1	1	0.8	0.8	<b>3</b>	<b>2</b>	5%	<b>0.1</b>
10.7	Concrete pavement slab movements	0%	0%	0%	0%	0%				
	<b>Results</b>	1	1	1	1	1	<b>5</b>	<b>0</b>	10%	<b>0</b>
10.8	Concrete pavement joint sealant	0%	0%	10%	0%	0%				
	<b>Results</b>	1	1	0.8	1	1	<b>4</b>	<b>1</b>	1%	<b>0.01</b>
10.11	Ravelling	1%	1%	1%	2%	1%				
	<b>Results</b>	1	1	1	1	1	<b>5</b>	<b>0</b>	5%	<b>0</b>
10.12	Loose Pavement Edges	0	0	0	0	1				
	<b>Results</b>	1	1	1	1	1	<b>5</b>	<b>0</b>	5%	<b>0</b>

			10.14	Drainage system	1	1	1	1	1	5	0	1%	0	
			10.15	Bridge routine maintenance	1	1	1	1	1		5	0	5%	0
			10.16	Embankment and cut slopes	1	1	1	1	1		5	0	5%	0
4. Road safety	100%	5.0	10.18	Functionality of road signs, marking and furniture	1	1	1	0	0		3	0	2%	0
5. Management	100%	5.0	10.20	Monitoring							-			
			10.21	Reporting							-			
			10.22	Planning & Design							-			
<b>TOTAL</b>											-	<b>SUM</b>	<b>0.23</b>	
Length in km for payment at this service level this month:													<b>4.77</b>	

**Prepared by:**

.....

(Name)

(Title)

**Accepted by:**

.....

(Name)

(Title)

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Ref.No. ARU/CD.33/562/01

9<sup>th</sup> March, 2021

REGIONAL MANAGER,  
 Tanzania Road Agency,  
 P.O.BOX 4838,  
 DAR ES SALAAM.

Dear Sir/ Madam,

**RE: INTRODUCTION LETTER FOR POSTGRADUATE STUDENT**

Refer to the subject above.

The Student above is pursuing Masters of Science in Construction Economics and Management (MSc. CEM) in our University. As a Student he is required to do dissertation work as part of the requirements for the award of the Masters of Science in Construction Economics and Management (MSc. CEM). For the accomplishment of this exercise, students are required to carry out literature review, extensive search for field data and subsequently analyse the same for conclusive scientific results.

We are therefore requesting you to assist the bearer of this letter Mr. PALLANGYO FRANK B, with Reg. No. HD/T.1385/2019, who will need information from your organisation. The title of his Dissertation is "*Assessment of Maintenance Management of Dar es salaam BRT*".

Thank you for your cooperation and contribution.

Yours Sincerely,

  
 Dr. Shubira Kalugila  
 For: Deputy Vice Chancellor  
 Academic Affairs  
 DAR ES SALAAM



UNITED REPUBLIC OF TANZANIA  
PRESIDENT'S OFFICE  
REGIONAL ADMINISTRATION AND LOCAL  
GOVERNMENT



**DAR RAPID TRANSIT AGENCY**

*In reply please quote:*

Ref. No AB.104/22/001/44

15<sup>th</sup> January, 2021

Pallangyo, Frank B  
C/o Ardhi University,  
P.O Box 35175.  
**DAR ES SALAAM.**

**RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH**

Reference is made to the heading above from your letter dated 11<sup>th</sup> January, 2021.

2. This letter serves to inform you that the Agency has accepted your request to conduct a research work titled "**Assessment of Effectiveness of Maintenance Management of Dar es Salaam Bus Rapid Transport (DART)**" effectively from January, 2021.

3. The Agency will appreciate to get the outcome of your research in order to improve the bus rapid transit services.

4. Thank you for your cooperation

Eng. Ronald M. Lwakatare  
**CHIEF EXECUTIVE**

Copy: Director of Operations and Infrastructure  
Management

- for Assistance

Ubungu Maji Morogoro Road, P.O Box 724, Dar es Salaam, Tanzania

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