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Effects of Prioritization of Counterterrorism Related Budgets: A Budgetary Allocation Queueing Fairness Model

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Abstract **Original Research Article**

The study, "Effects of Prioritization of Counterterrorism (CT) Related Budgets: A Budgetary Allocation Queueing Fairness (BAQF) Model", explores the inefficiencies and socio-economic consequences of prioritizing CT budgets over other critical sectors. It introduces the BAQF model, which employs queueing theory to analyze budget allocation as a single-server system with priority levels. The model incorporates the effects of "terrorpreneurial activities" -fabricated or exaggerated terrorism threats, and false-flag operations, which distort resource allocation by inflating CT budget demands. Assumptions include limited government detection capabilities, finite budgets, and the socio-economic costs of misallocation. Key findings reveal that over-prioritization of CT budgets exacerbates socio-economic inequalities, neglects essential sectors like education, agriculture, and healthcare, and perpetuates a cycle of insecurity. Misallocation incentivizes fabricated threats, creating a self-sustaining "market for fear". The study aligns with theories such as Maslow's Hierarchy of Needs, Rational Choice Theory, and Broken Windows Theory, emphasizing the importance of addressing root causes of instability - poverty, unemployment, illiteracy and inequality, rather than over-relying on punitive measures. Case studies, including post-9/11 United State CT spending and Nigeria's Boko Haram insurgency, demonstrate the adverse effects of disproportionate security spending, such as corruption and inefficiency. The study concludes that balancing resource allocation between CT and socio-economic sectors is critical. It proposes strategies to improve threat detection, mitigate fabricated threats, and promote fairness in budget allocation to prevent long-term socio-economic instability and radicalization. Simulations are recommended to optimize the trade-off between efficiency and fairness in resource distribution.

Keywords: Counterterrorism Budgets, Budget Misallocation, BAQF Model, Socio-Economic Inequality, Fabricated Threats, Resource Allocation, Radicalization.

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1.0 INTRODUCTION

A fair and equitable allocation of government resources is a critical determinant of a nation's socio-economic stability and growth. In resource-constrained settings, the prioritization of one sector often comes at the expense of others. In recent years, the global rise in terrorism has necessitated increased funding for security/defence budgets, and counterterrorism (CT) budgets in particular, leading to a reallocation of resources away from sectors like education, agriculture, healthcare, and infrastructure. While this strategy addresses immediate security concerns, it has created unintended consequences, particularly in nations where all sectors depend heavily on government budgetary allocations (GBA) system.

Ironically, the high priority place on security/defence and CT-related budgets has led to the emergence of "Terrorpreneurial" activities - where individuals or groups of individuals or states simulate acts of terrorism to attract larger budgetary allocations, and False-Flag terrorism - where fabricated terror alerts are raised to justify increased government expenditure in security. Handful of these moral hazards are vividly captured in literature, for example, the work of Abrahamsen & Williams, (2011), examines how private security firms and other actors exploit the fear of terrorism to profit from government contracts. The authors discuss the commercialization of security and how some entities may inflate or simulate threats to secure larger budgets.

Leander (2005) explores how private military companies and other actors in the security industry benefit from exaggerated or simulated threats. This aligns with the concept of terrorpreneurial activities, where actors manipulate perceptions of insecurity for financial gain. Singer (2008) also discusses how private military contractors' profit from the global war on terror, often lobbying for increased CT-related budgets. The book highlights cases where the line between genuine security needs and profit motives becomes blurred. Kaldor, (2012) examines how the privatization of security and the commercialization of warfare have created incentives for actors to simulate or exaggerate threats. This also aligns with the idea of terrorpreneurial activities in CT environments. Finally, Jackson, (2007) analyses how the discourse around terrorism is constructed and sometimes manipulated to justify increased budgets and security measures. This provides a critical lens for understanding terrorpreneurial activities.

Similarly, discussing false flag syndrome in CT environment, Ganser, (2005) provides historical examples of false-flag operations, particularly during the Cold War. It discusses how fabricated terror alerts were used to justify military spending and CT measures. Ahmed (2005) explores the role of disinformation and false-flag operations in shaping public perceptions of terrorism. The book discusses how fabricated threats have been used to justify increased government expenditure on security. Robinson, (2004), "Theory of Global Capitalism" critiques the global war on terror, arguing that fabricated terror alerts have been used to manipulate public opinion and justify large-scale CT-related budgets. Curtis (2003) examines how governments have historically manipulated or fabricated threats to justify military interventions and CT measures. These works provide case studies that align with the concept of false-flag terrorism.

The emergence of terrorpreneurial activities and false-flag terrorism highlights the complex interplay between security, politics, and economics in CT environments. These practices raise ethical and governance concerns, particularly when they result in the misallocation of resources or the erosion of public trust. These phenomena also distort resources allocation process, by inflating the demand for CT funding, delaying genuine requests, and diverting resources from critical socio-economic sectors. Thereby, leading to inefficiencies, resource misallocation, and socio-economic instability. This raises important questions about the fairness and efficiency of GBA process, as well as its long-term implications for security and socio-economic stability. To address these questions, this study seeks to models the GBA system as a single-server queueing system to evaluate the performance measures and implications of prioritizing security/defence related budget over other key socioeconomic sectors.

Queueing theory, a mathematical framework for analyzing waiting lines (Kleinrock, 1975; Gross, et al 2018; Takagi, 1991), offers a powerful framework for analyzing such resource allocation problems. By modeling the GBA system as a single-server queueing system, this study seeks to evaluate the implications of prioritizing CT-related sectors in the presence of fabricated threats. By extending the model to incorporate terrorpreneurial activities and false flag terrorism, the study seeks to provides a framework for understanding how fabricated threats inflate resource demands, delay genuine requests, and exacerbate socio-economic challenges. The study also incorporates detection mechanisms to assess the effectiveness of identifying fabricated threats and their impact on system performance.

Ultimately, the study aims to provide insights into how governments can balance security and socio-economic needs while mitigating the negative effects of terrorpreneurial activities and false flag terrorism. The study highlights the trade-offs between addressing immediate security concerns and ensuring long-term socio-economic stability. It emphasizes the need for balanced resource allocation, improved detection mechanisms, and policies to mitigate the incentives for fabricated threats. By studying these dynamics, policymakers and researchers can develop strategies to mitigate their impact and ensure that CT efforts remain focused on genuine threats. By simulating the performance characteristics of the queueing system, the study aims to inform policymakers on the economic and security implications of these emerging challenges.

1.1 Statement of the Problem

The prioritization of CT-related sectors in GBA has created a resource scarcity problem for other socio-economic sectors. This issue is further exacerbated by the emergence of terrorpreneurial activities and false-flag terrorism, where fabricated threats are used to attract larger budgetary allocations or justify increased government expenditure. These activities distort the allocation process, leading to inefficiencies, longer waiting times for genuine requests, and misallocation of resources. The problem lies in understanding how these fabricated threats influence the performance of the budgetary allocation system and their implications for both security and socio-economic stability. Without a systematic approach to evaluate these distortions, the government risks undermining its CT efforts while neglecting critical sectors that contribute to long-term development. This study seeks to address this gap by modelling the budgetary system as a queueing process and incorporating the effects of terrorpreneurial activities and false flag terrorism.

1.2 Aim and Objectives

1.2.1 Aim: To develop and evaluate a "Budgetary Allocation Queueing Fairness (BAQF)" model that incorporates the effects of terrorpreneurial activities and false flag terrorism, and to assess their security implications in the context of GBA system.

1.2.2 Objectives:

(i) To model the GBA process as a single-server queueing system with priority levels for security/defence related and other socio-economic sectors.

(ii) To incorporate terrorpreneurial activities and false-flag terrorism into the queueing model and evaluate their impact on system performance.

(iii) To analyze the performance metrics of the BAQF system, including utilization, waiting times, fairness, misallocation costs and mean time before budget exhaustion.

(iv) To assess the security implications of resource misallocation, and the system fairness caused by fabricated threats and its impact on socio-economic sectors.

(v) To evaluate the security implications of reducing CT effectiveness due to fabricated threats.

(vi) To propose strategies for improving detection mechanisms, balancing resource allocation, and mitigating the incentives for fabricated threats.

1.3 Significance of the Study

This study is significant as it provides a comprehensive framework for understanding the economic and security implications of terrorpreneurial activities and false-flag terrorism on GBA. By extending queueing theory to analyze these scenarios, the study offers a novel approach to evaluate the distortions caused by fabricated threats. The findings will inform policymakers on the trade-offs between addressing immediate security concerns and ensuring long-term socio-economic stability. The study contributes to the academic literature on resource allocation, queueing theory, and public policy by introducing a model that accounts for fabricated threats and their impact on system performance. It also provides practical insights for governments on improving detection mechanisms, balancing resource allocation, and mitigating the incentives for terrorpreneurial activities. Ultimately, the study aims to promote more equitable and efficient resource allocation strategies that address both security and socio-economic needs.

2.0 REVIEW OF RELATED LITERATURE

The allocation of national resources is a critical aspect of governance, particularly in countries facing security threats. The prioritization of CT-related budgets over economic development has been a contentious issue in both policy-making and academic discourse. While CT efforts are essential for national security, its often consume significant portions of government budgets, potentially diverting resources from critical sectors such as healthcare, education, and infrastructure development. This resource allocation dilemma has been explored in various studies, with scholars examining the trade-offs, opportunity costs, and long-term implications of prioritizing security over economic growth.

2.1 CT Efforts and Economic Development: A Trade-Off

Several studies have highlighted the trade-offs between CT efforts and economic development. For instance, Sandler and Enders (2004) argue that while CT spending is necessary to mitigate immediate threats, excessive allocation of resources to security can stifle economic growth by reducing investments in productive sectors. Similarly, Collier and Hoeffler (2004) suggest that economic underdevelopment can exacerbate security challenges by creating conditions conducive to radicalization and conflict. This creates a cyclical problem where underdevelopment fuels insecurity, and insecurity diverts resources from development.

2.1.1 Budgetary Prioritization and Opportunity Costs: The concept of opportunity cost is central to understanding the implications of budgetary prioritization. Studies such as those by Gupta et al. (2004) emphasize that governments must weigh the benefits of CT spending against the potential gains from investing in economic development. For example, investments in education and job creation can address the root causes of terrorism by reducing poverty, illiteracy and inequality, thereby contributing to long-term stability. On the other hand, excessive focus on CT measure can lead to a militarized economy, reduced public trust, and diminished social welfare.

2.1.2 Queueing Theory in Resource Allocation: Queueing theory, a mathematical approach to analyzing waiting lines or queues, has been applied to various resource allocation problems, including healthcare, transportation, and telecommunications (Kleinrock, 1975; Bertsekas et al., 1992; Gelenbe, & Mitrani, 1980). However, its application to budgetary prioritization in the context of CT and economic development is relatively novel. The theory provides a framework for understanding how limited resources can be optimally allocated to competing priorities, ensuring fairness and efficiency.

2.2 Conceptual Framework

The conceptual framework for this study integrates the principles of queueing theory with the dynamics of resource allocation in CT and economic development. The framework posits that government budgets can be modelled as a finite resource queue, where competing demands (e.g., CT-related and economic development sectors) are treated as "customers" waiting for service. Key components of the framework include:

- **Resource Pool (Server):** The national budget serves as the finite resource or "server" in the queueing model.
- **Competing Priorities (Customers):** CT-related and economic development sectors represent the competing demands or "customers" in the queue.
- **Service Discipline:** The prioritization of demands is governed by a service discipline, such as first-come-first-served (FCFS), priority-based, or fairness-based allocation.
- **Performance Metrics:** Metrics such as waiting time, service time, and system utilization are used to evaluate the efficiency and fairness of resource allocation.

The BPQF framework allows for the analysis of trade-offs between competing priorities, providing insights into how resource allocation decisions impact both short-term security and long-term development.

2.3 Applications of Queueing Theory:

Queueing theory offers several applications for analyzing the effects of prioritizing CT related budgets over economic development. Below is a brief overview of its applications in the context of resource allocation, fairness, optimization, scenario analysis, and dynamic decision-making.

2.3.1 Modelling Resource Allocation: Queueing theory provides a structured approach to model how limited resources are allocated to competing demands. In resource allocation problems, the "server" represents the finite resource (e.g., budget, infrastructure, or personnel), while "customers" represent the competing priorities or tasks requiring attention. By simulating different budgetary allocation scenarios, allowing policymakers to evaluate the impact of various prioritization strategies, thereby understanding the trade-offs and identify optimal allocation mechanisms. For example, a priority-based queueing model can assess how giving precedence to CT affects the availability of resources for economic development.

In healthcare for example, Green (2006) have used queueing models to allocate hospital resources, such as beds and staff, to patients efficiently. Similarly, in public budgeting, queueing theory can simulate how prioritizing counterterrorism over economic development impacts resource availability for other sectors.

2.3.2 Fairness Evaluation: Fairness is a critical consideration in resource allocation, especially when multiple stakeholders or sectors compete for limited resources. Queueing theory offers fairness-based models, such as egalitarian or proportional allocation mechanisms, to ensure equitable distribution. These models evaluate whether resources are distributed in a way that aligns with the relative importance or urgency of competing demands. For instance, a fairness index can be calculated to determine whether economic development is receiving a proportionate share of the budget relative to its importance. In telecommunications, for instance, Bonald and Proutière (2003) have proposed fairness metrics to allocate bandwidth among users. Similarly, in public policy, queueing models can assess whether CT-related budgets disproportionately overshadow economic development allocations, thereby compromising fairness. Also, Udoh et al., (2021), recently employ resource allocation queuing fairness approach to appraise the leadership decapitation CT strategies of most world government. The study lay a formal foundation for considering fairness aspect in the choice for CT strategy.

2.3.3 Optimizing Resource Utilization: Queueing theory helps optimize the utilization of scarce resources by minimizing idle time and ensuring that resources are allocated where they are most needed. Performance metrics such as system utilization, waiting time, and throughput are used to assess efficiency. This is particularly useful in environments where resources are constrained, such as public budgets or emergency response systems. Thereby identifying inefficiencies in resource allocation, such as underutilization or overcommitment of budgets to specific sectors. This information can guide policymakers in optimizing the use of limited resources. For example, in disaster management, queueing models have been used to optimize the allocation of emergency services, ensuring that resources like ambulances and rescue teams are deployed efficiently (Zhang et al., 2012). In the context of counterterrorism and economic development, queueing models can identify inefficiencies in budget allocation and suggest improvements.

2.3.4 Scenario Analysis: Queueing theory enables policymakers to conduct scenario analysis by simulating different resource allocation strategies under varying conditions. This approach helps evaluate the potential outcomes of decisions, such as increasing counterterrorism budgets during heightened security threats or reallocating funds to stimulate economic growth during a recession. For example, the impact of increasing CT-related budgets during periods of heightened security threats can be compared to the effects of maintaining a balanced allocation. In transportation systems, for instance, queueing models have been used to simulate traffic flow under different infrastructure investment scenarios (Vandaele et al., 2000). Similarly, in public budgeting, queueing models can simulate the effects of reallocating resources between security and development priorities.

2.3.5 Dynamic Resource Allocation: Dynamic environments, such as fluctuating security threats or economic conditions, require adaptive resource allocation strategies. Queueing theory provides dynamic models that adjust resource allocation in real-time based on changing demand patterns. These models are particularly useful in systems where priorities shift frequently, such as emergency response or national security. For instance, a dynamic queueing model can adjust budgetary priorities in response to changes in threat levels or economic indicators. In cloud computing, for instance, queueing models have been used to dynamically allocate server resources based on user demand (Gandhi et al., 2010). In public policy, dynamic queueing models can adjust budget allocations between counterterrorism and economic development as conditions evolve.

In conclusion, the prioritization of CT-related budgets over economic development presents a complex resource allocation challenge. While CT effort is essential for ensuring national security, excessive focus on security spending can undermine long-term economic growth and stability. Queueing theory offers a versatile framework for addressing this complex resource allocation problems. Its applications in modelling resource allocation, evaluating fairness, optimizing utilization, conducting scenario analysis, and enabling dynamic decision-making make it an invaluable tool for policymakers. By leveraging these models, governments and organizations can make data-driven decisions that balance competing priorities effectively. By integrating queueing models into policy analysis, governments can make informed decisions that balance immediate security needs with long-term development goals.

3.0 THEORETICAL FRAMEWORK

To model the GBA system as a queueing system, we adopt queueing theory, a branch of operations research (OR) that studies waiting lines (Hillier& Lieberman, 2020). Specifically, we treat the budgetary allocation process as a single-server queueing system where government (server) allocates resources to various socio-economic sectors (customers) based the following characteristics:

(i) Single Server ($\mathbf{k = 1}$): The government acts as the sole server, distributing resources (budget) to queued sectors annually.

(ii) Customers flow (Sectors): Socio-economic sector (e.g., education, healthcare, infrastructure, defence) represents "customer" in the queue.

(iii) Arrival Rate ($\boldsymbol{\lambda}$): The sectors "arrive" at the queue annually with budget requests. The arrival rate is assumed to follow a Poisson distribution, which is common in queueing systems. The total arrival rate is given by: $\lambda = \sum_{i=1}^{n} \boldsymbol{\lambda_i}$, where n is the number of sectors.

(iv) Service Rate ($\boldsymbol{\mu}$): The government allocates to each sector at quarterly rate, after budget approval. The service time follows an exponential distribution for $M/M/k$ model, and general service distribution for $M/G/k$ model; as is typical in single-server queueing models. The total service rate is given by $\mu = \sum_{i=1}^{n} \mu_i$.

(v) System Utilization ($\boldsymbol{\rho_i}$)**:** The fraction of time the server is busy serving class C_i is given by:

$$\rho_i = \frac{\lambda_i}{\mu_i};\ \rho = \sum_{i=1}^{n} \rho_i = \sum_{i=1}^{n} \frac{\lambda_i}{\mu_i} \qquad (3.0.0)$$

If $\rho \to 1$, then the system is said to be overburdened, leading to longer waiting times for low-priority sectors.

(vi) Queuing Service Discipline: Arriving economic sectors are classified under three major priority classes: Higher priority; Medium Priority, and Low Priority. This introduces the two major priority queuing system, where sectors are served based on their priority levels:

- **Pre-emptive Priority Queuing (PPQ) system**: Higher-priority sectors interrupt lower-priority sectors, and
- **Non-pre-emptive priority Queuing (NPPQ) system**: Lower-priority sectors are not interrupted once service begins.

(vii) Budget Constraints: The total budget available is finite, and the allocation must satisfy this constraint.

(viii) Average Allocation ($\mathbf{A_i \geq \delta D_i}$): Represent a minimum allocation to sector i; to guarantee that the lower-priority sectors are not entirely starved of resources when higher-priority sectors are served. Here D_i is the demand of sector i, and δ is a constant representing the fairness parameter.

(ix) Fraud Detection Probability ($\mathbf{P_d}$)***:*** The capability of government or the budgetary allocation system to detect possible fraud, padded or fabrication of budgets by the respective sector is denoted by $\boldsymbol{P_d}$. This implies that $(1 - P_d)$ is the probability of fabricated budgets going undetected in the system, allowing fraudulent claims to inflate the workload for high-priority sectors.

(x) System Fairness: The fairness of the budget allocation is evaluated using the waiting time, service time, and resource distribution equity (fairness) metrics. In a priority queueing system, higher-priority sectors are served first, this can lead to resource starvation for lower-priority sectors. This is particularly problematic in economic systems, where neglecting sectors like education, health, social welfare, agriculture, etc., can have long-term negative implications for economic growth and societal stability. Therefore, the fairness parameter δ is introduce to ensures that:

- The lowest-priority sectors receive a minimum allocation proportional to their demand, hence, no sector is completely neglected.
- While prioritizing urgent needs (e.g., CT related budgets), the government also invests in long-term growth-enhancing sectors.
- The budgetary allocation system, aligns with principles of distributive justice, ensuring that all sectors benefit from public resources. Thus, the value of δ determines how much fairness is enforced in the system. For examples:
- If $\delta = 0$: then no fairness constraint is applied, and lower-priority sectors may receive zero allocation, while the higher-priority sectors consume the entire budget, leading to a purely priority-driven allocation.
- If $\delta = 0.1$ (10%): Then each sector must receive at least 10% of its demand ($0.1D_i$), even if it has the lowest priority. This ensures that lower-priority sectors are not entirely neglected, though higher-priority sectors still dominate.
- If $\delta = 1$ (100%): Then each sector receives 100% of its demand D_i, regardless of priority level. This leads to a purely demand-driven allocation**,** ignoring priorities.

(xi) *Queuing Model:* To proffer optimal queue model, we analyse the performance characteristics of the GBA system under two key queueing models – the Markovian service time (M/M/k) queue, and the general service time (M/G/k) queuing priority queueing models.

3.1 M/G/k Priority Queueing Model:

The $M/G/k$ queueing model assumes that: M - the arrival process follows a Poisson distribution (Markovian arrivals), where the time between arrivals is exponentially distributed. G - the service time distribution is general (not necessarily exponential), as resource allocation may vary by sector, and $k = 1$ - the number of servers (the government budget). To appraised the performance measure of the system, we commence with: (i) waiting time parameters, (ii) resources misallocating cost, (iii) fairness index, and (iv) mean time before resources exhaustion (MTBE).

3.1.1 Waiting time under M/G/k: A sector waits in the queue before receiving its allocation depends on the priority class. The waiting time in the $M/G/k$ priority queue depends on the priority class and the service discipline. For PPQ Model, the high-priority sectors have minimal waiting time since they pre-empt lower-priority classes. Also, the Medium-priority sectors waiting time is influenced by the service time of higher priority sector. While the low-priority sectors waiting time is the longest, as they are interrupted by both high and medium priority sectors (Kleinrock, 1975; Green, 2006; Vandaele, et al. 2000). The average waiting time for each class under the PPQ model is given by:

$$W_i = \lambda \mathrm{E}[S^2]/2(1 - \rho_i) \tag{3.0.1}$$

where: $\rho_i = \lambda_i/\mu_i$ is the utilization factor for each priority class, and $\mathrm{E}[S^2]$ is the second moment of the service time distribution. For the non-pre-emptive Priority Queue (NPPQ) model, the lower-priority sectors are not interrupted once in service, but must wait for higher-priority sectors to finish service. The waiting time for each priority class under the NPPQ model is influenced by the service time of all higher-priority classes. Therefore, the average waiting time is given by:

$$W_i = \lambda \mathrm{E}[S^2]/2(1 - \rho) \tag{3.0.2}$$

Where $\rho = \sum \rho_i$ is the total system utilization, and $\lambda = \sum \lambda_i$ is the total system arrival rate.

3.1.2 Waiting time under M/M/k: Synonymous to $M/G/k$ queue model, with exception of the service time which is exponentially distributed, all parameters of $M/M/k$ model are the same. The $M/M/1$ queueing model assumes the first M - Poisson arrival process, the second M - exponential service time distribution, and $k = 1$ - the server (the government budget). Due to the exponential service time distribution, the waiting time for an $M/M/k$ priority queue, can be define by for PPQ model by:

$$W_i = \rho_i/\mu(1 - \rho_i) \tag{3.0.3}$$

Where ρ_i is the utilization factor for priority sector i, and $\mu = \sum \mu_i$ is the total service rate. For the NPPQ mode, the waiting time for sector i, is given by:

$$W_i = \rho/\mu(1 - \rho) \tag{3.0.4}$$

Where ρ is the total system utilization, and μ is the total service rate.

3.1.3 Budget Misallocation Cost (BMC): BMC refers to the financial and operational losses incurred when resources are not distributed effectively or efficiently among different sectors, departments, or projects. This misallocation cost can arise from various factors, such as poor planning, inadequate data, or biases in decision-making. The costs associated with misallocation can include wasted funds, reduced productivity, and missed opportunities for optimizing resource use (Jiapin and Qiao, 2024; Binkai and, Justin, 2021). Understanding and minimizing these costs is crucial for improving overall efficiency, enhancing service delivery, and ensuring that resources are directed towards areas of greatest need or impact. The cost of misallocating resources in the system can be modelled as:

$$C_{\text{Misall}} = \sum_{i=1}^{n} A_i X_i^{\text{Pad}}(1 - P_d) \tag{3.0.5}$$

Where A_i is the total budget allocated to priority sector i, X_i^{Pad} is the probability of fraud in priority sector i, and P_d is the probability of detecting fraud in BAQF system.

3.1.4 Budget Allocation Fairness (BAF): Represent the equitable distribution of financial resources among various sectors, departments, or groups based on their needs, contributions, and priorities. BAF seek to ensure that all entities receive a fair share of the budget relative to their requirements, responsibilities, or performance metrics. This concept is critical in public policy, organizational management, and resource management, as it seeks to minimize disparities and promote equity while maximizing the overall effectiveness and efficiency of resource utilization (Jan, et al 2023; Nguyen et al 2019). Fair budget allocation can enhance trust among stakeholders, improve service delivery, and ensure that critical needs are addressed adequately. Key budget allocation fairness metrics include:

(i) Resource Allocation Fairness (RAF) Index can be modelled by:

$$RAF = \sum_{i=1}^{n} \frac{\delta D_i}{A_i} \tag{3.0.6}$$

where: D_i is the demand of sector i, A_i is the allocation to sector i, and δ is fairness parameter to ensures the starvation of lower-priority sectors. To compare the Fairness coefficients, we consider other fairness metrics.

(ii) Jain's fairness Index (JFI) (Jain, et al., 1984) can be modelled by:

$$JFI = \left(\sum_{i=1}^{n} x_i\right)^2 \left(n \sum_{i=1}^{n} x_i^2\right)^{-1} \tag{3.0.7}$$

Where x_i is the resource allocation to priority sector i. This also include the waiting time or the service time of priority sector i. JFI metrics ranges from 0 to 1, $(0 \le \text{JFI} \le 1)$ with 1 indicating perfect fairness (i.e., all classes receive equal allocation). A low fairness index $(JFI \ll 1)$ indicates inequitable resource distribution, which could lead to socio-economic instability.

(iii) Max-Min Fairness Index (MFI) (Marson and Gerla, 1982) can be determined from:

$$\text{MFI} = \frac{Min(x_i)}{Max(x_i)} \tag{3.0.8}$$

MFI metrics focuses on ensuring that the minimum allocation among all priority classes is maximized. It assesses fairness based on the class with the least allocation.

(iv) Coefficient of Variation (CV) *(Everitt, 1998)*, can be calculated from:

$$\text{CV} = \frac{\text{Standard Deviation of Allocations}}{\text{Mean of Allocations}} = \frac{\sigma}{\mu} \tag{3.0.9}$$

Lower CV values indicate more equal distribution, while higher values indicate greater inequality.

(v) Resource Allocation Queueing Fairness (RAQF) metrics (Raz et al., 2004), which consider the relative satisfaction of demands across different priority classes can be calculated from:

$$\text{RAQF} = 1 - \left(\frac{1}{n}\sum_{i=1}^{n}\left(\frac{A_i}{D_i} - \frac{\bar{A}}{\bar{D}}\right)^2\right)^{0.5} \tag{3.1.0}$$

Where A_i represent allocation to each sector, D_i represent the demand of each sector, and n is the number of priority classes. RAQF is particularly useful in systems where resources are distributed among competing entities with varying priorities and demands. RAQF value ranges from 0 to 1, $(0 \le \text{RAQF} \le 1)$; where $\text{RAQF} = 1$ implies a perfect fairness (allocations are proportional to demands), and $\text{RAQF} = 0$, implies extreme unfairness (allocations are highly disproportionate to demands). Given that each of these metrics, measures fairness differently, this allowing us to justify and contextualize each calculation.

3.1.5 Mean Time Before Exhaustion (MTBE): To analytically define and establish the Mean Time Before Exhaustion (MTBE) of resources in the context of the Nigerian government's budgetary allocation system, we draw parallels to the well-established concept of Mean Time Before Failure (MTBF) in system reliability theory (O'Connor, 2002; Birolini, 2017). Mathematically, MTBF is defined as

$$MTBF = \frac{\text{Number of Failures}}{\text{Total Operating Time}} \tag{3.1.1}$$

Equation (3.1.1) provide a robust theoretical background for understanding MTBE in resource allocation systems, particularly in the prioritization of security/defence related budgets over non-security related budgets. Traditionally, MTBF is typically used to describe the average time between failures of a repairable system, such as a machine or a network. It is a key metric in reliability engineering and system performance analysis, representing the average time a system operates before experiencing a failure. The metrics is used to evaluate the reliability and sustainability of systems, where "failure" refers to the point at which a system can no longer perform its intended function. The key characteristics of MTBF includes:

(i) ***System Reliability:*** MTBF measures the reliability of a system by quantifying the expected time between failures.

(ii) ***Resource Consumption:*** In systems, failures often occur due to the depletion or exhaustion of critical resources (e.g., energy, components, or capacity).

(iii) ***Sustainability:*** A higher MTBF indicates a more sustainable and reliable system, while a lower MTBF suggests frequent failures and inefficiencies.

3.1.6 MTBF and Resource Allocation Systems: In resource allocation systems, such as the government's budgetary system, the concept of "failure" can be interpreted as the exhaustion of allocated resources before the end of the fiscal year. This draws a direct analogy to MTBF, leading to the concept of Mean Time Before Exhaustion (MTBE) of the server's resources. In a queueing system, "failures" can be defined as events such as:

- **System overflow:** When the queue reaches its maximum capacity.
- **Server failure:** When a server or service becomes unavailable.
- **Deadline misses:** When a job or request misses its deadline.

Therefore, to apply MTBF to a queueing system, underscored calculating the average time between these "failure" events.

Definition 3.0: MTBE represents the average time until allocated resources are exhausted in a resource allocation system. It is analogous to MTBF in reliability theory but adapted to systems where resource consumption and exhaustion are the primary concerns (Barlow, & Proschan, 1975; Trivedi, 2002). In the context of the government's budgetary system, MTBE measures how long the allocated budget for security/defence or non-security sectors can sustain operations before being fully depleted.

Mathematical MTBE for a resource allocation system is given by: $MTBE = R/W^{\text{Eff}}$, where, R is the total units of allocated resources (e.g., the yearly budget for a sector), and W^{Eff} is the total effective workload or demand on the resources, which depends on factors such as arrival rates (λ_i) and service times $(E[S_i]$ of each sector. key characteristics of MTBE include:

- **Resource Sustainability:** MTBE quantifies the sustainability of allocated resources. A higher MTBE indicates that resources will last longer, while a lower MTBE suggests faster exhaustion.
- **Workload Sensitivity:** MTBE is inversely proportional to the effective workload $\left(\mathrm{W}^{\text{Eff}}\right)$. As the workload increases (e.g., due to fabricated budgets or inflated demands), the MTBE decreases.
- ***Priority-Driven Dynamics:*** In systems with prioritized resource allocation (e.g., security/defence budgets prioritized over non-security budgets), the MTBE for lower-priority sectors is often reduced due to resource dominance by higher-priority sectors.

3.2 MTBE under $\mathrm{M/G/k}$ **Queuing System:**

From the understudied GBA system, we are dealing with a **single-server priority queueing system** $(M/G/1)$ with finite resources and three priority classes. Our goal is to determine the **MTBE** of the server's resources for each priority class under the two service disciplines: **pre-emptive priority** and **non-pre-emptive priority**. The theoretical framework for MTBE assumed that the resource exhaustion rate depends on the total workload processed by the server $(\sum \rho_i)$. This workload is determined by the arrival rates, (λ), the service times (μ), and the priority service discipline. The effective workload for high and medium priority sectors is influenced by the proportion of fabricated budgets that goes undetected. Let ρ^{Fab} represent the workload contribution from fabricated budgets. Therefore, the adjusted workload for priority sectors can be given by:

$$\begin{aligned}\rho_1^{\text{Adj}} &= \rho_1 + (1 - P_d)\rho^{\text{Fab}} \\ \rho_2^{\text{Adj}} &= \rho_2 + (1 - P_d)\rho^{\text{Fab}} \\ \rho_3^{\text{Adj}} &= \rho_3 + (1 - P_d)\rho^{\text{Fab}}\end{aligned} \qquad (3.1.2)$$

3.2.1 MTBE under PPQ System: In the PPQ system, higher-priority classes dominate the server, and lower-priority classes are served only when no higher-priority jobs are present. The effective workload for each class is adjusted based on the priority structure. The total workload processed by the server is given by:

$$W = \sum_{i=1}^{n} \rho_i^{\text{Adj}} = \sum_{i=1}^{n} \rho_i + (1 - P_d)\rho_i^{\text{Fab}} \qquad (3.1.3)$$

Given that the rate of resource consumption is proportional to the total workload W, then MTBE is given by:

$$MTBE = R/W = R\Big/\sum_{i=1}^{n} \rho_i^{\text{Adj}} = R\Big/\sum_{i=1}^{n} \rho_i + (1 - P_d)\rho_i^{\text{Fab}} \qquad (3.1.4)$$

For each priority sector, the effective workload $\left(\rho_i^{\text{Eff}}\right)$ which depends on the pre-emptive nature of the system is given by:

$$\rho_1^{\text{Eff}} = \rho_1 + (1 - P_d)\rho^{\text{Fab}}\,;\, \rho_2^{\text{Eff}} = \rho_2^{\text{Adj}}\left(1 - \frac{\rho_1^{\text{Adj}}}{W}\right);\; \rho_3^{\text{Eff}} = \rho_3\left(1 - \frac{\rho_1^{\text{Adj}} + \rho_2^{\text{Adj}}}{W}\right) \qquad (3.15)$$

Therefore, the total effective workload is:

$$W^{\text{Eff}} = \sum_{i=1}^{n} \rho_i^{\text{Eff}} = \rho_1^{\text{Eff}} + \rho_2^{\text{Eff}} + \rho_3^{\text{Eff}} \tag{3.1.6}$$

And the MTBE for PPQ system becomes:

$$MTBE = R/W^{\text{Eff}} = R \Big/ \sum_{i=1}^{n} \rho_i^{\text{Eff}} = \rho_1^{\text{Eff}} + \rho_2^{\text{Eff}} + \rho_3^{\text{Eff}} \tag{3.1.7}$$

3.2.2 MTBE under NPPQ System: In the NPPQ system, once a job starts, it cannot be interrupted. The server processes jobs in the order of priority, but lower-priority jobs are not interrupted. However, the effective workload (ρ_i^{Eff}) for each class is the same as PPQ system:

$$\rho_1^{\text{Eff}} = \rho_1 + (1 - P_d)\rho^{\text{Fab}}\,;\, \rho_2^{\text{Eff}} = \rho_2^{\text{Adj}}\left(1 - \frac{\rho_1^{\text{Adj}}}{W}\right);\; \rho_3^{\text{Eff}} = \rho_3\left(1 - \frac{\rho_1^{\text{Adj}} + \rho_2^{\text{Adj}}}{W}\right) \tag{3.1.8}$$

Therefore, the total effective workload is:

$$W^{\text{Eff}} = \sum_{i=1}^{n} \rho_i^{\text{Eff}} = \rho_1^{\text{Eff}} + \rho_2^{\text{Eff}} + \rho_3^{\text{Eff}} \tag{3.1.9}$$

And the MTBE for PPQ system becomes:

$$MTBE = R/W^{\text{Eff}} = R \Big/ \sum_{i=1}^{n} \rho_i^{\text{Eff}} = R/\left(\rho_1^{\text{Eff}} + \rho_2^{\text{Eff}} + \rho_3^{\text{Eff}}\right) \tag{3.2.0}$$

Generally, in both PPQ and NPPQ disciplines, the MTBE depends on the total effective workload W^{Eff} which is adjusted based on the priority structure. However, the lower-priority classes often have reduced effective workloads $\left(\rho_1 > \rho_2^{\text{Eff}} > \rho_3^{\text{Eff}}\right)$, due to the dominance of higher-priority classes. Therefore, the PPQ system generally results in shorter MTBE for lower-priority classes compared to NPPQ system, as lower-priority jobs are interrupted more frequently.

3.3 Model's Assumptions

The emergence of terrorpreneurial activities and false-flag introduces new complexities into the resource allocation system. These activities have distorted the prioritization process, leading to inefficiencies, misallocation of resources, and unintended socio-economic consequences. To address these scenarios, we make the following assumption:

(i) Terrorpreneurial/False Flag terrorism Activities: Certain regions, or states or agencies may simulate or exaggerate terrorism threats to attract higher budgetary allocations. While some may raise false terror alerts to justify increased government expenditure on CT and other security related budgets. This can lead to misclassification of priorities, where non-urgent or fabricated requests are treated among high-priority requests. These activities artificially inflate the average budget demand (D_i) of CT and security related sectors.

(ii) Limited Detection Capability: The government has a limited ability to detect and differentiate between genuine and fabricated terrorism threats. Therefore, government fraud detection mechanism is modelled as a probabilistic process, with probability (P_{d}) and a false negative rate $(1 - P_{\text{d}})$.

(iii) Budget Constraints: The total budget remains finite, meaning that resources allocated to fabricated threats reduce the resources available for genuine socio-economic needs.

(iv) Economic and Social Costs: Misallocation of resources to fabricated threats leads to opportunity costs for other sectors. Prolonged neglect of socio-economic sectors exacerbates instability, potentially fuelling genuine terrorism in the long run.

In conclusion, t**he** $M/G/k$ and $M/M/k$ models provide a framework to analyze the resource allocation queueing system. The pre-emptive priority system favours high-priority sectors but risks starving lower-priority sectors, while the non-pre-emptive system ensures fairness but may increase waiting times for high-priority sectors. Simulations can help determine the optimal balance between efficiency and fairness.

4.0 ANALYSIS OF MODEL

To analyse and demonstrate the validity of the BPQF model, we evaluate the performance characteristics of the system based on sample dataset from the Nigerian government budgetary appropriation 2020. Nigeria is a country with a diverse economy and complex security situation. The country has been facing several security challenges, including Boko Haram insurgency, kidnapping, armed bandits, and armed robbery in recent times. At the same time, the country has been struggling to achieve sustainable socio-economic development, to address some of the drivers of instability. In this case study, we use the BAQF model to appraise GBA system in Nigeria. Below is a summarized dataset on Nigerian government's budgetary allocation in 2020.

Table 4.0: Summarized 2020 Nigerian Budgetary Allocation

Priority Sector	Budgetary Demand (D_i)			Total Allocation
	Arrival	**Genuine**	**Fabricated**	
High Priority Sectors	1.98E+12	1.188E+12	6.72E+11	1.68E+12
Medium Priority Sectors	1.812E+11	1.45E+11	3.624E+10	1.45E+11
Low Priority Sectors	9.525E+12	9.525E+12		7.62E+12
Total	**1.169E+13**	**1.086E+13**	**7.083E+11**	**9.445E+12**

*Source: https://budgetoffice.gov.ng/index.php/resources/internal-resources/budget-documents/2020-budget/2020-revised-budget

- **High-Priority Sectors:** Consisting of 5 MDAs sectors are directly related to national security, defence, and law enforcement. They receive significant allocations due to their critical role in maintaining stability and addressing security challenges.
- **Medium-Priority Sectors**: Consisting of 7 MDAs are areas of government and public spending that, while important, do not directly pertain to national security or defence. These sectors typically include public health, education, transportation, and infrastructure development. They receive moderate budget allocations because they are essential for maintaining societal well-being and economic stability.
- **Low-Priority Sectors:** consisting of 36 MDAs, encompass areas of public spending that are not directly linked to security or defence and are often seen as less critical to immediate national interests. These sectors may include cultural programs, recreational services, arts funding, and certain environmental initiatives. Budget allocations to these sectors are typically limited, as they are viewed as supplementary to the core functions of government.

4.1 Performance Characteristics of BAQF Model:

The BAQF system models the allocation of budgetary resources to various sectors (or MDAs) as a queueing system, where sectors "arrive" with budgetary demands and are "served" based on priority and available resources. Base on the Nigerian Government Appropriation Bill 2020[1], government prioritized resources allocation into three major classes, namely (a) High priority Class - high security/defence related sectors, (b) Medium priority class - low security/defence related sectors, and (c) Low priority classes - non-security/defence related Sectors. To analyse the performance characteristics of the BAQF system, the following observation was deduced from the dataset:

(i) Arrival rate (λ_i): Represents the rate at which budgetary demands (requests) are submitted to the system for allocation. In this model, we assumed that each priority sector submits budgetary demand once per year: $\lambda_i = \lambda_1 = \lambda_2 = \lambda_3 = 1$ time per year.

The system arrival rate can also be measured in terms of the number of budgetary requests per unit time.

(ii) Service rate (μ_i): Represents the rate at which budgetary demands are processed and fulfilled: $\mu_i = \mu_1 = \mu_2 = \mu_3 = 4$ time per year. The system service rate can also be measured in terms of the number of demands served per unit time.

(iii) Mean Service times $E[S_i]$: Represent the average time required to process a priority class budgetary request, $E[S_i] = 1/\mu = 0.25$.

(iv) Server Utilization Rate or Traffic Intensity, (ρ_i): Represents the proportion of time the system is actively processing demands. It is the ratio of the arrival rate: $\rho_i = \lambda_i E[S_i]$; $\rho_1 = \rho_2 = \rho_3 = 0.25$.

(v) Budget Exploitation: The GBA system which services three major priority sectors, is characterised by the following padded or fabricated or inflated budget items:

- High Priority), with 40% inflated budget items.
- Medium Priority), with 20% inflated budget items.
- Low Priority), with no inflated budget items.

(vi) Padding/Fraud detection Probability: The GBA system is characterised by fraud detection probability: $P_d = 0.45$ (45%). This implies that $1 - P_d = 0.55$ (55%) is the probability of fabricated budgets going undetected, allowing fraudulent claims to inflate the workload for high-priority sectors.

(vii) Budget Allocation Threshold ($\mathbf{A_i \geq \delta D_i}$): To guarantee that minimum proportion of resources is allocated to each priority sector, an allocation threshold: $A_i \geq \delta D_i$ is assigned. Where, A_i is allocation to each sector, D_i is the demand from each sector, and $\delta = 0.1(10\%)$ is a fairness constraint aimed at ensuring that the lower-priority sectors are not completely starved, while prioritizing higher-priority sectors in the GBA system.

Table 4.1: Budget Allocation Fairness Threshold

Priority Sector	Demand ($\boldsymbol{D_i}$)	Allocation ($\boldsymbol{A_i}$)	Allocation Threshold$(\mathbf{0.1}\boldsymbol{D_i})/n$	% Fairness
High Priority Sectors	1.976E+12	1.68E + 12	3.96E+10	0.020
Medium Priority Sectors	1.813E+11	1.45E + 11	2.589E+9	0.014
Low Priority Sectors	9.525E+12	7.62E + 12	2.646E+10	0.003
Total:	**1.168E+13**	**9.445E+12**	**2.4354E+10**	**0.037**

Table 4.1 above, shows that contrary to objective of the budget allocation threshold ($A_i \geq \delta D_i$), each priority sectors allocation was less than its threshold value ($A_i < \delta D_i$).

4.1.1 Budget Misallocation Cost (BMC): The Cost incurred due to the fraud or padding, adjusted for the probability of detection. BMC measures the inefficiency caused by padded or inflated budget by the higher priority sectors. By equation (3.0.5), we have:

$$\mathrm{BMC} = \sum_{i=1}^{3} \left(A_i - (1 - P_d) D_i^{Gen}\right) - 3.47E + 12 \qquad (4.0.0)$$

Table 4.2: Budget Misallocation Cost Analysis

[1] https://budgetoffice.gov.ng/index.php/resources/internal-resources/budget-documents/2020-budget/2020-revised-budget

Priority Sector	Demand (D_i)	Padded (D_i^{Pad})	Genuine (D_i^{Gen})	Allocation (A_i)	Mark off (D_i^{Mk})	BMC	BIW
High Priority Sectors	1.98E+12	7.9E+11	1.19E+12	1.68E + 12	6.55E+11	1.025E+12	0.29
Medium Priority Sectors	1.81E+11	3.63E+10	1.45E+11	1.45E + 11	7.98E+10	6.52E+10	0.00
Low Priority Sectors	9.53E+12	00	9.53E+12	7.62E + 12	5.24E+12	2.38E+12	-0.25
Total:	**1.17E+13**	**8.27E+11**	**1.09E+13**	**9.45E+12**	**5.97E+12**	**3.47E+12**	**0.04**

Table 4.2 above shows that the total cost of misallocation due to padded or fabricated budgets due to prioritization is ₦3.47E+12 billion. This represents 58.12% of the total sectors' mark-off demand, and 36.72% of the total sectors allocation.

4.1.2 Implication of Misallocation Cost: This misallocation cost (58.12%) through budget padding or fabrication, poses significant security implications to the system. This diversion of resources can lead to a weakened national security posture, as funds that could be utilized for critical infrastructure, agriculture, public health, and education are instead funnelled into potentially illegitimate or exaggerated threats. Boin et al., (2010) observed that the prioritization of security/CT funding over other socio-economic sectors may foster an environment where genuine threats are overshadowed by fabricated crises, leading to a misallocation of resources that could otherwise enhance community resilience and social stability. Furthermore, Schmid, (2013) observed that the emergence of "Terrorprenuership" can create a cycle of fear and distrust among the populace, undermining social cohesion and potentially inciting real acts of violence as groups exploit the narrative of insecurity for their agendas. This misallocation not only compromises the effectiveness of CT strategies but also risks eroding public trust in government institutions, which is essential for effective governance and community cooperation in security efforts[2,3,4]

4.1.3 Budget Inefficiency/Waste: The surplus between the allocated budgets and genuine sectors' demand (adjusted for padded items:

$$\text{BIW} = \sum_{i-1}^{n} \frac{1}{A_i}\left(A_i - D_i\left(1 - X_i^{\text{Pad}}\right)\right) = \sum_{i-1}^{n} \frac{1}{A_i}\left(A_i - D_i^{\text{Gen}}\right) = 0.04\ (4\%) \qquad (4.0.1)$$

Due to resource prioritization, which instigate budget padding and fabrication, Table 4.2 also shows that the high priority sectors were allocated 29% above their genuine demand, while the low priority sectors were underfunded by 25%. In general, the system has a budget allocation of 4% above the sectors' genuine demands

4.1.5 Implication of Budget Deficiency: The misallocation of resources, where high-priority sectors receive 29% above their genuine demand while low-priority sectors are underfunded by 25%, has several significant security implications:

(i) Inadequate Response to Emerging Threats: Underfunding low-priority sectors, which may include critical areas like public health, education, and social services, can lead to vulnerabilities that are exploited by extremist groups. This can result in increased risks to national security as social unrest and dissatisfaction grow.

(ii) Increased Budget Waste: A general budget waste of 4% above the genuine demands of priority sectors indicates inefficiencies that could divert resources away from essential security initiatives. This inefficiency can undermine operational readiness and the ability to respond effectively to security challenges.

(iii) Erosion of Public Trust: The perception of budget padding and fabrication can erode public trust in government institutions. A lack of transparency and accountability in budget allocation may lead to societal discontent and could provoke civil unrest, further complicating security efforts.

(iv) Neglect of Comprehensive Security Strategies: Prioritizing CT and defence without adequately addressing underlying social issues can create an environment where security measures are reactive rather than proactive. This neglect can lead to a cycle of violence and instability.

(v) Resource Drain on Security Forces: If security forces are compelled to operate with inflated budgets that do not translate into genuine capabilities, this can lead to resource drain, mismanagement, and ultimately decreased effectiveness in addressing security threats.

(vi) Potential for Increased Crime and Terrorism: Underfunded sectors that contribute to social stability can lead to increased crime rates and potential recruitment grounds for terrorist organizations. The lack of investment in education and social welfare can exacerbate socio-economic inequalities, fuelling discontent.

In summary, these findings highlight the critical need for balanced and equitable budget allocation that aligns with genuine demands across all sectors. Addressing these imbalances is crucial for enhancing national security and ensuring a resilient and stable society.

4.2 Budget Allocation Fairness (BAF)

BAF refers to the equitable distribution of financial resources across various sectors, departments, or programs within an organization or government. It emphasizes the importance of aligning budget allocations with genuine needs, priorities, and social equity considerations. BAF seeks to ensure that all stakeholders have a fair opportunity to access resources, promoting transparency, accountability, and inclusivity in the budgeting process. By addressing disparities and fostering a sense of justice in resource distribution, BAF aims to enhance overall effectiveness, optimize service delivery, and improve the well-being of communities. We appraise the system BAF, under

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2 *Homeland Security - https://www.dhs.gov/publications?page=322*

3 *Transforming the Federal Government to Protect America from Terrorism - https://www.govinfo.gov/content/pkg/CHRG-107hhrg83171/html/CHRG-107hhrg83171.htm*

4 *House Report 112-91 - Department Of Homeland Security Appropriations Bill, 2012 - https://www.govinfo.gov/content/pkg/CRPT-112hrpt91/html/CRPT-112hrpt91.htm*

5 fairness metrics:

(i) From equation (3.0.6) RAF index is: $RAF \approx 0.0095$. RAF value of 0.0095, (0.95%) indicate a very low fairness system, where the high priority sectors are disproportionately served in expensed of the low-priority sectors.

(ii) From equation (3.0.7) JFI is: $JFI = 0.4882$. JFI value of 0.4882 (48.82%) indicate a low fairness system, where the high priority sectors are disproportionately served in expensed of the low-priority sectors.

(iii) From equation (3.0.8), MMF index is: $MMF \approx 0.019$. MMF value of 0.019 (1.9%) indicate a very low fairness system, where the system resources are entire disproportionately allocated to the high priority sectors, in expensed of the low-priority sectors.

(iv) From equation (3.0.9) CV fairness is: $CV \approx 0.98$. CV value of 0.98, (98%) indicate a very high dispersion, corroborating a very low fairness system, where the resources are mostly disproportionately allocated to the high priority sectors, in expensed of the low-priority sectors.

(v) From equation (3.1.0), RAQF Index is given by: $RAQF \approx 0.8678$. RAQF value of 0.6754, (67.54%) indicates a moderately fair system, where the system resources are not highly disproportionately distributed to contending sectors, with respect to their demand satisfaction, irrespective of prioritization. Despite disparities in absolute allocations, the relative satisfaction of demands (A_i/D_i) shows consistency across sectors, suggesting that the system is relatively fair in meeting sectoral demands.

RAQF measure confirms that the BPQF system achieves a moderate level of fairness, even though absolute allocations vary significantly with prioritization index. This result aligns with the objective of the fairness threshold, $(\delta = 0.1)$ aimed to ensure that lower-priority sectors are not entirely starved of resources.

Table 4.3: Summary of Budget Allocation Fairness Metrics

Fairness Metrics	Value	Interpretation
• System Fairness Index	0.0095	Very low fairness; allocations are disproportionally distributed across sectors.
• Jain's Fairness Index	0.4882	Low fairness system with disproportionate distribution of resources across sectors.
• Max-Min Fairness Index	0.019	Very low fairness system with significant disparity between the smallest and largest allocations.
• Coefficient of Variation	0.98	Very high dispersion in resources allocations, indicating low fairness.
• RAQF Index	0.6754	Moderately fair system relative to demands satisfaction (A_i/D_i) across sectors.

In aggregate, the fairness indices in Table 4.3 yield an average of 0.2424 (24.24%), indicating high inequality in the resource allocation; with low-priority sectors excessively starve of the system resources.

4.2.1 Implications of Budget Allocation Fairness Index:

The implementation of a BPQF system with a fairness index of 0.2424 (24.24%) suggests that the allocation process may not be equitable or effective in balancing the security with the most pressing socio-economic needs. Key security implications of this fairness characteristics include:

(i) Ineffective Resource Allocation: A fairness index of 24.24% indicates a low level of fairness, suggesting that resources may not be allocated in a manner that effectively balanced security needs with critical socio-economic requirement of the society. This could lead to essential areas being underfunded while less critical areas receive disproportionate funding, exacerbating vulnerabilities in socio-economic instability.

(ii) Public Trust and Morale: The perception of unfairness in budget allocation can lead to public discontent and a loss of trust in government institutions. If citizens believe that their safety is not being prioritized appropriately, it can undermine confidence in the government's ability to protect them, which is crucial for maintaining social order and national security.

(iii) Long-term Strategic Consequences: The combine effects of 58.12% misallocation cost, 29% inefficient high priority budget, 25% deficient low priority budgets, and 24.24% fairness index can hinder the long-term strategic planning necessary for effective CT efforts. Without a fair and effective allocation system, the government may struggle to adapt to evolving threats, ultimately compromising national security.

In summary, the implications of BPQF system with 24.24 fairness index, with 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budgets, highlight the need for a more equitable and effective approach to budget allocation in the security sector. Addressing these issues is essential for enhancing national security and public trust.

4.3 M/M/1 Queue Performance Characteristics

To appraised the performance characteristics of the BPQF system under the $M/M/1$ queueing model, we calculate the average waiting time for each priority class under the two service disciplines – the PPQ and NPPQ disciplines.

4.3.1 PPQ System:

PPQ System: Under the PPQ system, the high-priority sectors are served first, minimizing their waiting time. While the medium-priority sectors wait for high-priority sectors to be served, the low-priority sectors, however, experience the longest waiting time due to interruptions by higher-priority sectors. From equation (3.03), we have:

$$
\begin{aligned}
W_{\mathrm{H}} &= \frac{\rho_1}{\mu(1-\rho_1)} = \frac{0.25}{4(1-0.25)} \approx 0.0833 \; years \text{ (1 months)} \\
W_{\mathrm{M}} &= \frac{\rho_1+\rho_2}{\mu(1-(\rho_1+\rho_2))} = \frac{0.5}{4(1-0.5)} \approx 0.25 \text{ years (3 months)} \\
W_{\mathrm{L}} &= \frac{\rho_1+\rho_2+\rho_3}{\mu(1-(\rho_1+\rho_2+\rho_3))} = \frac{0.75}{4(1-0.75)} \approx 0.75 \; years \text{ (9 months)}
\end{aligned} \tag{4.0.2}
$$

These implies that the high priority sectors would enter into service after 1 month of budget approval, the medium priority sectors would enter after 3 months, while the low priority sectors would enter into service after 9 months of budget approval.

4.3.2 Implications of PPQ Waiting Time Distribution: In the M/M/1 PPQ system, the distinct waiting times for high, medium, and low priority sectors reveal critical insights into resource allocation and its security implications. The high priority sectors related to security/CT experience a significantly shorter waiting time of 1 months, while medium and low priority sectors face waiting times of 3 months and 9 months, respectively. This disparity suggests a prioritization strategy aimed at addressing urgent security needs. However, the 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority raise concerns about the overall effectiveness of this strategy. Key implications of this performance metrics include:

(i) Timely Response to High-Priority Threats: The short waiting time for high-priority sectors indicates that resources are allocated swiftly to critical security needs, which is essential for effective CT efforts. This responsiveness can mitigate immediate threats and enhance national security. However, if resources are misallocated (58.12%), there's a risk that funds are not directed towards the most effective interventions, potentially leaving critical vulnerabilities unaddressed.

(ii) Neglected Medium and Low-Priority Sectors: The longer waiting times for medium priority (3 months) and low priority (9 months) sectors suggest that these sectors may not receive timely funding and support. This delay can lead to increased risks of socio-economic instability, as threats may emerge or escalate in these areas without adequate preventive measures. The existing 29% inefficient high priority budget, and 25% deficient low priority further exacerbate this issue, indicating that even prioritized sectors may not receive the full support they require, potentially leaving gaps in security.

(iii) Long-Term Strategic Risks: The current allocation strategy, while responsive to high-priority needs, may overlook the importance of a comprehensive approach that includes medium and low-priority sectors. Without addressing these areas, the system risks becoming reactive rather than proactive, ultimately compromising the long-term effectiveness of national security strategies.

In summary, the waiting time characteristics in the M/M/1 PPQ system highlight the need for a careful balance between immediate response to high-priority security needs and the equitable allocation of resources across all sectors. Addressing issues of misallocation and budget deficiency is crucial to ensure a robust and effective national security framework.

4.3.3 Waiting-time Fairness of PPQ System: From equation (3.0.6) RAF index is: $RAF = 0.0231$. RAF value of 0.0231, (2.31%) indicate a very low fairness system, where the higher priority sectors enjoy absolute short waiting time in expensed of the low priority sectors.

(i) From equation (3.0.7) JF Index with respect to waiting-time distribution is: $JFI \approx 0.6191$

(ii) JF index of 0.6191 (61.91%) indicate a moderately fair system, where the higher priority sectors are not entirely disproportionately served in expensed of the low priority sectors.

(iii) From equation (3.0.8), MM Index with respect to waiting-time distribution is: $MFI \approx 0.1111$. MMF Index of 0.111 (11.11%) indicate a very low fairness system, where resources are mostly disproportionately allocated to higher priority sectors, in expensed of the low priority sectors.

(iv) From equation (3.0.9) CV with respect to waiting time distribution is $\mathrm{CV} = 0.4414$. CV index of 0. 4414 (44.14%) indicate low dispersion (moderate inequality), corroborate a low PPQ system, where the system favours the higher priority sectors, in expensed of the low priority sectors.

(v) From equation (3.1.0) RAQF Index with respect to waiting time distribution is: $RAQF \approx 0.7167$

RAQF index of 0. 7167, (71.67%) indicates a highly fair system, where the waiting time are proportionately distributed across all sectors, irrespective of class priority. RAQF measure confirms that though there are significant variation in allocations, however, the system is highly fair in its waiting time distribution. This result aligns with the system's fairness threshold, ($\delta = 0.1$) objective, aimed at guarantee that lower-priority sectors are not entirely marginalized, in this respect spend longer waiting time in the system.

Table 4.4: Summary of PPQ Waiting Time Fairness

Fairness Metrics	Value	Interpretation
• System Fairness Index	0.0231	Low fair system with disproportionate disparity in system waiting times, due to prioritization.
• Jain's Fairness Index	0.619	Moderately fair allocation of waiting; though with variation in resource allocation across sectors.
• Max-Min Fairness Index	0.1111	Very low fairness system, with disproportionate disparity in system waiting time
• Coefficient of Variation	0.4414	Moderate dispersion in waiting time, indicating low fairness system.
• RAQF Index	0.7167	Highly fair system relative to the waiting time distribution.

In aggregate, the fairness indices in table 4.4 yield an average of 0.4057 (40.57%), indicating significant inequities in the waiting time distribution, with low-priority sectors excessively delayed in entering service.

4.3.4 Implications of PPQ Waiting-Time Fairness Index: The combine effect of 12.6% misallocation cost due to Terrorpreneurial or false flag activities and a 38.81% budget deficit due to prioritization, presents significant security implications, particularly within the context of an M/M/1 PPQ system with average fairness index of 0.4057.

(i) Inequitable Resource Distribution: A fairness index of 40.57% indicates a low level of fairness in waiting allocation process. This suggests that the time to enter service may not be distributed equitably among various sectors, leading to critical socio-economic sectors being delayed funding. The misallocation of 58.12% towards terrorpreneurial activities further exacerbates this issue, diverting funds away from legitimate security needs and potentially fostering an environment conducive to terrorism.

(ii) Public Trust and Perception: The perception of unfairness in budget allocation can erode public trust in government institutions. If citizens believe that their safety is not being prioritized appropriately, it can lead to discontent and a lack of confidence in the government's ability to protect them. This erosion of trust can have long-term implications for social cohesion and national security[5,6].

(iii) Strategic Implications: The combination of waiting time unfairness, misallocation and budget deficiencies can hinder long-term strategic planning in the security sector. Without a fair and effective allocation system, the government may struggle to adapt to evolving threats, ultimately compromising its ability to maintain national security and public safety[7,8].

In summary, the implications of a fairness index of 40.57% in the context of significant budget misallocation and deficiencies highlight the urgent need for reform in the budget allocation process. Ensuring a more equitable distribution of resources is essential for enhancing national security and effectively addressing the challenges posed by terrorism.

4.4 NPPQ System:

Here lower-priority sectors are not interrupted once their service begins, however, they must wait for all higher-priority sectors in the queue to finish their service. The waiting-time for each class depends on the arrival rate (λ), service rate (μ), and the priority discipline. By equation (3.0.3) the waiting time for each priority sectors is given by:

$$
\begin{aligned}
W_{\mathrm{H}} &= \frac{\rho_1}{\mu(1-\rho)} = \frac{0.25}{4(1-0.75)} \approx 0.25 \text{ years (3 Months)} \\
W_{\mathrm{M}} &= W_{\mathrm{H}} + \frac{\rho_2}{4(1-\rho)} = 0.25 + \frac{0.25}{4(1-0.75)} \approx 0.5 \text{ years (6 months)} \\
W_{\mathrm{L}} &= W_{\mathrm{H}} + W_M + \frac{\rho_3}{\mu(1-\rho)} = 0.75 + \frac{0.25}{4(1-0.75)} \approx 1 \text{ years (12 months)}
\end{aligned} \tag{4.0.3}
$$

These implies that the high priority sectors would enter into service after 3 month of budget approval, the medium priority sectors would enter after 3 months, while the low priority sectors would enter into service after 12 months of budget approval.

4.4.1 Implications of NPPQ Waiting-Time Distribution:

In system, where the waiting times for the high priority sectors is 3 months, the medium priority sectors are 6 months, and the low priority sectors is 12 months, provide critical insights into resource allocation and its implications for security. The existing budget misallocation of 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budget, further compounds these implications. Key security implications of these waiting time distribution include:

(i) Timeliness of Resource Allocation: The relatively short waiting time of 3 months for high priority sectors suggests that urgent security needs are addressed fairly quickly. This prompt allocation is essential for effective CT and security measures. However, the significant misallocation (58.12%) raises concerns about whether the funds are being directed to the most effective initiatives, potentially undermining the intended benefits of timely funding.

(ii) Risks for Medium and Low Priority Sectors: The waiting times for medium (6 months) and low priority sectors (12 months) indicate that these areas may not receive timely support, which can increase vulnerabilities. Medium priority sectors, while not critical, still play a role in overall security; therefore, delays in funding can hinder preventive measures and leave gaps that adversaries could exploit. The lengthy waiting time for low priority sectors may mean that non-security-related areas continue to receive low funding in-spite of the inherent inadequacy in high priority resource allocation

(iii) Long-Term Strategic Risks: The combine effect of waiting time disparity, budget misallocation and budget deficiency poses long-term risks for national security. If the system fails to allocate resources effectively, it may become increasingly reactive rather than proactive, making it difficult to anticipate and mitigate future threats. This can hinder long-term strategic planning and preparedness.

In summary, the waiting time distributions in the M/M/1 NPPQ system, along with significant misallocation cost and budget deficit, highlight the challenges in ensuring effective resource allocation for national security. Addressing these issues is essential for enhancing the overall security framework and ensuring that all sectors receive the support they need to mitigate risks effectively.

4.4.2 NPPQ Waiting-Time Fairness:

From equation (3.0.6) RAF index with respect to waiting-time distribution is given by: $RAF = 0.1714$. RAF index of 0.1714, (17.14%) indicate a very low fairness system, where the higher priority sectors solely enjoy disproportionate waiting time in expensed of the low priority sectors.

(i) From equation (3.0.7), JF index with respect to waiting time distribution is: $JFI \approx 0.7778$.

(ii) JF Index of 0.7778 (77.78%) indicate a highly fair system, where the higher priority sectors do not entirely enjoy disproportionate shorter waiting time in expensed of the low priority sectors.

(iii) From equation (3.0.8), MMF Index with respect to waiting time distribution is: $MMF \approx 0.25$

[5] The Department of Defense Releases the Fiscal Year 2024 Strategic Management Plan: Annual Performance Report > U.S. Department of Defense. (https://www.defense.gov/News/Releases/Release/Article/4033787/the-department-of-defense-releases-the-fiscal-year-2024-strategic-management-pl/

[6] Federal Register: (https://www.federalregister.gov/documents/2024/07/22/2024-15370/clarifications-and-updates-to-defense-priorities-and-allocations-system-regulation

(iv) MMF Index of 0.25 (25%) indicate low fairness system, where the higher priority sectors disproportionately enjoy shorter waiting time in expensed of the low priority sectors.
(v) From equation (3.0.9), CV with respect to waiting time distribution is given by: $\text{CV} = 0.5345.$ CV fairness value of 0.5345 (53.45%) indicate an averagely fair system, with averagely distributed waiting time across all priority sectors.
(vi) From equation (3.1.0), RAQF Index with respect to waiting time distribution is $RAQF \approx 0.6882$. RAQF fairness index of 0.6882 (68.82%) indicates a moderately fair system, where the waiting time are moderately proportionately distributed across all sectors. RAQF measure confirms that notwithstanding the significant variation in allocations, the system is highly fair with respect to its waiting time distribution. This result aligns with the objective of fairness threshold, ($\delta = 0.1$) aimed to guarantee that lower-priority sectors are not entirely starved of resources.

Table 4.5: Summary of NPPQ Waiting Time Fairness Metrics

Fairness Metrics	Value	Interpretation
• System Fairness Index	0.1714	Very low fairness system with disproportionate disparity in system waiting times distribution.
• Jain's Fairness Index	0.7778	Highly fair system with proportionate disparity in system waiting times distribution.
• Max-Min Fairness Index	0.25	Very low fairness with disproportionate disparity in system waiting time distribution.
• Coefficient of Variation	0.5345	Average dispersion in waiting distribution, indicating moderate fairness system
• RAQF Index	0.6882	High fairness system with proportionate disparity in system waiting times distribution.

By aggregate, the fairness indices in table 4.5 yield an average of 0.4706, (47.06%) indicating significant inequities in the waiting time distribution, with low-priority sectors excessively delayed in entering service.

4.4.3 Implications of NPPQ Waiting-Time Fairness Index: In the context of an M/M/1 NPPQ system with a fairness index of 0.4706, the waiting time distributions for high priority (3 months), medium priority (6 months), and low priority (12 months) sectors raise important security considerations, especially in light of 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budgets.
(i) **Moderate Fairness in Resource Distribution:** A fairness index of 0.4706 indicates a low level of fairness in waiting time distribution. This suggests some level of inequity, implying that there may be disparities in distribution of funds across different sectors. High-priority sectors receiving timely support is essential for addressing urgent security needs, however, the effectiveness of this support may be diminished by the existing misallocation cost, which can divert resources away from critical initiatives.
(ii) **Potential Vulnerabilities in Medium and Low Priority Sectors:** The waiting times for medium priority (6 months) and low priority (12 months) sectors indicate that these areas may experience delays in receiving necessary funding. This can create vulnerabilities, particularly in medium priority sectors that, while not as urgent, still contribute to overall security. Lengthy delays in funding could hinder their ability to implement preventive measures, increasing the risk of threats emerging in these areas.
(iii) **Long-Term Strategic Considerations:** Considering that the fairness index of the NPPQ architecture indicates a low approach to waiting time allocation, the potential misalignment between funding and actual security needs may hinder long-term strategic planning. As the system does not adapt to changing threats or allocate resources effectively and efficiently, it risks becoming reactive rather than proactive, which is detrimental to national security.

In summary, the implications of a fairness index of 0.4706 within the M/M/1 NPPQ system highlight a critical need for evaluation and adjustment of resource allocation strategies. Ensuring that funding is effectively directed to all priority sectors is essential for enhancing national security and addressing the challenges posed by both immediate and evolving threats.

4.5 M/G/1 Queue Performance Characteristics

Unlike the $M/M/1$ queue, the $M/G/1$ queue allows for more flexibility in modeling real-world systems where service times are not exponentially distributed. The waiting time in M/G/1 queue also depends on the priority discipline.

4.5.1 PPQ System: As usual higher-priority classes are always served first, while the lower-priority classes must wait for all higher-priority classes to finish. The waiting time for each class depends on the cumulative effect of all higher-priority classes. From equation (3.0.1):

$$\begin{aligned} W_H &= \frac{\lambda E[S^2]}{2(1-\rho_1)} = \frac{3(0.0625)}{2(1-0.25)} = 0.125\ years \approx 1.5 \text{ months} \\ W_{\mathrm{M}} &= \frac{\lambda E[S^2]}{2\big(1-(\rho_1+\rho_2)\big)} = \frac{3(0.0625)}{2(1-0.5)} = 0.1875\ years \approx 2.25 \text{ months} \\ W_{\mathrm{L}} &= \frac{\lambda E[S^2]}{2\big(1-(\rho_1+\rho_2+\rho_3)\big)} = \frac{3(0.0625)}{2(1-0.75)} = 0.375\ years \approx 4.5 \text{ months} \end{aligned} \quad (4.0.4)$$

These implies that the high priority sectors would enter into service after 1.5 month of budget approval, the medium priority sectors would enter after 2.25 months, while the low priority sectors would enter into service after 4.5 months of budget approval.

4.5.2 Implications of PPQ Waiting Time Distribution: In an M/G/1 PPQ system, where the waiting times for the high priority sectors is1.5 months the medium priority sector is 2.25 months, and the low priority sector is 4.5 months, the combination of 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budgets, present several important security implications:

(i) Urgency vs. Resource Allocation: The waiting time for high priority sectors (1.5 months) indicates that while they have preferential access to resources, delays still exist. In high-security contexts, even a 1.5-months wait can be detrimental, potentially allowing threats to materialize during this period. Medium priority sectors, with a waiting time of 2.25 months, may struggle to address issues that could escalate into more serious threats if not managed promptly.

(ii) Significant Delays for Low Priority Sectors: The 4.5-months waiting time for low priority sectors reflects a systemic neglect of non-security related but critical economic sectors, which may still influence overall security indirectly. If these sectors are responsible for foundational services or community safety, their delays could lead to vulnerabilities that affect higher priority sectors.

(iii) Cascading Effects on Security: The interplay of waiting times, misallocation costs, and budget deficiencies can create a cascading effect where each sector's inability to function optimally can impact the overall security framework. High priority sectors may find themselves overwhelmed if lower priority sectors fail to address emerging risks.

(i) Long-Term Strategic Vulnerabilities: The distribution of waiting times may reflect a short-term focus on immediate security needs at the expense of a comprehensive strategy. This approach can lead to long-term vulnerabilities, as systemic issues may remain unaddressed due to prolonged waiting times in lower priority sectors.

(ii) Public Trust and Confidence: The apparent inequity in waiting times may erode public trust in the government's ability to manage security effectively. Citizens may perceive that critical security needs are not being prioritized appropriately, leading to a lack of confidence in protective measures.

In summary, the waiting time distributions, combined with high misallocation costs and significant budget deficiencies, highlight critical security implications in the M/G/1 PPQ system. To enhance the effectiveness and resilience of security measures, it is essential to address these waiting times and improve the efficiency of resource allocation across all priority sectors. This will help mitigate risks and ensure a more robust security posture.

4.5.3 Waiting Time Fairness of PPQ System: From equation (3.0.6) RAD index (SFI) with respect to waiting time distribution is: $RAF = 0.4364$. RAF value of 0.4364 (4364%), indicate an unfair system, where the higher priority sectors, enjoy disproportionate waiting time in expensed of the low priority sectors.

(i) From equation (3.0.7), JF Index with respect to waiting time distribution is: $JFI \approx 0.8232$. JFI value of 0.8232 (82.32%) indicate a highly fair system, where the higher priority sectors are not entirely disproportionately served in expensed of the low priority sectors.

(ii) By equation (3.0.8), MMF Index with respect to waiting time distribution is: $MMF \approx 0.3333$. MMF Index of 0.3333 (33.33%) indicate a low fairness system, where the higher priority sectors, enjoy shorter waiting time in expensed of the low priority sectors.

(iii) From equation (3.0.9), CV with respect to waiting time distribution is: $CV = 0.4638$. CV value of 0.4638 (46.38%) indicate a low dispersion of waiting time (high equality), corroborating a fairer system.

(iv) By equation (3.1.0), RAQF Index with respect to waiting time distribution is: $RAQF \approx 0.5295$. RAQF index of 0.5295 (52.95%), indicates an averagely fair system, where the waiting time are moderately proportionately distributed across the priority classes.

RAQF measure confirms that, though with significant variation in allocations, the system is averagely fair with respect to its waiting time distribution. This result aligns with the objective of the fairness threshold, ($\delta = 0.1$) aimed to guarantee that lower-priority sectors are not entirely starved of resources.

Table 4.6: Summary of NPPQ Fairness Metrics

Fairness Metrics	Value	Interpretation
• System Fairness Index	0.4364	Low fairness system with disproportionate waiting times distribution across priority sectors.
• Jain's Fairness Index	0.8232	Highly fair system with proportional distribution of system waiting time across priority sectors.
• Max-Min Fairness Index	0.3333	Low fairness system with disproportionate disparity in system waiting time distribution.
• Coefficient of Variation	0.4638	Low dispersion in waiting distribution, indicating moderately fair system.
• RAQF Index	0.5295	Averagely fair system relative to the waiting time distribution across sectors.

Aggregately, the fairness indices in table 4.6 yield an average of 0.5317, (53.17%) indicating an aversely fairer (low inequities) waiting time distribution, where low-priority sectors enjoy moderate delayed in entering service.

4.5.4 Implications of PPQ Waiting-Time Fairness Index: In an M/G/1 PPQ system, the waiting time fairness index of 0.5317, coupled with a misallocation cost of 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority, budget, indicates several important implications regarding the efficiency and effectiveness of resource allocation across different priority sectors:

(i) Moderate Fairness but Significant Inequities: A fairness index of 0.5317 suggests a moderate level of fairness, indicating that while there is some effort to distribute waiting times equitably among priority sectors, significant discrepancies remain. The waiting times for high (1.5 months), medium (2.25 months), and low priority (4.5 months) sectors illustrate that low priority sectors are facing disproportionately longer delays, which can compromise their operational effectiveness.

(ii) Long Waiting Times for Low Priority Sectors: The waiting time of 4.5 months for low priority sectors may reflect a neglect of these areas, which could lead to vulnerabilities that affect overall security. If low priority sectors are responsible for essential services, their inability to access timely resources can create gaps that high-priority sectors may be forced to address, ultimately straining their resources.

(iii) Public Perception of Fairness: The waiting time fairness index, while moderate, may not translate to public trust in the system. Citizens may perceive that critical areas are not prioritized adequately, leading to dissatisfaction and a lack of confidence in the government's commitment to security.

(iv) Strategic Implications for Resource Allocation: The combination of moderate fairness, misallocation costs, and significant budget deficits suggests a need for strategic re-evaluation of resource allocation policies. Improving the fairness index requires addressing both the misallocation of resources and the budget shortfall to ensure that all sectors receive appropriate support.

(v) Risk of Systemic Vulnerabilities: The interplay of these factors highlights a risk of systemic vulnerabilities. If high-priority sectors cannot operate effectively due to insufficient resources or if low-priority sectors are neglected, the entire security framework may be weakened, increasing the likelihood of security breaches or crises.

In summary, the implications of a waiting time fairness index of 0.5317, alongside 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budgets, suggest that while some efforts toward equitable resource distribution exist, significant inequities and inefficiencies remain. Addressing these issues is crucial for enhancing the overall effectiveness and resilience of the security system, ensuring that all sectors can operate optimally in response to emerging threats.

4.6 NPPQ System:

In NPPQ, once service begins for a lower-priority class, it cannot be interrupted by higher-priority classes. As usual, the waiting time for each priority sector includes: (i) the waiting time caused by higher-priority, and (ii) the waiting time caused by its own class. By equation (3.0.2), we have:

$$\begin{aligned} W_{\mathrm{H}} &= \frac{\lambda E[S^2]}{2(1-\rho)} = \frac{3(0.0625)}{2(1-0.75)} = 0.375\ years \approx 4.5 \text{ months} \\ W_{\mathrm{M}} &= W_{\mathrm{H}} + \frac{\lambda E[S^2]}{2(1-\rho)} = 0.375 + \frac{0.1875}{0.5} = 0.75\ years \approx 9 \text{ Months} \\ W_3 &= W_1 + W_2 + \frac{\lambda E[S^2]}{2(1-\rho)} = 1.125 + \frac{0.1875}{0.5} = 1.5\ years \approx 18 \text{ months} \end{aligned} \tag{4.0.5}$$

These implies that the high priority sectors would enter into service after 4.5 month of budget approval, the medium priority sectors would enter after 9 months, while the low priority sectors would enter into service after 18 months of budget approval.

4.6.1 Implications of NPPQ Waiting Time Distribution: In an M/G/1 NPPQ system, the waiting time distributions of 4.5 months for high priority, 9 months for medium priority, and 18 months for low priority sectors, combined with a misallocation cost of 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budgets, indicate several critical implications:

(i) Severe Delays Across All Sectors: The waiting times of 4.5 months for high priority, 9 months for medium priority, and 18 months for low priority, are exceptionally long. Such delays can severely impede the ability of all sectors to respond effectively to security needs. High-priority sectors, which are expected to address urgent threats, may not be able to act swiftly enough, increasing vulnerability.

(ii) Impact of non-pre-emptive Allocation: In a NPPQ system, once a sector begins receiving resources, it cannot be interrupted by higher priority sector until its allocation is complete. This can exacerbate waiting times for high priority sectors, as they must wait for medium and low priority sectors to exhaust their allocations before they can access resources.

(iii) Inequitable Resource Distribution: The significant disparities in waiting times highlight inequities in resource allocation. Low priority sectors, with an 18-month wait time, are particularly disadvantaged, which can create systemic weaknesses in security. If these sectors provide foundational services, their delays can compromise the overall security infrastructure.

(iv) Cascading Effects on Security Operations: The combination of long waiting times and funding inefficiencies arising from the 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budgets, can create a cascading effect where delays in one sector affect others. High-priority sectors may become overwhelmed if they cannot access resources in a timely manner, leading to a potential breakdown in security operations.

(v) Public Trust and Perception: The perception of extreme waiting times across priority sectors may erode public trust in the government's ability to manage security effectively. Citizens may feel that their safety is not being prioritized, which can lead to dissatisfaction and decreased confidence in governmental institutions.

(vi) Need for Strategic Re-evaluation: Given the significant waiting times, misallocation costs, and budget deficiencies, there is a pressing need for strategic re-evaluation of resource allocation policies. Improving the efficiency of resource distribution and addressing funding shortfalls are crucial for enhancing the responsiveness and effectiveness of the security system.

In summary, the implications of waiting time distributions in a NPPQ system, in conjunction with 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budgets, reveal serious challenges to operational effectiveness across all priority sectors. To improve the overall security posture, it is essential to address these waiting times and enhance resource allocation strategies, ensuring that all sectors receive the necessary support to operate effectively and respond to security threats.

4.6.2 Fairness of NPPQ System: From equation (3.0.6), RAF index with respect to waiting time distribution is, $RAF = 0.1143$. RAF value of 0.1143 (11.43%), indicate a highly unfair system, where the higher priority sectors, entirely enjoy shorter waiting time in expensed of the low priority sectors.

(i) From equation (3.0.7), JFI with respect to waiting time distribution is $JFI \approx 0.7778$. JFI value of 0.7778 (77.78%) indicate a highly fair system, where higher priority sectors do not entirely enjoy shorter waiting time in expensed of the low priority sectors.

(ii) From equation (3.0.8), MMF Index with respect to waiting time distribution is: $MMF \approx 0.25$. MMF value of 0.2497 (24.97%) indicate a low fairness system, where the higher priority sectors, entirely enjoy shorter waiting time in expensed of the low priority sectors.

(iii) From equation (3.0.9), CV with respect to waiting time distribution is: $CV = 0.5345$. CV value of 0.5345 (53.45%) indicate average dispersion (average inequality), corroborating a moderately unfair system.

(iv) From equation (3.1.0), RAQF Index with respect to waiting time distribution is $RAQF \approx 0.5323$. RAQF index of 0.5323 (53.23%), indicates an averagely fair system, where the waiting times are averagely distributed across the priority classes. This also with objective of the fairness threshold, ($\delta = 0.1$), which aimed to ensure that the lower-priority sectors are not entirely starved of resources.

Table 4.7: Summary of NPPQ Fairness Metrics

Fairness Metrics	Value	Interpretation
• System Fairness Index	0.1143	Highly unfair system with disproportionate waiting times distribution across priority sectors.
• Jain's Fairness Index	0.7778	Highly fair system with proportional distribution of system waiting time across priority sectors.
• Max-Min Fairness Index	0.25	Low fairness system with disproportionate disparity in system waiting time distribution.
• Coefficient of Variation	0.5345	Average dispersion in waiting distribution, indicating moderately unfair system.
• RAQF Index	0.5323	Averagely fair system relative to the waiting time distribution across sectors.

By aggregate, the fairness indices in table 4.7 yield an average of 0.42.8, (42.8%) indicating significant high inequities in the waiting time distribution, with low-priority sectors disproportionately delayed in entering service.

4.6.3 Implications of NPPQ Waiting Time Fairness Index: In the context of an M/G/1 non-pre-emptive priority queueing system, where the waiting times are 4.5 months for high priority, 9 months for medium priority, and 18 months for low priority sectors, along with 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budget, the waiting time fairness index of 0.428 presents several critical implications:

(i) Low Fairness Index: A fairness index of 0.428 indicates a low level of equity in waiting times across the sectors. This suggests that the system is failing to provide a balanced distribution of resources and support among the priority sectors. The significant differences in waiting times reflect a lack of responsiveness to the needs of all sectors.

(ii) Extended Waiting Times: The waiting times of 4.5 months for high priority, 9 months for medium, and 18 months for low priority are excessively long. Such delays can severely hinder the ability of sectors to operate effectively. High-priority sectors, in particular, may struggle to address urgent security threats in a timely manner, leading to potential vulnerabilities.

(iii) Impact of non-pre-emptive Queueing: In a NPPQ system, high priority sectors cannot interrupt lower priority allocations. This can further exacerbate waiting times, as high-priority tasks must wait until lower priority tasks are fully serviced. The prolonged waiting times for low priority sectors can result in a backlog that delays critical operations.

(iv) Cascading Effects on Security: The combination of long waiting times, low fairness, and funding inefficiencies can create cascading effects that compromise the entire security framework. If high-priority sectors cannot access resources promptly, they may become overwhelmed, which could impact the response to emerging threats.

(v) Public Perception and Trust: The low fairness index and significant waiting times may erode public trust in governmental capabilities. Citizens may perceive a lack of prioritization in security measures, leading to dissatisfaction and a decline in confidence in the effectiveness of government institutions.

(vi) Need for Strategic Reassessment: The identified issues highlight the urgent need for a strategic reassessment of resource allocation policies. Improving the fairness index requires addressing both the misallocation of resources and the budget deficit, ensuring that all sectors receive adequate support in a timely manner.

In summary, the implications of a waiting time fairness index of 0.428, alongside 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budget, indicate significant challenges in the M/G/1 NPPQ system. To enhance the overall effectiveness of security operations and improve the fairness of resource distribution, it is essential to address these issues through strategic policy changes and better allocation of available resources. This will help mitigate risks and ensure that all priority sectors can operate effectively in response to security threats.

4.7 MTBE Analysis for BAQF System:

From Table 4.1b, we can deduce the following information for the analysis of MTBE in each of the queuing systems:

(i) Server Resource (Total Sectors' budgetary allocation): $\sum R_i = 48$ MDAs.

(ii) Arrival rate of each MDA, $\lambda_1 = 5$, Sectors; $\lambda_2 = 7$, Sectors; and $\lambda_6 = 36$ Sectors

(iii) Mean Service Times for each priority sector $E[S_i] = 1/4 = 0.25$ quarterly

4.7.1 PPQ system: Genuine workloads ρ_i^{Gen} for each priority sector: $\rho_i^{\text{Gen}} = \lambda_i^{\text{Gen}} E[S_i]$
Therefore,

$$\rho_1^{\text{Gen}} = 0.6(5)0.25 = 0.75;\ \rho_2^{\text{Gen}} = 0.8(7)0.25 = 1.4;\ \rho_3 = 36(0.25) = 9$$

(i) Total effective workload (without accounting for priority): $W = \sum \rho_i^{\text{Gen}} = 11.15$

(ii) Fabricated workloads, ρ_1^{Fab} for each higher priority sector: $\rho_i^{\text{Fab}} = \lambda_i^{\text{Fab}} E[S_i]$

$$\rho_1^{\text{Fab}} = 0.4(5)0.25 = 0.5;\ \rho_2^{\text{Fab}} = 0.2(7)0.25 = 0.35$$

(iii) Adjusted workload, ρ_i^{Adj} for each priority sector: $\rho_i^{\text{Adj}} = \rho_i + (1 - P_d)\rho_i^{\text{Fab}}$

$$\rho_1^{\text{Adj}} = 0.25 + (1 - 0.45)0.5 = 0.525;\ \rho_2^{\text{Adj}} = 0.25 + (1 - 0.45)0.35 = 0.4425$$

(iv) Effective workload (accounting for prioritization) is given by:

$$\rho_2^{\text{Eff}} = \rho_2^{\text{Adj}}\left(1 - \frac{\rho_1^{\text{Adj}}}{W}\right) = 0.4425\left(1 - \frac{0.525}{11.15}\right) = 0.4217$$
$$\rho_3^{\text{Eff}} = \rho_3\left(1 - \frac{\rho_1^{\text{Adj}} + \rho_2^{\text{Eff}}}{W}\right) = 9\left(1 - \frac{0.525 + 0.4217}{11.15}\right) = 8.2358 \quad (4.0.6)$$

(v) Total effective workload (accounting for prioritization): $W^{\text{Eff}} = \sum \rho_i^{\text{Eff}} = 9.1825$

(vi) The System MTBE for the PPQ system: $[\text{MTBE}]_i = R_i / W^{\text{Eff}}$

$$[\text{MTBE}]_1 = 5/9.1825 = 0.5445 \approx 0.5 \text{ months}$$
$$[\text{MTBE}]_2 = 7/9.1825 = 0.76232 \approx 0.8 \text{ months} \quad (4.0.7)$$
$$[\text{MTBE}]_3 = 36/9.1825 = 3.9205 \approx 4 \text{ months}$$

In the context of the PPQ system model, $[\text{MTBE}]_1 = 0.5$, implies that the high priority sectors have an average of 15 days to access their approved budgetary allocation before the system get exhausted. $[\text{MTBE}]_2 = 0.8$, implies that the medium priority sectors have an average of 24 days to access their approved budgetary allocation before the system get exhausted. $[\text{MTBE}]_3 =$ 4 months implies that the low priority sectors have an average of 4 months to access their approved budgetary allocation before the system get exhausted. In general, in the PPQ system has an average of: $\text{MTBE} = R/W^{\text{Eff}} = 48/9.1825 = 5.2273 \approx$ 5 months to allocate budgetary resource before the server gets exhausted.

4.7.2 NPPQ System: The effective workload of the NPPQ model is similar to the PPQ case, except that the priority structure does not reduce the workload as aggressively

(i) Genuine workloads ρ_i for each priority sector: $\rho_i^{\text{Gen}} = \lambda_i^{\text{Gen}} E[S_i]$

$$\rho_1^{\text{Gen}} = 0.6(5)0.25 = 0.75;\ \rho_2^{\text{Gen}} = 0.8(7)0.25 = 1.4;\ \rho_3 = 36(0.25) = 9$$

(ii) Total effective workload (without accounting for priority): $W = \sum \rho_i^{\text{Gen}} = 11.15$

(iii) Fabricated workloads ρ_1^{Fab} for each higher priority sector: $\rho_i^{\text{Fab}} = \lambda_i^{\text{Fab}} E[S_i]$

$$\rho_1^{\text{Fab}} = 0.4(5)0.25 = 0.5;\ \rho_2^{\text{Fab}} = 0.2(7)0.25 = 0.35$$

(iv) Adjusted work load ρ_i^{Adj} for the two higher priority sectors: $\rho_i^{\text{Adj}} = \rho_i + (1 - P_d)\rho_i^{\text{Fab}}$

$$\rho_1^{\text{Adj}} = 0.25 + (1 - 0.45)0.5 = 0.525;\ \rho_2^{\text{Adj}} = 0.25 + (1 - 0.45)0.35 = 0.4425$$

(v) Effective workload (accounting for prioritization):

$$\rho_2^{\text{Eff}} = \rho_2^{\text{Adj}}\left(1 - \frac{\rho_1^{\text{Adj}}}{W}\right) = 0.35\left(1 - \frac{0.5}{11.15}\right) = 0.3343$$
$$\rho_3^{\text{Eff}} = \rho_3\left(1 - \frac{\rho_1^{\text{Adj}} + \rho_2^{\text{Adj}}}{W}\right) = 9\left(1 - \frac{0.9675}{11.15}\right) = 8.2191 \quad (4.0.8)$$

(vi) Total effective workload is: $W^{\text{Eff}} = \rho_1^{\text{Adj}} + \rho_2^{\text{Eff}} + \rho_3^{\text{Eff}} = 9.0784$

(vii) Sector MTBE for the NPPQ system can be given by: $\text{MTBE} = R_i / W^{\text{Eff}}$

$$[\text{MTBE}]_1 = 5/9.0784 = 0.5507 \approx 0.6 \text{ Months}$$
$$[\text{MTBE}]_2 = 7/9.0784 = 0.7710 \approx 0.8 \text{ Months} \quad (4.0.9)$$
$$[\text{MTBE}]_3 = 36/9.0784 = 3.9655 \approx 4 \text{ Months}$$

In the context of the NPPQ system model, $[\text{MTBE}]_1 = 0.6$ months implies that the high priority sectors have an average of 18 days to access their approved budgetary allocation before the system get exhausted. $[\text{MTBE}]_2 = 0.8$ moths implies that the medium priority sectors have an average of 24 days to access their approved budgetary allocation before the system get exhausted. $[\text{MTBE}]_3 = 4$ months implies that the low priority sectors have an average of 4 months to access their approved budgetary allocation before the system get exhausted. In general, in the NPPQ system has an average of: $\text{MTBE} = 48/9.0784 = 5.2873 \approx 5$ months to allocate budgetary resource before the server gets exhausted.

4.7.3 Implications of MTBE Analysis: In BAQF system, the system's structure, with varying mean times before server exhaustion (MTBE) across different priority classes, coupled with the implications of 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budget, raises several security concerns:

(i) Disparity in Resource Allocation: The high priority sectors, with an MTBE of 15 days, and the medium priority sectors, with an MTBE of 24 days, indicate that these sectors are prioritized for resource allocation, given the sensitivity of their function and fewer constituent sectors. However, the low priority class, with an MTBE of 4 months, suggests a significant delay in accessing necessary resources. This disparity can lead to vulnerabilities in lower priority sectors, which may be critical for overall economic stability but are not receiving timely support.

(ii) Increased Vulnerability to Threats: The extended MTBE for the low priority class (4 months) may leave these sectors particularly vulnerable to threats. If these sectors are responsible for foundational services or community safety, their inability to access timely resources can create gaps that higher priority sectors may be forced to address, ultimately straining their resources and compromising overall security.

(iii) Cascading Effects on Security Operations: The interplay of 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budget, and varying MTBE can create cascading effects that compromise the entire security framework. If high priority sectors cannot operate effectively due to insufficient resources or if low priority sectors are neglected, the entire system may be weakened, increasing the likelihood of security breaches or crises.

(iv) Public Trust and Perception: The apparent inequity in resource allocation and the significant waiting times may erode public trust in the government's ability to manage security effectively. Citizens may perceive that critical security needs are not being prioritized appropriately, leading to a lack of confidence in government institutions responsible for security.

(v) Strategic Implications for Resource Allocation: The identified issues highlight the urgent need for a strategic reassessment of resource allocation policies. Improving the efficiency of resource distribution and addressing funding shortfalls are crucial for enhancing the responsiveness and effectiveness of the security system.

In summary, the implications of varying MTBE, the 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budget in the respective priority queuing systems, highlight significant challenges in the budgetary allocation system. To enhance the overall effectiveness and resilience of security measures, it is essential to address these disparities and ensure that all sectors receive adequate resources in a timely manner. This will help mitigate risks and vulnerabilities across the entire security framework.

5.0 DISCUSSION RESULTS OF THE ANALYSIS

Using statistical and data science principles, while integrating relevant theories and references to analyze the implications of the Budgetary Allocation Prioritization Queue Fairness (BAQF) model results, we seek to elaborate the interplay between budget allocation unfairness, socioeconomic impacts, and security implications.

5.1 Contextual Analysis of the Results

The BAQF model reveals critical inefficiencies in budget allocation, particularly in the context of prioritizing security/defence related sectors over other critical socioeconomic sectors. The metrics provided highlight systemic unfairness and inefficiencies that exacerbate societal vulnerabilities and contribute to the rise of terrorprenuerial activities and false flag terrorism. Key among these metrics include:

5.1.1 High Budgetary Allocation Unfairness among Priority Sectors: This metric indicates that the allocation of resources is skewed heavily toward security/defence at the expense of other critical sectors like healthcare, education, and infrastructure. From a statistical perspective, this suggests a high variance in the distribution of budgetary resources, leading to a Gini coefficient-like measure of inequality. According to the "Resource Curse Theory" (Collier & Hoeffler, 2004), over-prioritization of one sector (e.g., defence) can lead to neglect of others, creating socioeconomic disparities. These disparities can fuel grievances, which are often exploited by terrorpreneurs to recruit and radicalize individuals. The neglect of socioeconomic sectors increases societal vulnerabilities, such as poverty and unemployment, which are known drivers of terrorism (Krueger & Malečková, 2003). This creates a feedback loop where increased insecurity justifies further defense spending, perpetuating the cycle.

5.1.2 High Disproportionate Waiting Among Priority Sectors: This metric reflects the inefficiency in resource allocation, where critical sectors experience delays in receiving necessary funding. As evidence by the non-pre-emptive priority queue, where lower-priority sectors face prolonged waiting times, the concept of "queue discipline" in operations research highlights that non-pre-emptive systems often lead to inefficiencies and dissatisfaction among lower-priority entities (Hillier& Lieberman, 2020). This aligns with the theory of "Relative Deprivation" (Runciman, 1966; Walker, & Smith, 2002), which posits that perceived inequities can lead to frustration and conflict. By security implication, this prolonged waiting times for socioeconomic investments exacerbate public dissatisfaction, creating fertile ground for terrorprenuerial activities. For example, delayed infrastructure projects can hinder economic growth, while delayed healthcare funding can lead to public health crises, both of which can destabilize communities.

5.1.3 High Waiting Time Unfairness Among Priority Sectors: This metric suggests that the time taken to address the needs of different sectors is highly unequal. Statistically, this was measured using different metrics like the "Proportional fairness (PF), Jain's Fairness Index (JF), Min-Max fairness (MMF), Coefficient of variation (CV), and Resource Allocation queue fairness (RAQF) of waiting times. The Equity Theory (Adams, 1963, 1965) suggests that perceived unfairness in resource allocation can lead to reduced trust in institutions. In the context of budget allocation, this can manifest as public disillusionment with government priorities. By security implication, unfair waiting times can erode trust in governance, leading to increased support for non-state actors who promise quicker solutions. This can manifest as support for terrorprenuerial activities or even participation in false flag operations aimed at discrediting the state.

5.1.4 Varying Mean Time of Budgetary Exhaustion (MTBE) Among Priority Sectors: MTBE measures the efficiency with which budgetary resources are utilized over time. High variability in MTBE indicates inefficiencies and inconsistencies in resource utilization. The concept of Pareto

Efficiency (Pareto, 1906; Arrow, 1951; Mas-Colell et al 1995), states that resources should be allocated in a way that no sector is made worse off without making another better off. High variability in MBTE violates this principle, leading to suboptimal outcomes. Inefficient resource utilization can lead to wasted opportunities for socioeconomic development. This not only perpetuates existing vulnerabilities but also creates new ones, providing terrorpreneurs with additional leverage to exploit.

5.2 Quantitative Implications

The statistics of 58.12% misallocation cost, 29% inefficient high priority budget, and 25% deficient low priority budget, quantify the economic inefficiencies resulting from unfair prioritization. Significantly, the misallocation cost (58.12%) represents the proportion of the budget that could have been used more effectively in other sectors but was instead diverted to defence/security. From a cost-benefit analysis perspective, this is a significant loss, as it represents foregone opportunities for socioeconomic development. The 29% inefficient high priority budget, and 25% deficient low priority budget indicates the extent to which critical sectors are underfunded.

5.3 Security Implications of the System

The systemic inefficiencies and inequities revealed by the BAQF model have far-reaching security implications. Key among these include:

(i) Rise of Terrorprenuerial Activities: Terrorprenuerial activities thrive in environments characterized by socioeconomic disparities and governance inefficiencies. The unfair prioritization of defence spending creates a dual effect diverting resources away from sectors that address root causes of terrorism (e.g., poverty, education), creating public resentment, which terrorpreneurs exploit to gain support.

(ii) Increased Risk of False Flag Terrorism: False flag operations often aim to manipulate public opinion or justify increased defence spending. The high budgetary allocation to defence creates perverse incentives for such activities, as stakeholders within the defence sector may seek to maintain or increase their share of the budget.

(iii) Destabilization of Governance: The inequities and inefficiencies highlighted by the BAQF model undermine public trust in governance. This can lead to increased support for non-state actors, further destabilizing the security landscape.

5.4 RECOMMENDATIONS

To address the issues highlighted by the BAQF model, the following recommendations are proposed:

(i) Adoption of a Balanced Budgetary Framework: Governments should adopt budgetary frameworks that prioritize socioeconomic development alongside CT efforts. This can be achieved by integrating the BPQF model into national budget planning to ensure fairness and efficiency in resource allocation. Governments should adopt multi-criteria decision-making (MCDM) models to ensure fair and efficient budget allocation. Tools like the Analytic Hierarchy Process (AHP) can help weigh competing priorities.

(ii) Investment in Root Cause Mitigation: Redirect significant portion of CT budgets toward addressing the root causes of terrorism, such as poverty, unemployment, and lack of education. Evidence-based programs, such as vocational training and community development initiatives, should be prioritized.

(iii) Enhance Transparency and Accountability: Government should implement robust monitoring and evaluation frameworks can mitigate corruption and misuse of CT funds - establish independent oversight bodies to monitor CT expenditures and prevent misuse of funds. Transparency in budgetary allocations will reduce the incentives for terrorprenuerial activities and false flag operations.

(iv) Develop Context-Specific CT Strategies: Government should develop CT strategies that take into account the local context, cultural nuances, and socioeconomic factors. Promote inclusive economic growth by supporting small and medium-sized enterprises (SMEs), encouraging entrepreneurship, and creating job opportunities. Shifting focus from reactive CT measures to proactive socio-economic development can address the underlying drivers of insecurity.

(v) Foster International Cooperation and Collaboration: Encourage regional cooperation in intelligence sharing, counter-radicalization programs, and socioeconomic development initiatives. Collaborate with international partners to share intelligence, best practices, and resources to combat terrorism. This will ensure a holistic approach to combating terrorism that transcends national boundaries.

(vi) Leverage Data-Driven Decision Making: Governments should adopt advanced data analytics models, such as BAQF, to continuously assess the effectiveness of budgetary allocations. Using systems dynamics models to simulate long-term impacts of budgetary decisions can help policymakers anticipate unintended consequences. Artificial intelligence (AI) algorithms can identify patterns of inefficiency and recommend real-time adjustments.

(vii) Strengthening Civil Society Engagement: Empower civil society organizations to play a more active role in CT efforts. Grassroots initiatives focused on education, mental health, and community resilience can help mitigate the appeal of extremist ideologies.

(viii) Reframe CT Narrative: Shift the focus of CT strategies from a "war on terror" to a "war on inequality and injustice". Prioritize sectors based on their potential to address root causes of insecurity, rather than focusing solely on immediate threats. This reframing will help align public perception with the long-term goals of peace and development.

(ix) Support Research and Development: Government should invest in robust research and development to improve understanding of terrorism, its causes, and effective CT measures. While relevant government policy should ensure that CT efforts respect human rights, adhere to the rule of law, and avoid perpetuating cycles of violence.

In summary, the BAQF model reveals critical insights into the unintended consequences of prioritizing security/defence budgets, particularly CT over other key socio-economic sectors. By fostering terrorpreneurial activities and false flag operations, such prioritization undermines genuine security goals and deprives socio-economic sectors of essential funding. The BAQF model provides a valuable framework for analyzing the inefficiencies and inequities in budget allocation. The results highlight the need for a more balanced and transparent approach to budget allocation, informed by economic and operational research theories, one that addresses the root causes of insecurity rather than focusing solely on immediate threats, while promoting sustainable socioeconomic development and national security. By adopting data-driven policies and leveraging theories of equity and efficiency, it is possible to mitigate the security risks associated with unfair budget prioritization.

In conclusion, the war on terror cannot be won through military might and surveillance alone. It requires a paradigm shift toward addressing the structural and systemic issues that fuel terrorism. By adopting a fair and equitable budgetary allocation system, as guided by the BAQF model, policymakers can create a sustainable framework for peace and security. Ultimately, the fight against terrorism is not just a battle against individuals or groups but a fight against the conditions that allow extremism to thrive.

CONCLUSION

The Budgetary Allocation Queueing Fairness (BAQF) model, as described is a theoretical framework for analyzing how government budgets are distributed across competing sectors (e.g., security, healthcare, education, infrastructure). Queueing theory, traditionally used in operations research to manage service systems (e.g., customer queues), is applied here metaphorically to budget allocation, where sectors "queue" for funding. In queueing systems, priority service disciplines determine which "customers" (or sectors) are served first. Two common disciplines have been studied – Pre-emptive Priority; where higher-priority sectors can interrupt lower-priority ones, and non-pre-emptive Priority, where higher-priority tasks are served first, but ongoing lower-priority tasks are completed before switching. When applied to budget allocation, the higher priority (Security/defence-related) sectors may "interrupt" funding for other sectors in the pre-emptive priority variant. In the non-Pre-emptive Priority variant, higher-priority budgets are prioritized, but other sectors receive residual funding after security needs are addressed.

These findings supported by the BAQF model, reveal a critical misalignment in the allocation of security/CT related budgets relative to other socio-economic sectors, suggesting that irrespective of the prioritization method employed, over-allocation to security/defence related sectors, especially CT budgets may create systemic inefficiencies and unintended consequences. This misallocation not only exacerbates the socio-economic inequalities that often serve as breeding grounds for terrorism but also incentivizes terrorprenuerial activities and false flag operations. These dynamics perpetuate a vicious cycle where the war on terror becomes self-sustaining, driven by systemic inefficiencies and the mismanagement of public funds. This includes:

(a) Terrorpreneurial Activities: These refer to individuals or groups exploiting CT funding for personal or organizational gain. This aligns with *"public choice theory"*, which posits that individuals in government or private sectors may act in self-interest, leading to inefficiencies and corruption. Overfunding CT sectors creates a perverse incentive structure. Entities may fabricate or exaggerate threats to secure funding, leading to a "terrorism-industrial complex" akin to the *"military-industrial complex"* described by Eisenhower (1961). With guaranteed funding, there's less incentive to efficiently address root causes of terrorism, as the focus shifts to sustaining the funding pipeline.

(b) False Flag Operations: These involve deceptive acts designed to mislead, often to justify increased security spending. Historically, false flag operations have been documented in political science and international relations (Operation Northwoods). Overemphasis on CT budgets may inadvertently encourage such activities, as stakeholders seek to justify continued prioritization.

(c) Jeopardizing Genuine Security Intentions: From a systems dynamics perspective, over-prioritization of one sector (e.g., security) can create feedback loops that undermine the original goal. Excessive focus on CT efforts diverts resources from addressing root causes of insecurity, such as poverty, inequality, and lack of education. In economics, the crowding-out effect occurs when government spending in one area reduces available resources for others. For example, prioritizing defence budgets may "crowd out" investments in healthcare, education, or infrastructure, which are critical for long-term stability. Studies in development economics (Collier and Hoeffler, 2004) show that socio-economic investments (e.g., education, healthcare) are more effective in reducing conflict and insecurity than military spending. Excessive defence spending often correlates with corruption and inefficiency, as highlighted by Transparency International's Government Defence Anti-Corruption Index[7].

(d) Deprivation of Key Socio-Economic Sectors: This underscores the opportunity cost of prioritizing security budgets. Opportunity cost, refers to the benefits foregone by choosing one option over others. In this case. For example, underfunding education and healthcare undermine the workforce's productivity and resilience, leading to long-term economic stagnation. Neglecting infrastructure and technological innovation hampers economic growth and global competitiveness.

From theoretical perspectives, the study aligns with *"Maslow's Hierarchy of Needs" (*Maslow, 1943, 1954), which emphasizes that individuals deprived of basic needs (e.g., food, shelter, education) are more susceptible to radicalization. In welfare economics, "*Pareto efficiency occurs when resources are allocated such that no one can be made better off without making someone else worse off" (*Pareto, 1906; Arrow, 1951; Mas-Colell et al 1995). Overfunding security at the expense of socio-economic sectors violates Pareto efficiency, as it disproportionately benefits one sector while harming others. Additionally, "*Rational Choice Theory"* (Becker, 1968; Cornish, & Clarke, 1986; Nagin, & Paternoster, 1993), suggests that terrorprenuerial actors exploit the lucrative nature of CT budgets, creating a market for fear and insecurity. The *"Broken Windows Theory"* (Wilson, & Kelling, 1982; Kelling, & Coles, 1996), further underscores the importance of addressing root causes - such as poverty, unemployment, illiteracy and inequality rather than focusing disproportionately on punitive measures.

Case studies, such as the post-9/11 United States CT spending spree and the Nigerian CT budget under Boko Haram insurgency, demonstrate how over-prioritization of security spending often leads to corruption, inefficiency, and neglect of critical sectors like education, healthcare, and infrastructure. In both cases, the lack of socioeconomic investment perpetuated cycles of violence and insecurity, proving that a militarized approach alone cannot win the war on terror.

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[7] Transparency International (2020). https//ti-defence.org

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