



IMPROVEMENT OF MAINTENANCE MANAGEMENT SYSTEM FOR ENHANCE PERFORMANCE OF MOTOR VEHICLE FLEET IN TANZANIA PUBLIC SECTOR

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ABSTRACT

Fleet management plays a vital role in an organisation's growth, and improving the maintenance management system is crucial for enhancing the availability performance of a motor vehicle fleet. This study focuses on Tanzania Electric Supply Company Limited (TANESCO), responsible for generating, purchasing, transmitting, distributing, and selling electricity in Tanzania Mainland and Zanzibar. The research design employed in this investigation is descriptive. The study was conducted at the TANESCO Arusha Regional Office, with a sample size of 73 respondents. Purposive sampling was utilised to select four senior staff members, ensuring relevant information for the research objectives. Both primary and secondary data were collected to ensure accuracy. A questionnaire survey was administered to 69 operational staff, and four managerial staff were interviewed. Data analysis was performed using SPSS version 26 and Excel. The Relative Importance Index (RII) was used to determine the critical components for improving the maintenance performance of the motor vehicle fleet at the TANESCO Arusha region. The Brake Disc Rotor emerged as the component with the highest RII value, indicating its critical importance. Timing belts, Brake Disc Rotor, Front Suspension, Brake Disc Pads, Latches/locks/linkage, and Engine Cooling System were the main variables considered in the regression model. The model was validated using historical data to assess its predictability and accuracy. The findings highlight the effectiveness of the developed maintenance management system, resulting in improved availability performance of the motor vehicle fleet at TANESCO Arusha region.

Keywords: Improvement of Maintenance, Maintenance Management System, Performance of Motor Vehicle Fleet, and Public Sector.

INTRODUCTION

Fleet management is becoming a substantial element in determining an organisation's growth. Among the modules of fleet management, maintenance holds a critical position. A properly maintained vehicle is considered safer, more lasting, and dependable. It gives the customer "What/Where/When they want?". Maintenance of a vehicle fleet should be subjected to continuous improvement. A proper maintenance system helps accomplish a vehicle's effective and efficient functioning and eliminates the critical problems that may leave the deliverables stranded in the middle of the road. It is a sector that offers services that the government provides. Its operations take different forms in different countries.

The public sector in Tanzania provides services like law enforcement, the armed forces, infrastructure (public roads, trains, water supply, sewage systems, electrical grids, telecommunications, etc.), public education, and health care. Most public

properties in the country lack maintenance due to a weak maintenance management system (Mkilania, 2016). The public sector represents a significant investment of taxpayer money, especially in the fleet. Hence, it must be preserved (Quayson, 2016).

In the northeastern region of Tanzania in East Africa, there lies a booming metropolis called Arusha. A regional and continental administrative hub is located in the city. As it was given city status in 2010, the area of its jurisdiction increased from 93 to 208 square kilometres. In 2022, the population of Arusha was 22,356,255 (matokeo2022, 2023).

The East African Community (EAC) has several sub-sectorial activities with many physical assets.

In truth, most of these physical assets, such as roads, fleets, and machinery, are beyond economic repair, a prevalent practice in Tanzania's public sector. Being the host city for the aforementioned international events

and a significant contributor to the growth of the national economy through tourism, Arusha needs a better maintenance management system that ensures the high-performance availability of its fleet of vehicles.

1.2 Maintenance Management System

Accepting the fundamental systems method, or connecting organisational goals with management objectives, is a requirement for maintenance management. Well-known maintenance management philosophies (TPM, RCM, RBI) used to improve processes frequently remain only on the premise of service implementation without the need for full integration into current management systems. The inability of management to support actual goals through maintenance management stems from a lack of knowledge of the nature of maintenance management, which results in ineffective steps.

A poor performance in terms of the availability of motor vehicles in a fleet is caused by the lack of care given to upgrading the maintenance management system. In addition, an unimproved maintenance management system provides many losses to any organisation, such as increasing equipment failure and unplanned downtime, reducing equipment's longevity, jeopardising workplace safety, failure to keep costs under control, and equipment inefficiency.

Therefore, completing this research will help develop a model to improve the maintenance management system and bring higher performance availability of motor vehicle fleets in Tanzania public institutions.

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2. METHODOLOGY

The research methodology was conducted at the Arusha Regional Office of Tanzania Electric Supply Company Limited (TANESCO), chosen due to limited regional studies on enhancing maintenance management for the public sector's motor

vehicle fleet and the low-performance availability of TANESCO's fleet. The study population included 180 managers and employees from TANESCO's Arusha Regional Office. The sample size of 73 respondents was determined using Slovin's formula with a 95% confidence level and a 5% margin of error, distributed between 4

management and 69 operational staff. Purposive sampling selected senior management staff, while stratified sampling organised the active team into homogeneous groups. Both primary and secondary data were used, collected through questionnaires and interviews, aiming for accuracy and comprehensive findings. While the primary data provided accessibility and control, secondary data, accessed in electronic and hard copy formats, offered cost-effectiveness but potentially lacked relevance or quality control. The methodology employed questionnaires, interviews, and documentary reviews, ensuring a thorough understanding of TANESCO's vehicle fleet management and improvement strategies.

3. FINDINGS

3.1 Respondent Characteristics

The tabular data presented herein illustrates the distribution of personnel within Tanzania Electric Supply Company Limited (TANESCO) based on their designated positions, tenure of service, and educational attainment. Within 73 employees, the breakdown reveals that 42.5% assume roles as engineers, 28.8% as managers, 16.4% as technicians, and 12.3% as artisans. Regarding professional experience, the predominant segments are those with 3-4 years (31.5%) and 4-5 years (31.5%) of service. As for educational qualifications, 42.5% of employees hold a degree, 26% possess a diploma, 24.7% have a master's degree, and 6.8% have a certificate. These statistical insights offer a snapshot of the composition of TANESCO's workforce, thereby furnishing pertinent information for the strategic planning and development of human resources within the organisation.

Table 3.1 Respondent Characteristics

VARIABLE	RESPONSES	FREQUENCY	PERCENTAGE
Position at TANESCO	Artisan	9	12.3
	Technician	12	16.4
	Engineers	31	42.5
	Managers	21	28.8
		73	100.0
Year of experience	1-2 years	3	4.1
	3-4 years	23	31.5
	4-5years	23	31.5
	5-6years	16	21.9
	7years and above	8	11.0
		73	100.0
Level of education	Certificate	5	6.8
	Diploma	19	26.0
	Degree	31	42.5
	Masters	18	24.7
		73	100.0



3.2 Maintenance Budget

The subsequent table provides an overview of respondents' perspectives concerning the influence of the maintenance budget on the maintenance management systems within the TANESCO Arusha regional office. The findings reveal that 16.4% of the respondents evaluated the maintenance budget as "very low," implying an inadequacy in the budget allocation for supporting maintenance management systems. For 41.1% of respondents, the funding received a "low" rating, indicating an inadequate distribution to maintenance yet insufficient to sustain the systems adequately. Notably, 28.8% of participants characterised the budget as "moderate," suggesting its adequacy and highlighting potential areas for enhancement. A mere 8.2% of respondents appraised the

budget as "high," while 5.5% assessed it as "very high," signifying a minority who perceived it as adequately supporting maintenance management systems. These outcomes underscore the requirement for augmenting the maintenance budget designated for maintenance management systems within the TANESCO Arusha regional office, aiming to ensure these essential systems' effective and efficient operation.

Table 3.2: Maintenance budget

Response	Frequenc y	Per cent
Very low	12	16.4
Low	30	41.1
Moderate	21	28.8
High	6	8.2
Very high	4	5.5
Total	73	100.0

3.3 Workforce

This analysis offers insight into the viewpoints expressed by the participants regarding the influence of workforce availability on the maintenance management systems operative within the TANESCO Arusha regional office. The findings notably reveal that 16.4% of respondents perceived a “meagre” impact of the workforce on maintenance management systems, while a substantial majority, accounting for 47.9%, acknowledged a “low” mark. Furthermore, 24.7% of respondents articulated the workforce’s “moderate” impact on maintenance management systems, with 11% attesting to a “high” effect. These outcomes collectively indicate a prevailing sentiment among many respondents, suggesting a comparatively subdued workforce influence on maintenance management systems. This factor could potentially introduce adverse

implications for the efficacy of maintenance operations. Consequently, a prudent course of action for the TANESCO Arusha regional office would involve an evaluation of its current workforce capacity, with potential considerations for augmentation, aimed at refining maintenance management systems and thereby guaranteeing a dependable and efficient power supply to its esteemed clientele.

Table 3.3: Manpower

Response	Frequency	Per cent
Very low	12	16.4
Low	35	47.9
Moderate	18	24.7
High	8	11.0
Total	73	100.0
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3.4 Spare Parts

The following analysis elucidates the insights derived from respondents' perspectives regarding the influence of spare parts on the maintenance management systems operating within the precincts of the TANESCO Arusha regional office. In this regard, participants were requested to assess the effect of spare parts on maintenance management systems using a spectrum encompassing categories like "very low," "low," "moderate," "high," and "very high." The resultant dataset is presented through frequency, percentage, valid percentage, and cumulative percentage metrics.

The outcomes unveiled a discerning pattern, indicating that 21.9% of respondents appraised the effect of spare parts as "very low," while a notable majority, encompassing 50.7%, assigned it a rating of "low." Subsequently, 23.3% of participants attributed a "moderate" influence to spare

parts, with a mere 4.1% attributing a "high" effect. Moreover, considering cumulative percentages, it becomes evident that approximately 72.6% of respondents collectively categorised the impact of spare parts as either "low" or "very low."

These findings underscore a palpable requirement for enhancing the spare parts management system at the TANESCO Arusha regional office. The preponderance of respondents assigning "low" or "deficient" ratings to the impact of spare parts accentuates this need. Consequently, the management must consider the feedback provided by the respondents prudently and subsequently embark on requisite measures to refine the spare parts management system. Such an endeavour would inherently contribute to the productive maintenance of equipment and systems, thereby augmenting overall operational effectiveness.

3.5 Training Program

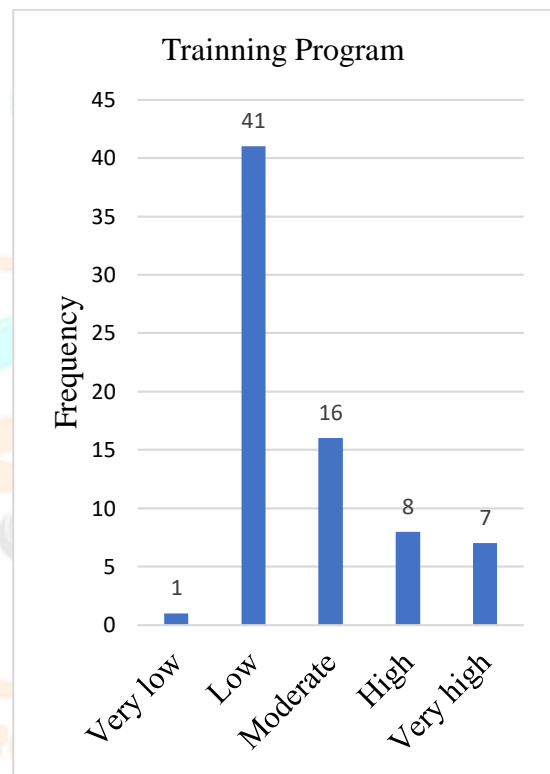
The outcomes of the analysis unveil a nuanced perspective on the efficacy of the

maintenance training program within the confines of the TANESCO Arusha regional

office. Specifically, the data indicates that a solitary respondent rated the effect of the training program as “very low,” while a substantive cohort of 41 respondents assigned it a “low” rating. An additional 16 respondents appraised it as having a “moderate” impact, followed by eight who adjudged it to possess a “high” effect. Seven respondents assigned a “very high” rating to the program’s impact. In sum, these results underscore that most participants harboured a perception of the maintenance training program’s effectiveness that aligns with a “low” classification. This collective sentiment towards the training program prompts contemplation regarding its

improvement or reevaluation, intending to fortify its efficacy and align it more closely with organisational objectives.

Figure 2.1: Training program



6 Maintenance Strategies

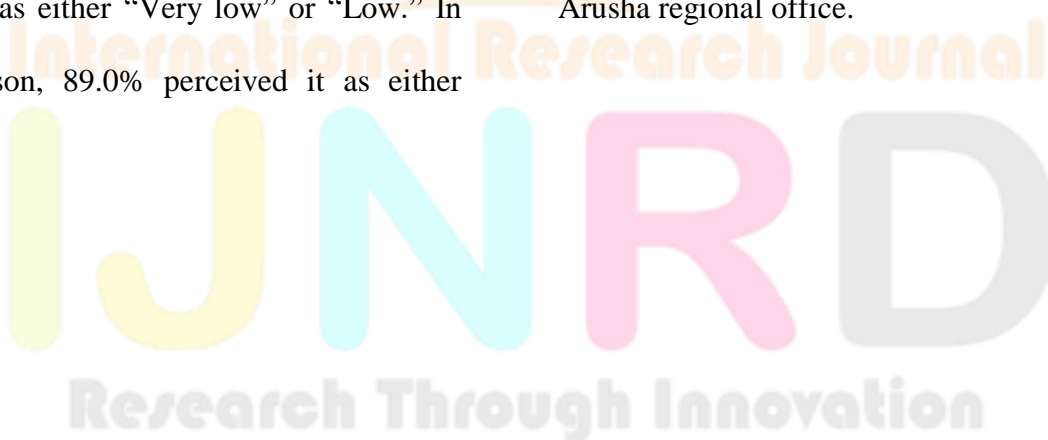
The analysis outcomes encapsulate the discernment of respondents regarding the influence of maintenance strategy on the maintenance management systems within the TANESCO Arusha regional office.

Within the scope of 73 total respondents, a cohort of seven individuals (constituting 9.6%) expressed the view that the effect of a maintenance strategy is “Shallow.” An additional 22 respondents (representing 30.1%) assigned a “Low” rating, while a notable majority of 36 respondents (equating to 49.3%) appraised it as having a “Moderate” impact. Conclusively, eight respondents (translating to 11.0%) attributed a “High” effect to the maintenance strategy.

The cumulative percentage distribution unveils that 39.7% of respondents characterised the impact of the maintenance strategy as either “Very low” or “Low.” In comparison, 89.0% perceived it as either

“Very low,” “Low,” or “Moderate.” Importantly, all respondents’ inputs were considered valid, encompassing a comprehensive 100%.

These findings hold the potential for guiding the identification of areas for refinement within the maintenance management systems of the TANESCO Arusha regional office. In aggregate, the preponderance of respondents leaned towards a “Moderate” appraisal of the maintenance strategy’s impact. This collective assessment indicates a potential avenue for further enhancement within the maintenance strategy at the TANESCO Arusha regional office.



3.7 Maintenance Delaying Time

This analysis delves into the perspectives of respondents concerning the implications of maintenance delaying time on the maintenance management systems operating within the confines of the TANESCO Arusha regional office. The ensuing results illuminate that 24.7% of the respondents perceived the effect of such delays as “low,” while 28.8% attributed a “moderate” impact, followed closely by 27.4% associating it with a “high” effect. A notable subset of 19.2% also characterised the result as “very high.”

These findings underline a prevailing sentiment among most respondents, signifying their belief that extending maintenance duration has adverse implications for the maintenance management systems within the TANESCO

Arusha regional office. The revealed insights are significant in pinpointing avenues for refinement within the maintenance management systems. By addressing areas related to reducing maintenance delaying time, the potential for upgrading the overall efficiency of the systems emerges as a tangible opportunity.

Table 2.4: Maintenance delaying the time

Response	Frequency	Per cent
Low	18	24.7
Moderate	21	28.8
High	20	27.4
Very high	14	19.2
Total	73	100.0

Result of Relative Importance Index on requirements for improving maintenance performance of motor vehicle fleet at TANESCO Arusha region- Arusha regional office

The primary objective of this study was to meticulously assess the varying degrees of significance attributed to distinct components, aiming to identify pivotal requisites for enhancing the maintenance performance of the motor vehicle fleet at the TANESCO Arusha regional office. The analysis employed the Relative Importance Index (RII) to achieve this objective, and the resulting findings have been systematically compiled in Table 2.5.

At the forefront of these findings stands the Brake Disc Rotor, possessing the highest RII value of 0.991, spotlighting its unparalleled importance in augmenting maintenance performance. This preeminent position is closely trailed by the Tire Tread/belt, securing the second spot with an RII of 0.985,

accentuating its substantive role in the maintenance performance landscape.

The Engine Cooling System, boasting an RII of 0.905, emerged as a robust contender, clinching the fourth position and underscoring its consequential influence on bolstering maintenance efficacy. The Ignition system, with an RII of 0.899, and the Latches/locks/linkage, seizing eighth place with an RII of 0.885, were recognised as substantive contributors to maintenance performance, albeit with slightly lesser RII values.

The Brake Disc Pads (RII: 0.894) and Front Suspension (RII: 0.784) retained their significance within this framework despite yielding RII values lower than the top-ranking components. Similarly, the Timing Belts (RII: 0.765) were appraised as influential, albeit with a relatively diminished RII value.

Conversely, a selection of components manifested minimal influence in enhancing maintenance performance. The Wiring (RII: 0.491), Wheel (RII: 0.486), Brake Hoses, Lines/piping, and Fittings (RII: 0.479), Steering Tie Rod Assembly (RII: 0.485), and Rear Suspension (RII: 0.324) collectively materialised as non-significant contributors, alluding to their limited role in affecting maintenance performance.

This analytical endeavour affords invaluable insights into the hierarchical significance of disparate components concerning enhancing

maintenance performance within the motor vehicle fleet stationed at the TANESCO Arusha regional office. These delineations hold potential utility for decision-makers and maintenance practitioners alike, as they endeavour to judiciously allocate resources and efforts towards the pivotal components, such as the Brake Disc Rotor, Tire Tread/belt, and Engine Cooling System, with the ultimate aspiration of optimising maintenance performance and safeguarding streamlined fleet operations.

Table 2.5: Relative importance index

Component	RII	Comment
F1. Brake Disc Rotor	0.84	Most Significant
F2. Tire Tread/belt	0.77	Most Significant
F3. Engine Cooling System	0.77	Most Significant
F4. Ignition	0.38	Not Significant
F5. Latches/locks/linkage	0.39	Not Significant
F6. Brake Disc Pads	0.75	Significant
F7. Front Suspension	0.87	Most Significant
F8. Timing belts	0.82	Most Significant
F9. Wiring	0.43	Not Significant
F10. Wheel	0.41	Not Significant
F11. Steering Tie Rod Assembly	0.37	Not Significant
F12. Brake Hoses, Lines/piping, And Fittings	0.34	Not Significant
F13. Transmission	0.73	Significant
F14. Rear Suspension	0.38	Not Significant

4. RESULT DISCUSSION

4.1 Assessment of the Current Maintenance Practice of the Motor Vehicle Fleet at the TANESCO Arusha Region Office

The analysis unveils several noteworthy discoveries regarding the current maintenance practices at the TANESCO Arusha regional office. Firstly, a meticulous assessment of the maintenance budget underscores a compelling insight: a significant number of respondents have appraised the budget as either “very low” or “low.” This factor glaringly points to the fact that the allocated budget for maintenance management falls short of what’s necessary to sustain the optimal functionality of the systems. Strengthening the maintenance budget designated for the TANESCO Arusha regional office is paramount to ensuring these critical systems’ efficiency and effectiveness. The consistently restricted budget allocation for Operation and Maintenance has contributed to the deterioration of the company’s operational endeavours, consequently heightening the vulnerability to

unplanned outages throughout the generation, transmission, and distribution networks (Peng and Poudineh, 2016).

Secondly, the analysis of the influence of workforce capacity on maintenance management systems highlights a significant perspective: a substantial segment of respondents perceive the impact of the workforce as relatively inadequate. In contrast to the study by Liu, Combs, et al. (2007) that established human resource management’s substantial contribution to organisational performance across 19,000 organisations, this study’s outcome contradicts that notion. Similarly, findings from Rosnes and Shkaratan (2011) suggest a relatively low impact of the workforce on maintenance performance in African power infrastructure aligns with this study’s results. Furthermore, the discrepancies with Foster and Briceño-Garmendia’s (2010) findings on labour redundancy as a source of inefficiency underline the suggestion that the current workforce level might not be sufficient for efficient maintenance management. It is

prudent for the TANESCO Arusha regional office to assess its workforce capacity and contemplate an augmentation to enhance the maintenance management systems, ultimately ensuring a dependable and efficient power supply to its customers.

Moreover, the analysis of the spare parts' effect reveals that most respondents rated the impact as either low or very low. This factor aligns with the study by Peng and Poudineh (2016), which underscores the availability of spare parts at TANESCO but implies their limited effect on maintenance performance. This factor unearths a compelling need for overhauling the spare parts management system at the TANESCO Arusha regional office. To enhance operational efficiency, it is imperative for management to carefully evaluate the feedback offered by respondents and apply suitable steps aimed at improving the spare parts management system. This action will ultimately result in the effective maintenance of equipment and systems.

The analysis delves into the respondents' perception of the training program for maintenance. Notably, most respondents rated the training program's effectiveness as low. This clear signal of ineffectiveness necessitates a thorough review or revamp of the training program to heighten its impact. This result diverges from the study by Fatoni and Rahmat (2018), which highlights a positive correlation between training program effectiveness and maintenance management. By addressing the shortcomings and implementing requisite enhancements, the TANESCO Arusha regional office can offer more impactful training opportunities to its staff, thereby fostering improved maintenance practices.

When considering the maintenance method, the data reveals that a significant proportion of participants rated its impact as moderate. This discernment indicates room for improvement in the maintenance strategy at the TANESCO Arusha regional office. Consistent with the study by Wang et al.

(2007), which posits the varying influence of maintenance strategy on fleet performance, this study's findings contrast with Sharma et al.'s (2005) assertion of a significant effect of maintenance strategy on maintenance performance. This fact underscores the opportunity for the office to leverage these results, identifying avenues for enhancement and adopting strategies aligned with industry best practices. Such a proactive approach would undoubtedly contribute to the comprehensive amelioration of the maintenance management systems.

Lastly, the analysis addresses the impact of maintenance delay on maintenance

management systems. The outcomes indicate that many respondents perceive maintenance delays as detrimental to performance. This concurrence with the findings of Peng and Poudineh (2016), which highlight the potential for massive breakdowns resulting from deferred maintenance, underscores the urgency of minimising maintenance delay and ensuring timely upkeep activities. By identifying areas for improvement and implementing measures to curtail delays, the TANESCO Arusha regional office can markedly enhance the efficiency and efficacy of its maintenance management systems.

4.2 Improving a Model for Maintenance Performance of the Motor Vehicle Fleet at TANESCO Arusha Region

The researcher improved and ran a Multiple Regression Model to enhance the availability performance of the motor vehicle fleet at TANESCO Arusha region. The model

comprises inputs and output variables based on the statistical correlation of inputs and dependent variables, as Chapter Five details. The R Square value for the model was 0.716, which implies that all the five independent variables; Timing belts, Brake Disc Rotor, Front Suspension, Brake Disc Pads, Latches/locks/linkage, and Engine Cooling

System Communication have a relationship with motor vehicle fleet at the TANESCO Arusha region office.

4.3 Improve a Maintenance Management System to Enhance the Availability Performance of the Motor Vehicle Fleet in at TANESCO Arusha Region

Based on the study findings and observation, the maintenance management system is for improving the availability performance of the motor vehicle fleet in the TANESCO Arusha region. The system allows the flow of information from different users to the Maintenance Monitoring Control Unit, where all maintenance work is managed according to priorities and resource availability. Based

The developed model was validated to check for its predictability and accuracy through other historical data.

on the developed system and assumptions made, the computation of availability performance after implementation of the developed maintenance management system for improving the availability performance of the motor vehicle fleet in the TANESCO Arusha region is 97%, as shown in Table 5.4. This fact implies that the developed maintenance management system is effectively done and, thus, improves the availability performance of the motor vehicle fleet in the TANESCO Arusha region.



5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The analysis of the current maintenance practices at the TANESCO Arusha regional office highlights the need for improvements in various areas. Increasing the maintenance budget, evaluating and adjusting workforce capacity, enhancing spare parts management, improving the training program, and refining the maintenance strategy are all crucial steps to enhance the efficiency and effectiveness of the maintenance management system. These improvements will contribute to a more reliable and adequate customer power supply.

Additionally, the researcher's successful implementation of the Multiple Regression Model demonstrates the relationship between specific independent variables and the motor vehicle fleet's availability performance at the TANESCO Arusha region. This finding provides valuable insights for effectively managing and addressing the identified independent variables.

Furthermore, implementing the maintenance management system has proven to be successful in improving the availability performance of the motor vehicle fleet. The system enables the efficient flow of information and prioritisation of maintenance tasks, resulting in a high availability rate of 97%. This data confirms the effectiveness of the developed maintenance management system and its positive impact on the overall availability performance of the motor vehicle fleet at TANESCO Arusha region.

Overall, by addressing the identified areas for improvement and implementing the necessary enhancements, the TANESCO Arusha region can establish a more efficient, reliable, and effective maintenance management system, improving operational efficiency and customer satisfaction.

5.2 Recommendations

Based on the analysis and findings presented, the following general recommendations can be accomplished to improve the maintenance practices and enhance the availability

performance of the motor vehicle fleet at the TANESCO Arusha regional office.

i. Increase the maintenance budget.

The maintenance budget should be increased to ensure sufficient resources for the effective maintenance of systems. These resources will contribute to improved operational efficiency and effectiveness.

ii. Evaluate and adjust workforce capacity.

Assess the current level of the workforce and consider increasing it to manage maintenance activities adequately. A sufficient force will lead to more timely and effective maintenance, resulting in a reliable power supply to customers.

iii. Enhance spare parts management.

Improve the spare parts management system to address the perceived low effectiveness of spare parts. This factor will ensure that necessary features are available, reducing downtime and improving overall operational efficiency.

iv. Improve the training program.

Enhance the training program for maintenance to address the low effectiveness rating by respondents. This factor can be achieved by identifying areas of improvement and making necessary enhancements to provide valuable training opportunities for staff, resulting in improved maintenance practices.

v. Enhance maintenance strategy

Utilise the feedback and ratings provided by respondents to identify areas for improvement in the maintenance strategy. Implement strategies aligned with industry best practices to optimise maintenance management systems.

vi. Minimise maintenance delaying time.

Take measures to reduce maintenance delaying time and ensure timely maintenance activities. The efficiency and effectiveness of maintenance management systems can be improved by addressing delays.

In addition to these general recommendations, the development and

implementation of the improved maintenance management system, as described in the analysis, can significantly enhance the availability performance of the motor vehicle fleet. The maintenance system should be regularly evaluated, validated, and adjusted

to ensure its predictability, accuracy, and effectiveness in improving availability performance.



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