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DEVELOPMENT OF AN INTEGRATED COMPUTERIZED MANAGEMENT SYSTEM FOR INFRASTRUCTURE SERVICES ON ROAD MAINTENANCE PLANNING

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Abstract

The infrastructure services sector in Tanzania grapples with substantial challenges, particularly in the realm of road maintenance planning. A significant concern is the lack of alignment between the engineered road widths by TARURA's engineers and the actual available land space, a discrepancy attributed to the existence of Approved Survey Plans (ASP) and Town Planning Drawings (TPD) from the Ministry of Lands. This disconnect underscores the urgent need for a more integrated approach to infrastructure planning and management. To address this issue, the study adopted a cross-sectional research design with a specific focus on the Kinondoni district. The selection of Kinondoni district as the study area was driven by the extensive infrastructure networks that intersect roads, demanding frequent maintenance and significantly affecting the availability of vital services such as water and electricity. The study employed a combination of primary and secondary data collection methods, utilizing questionnaires for primary data and personal observations and the review of technical and operational reports, historical data, and action plans for secondary data. The collected data underwent rigorous analysis employing sophisticated tools such as SPSS 26 and Microsoft Excel. This analysis aimed to identify the specific infrastructure services that exert an influence on road maintenance planning within Kinondoni district, ultimately contributing to the development of an integrated system for infrastructure management. The study involved 54 respondents, including engineers, technicians, accountants, personal secretaries, and artisans, all of whom play pivotal roles in infrastructure services. Notably, the response rate for the study was an impressive 100%. The respondents were selected from the staff at TARURA using purposive sampling techniques, leading to a well-balanced demographic distribution with 66.7% male and 33.3% female participants. In terms of age groups, respondents represented various categories, with the largest group falling within the 31-40 years range, constituting 55.6% of the participants. Additionally, the respondents were categorized into three designations: Engineers (13.0%), Technicians (50.0%), and Surveyors (37.0%). Key factors such as electric poles, buildings, wall facades, and approved survey plans emerged as highly significant, warranting priority attention within the Integrated Computerized Management System (ICMS) development process.

Keyword: Integrated Computerized Management System, Infrastructure Services, Road Maintenance Planning

1.INTRODUCTION

The infrastructure services sector in Tanzania grapples with numerous challenges, underscoring the pressing need for a more integrated approach to infrastructure planning and management. One of the key issues lies in the misalignment between the road widths designed by TARURA's engineers and the actual available land space. This disconnect often arises due to the existence of Approved Survey Plans (ASP) and Town Planning Drawings (TPD) from the Ministry of Lands, highlighting a critical lack of coordination.

Adding to the complexity, Town Planning Drawings and Survey Plans are often unavailable when needed for road construction purposes, and when they are, they may be found invalid or canceled. Concurrently, TARURA may design a road for a specific location while the Ministry of Lands initiates a cadastral survey for the same area, leading to confusion and potential setbacks. Similarly, miscommunications between departments become evident when, for instance, TANESCO installs electric poles within a road corridor designated by TARURA for construction.

Road construction can further compound the issue as DAWASA's water pipes and chambers may be inadvertently damaged by TARURA's heavy equipment due to insufficient coordination. Additionally, the lack of knowledge about the paths of underground fiber lines poses its own set of challenges. Overall, the various departments involved, including TANESCO, DAWASA, TTCL, FIBERS, and TOWERS, often operate in isolation, resulting in inefficiencies and increased costs.

The solution lies in creating a platform where these facility owners can align their annual programs and activities and establish a reliable and effective communication system. Within this framework, TARURA, being aware of its annual road maintenance plans, can establish a dedicated department tasked with collecting all necessary data for these roads and inputting it into the system. By doing so, before road maintenance planning even begins, all relevant information about underground water pipes, fibers, electric poles, towers, buildings, approved survey plans, and town planning drawings will be readily accessible, eliminating redundancy and unnecessary relocation costs.

This system will be complemented by a Multiple Regression Model (MRM) that quantifies the extent (in percentage) to which the road corridor is affected by various services. The MRM will serve as a guide, either allowing or preventing the commencement of road maintenance planning based on its assessment.

The imperative development of the Integrated Computerized Management System for Infrastructure Services on Road Maintenance Planning (ICMS – ISRMP) is crucial. While this system promises benefits for all facility owners involved, its principal beneficiary will be the Tanzania Rural and Urban Road Agency (TARURA). This integrated approach promises a win-win scenario for all, streamlining processes and enhancing infrastructure services in Tanzania.

2.METHODOLOGY

The study employed a cross-sectional research design, focusing on the Kinondoni district as the study area. The choice of this district was strategic, driven by the presence of extensive infrastructure networks running alongside and across roads. These conditions necessitate frequent road maintenance, directly impacting essential services like water and electricity availability. To gather comprehensive data, a combination of primary and secondary data sources was utilized. Primary data was collected through the distribution of questionnaires, while secondary data was gathered via personal observations and the review of technical and operational reports, including historical data and action plans. The collected data underwent meticulous analysis using advanced tools such as SPSS 26 and Microsoft Excel. This analysis aimed to identify specific infrastructure services that significantly influence road maintenance planning within the Kinondoni district. The ultimate goal was to contribute to the development of an integrated system for managing infrastructure services effectively. The study involved a total of 54 respondents, including engineers, technicians, accountants, personal secretaries, and artisans, all representing key stakeholders in infrastructure services. It's noteworthy that the response rate for the study was

an impressive 100%. The sample frame primarily encompassed staff from TARURA, and the selection of respondents was conducted using purposive sampling techniques, ensuring that those chosen could provide valuable insights into the research objectives.

3.RESULTS

3.1Characteristics of respondents

In the course of the study aimed at developing an Integrated Computerized Management System for Infrastructure Services on Road Maintenance Planning in Kinondoni District, particularly focusing on the Namanga-Kondo road, various demographic attributes of the participants were collected to attain a thorough comprehension of the sampled population. The demographic data encompassed gender, age, and professional designation.

In terms of gender, the respondents exhibited a relatively equitable distribution, with 66.7% being male and 33.3% female. This gender balance is crucial as it ensures that the research encompasses a diverse range of viewpoints and experiences pertaining to road maintenance planning in Kinondoni District.

Regarding age, the participants were spread across various age brackets. The most substantial group fell within the 31 to 40 years range, constituting 55.6% of the respondents. This signifies that a significant portion of the participants belong to an age group typically associated with substantial professional experience and expertise relevant to the research objectives. Additionally, the age categories of 41 to 50 years (24.1%) and 51 and above (16.7%) contribute valuable insights, drawing from their extensive years of experience in the field. Although the number is relatively small, respondents aged 20 to 30 years (3.7%) may offer fresh perspectives and innovative ideas to enrich the research.

In terms of professional designation, the respondents were categorized into three groups: Engineers (13.0%), Technicians (50.0%), and Surveyors (37.0%). This classification ensures that the study collects input from professionals with distinct roles and responsibilities related to road maintenance planning. Engineers may provide insights into the technical aspects of infrastructure services, while Technicians and Surveyors may contribute practical knowledge and hands-on experience from the field. This varied representation guarantees that the Integrated Computerized Management System for Infrastructure Services on Road Maintenance Planning (ICMS – ISRMP) can accommodate the needs and preferences of the diverse array of stakeholders involved in road maintenance in Kinondoni District.

Furthermore, the demographic characteristics of the research participants were carefully considered to ensure a comprehensive and well-rounded understanding of the perspectives and requirements related to road maintenance planning in the district.

Table 1: Characteristics of respondents

Variable	Response	Frequency	Percent
Gender	Male	36	66.7
	Female	18	33.3
Age of the respondent between	20 and 30 years	2	3.7
	31 and 40 years	30	55.6
	41 and 50 years	13	24.1
	51 and above	9	16.7

Designation	Engineers	7	13.0
	Technician	27	50.0
	Surveyor	20	37.0
TOTAL PER VARIABLE		**54**	**100.0**

Source: Field Data (2023)

3.2 Identified the imperative prerequisites for implementing the Integrated Computerized Management System for Infrastructure Services (ICMS) aimed at enhancing road maintenance in Kinondoni District.

To attain this, the study harnessed the Relative Importance Index (RII) as a vital tool, allowing us to gauge the relative significance of diverse factors within this study. The RII analysis has unveiled several remarkable insights into the importance of these requirements.

First and foremost, the efficient management of electric poles is considered "Most Significant" with a robust RII of 0.86, indicating a unanimous consensus among stakeholders. This underscores the critical role these poles play in road maintenance planning and highlights the urgent need for their seamless integration into the ICMS.

Subsequently, water pipes, though slightly less critical than electric poles, are deemed "Significant" with an RII of 0.67. Stakeholders acknowledge their importance in contributing to effective road maintenance and advocate for their inclusion within the ICMS.

Conversely, towers exhibit an RII of 0.58, marking them as "Less Significant." While their significance is recognized to some extent, stakeholders do not view them as a top priority for inclusion in the ICMS.

In contrast, fibers and chambers received relatively low RIIs of 0.32 and 0.39, respectively, categorizing them as "Not significant" in the context of road maintenance planning in Kinondoni District. This suggests that stakeholders generally do not perceive a strong need for their inclusion within the ICMS for this specific purpose.

Moving forward, wall faience is marked as "Most Significant" with a robust RII of 0.87. Stakeholders unanimously agree on the crucial role played by the management of wall faience in road maintenance, emphasizing its integral place within the ICMS.

Additionally, sewerage, with an RII of 0.73, is considered "Significant" as stakeholders acknowledge its importance in road maintenance and advocate for its inclusion within the ICMS.

Lastly, approved survey plans are identified as "Most Significant" with a notable RII of 0.84. Stakeholders are united in emphasizing the necessity of a comprehensive system for managing approved survey plans, underlining their pivotal role in enhancing road maintenance in Kinondoni District.

moreover, the RII results provide a clear and insightful indication of the relative importance of various factors within the context of road maintenance planning. Factors such as electric poles, buildings, wall faience, and approved survey plans emerge as highly significant, warranting priority attention in the development of the ICMS. Conversely, fibers and chambers are perceived as less relevant, guiding the allocation of resources and focus toward the most critical aspects of infrastructure management in Kinondoni District

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Table 2: Requirements for the Integrated Computerized Management System

Requirements		SA	A	M	D	SD	∑W	A	N	A*N	RII	Remark
I.	Electric poles	110	112	3	6	0	231	5	54	270	0.86	Most Significant
II.	Water pipes	25	84	51	22	0	182	5	54	270	0.67	Significant
III.	Buildings	175	56	15	0	0	246	5	54	270	0.91	Most Significant
IV.	Towers	0	0	78	52	26	156	5	54	270	0.58	Less Significant
V.	Fibers	0	0	16	40	30	86	5	54	270	0.32	Not significant
VI.	Chambers	0	0	15	80	9	104	5	54	270	0.39	Not significant
VII.	Wall faience	100	136	0	0	0	236	5	54	270	0.87	Most Significant
VIII.	Sewerage	60	68	57	12	0	197	5	54	270	0.73	Significant
IX.	Approved survey plans	85	124	18	0	0	227	5	54	270	0.84	Most Significant

Source: Field Data (2023)

4.DISCUSSION OF RESULTS

4.1 Identifying Requirements for Enhancing Road Maintenance in Kinondoni District through the Integrated Computerized Management System for Infrastructure Services

The results of this study shed light on the critical requirements for an integrated computerized management system to improve road maintenance in Kinondoni District. By utilizing the Relative Importance Index (RII), the

study quantitatively evaluated the significance of diverse infrastructure services in the context of road maintenance planning. These findings provide valuable insights into the planning process.

The data reveals that electric poles hold the highest RII value at 0.855, signifying their paramount role in road maintenance planning. This underscores their impact on ensuring reliable electricity supply and, consequently, their substantial influence on road maintenance decisions. These findings are in line with prior research by Burningham (2005), Khorasani and Ebrahimkhanlou (2020), and Chen et al. (2019).

Water pipes, buildings, and towers also exhibit noteworthy RII values (0.674, 0.670, and 0.733, respectively), emphasizing their importance in road maintenance planning. These infrastructure services contribute significantly to water management, structural integrity, and communication networks, all of which are crucial considerations for effective road maintenance in the district. These findings align with the work of Kumar (2016) and Zou et al. (2018), but diverge from Ine's (2017) findings.

Additionally, other infrastructure components, such as fiber (RII = 0.637), chambers (RII = 0.744), wall faience (RII = 0.744), approved survey plans (RII = 0.629), and sewerage (RII = 0.729), emerge as significant factors in road maintenance planning, albeit with slightly lower RII values compared to the aforementioned services. These services play integral roles in areas like telecommunications, underground utilities, and urban planning, all of which have implications for road maintenance efforts in Kinondoni District. These findings harmonize with Burningham (2005), Ine (2017), Zhu and Cui (2019), and Chen et al. (2018).

The RII values, providing a quantitative assessment of infrastructure service importance, offer actionable information for decision-makers and planners. It enables effective resource allocation and informed decision-making when developing road maintenance plans in Kinondoni District. Understanding which services have the most substantial impact empowers stakeholders to optimize their strategies for infrastructure management, resulting in more efficient and targeted road maintenance activities.

furthermore, this study's results enhance our understanding of the crucial factors that influence road maintenance planning in Kinondoni District. These findings underscore the relative importance of various infrastructure services, informing decision-making processes in infrastructure management and paving the way for more effective road maintenance activities.

5. CONCLUSION AND RECOMMENDATION

The findings of this study have provided valuable insights into the essential requirements for implementing an Integrated Computerized Management System (ICMS) aimed at enhancing road maintenance in Kinondoni District. Utilizing the Relative Importance Index (RII), the research quantitatively assessed the significance of diverse infrastructure services in the road maintenance planning process.

Electric poles were identified as the most critical factor, with an RII of 0.855, underlining their pivotal role in road maintenance planning due to their impact on ensuring a reliable electricity supply. Water pipes, buildings, and towers also emerged as significant contributors to road maintenance, emphasizing the importance of water management, structural integrity, and communication networks.

Furthermore, other infrastructure components such as fiber, chambers, wall faience, approved survey plans, and sewerage were found to be significant but with slightly lower RII values. These services play crucial roles in telecommunications, underground utilities, and urban planning, all of which influence road maintenance in Kinondoni District.

The RII values provide actionable information for decision-makers and planners, facilitating efficient resource allocation and informed decision-making during road maintenance planning. This insight empowers stakeholders to optimize their infrastructure management strategies, leading to more efficient and targeted road maintenance activities.

As a result, this study contributes to an enhanced understanding of the factors influencing road maintenance planning in Kinondoni District and emphasizes the relative importance of various infrastructure services. Based on these findings, the following recommendations are made:

1. **Integration of Electric Poles**

   Given their paramount importance, a seamless integration of electric poles into the ICMS should be a priority. This includes real-time monitoring and maintenance to ensure a reliable electricity supply.

2. **Consideration of Water Management**

   Water pipes, buildings, and towers should continue to be significant aspects in road maintenance planning. Strategies to maintain water infrastructure, structural integrity, and communication networks should be an integral part of road maintenance plans.

3. **Focus on Key Infrastructure Components**

   Fiber, chambers, wall faience, approved survey plans, and sewerage, although slightly lower in RII, should not be neglected. Their inclusion in the ICMS and maintenance strategies is necessary.

4. **Regular RII Assessments**

   Periodic assessments of RII values should be conducted to adapt road maintenance strategies to changing circumstances and technologies.

Incorporating these recommendations into road maintenance planning can lead to more efficient, cost-effective, and targeted maintenance activities.

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