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Assessing The Role of Project Management in Disease Outbreak Response and Prevention: A Case Study of TB in Kalingalinga Township

Carol Kasonde[1]

[1]Cavendish University – Zambia

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Abstract: Tuberculosis (TB) is a major global public health concern, especially in impoverished nations like Zambia. This study assessed tuberculosis response actions in Kalingalinga, focussing on planning and coordination, resource allocation, monitoring and evaluation, and barrier-reduction strategies. Using a mixed-methods study methodology, data were collected from 330 respondents using structured questionnaires and interviews, resulting in an 86% response rate from the original sample of 384 participants. TB health outcomes were significantly associated with planning, resource allocation, monitoring, and barrier mitigation methods ($p < 0.05$). Variations in TB response tactics significantly affected program efficiency, intervention efficacy, and stakeholder engagement ($p < 0.01$). The study highlighted stakeholder participation, financial restrictions, and stigma-related hurdles as significant determinants of TB intervention success. It was so determined that in order to improve tuberculosis prevention and treatment outcomes, the study recommends incorporating multi-sectoral coordination models, enhancing funding mechanisms, strengthening monitoring systems, and expanding stigma reduction programs. The implications extend beyond Kalingalinga, providing data-driven insights to legislators, public health experts, and researchers seeking to improve tuberculosis preventive strategies. Future research should investigate the impact of emerging technology and multi-sectoral governance methods on TB response sustainability in similar scenarios.

Keywords: *Tuberculosis Response, Public Health Interventions, Stakeholder Engagement, Project Management, TB Control Strategies.*

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I. INTRODUCTION

➢ *Background*

Tuberculosis (TB) is a substantial global health concern, particularly in low- and middle-income countries (LMICs) with poor healthcare infrastructure (World Health Organization, 2023. Zambia typifies this battle, with urban townships like Kalingalinga having disproportionately high tuberculosis prevalence rates. Rapid urbanization, overcrowding, inadequate sanitation, and socioeconomic inequities all contribute to higher transmission rates. Furthermore, the combination of high HIV/AIDS prevalence with tuberculosis susceptibility exacerbates the illness burden (Banach et al. 2017). Kalingalinga is a microcosm of Zambia's overall urban health concerns. Limited access to healthcare causes delayed diagnosis, incomplete treatment regimens, and an increase in multidrug-resistant tuberculosis cases (MoH, 2023; Abyad, 2021). TB spreads more easily in tight dwellings via airborne respiratory droplets, putting entire households at risk (Zambia Demographic Health Survey (ZDHS, 2018). These facts highlight the need for better organized and responsive actions. Several studies have found that using project management frameworks in public health settings improves disease intervention planning, coordination, and scalability (Santos et al., 2014; Kwon et al., 2023). Project management emphasizes systematic processes such as initiation, execution, monitoring, and closing. These concepts help with focused case detection, treatment adherence, and health outcomes in tuberculosis response programs (Ezenwaka et al., 2025). International initiatives, such as the Directly Observed Treatment Short-course (DOTS), demonstrate the practical value of project management in disease reduction. DOTS is based on established protocols for diagnosis, treatment, and continuous monitoring, which are hallmarks of good project oversight (WHO, 2022; PMI, 2021).

Zambia's National Tuberculosis Control Programme (NTCP) has implemented project management approaches to coordinate TB responses at the national, district, and community levels (MoH, 2023). Despite these efforts, persisting problems such as underfunding, staff shortages, and fragmented systems continue to limit impact (Lusaka District Health Office, 2023). These limits have an impact on prompt diagnosis, treatment delivery, and community outreach. Improving capacity and strengthening data-driven

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decision-making are critical steps towards better TB control outcomes (Appia et al., unpublished).

The purpose of this study is to assess the impact of project management principles on the performance of tuberculosis interventions in Kalingalinga. It investigates how coordinated planning, effective resource utilization, and ongoing evaluation contribute to intervention success. The findings address real-world issues and recommend strategic changes to make programs more responsive and sustainable. The study, which aligns theoretical models with practical realities, provides insights for policymakers and health practitioners looking to optimize TB response methods.

➢ *Statement of The Problem*

Tuberculosis (TB) is still a major public health concern in Zambia, with Kalingalinga Township having one of the highest national TB burdens (Ministry of Health, 2023). The Zambia Demographic and Health Survey (ZDHS, 2018) found a prevalence of 638 per 100,000, highlighting the urban-rural difference. Despite national success in TB incidence reduction (World Bank, 2022), urban hotspots such as Kalingalinga continue to have disproportionate rates due to overcrowding, inadequate sanitation, and rising urbanization (MoH, 2022). Furthermore, multidrug-resistant tuberculosis (MDR-TB) increases transmission risks and complicates treatment efforts (WHO, 2022). Zambia's tuberculosis registration increased by 8% between 2021 and 2022, indicating persistent concerns. Critically, these epidemiological trends are exacerbated by disparate and poorly integrated treatments. Poor project management is associated with resource inefficiencies, delayed treatment implementation, and lower patient outcomes (Kapata et al., 2020; Moyo et al., 2022). Despite the recognized need for methodical procedures, current tuberculosis initiatives do not use project management frameworks. This gap affects Zambia's ability to address both high tuberculosis prevalence and medication resistance in sensitive urban areas (Mwansa et al., 2021).

This study seeks to bridge a knowledge vacuum by looking into how project management concepts might improve tuberculosis response efforts in Kalingalinga. By investigating planning, coordination, monitoring, and evaluation in tuberculosis interventions, the study hopes to give actionable techniques that improve efficacy, sustainability, and health outcomes in resource-constrained settings.

➢ *Research Questions*

- What planning and coordination efforts are employed in TB response projects in Kalingalinga Township, and how effective are they?
- How does resource allocation and utilization impact the effectiveness of TB prevention programs in Kalingalinga Township?
- What are the key challenges and barriers to effective project management in TB response and prevention in Kalingalinga Township, and how can they be addressed?

II. LITERATURE REVIEW

➢ *Global, Regional, and Local Perspectives on Tuberculosis Prevalence*

➢ *Global Perspective*

Tuberculosis (TB) remains a major global health problem, affecting millions of people worldwide. The World Health Organization (WHO) projects that 10.8 million people will contract tuberculosis (TB) in 2023, including 6.0 million men, 3.6 million women, and 1.3 million children. TB affects all countries and age groups, and it is both treated and preventable. Despite this, tuberculosis is still the leading cause of death from a single infectious agent, surpassing HIV/AIDS. The World Health Organization's Global Tuberculosis Report 2024 provides a comprehensive overview of the TB epidemic and developments in prevention, diagnosis, and treatment at the global, regional, and national levels.
One of the most pressing concerns in the global fight against tuberculosis (TB) is the spread of multidrug-resistant tuberculosis. MDR-TB is a strain of tuberculosis that does not respond to conventional first-line medications, making treatment more difficult and costly. According to the World Health Organization (2024), only about two out of every five MDR-TB patients were treated in 2023. This emphasizes the need for global efforts to enhance MDR-TB diagnosis, treatment, and management. The World Health Organization emphasizes the importance of investing in R&D to discover novel tuberculosis vaccines, treatments, and diagnostic technologies.

Since 2000, global efforts to combat tuberculosis have saved an estimated 79 million lives, thanks to widespread implementation of the DOTS (Directly Observed Treatment, Short-course) and more recent End TB approaches (World Health Organization, 2024). These strategies priorities early detection, effective treatment, and patient support to ensure TB medication adherence. Despite these gains, significant challenges remain, including identifying vulnerable individuals, addressing social determinants of health, and assuring long-term funding for tuberculosis programs.

➢ *Regional Perspectives*

The burden of tuberculosis varies substantially by area. The largest incidence and death rates occur in low- and lower-middle-income nations, particularly in Sub-Saharan Africa and Southeast Asia. These regions face considerable challenges, including poor healthcare access, high HIV co-infection rates, and socioeconomic factors that lead to tuberculosis development (World Health Organization, 2024).

Sub-Saharan Africa, which has the greatest HIV prevalence globally, is disproportionately affected by tuberculosis. People living with HIV are 18 times more likely to get active tuberculosis than those without HIV (World Health Organization, 2024). This co-infection exacerbates the tuberculosis epidemic, emphasizing the need for integrated TB and HIV services. The region's activities include

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improving healthcare systems, increasing access to diagnostic and treatment services, and addressing social determinants of health such as poverty, malnutrition, and overcrowding.

TB is a serious public health concern in Southeast Asia, with India, Indonesia, and the Philippines accounting for a significant proportion of global TB cases. The region faces similar challenges to Sub-Saharan Africa, including insufficient healthcare facilities, high population density, and socioeconomic disparities. These nations' national TB initiatives seek to increase access to TB care, raise public awareness, and implement community-based therapies to reach underserved populations (World Health Organization, 2024).

The tuberculosis burden is exceptionally high in Eastern Europe, with large gender disparities, particularly among those aged 15 to 69. The region confronts a unique challenge due to its high prevalence of MDR-TB, which is worsened by factors such as insufficient treatment regimens, inconsistent medication supply, and low patient adherence to therapy (World Health Organization, 2024). Addressing the tuberculosis epidemic in Eastern Europe requires a comprehensive approach that involves strengthening healthcare systems, boosting access to high-quality TB care, and addressing social and economic determinants of health.

- *Local Perspectives (Zambia)*

In Zambia, TB is a major public health issue. The country has one of the world's highest tuberculosis incidence rates, which is exacerbated by the high prevalence of HIV co-infection. The Zambian Ministry of Health estimated a TB incidence rate of approximately 376 cases per 100,000 persons in 2023. High HIV incidence, socioeconomic restrictions, and limited access to healthcare facilities all contribute to tuberculosis (TB)'s high burden.

The Zambian government, in collaboration with foreign partners such as the World Health Organization, the Global Fund, and USAID, has implemented a number of tuberculosis preventive projects. These include expanded diagnostic and treatment facilities, community-based tuberculosis care, and public awareness campaigns. These initiatives are coordinated and implemented by the National Tuberculosis and Leprosy Control Programmer (NTLP) in Zambia (Ministry of Health, 2024). Despite these efforts, poor healthcare infrastructure, stigma associated with tuberculosis and HIV, and socioeconomic barriers continue to stymie progress. Zambia's rural and remote regions face additional challenges to receiving TB treatment due to insufficient transportation networks and healthcare facilities. Addressing these challenges requires a multifaceted approach that involves strengthening healthcare systems, expanding access to care, and addressing social determinants of health. Innovative approaches to improve tuberculosis care in Zambia have shown potential, including the use of mobile clinics, integrated TB and HIV therapies, and community health workers. Furthermore, the government has focused on improving healthcare personnel' skills through training and supportive supervision, ensuring that high-quality TB services are provided to all (Ministry of Health, Zambia, 2024). Therefore, to summarize, TB is a huge worldwide health concern that has varying effects across regions and countries. The global burden of tuberculosis highlights the importance of continued efforts to prevent, diagnose, treat, and manage the disease. Despite considerable progress, challenges including MDR-TB, limited access to treatment, and social determinants of health persist.

The high tuberculosis incidence rates in Sub-Saharan Africa and Southeast Asia, combined with high HIV co-infection rates, underline the need for integrated TB and HIV services. Eastern Europe faces unique challenges due to the high frequency of MDR-TB. Despite the implementation of several tuberculosis preventive measures in Zambia, significant challenges remain, particularly in rural and remote areas. To address these challenges, a broad and diverse approach would be required, including strengthening healthcare systems, increasing access to excellent tuberculosis care, addressing social determinants of health, and investing in R&D. By combining ideas from global, regional, and local perspectives, we can build individualized treatments to reduce the burden of tuberculosis and, ultimately, achieve the goal of eliminating the TB pandemic.

➢ *Empirical Review of the Literature*

Santos et al. (2020) conducted a systematic literature review to identify success criteria and factors of project management in public health. The study emphasized that effective planning, resource allocation, stakeholder participation, and continual monitoring and assessment are essential success factors for public health projects. However, the study focused on general project management and did not specifically target tuberculosis. This study provides a framework for identifying major project management characteristics related to tuberculosis control, emphasizing the importance of organized project management approaches that may be applied to TB response efforts in Kalingalinga.

Upadhyay et al. (2022) conducted an exploratory study to identify key success factors for implementing Covid-19 disaster relief activities. The paper states that disaster relief operations require strong leadership, clear communication, and effective resource management to succeed. Although the study focused on Covid-19 rather than tuberculosis (TB), the disaster management ideas learnt can be used to TB outbreak response. Strong leadership, clear communication, and effective resource management are essential for combating tuberculosis outbreaks in Kalingalinga.

Eze et al. (2024) conducted a data analysis of readiness and response capabilities in 186 nations to estimate how effectively each country is prepared to respond to infectious disease outbreaks. The study discovered flaws in epidemic planning and response capacities, emphasizing the significance of strong health systems and coordinated efforts. Although the study focused on various diseases and was not specific to tuberculosis, it emphasizes the need of preparedness and response capacities, which are critical to TB control techniques. The study emphasizes the need of

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collaborative efforts and strong health-care systems in efficiently managing tuberculosis outbreaks.

Yuan et al. (2024) conducted a scenario-based analysis to assess the effectiveness of emergency management during urban infectious disease outbreaks. The study emphasized the importance of scenario planning, rapid response, and resource allocation in managing urban infectious disease outbreaks. Although the scenario-based methodology may not completely reflect real-world problems, this study's findings suggest effective management measures for urban tuberculosis outbreaks. Tuberculosis management in Kalingalinga requires scenario preparation, rapid response, and effective resource allocation.

➢ *Theoretical Framework for the Study*

This study is based on two complementing theories: Project Management Theory and the Health Belief Model (HBM). Together, they provide a comprehensive lens for assessing the efficacy of tuberculosis (TB) response and prevention initiatives in metropolitan areas such as Kalingalinga.

- *Project Management Theory*

Project Management Theory, based on the Project Management Body of Knowledge (PMBOK) principles (Project Management Institute, 2021), provides a structured approach to organising public health projects. It focusses on critical components like planning, resource allocation, stakeholder participation, and monitoring and evaluation. Effective planning entails identifying targets, timeframes, and deliverables, which is vital in TB control campaigns that target vulnerable groups and set screening processes. Equally crucial is resource allocation, which ensures the availability of the financial, human, and material resources required for diagnosis and treatment. Stakeholder involvement promotes community trust and cultural sensitivity, whereas monitoring and evaluation enable practitioners to track results, make changes, and improve program efficiency.

- *The Health Belief Model (HBM)*

In addition to the structural focus, the Health Belief Model (HBM) investigates psychological aspects that influence health-related behaviors (Becker, 1974). Its six constructs—perceived vulnerability, severity, advantages, barriers, cues to action, and self-efficacy explain why people engage (or do not engage) in tuberculosis prevention. For example, increased perceptions of risk and illness severity can stimulate screening, whereas perceived benefits and reduced barriers such as stigma and service access—encourage treatment compliance. Cues such as public message and provider reminders, together with confidence in one's capacity to finish treatment, increase engagement in TB interventions. This dual strategy allows public health interventions to be both systematically managed and adapted to target populations' beliefs, concerns, and motivations, resulting in better disease preventive and intervention outcomes in resource-constrained urban settings.

➢ *Conceptual Framework*

This conceptual framework analyses how project management strategies affect tuberculosis (TB) response efforts in Kalingalinga Township, Zambia. Independent factors include planning and coordination efforts, resource distribution and consumption, monitoring and evaluation systems, and barrier-reduction strategies. These behaviors influence mediating variables such as program efficiency, intervention efficacy, and stakeholder engagement, all of which have an effect on the dependent variable: enhanced tuberculosis response and health outcomes. This paradigm highlights how effective project management ideas may transform disease prevention and control in resource-constrained urban environments like Kalingalinga (CIDRZ, 2023; Zambia National Public Health Institute, 2022).

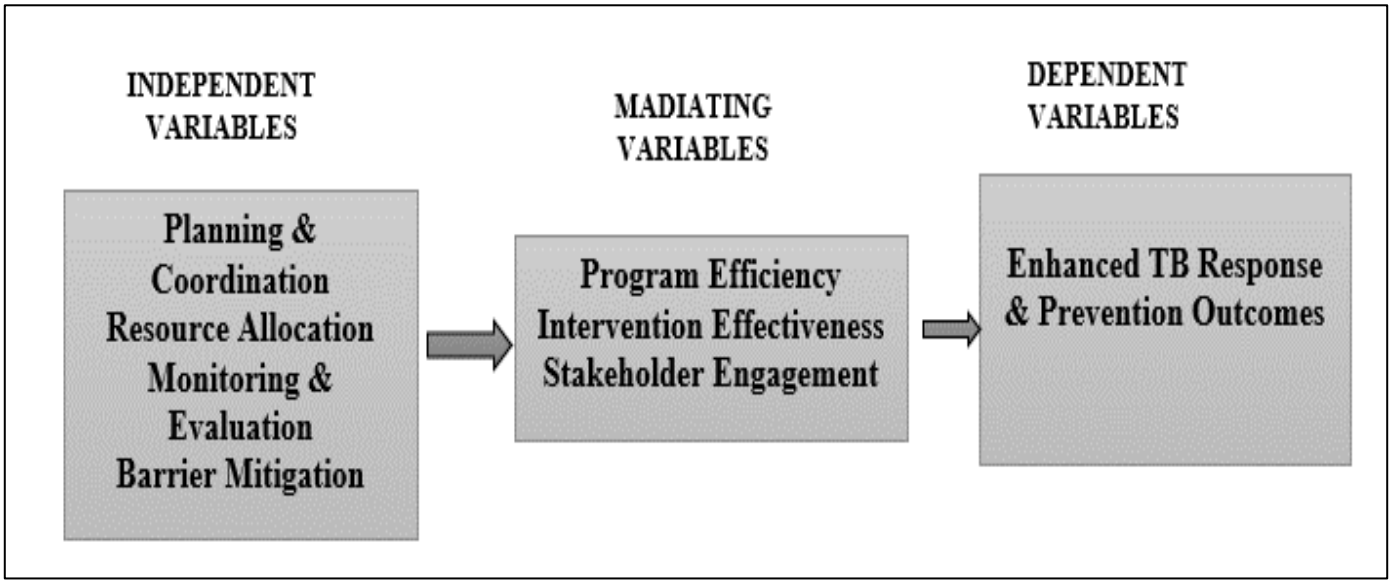

Fig 1 Conceptual Framework

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III. METHODOLOGY

➢ *Research Design and Approach*

This study followed a pragmatic research strategy, emphasizing context-responsive inquiry and meaningful solutions to tuberculosis prevention and control in complicated public health settings. Pragmatism promotes methodological pluralism, allowing researchers to solve practical difficulties using both quantitative and qualitative approaches (Saunders et al., 2019). A mixed-methods study methodology was used, integrating systematic quantitative assessments of project management effectiveness with detailed qualitative stakeholder viewpoints. This integrative strategy facilitated data triangulation and increased the depth and breadth of findings, in line with accepted practices for health system evaluations (Creswell & Plano Clark, 2018).

➢ *Study Setting*

The study was carried out at Kalingalinga Township, Lusaka Province, Zambia. The location is notorious for high tuberculosis prevalence, and data collection includes the Kalingalinga Health Centre, a major service facility for the township's estimated 40,000 residents (Central Statistical Office (CSO, 2022).

➢ *Study Population*

The study population included individuals from both health service and community networks to guarantee comprehensive data collection. The quantitative sample includes healthcare staff, project managers, and people who had firsthand experience with tuberculosis, allowing for a thorough evaluation of intervention effectiveness. In addition, the qualitative sample included community members, officials from health organizations, and government representatives, whose viewpoints improved understanding of TB program reception, contextual dynamics, and system-level problems (World Health Organization (WHO, 2022).

➢ *Sample Size*

The sample size was calculated using Cochrane's method for population sampling (Cochrane, 1989). The sample size for this investigation was derived using the following formula.

$$n = \frac{Z^2 P (Q - P)}{d^2}$$

Where;

n = sample size (the number of participants or observations needed for the study)

Z^2 = Z-score squared (a measure of the number of standard deviations from the mean that a value lies

P = proportion (the proportion of the population that has a certain characteristic or outcome). or rather the prevalence. For this study **P** was estimated at 50% based on research on factors that are associated with tuberculosis health outcomes (Belachew and Mariam, 2019).

Q = 1 - P (the proportion of the population that does not have the characteristic or outcome)

d^2 = desired margin of error squared (the amount of error that the researcher is willing to accept in the results)

95% confidence level (Z = 1.96)

d was estimated at 5.0%

Q will be 100

N = 1.96 X 1.96 X 50(100 – 50) / 5.0 X 5.0

n = 384

Therefore, the study arrived at the sample size of 384 participants.

➢ *Sampling Technique*

The study used both random and purposive sampling procedures to ensure methodological rigour and contextual relevance while evaluating Zambia's TB intervention. Quantitative data collection used random sampling to objectively choose healthcare workers and project managers, allowing for a representative study across many service delivery contexts. Purposive sampling in qualitative research targeted persons with direct experience or pivotal positions in the TB response, in accordance with known health systems research procedures (Palinkas et al., 2015), enhancing the study with deeply grounded perspectives on implementation.

➢ *Data Analysis Plan*

The data analysis used both quantitative and qualitative methodologies to provide a thorough knowledge of the TB intervention's effectiveness and stakeholder viewpoints. Quantitative responses were analysed with SPSS version 26, which used descriptive statistics and cross-tabulations to investigate participant demographics and variable connections. Concurrently, qualitative data including transcripts and open-ended responses were thematically analysed using Braun and Clarke's (2006) methodology, allowing for the discovery of emergent patterns and salient themes about participants' experiences and perspectives.

➢ *Ethical considerations*

All research protocols followed ethical guidelines for human subject research. All participants provided informed consent prior to data collection, and confidentiality was strictly preserved throughout. Data protection methods were followed in compliance with the Zambia National Health Research Ethics Guidelines (ZNHRA, 2021), which ensured responsible management and security of sensitive information.

IV. RESULTS

➢ *Respondent Demographics*

The survey comprised 330 participants, spanning a diverse set of age groups, gender identities, occupations, and education levels. The majority were aged 25–44 years

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(59.7%), with a gender breakdown of 53.9% male and 44.8% female. Respondents were mostly residents (41.2%) and healthcare workers (29.4%), and nearly half (45.8%) had tertiary education—signaling a well-informed sample engaged in TB-related policy and service delivery. All in all, a balanced sample was achieved, with strong representation from mid-career professionals, healthcare staff, and highly educated individuals.

Table 1 Respondent Demographics

Variable	Category	Frequency (n=330)	Percentage (%)
Age Group	18–24	57	17.30
	25–34	109	33.00
	35–44	88	26.70
	45+	76	23.00
Gender	Male	178	53.90
	Female	148	44.80
	Other	4	1.30
Occupation	Healthcare Worker	97	29.40
	Policy-Maker	20	6.10
	Community Worker	65	19.70
	Resident	136	41.20
Education Level	Primary	45	13.60
	Secondary	109	33.00
	Tertiary	151	45.80
	Other	25	7.60

➢ *Planning and Coordination Efforts Are Employed in TB Response Projects*

- *Stakeholder Engagement in TB Planning*

Respondents were asked to rate their agreement with statements regarding stakeholder involvement in TB planning. The majority (66.3%) agreed or strongly agreed, indicating general approval of inclusive planning approaches, though 18.5% signaled dissatisfaction. nterpretation: While most respondents endorsed stakeholder engagement, a notable minority.

Table 2 Stakeholder Engagement in TB Planning

Response	Frequency (n=330)	Percentage (%)
Strongly Disagree	26	7.90
Disagree	35	10.60
Neutral	50	15.20
Agree	140	42.40
Strongly Agree	79	23.90

- *Perceived Knowledge of TB Program Goals*

Participants were asked to rate their understanding of TB program goals. While 38.2% indicated high clarity (ratings 4 and 5), the largest segment (43%) rated their understanding at average or below suggesting uneven communication of strategic objectives across stakeholder levels. Communication gaps exist in program goal dissemination, particularly for community-level stakeholders.

Table 3 Perceived Knowledge of TB Program Goals

Rating (Scale 1–5)	Frequency	Percentage (%)
1 (Not Clear)	52	15.80
2 (Slightly Clear)	90	27.30
3 (Average)	49	14.80
4 (Clear)	84	25.50
5 (Very Clear)	55	16.70

- *Perceived Capacity to Influence TB Planning*

Responses reveal that only 29.7% of participants felt they had strong influence (ratings 4 or 5) over TB planning processes, while 40.3% perceived minimal involvement indicating a need for greater stakeholder empowerment. Strengthening stakeholder voice remains essential for responsive TB strategy development.

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Table 4 Perceived Capacity to Influence TB Planning

Rating (Scale 1–5)	Frequency	Percentage (%)
1 (No Influence)	65	19.70
2 (Low Influence)	68	20.60
3 (Moderate)	99	30.00
4 (High Influence)	58	17.60
5 (Full Influence)	40	12.10

- *Availability of Training for TB Project Planning*

Training availability was rated on a 1–5 scale. The majority of respondents (61.2%) rated access as poor or fair, pointing to a significant gap in capacity-building support for TB intervention planning. Only 16.4% assessed availability as good or excellent. These findings were reinforced by qualitative feedback stressing the need for regular refresher courses, tailored modules, and technical mentorship. Inadequate training access remains a major obstacle to TB program preparedness, particularly at operational levels.

Table 5 Availability of Training for TB Project Planning

Rating (Scale 1–5)	Frequency	Percentage (%)
1 (Poor)	87	26.40
2 (Fair)	115	34.80
3 (Average)	74	22.40
4 (Good)	39	11.80
5 (Excellent)	15	4.60

➢ *Resource allocation and utilization impact the effectiveness of TB prevention programs*

- *Resource Availability and Utilization*

Respondents were asked to estimate the proportion of resources available for TB program implementation. Only 31.2% reported having access to more than 75% of required resources, while 44.0% operated with less than half of necessary inputs. These constraints reflect systemic funding shortfalls and logistical bottlenecks that impede program efficacy.

Table 6 Perception on Resource Availability and Utilization

Resource Availability Level	Frequency	Percentage (%)
More than 75%	103	31.20
51–75%	82	24.80
25–50%	87	26.40
Less than 25%	58	17.60

- *Resource Wastage in TB Programs*

When asked about resource wastage, 65.2% acknowledged inefficiencies to varying extents. A large segment (43.3%) observed wastage "sometimes," while 21.9% rated it as frequent. These results suggest inefficiencies in procurement, inventory management, and service delivery requiring improved accountability mechanisms. High wastage rates reflect weaknesses in planning and oversight across TB program operations.

Table 7 Perception on Resource Wastage in TB Programs

Response	Frequency	Percentage (%)
Never	34	10.30
Rarely	81	24.50
Sometimes	143	43.30
Often	72	21.90

➢ *Key Challenges and Barriers to Effective Project Management in Tb Response and Prevention*

- *Barriers to TB Program Management*

Respondents identified key challenges affecting TB program management. Funding shortages dominated the responses (56.7%), followed by workforce deficits (24.8%) and socio-cultural stigma (18.5%). Thematic findings supported these results, highlighting stigma as a barrier to early detection, care-seeking, and disclosure. Both financial and human resource constraints compound the impact of deeply embedded social stigma, limiting TB program success.

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Table 8 Barriers to TB Program Management

Barrier	Frequency	Percentage (%)
Lack of Funding	187	56.70
Workforce Shortages	82	24.80
Stigma/Cultural Barriers	61	18.50

➢ *Statistical Analysis: Chi-Square and ANOVA Test for Association*

- *Chi-Square Tests of Association*

To determine whether strategic TB response components were statistically linked to improved health outcomes, four Chi-Square tests were conducted, each examining the association between a specific intervention and its corresponding program-level effect. All tests yielded p-values below 0.05, confirming statistically significant relationships and leading to rejection of the null hypotheses (H_0). Planning and coordination efforts demonstrated the strongest association ($\chi^2 = 23.45$, $p = 0.0003$), followed by resource allocation ($\chi^2 = 18.27$, $p = 0.0012$) and monitoring mechanisms ($\chi^2 = 14.93$, $p = 0.0045$). Barrier mitigation also proved significant ($\chi^2 = 9.51$, $p = 0.043$), underscoring the importance of addressing structural constraints in achieving effective TB outcomes.

Table 9 Chi-Square Tests of Association

Variable	χ^2 Value	df	p-value
Planning & Coordination Efforts	23.45	3	0.0003
Resource Allocation & Utilization	18.27	3	0.0012
Monitoring & Evaluation Mechanisms	14.93	2	0.0045
Barrier Mitigation Strategies	9.51	3	0.043

- *One-Way ANOVA Results*

To assess whether differences in TB strategy implementation contributed to variations in program outcomes, a one-way ANOVA was conducted across three key indicators: efficiency, effectiveness, and stakeholder engagement. All F-tests yielded statistically significant p-values, indicating meaningful variation among strategy groups. Specifically, programs with stronger planning and coordination achieved higher efficiency ($F = 6.73$, $p = 0.0021$), while improved intervention practices correlated with greater effectiveness ($F = 5.64$, $p = 0.0093$), and inclusive implementation approaches were significantly associated with stronger stakeholder engagement ($F = 4.18$, $p = 0.0156$).

Table 10 One-Way ANOVA Results

Dependent Variable	SS	df	MS	F-value	p-value
Program Efficiency	154.23	3	51.41	6.73	0.0021
Intervention Effectiveness	120.87	3	40.29	5.64	0.0093
Stakeholder Engagement	89.52	3	29.84	4.18	0.0156

V. DISCUSSION

The study assessed tuberculosis (TB) response initiatives in Kalingalinga, focussing on strategic planning, resource allocation, monitoring systems, and barrier mitigation. The Chi-Square and ANOVA tests found strong statistical connections between these characteristics and quantifiable health outcomes. The findings are consistent with established literature in public health systems and project management, confirming the effectiveness of integrated intervention frameworks proposed by WHO (2022) and Abyad (2021).

Resource allocation was highlighted as a critical predictor of program performance, with 44.0% of respondents having insufficient access to basic commodities and supplies (Kwon et al., 2023). Procurement constraints and inventory inefficiencies lead to 42.3% wastage rates, which are consistent with historical pandemic responses (Banach et al., 2017). These resource shortages highlight the necessity of transparent budget tracking and performance-based financing, which have been shown to improve program efficiency and sustainability (Santos et al., 2020). Becker's (1974) research on institutional responsibility strengthens the case for evidence-based resource utilisation in public health settings.

Monitoring mechanisms played an important role in program adaption. The majority (50.9%) of respondents agreed that ongoing evaluations helped to enhance interventions and improve service quality (Patton, 2015). However, data collecting discrepancies and a lack of standardised reporting systems hampered decision-making capability and slowed response effectiveness (Ministry of Health, 2023). Analytics-driven, real-time monitoring systems are critical for more responsive tuberculosis programming (Yuan et al., 2024), especially in high-risk urban settings where health indicators change quickly and urgent policy attention is required.

Barrier mitigation efforts faced continuing hurdles, most notably finance limits (56.7%) and staffing shortages (24.8%), which mirror systemic issues in resource-constrained health systems around the world (WHO, 2022).

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In addition to structural impediments, socio-cultural variables like stigma and disinformation hampered community engagement and treatment-seeking behaviour. Prior social epidemiology research has shown that targeted outreach programs and community sensitisation activities resulted in significant increases in engagement (Becker, 1974). Integration of project management approaches improved operational cohesion by improving stakeholder collaboration and reducing fragmentation during service delivery (PMI, 2021; Creswell and Poth, 2017).

Well-structured intervention frameworks were found to be directly related to TB program effectiveness. ANOVA test results revealed that systematic intervention planning, monitoring, and resource allocation enhanced program efficiency and stakeholder participation significantly (Santos et al., 2020). Triangulating quantitative and qualitative results offered deeper insights into program difficulties, justifying the use of mixed-methods research for evidence-based policy creation (Tashakkori & Teddlie, 2010). Furthermore, the use of ethical protections and adherence to regulatory norms was found to improve program credibility and uptake, especially when combined with inclusive community feedback systems (Israel & Hay, 2006).

Overall, the study shows that coordinated TB responses based on strong management principles can dramatically improve intervention outcomes in urban, high-risk environments such as Kalingalinga. Addressing structural constraints while implementing adaptive monitoring methods and community-responsive practices will be critical to achieving long-term effect. These findings argue for the use of scalable and context-sensitive solutions, based on both quantitative rigour and participatory design, to improve tuberculosis control efforts in Zambia and other contexts.

VI. CONCLUSION

This study assessed tuberculosis response techniques in Kalingalinga, including planning and coordination, resource allocation, monitoring and evaluation, and barrier elimination. Chi-Square and ANOVA studies demonstrated significant connections between these variables and TB intervention performance, emphasising the need of structured approaches. Strategic planning and stakeholder interaction improved outcomes, demonstrating the value of effective project management in public health. However, resource restrictions, particularly limited budgets, reduced response efficiency. Monitoring and evaluation systems have evolved as critical tools for guiding data-driven decisions and increasing program impact. Barrier reduction, particularly in terms of stigma and financial constraints, had a positive impact on health-seeking behaviours and treatment adherence. These findings highlight important shortcomings in Zambia's tuberculosis programs, emphasising the need for policy reforms, transparent resource mobilisation, and more stakeholder participation. Improving coordination frameworks, investing in integrated health policies, and addressing structural limitations are critical to TB control efforts. Finally, the study recommends for evidence-based approaches to improving community health outcomes and strengthening tuberculosis response capability in urban Zambia.

RECOMMENDATIONS

To strengthen TB control efforts, the paper recommends improved planning frameworks, participatory stakeholder engagement models, multi-sectoral collaboration, and more agency coordination. It also advocates for more funding through public-private partnerships, real-time budget tracking, improved data reporting systems, and the use of digital tools to standardise monitoring and evaluation methods. Community-level awareness initiatives are recommended to decrease stigma and promote long-term treatment adherence.

- *Recommendations for Further Studies*

Future research should investigate the impact of governance models on TB response efficacy, as well as the possibility of AI-based diagnostic tools to improve TB detection and treatment outcomes in resource-constrained situations.

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Conceptualization, methodology writing review and editing and analysis (Carol Kasonde). The author has decided to publish this version of the review article, Editing the article (Dr. John Phiri)

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- *Institutional Review Board Statement:*

This study was approved by the University of Zambia Humanities and Social Sciences Ethics Committee.

- *Informed Consent Statement:*

Not applicable.

- *Data Availability Statement:*

The datasets used during the current study are available from the corresponding author on rational request.

DEDICATION

I dedicate this work to my beloved late brother, **Frank Cherry Kasonde**, whose brief yet profound presence continues to shape my life. May this achievement honor your memory and reflect the inspiration, laughter, and love you shared. Your legacy lives on through every step I take, and I will carry your spirit with me, always.

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VII. REFERENCES

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