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Institutionalizing Transport Fare Insurance Scheme (TFIS) for Optimizing Urban Passenger Transport Efficiency in Abuja, Nigeria

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Abstract: Urban mobility in Abuja continues to suffer from prolonged passenger waiting times and unpredictable departure schedules due to the dominance of occupancy-based dispatch systems in the informal transport sector. These inefficiencies impose high opportunity costs on commuters, create unstable revenue patterns for drivers, and limit the development of reliable urban transport services. This study introduces the Transport Fare Insurance Scheme (TFIS) as a financial–institutional framework designed to redistribute demand risk, enable timely departures, and stabilize driver income. Using a mixed-methods approach combining commuter surveys, operational cost assessments, simulation modeling, and stakeholder interviews, the research evaluates how fare-insurance mechanisms can reshape departure behavior and improve service reliability. The simulation results indicate substantial reductions in average waiting time and greater income predictability for operators under insured-departure scenarios. Behavioral and institutional insights further reveal that policy coordination, union sensitization, and digital fare governance are essential conditions for successful TFIS adoption. Although the simulation relies on model-based parameters requiring future pilot validation, the findings demonstrate that TFIS offers a practical, scalable pathway for enhancing transport efficiency in Abuja and similar Sub-Saharan African cities. The study contributes to emerging research on integrating financial instruments into public transport operations and aligns with global development targets under SDG 9 (Industry, Innovation and Infrastructure) and SDG 11 (Sustainable Cities and Communities).

Keywords: Transport Economics, Urban Mobility, Fare Insurance, Informal Transport, Abuja

I. Introduction

Urban mobility remains a defining factor in the productivity, inclusivity, and economic competitiveness of rapidly growing African cities. In Abuja, Nigeria's administrative capital, mobility systems are heavily dependent on informal shared-ride taxis and minibuses whose operational logic is primarily driven by vehicle occupancy thresholds rather than scheduled departures. This operational model forces vehicles to wait until seats are fully occupied before commencing trips, generating unpredictable delays, extended queuing times, and negative welfare impacts for commuters. The problem has intensified with the city's rising population, growing service economy, and increasing reliance on time-sensitive mobility for work, trade, and administrative functions. As a result, the informal transport sector, despite being the backbone of urban travel, has become increasingly inefficient, with significant productivity losses attributed to prolonged waiting times and unreliable travel schedules.

The inefficiency stems from the structure of risk allocation within the transport system. Drivers bear full demand risk, including fluctuating passenger volumes, fuel costs, and daily revenue expectations, while commuters shoulder the temporal burden of unpredictable departures. This imbalance is consistent with wider evidence across Sub-Saharan African paratransit systems where fragmented institutions and weak regulatory oversight produce service unreliability, long access times, and suboptimal operating practices (Behrens et al., 2016; Falchetta et al., 2021). While global transport economics literature emphasizes the importance of schedule adherence, risk-sharing mechanisms, and structured fare policies in achieving operational efficiency (Small and Verhoef, 2007; Banister, 2005), these principles have rarely been adapted to the realities of Abuja's predominantly informal mobility network. Existing approaches ranging from operational reforms to ride-hailing innovations have not addressed the underlying economic logic that drives occupancy-based delays.

While ride-hailing services such as Uber and Bolt provide flexible and responsive commuting options, their affordability limits accessibility for the average middle-income worker, with daily costs reaching as high as ₦50,000 (Oni and Olagunju, 2019). Consequently, a significant portion of urban commuters depend on informal public transport operations, where decision-making structures are driven by profit motives rather than service punctuality or commuter welfare (Adesanya, 2011; Gbadamosi and Adebayo, 2022).

Against this backdrop, this research introduces the Transport Fare Insurance Scheme (TFIS), a financial and institutional model designed to redistribute under-occupancy risk away from drivers and allow for timely departures at predefined intervals. TFIS functions as a risk-absorbing mechanism where an insurance pool covers revenue gaps for early departures with partially filled vehicles. This shifts the transport system from a profit-maximization model based solely on vehicle capacity to a reliability-driven model anchored in predictable service delivery. International precedents show that financial instruments such as subsidies, guarantees, and operational insurance have been used to support reliability in formal transport systems, including BRT corridors, commuter rail systems, and demand-responsive transit (Litman, 2021; Chen et al., 2019). However, no known study has extended this logic to informal shared-ride operations in African cities where departure uncertainty is a core constraint.

This research bridges that gap by examining how fare insurance can transform commuter experience, departure behavior, and revenue stability in Abuja's informal transport sector. Through a mixed-methods approach involving commuter surveys, cost modeling, operational data, simulation, and stakeholder interviews, this study evaluates the feasibility, economic rationale, and operational dynamics of TFIS within Abuja's mobility ecosystem. Particular attention is given to behavioral responses among drivers and passengers, as well as institutional readiness across unions, regulators, and policy bodies.

The goal of this study is not merely to propose a theoretical construct, but to develop an evidence-based, scalable model that aligns with national transport reform priorities and global sustainable mobility targets under SDG 9 and SDG 11. By integrating insights from transport economics, insurance theory, and African urban mobility research, the study provides a new lens for addressing temporal inefficiencies and enhancing service reliability in cities reliant on informal transport systems. This paper proposes the Transport Fare Insurance Scheme (TFIS), an institutional and financial innovation designed to balance commuter punctuality with driver revenue sustainability. The inadequate localization of transport economic principles within Nigeria's informal transport sector has perpetuated inefficiencies in passenger mobility (Filani and Abiodun, 2021).

This study therefore seeks to conceptualize and develop a Transport Fare Insurance Scheme (TFIS) that institutionalizes shared economic risk between passengers and operators. The scheme aims to optimize the economics of urban transport provision by ensuring timely departures, reducing commuter delays, and maintaining driver profitability. The TFIS model will particularly address the temporal inefficiencies experienced by early passengers and the operational constraints that compel drivers to wait for full vehicle occupancy before departure (Mogaji et al., 2023).

Underlying Issues and Mobility Challenges

The current informal transport model operating in Abuja relies heavily on occupancy thresholds, where vehicles wait to be fully loaded before departing. This operational framework causes prolonged waiting times for early passengers, resulting in significant service unreliability and inefficiency (Agunloye and Odewumi, 2020; Gbadamosi, 2010). The inefficiencies manifest as high opportunity costs of waiting, imbalanced fare distribution, and a lack of financial mechanisms to buffer under-occupancy risks (Adesanya, 2011).

Despite the increasing mobility demand within Abuja's rapidly urbanizing environment, dependency on occupancy-based dispatching undermines schedule reliability and constrains commuter productivity (Filani and Abiodun, 2021). Many passengers lose valuable time waiting for vehicles to fill, while drivers bear inconsistent income risks that further incentivize long waiting periods and fare overcharges (Oni and Olagunju, 2019).

Technically, the system suffers from multiple operational weaknesses. First, there is a high opportunity cost of time due to unpredictable departure schedules. Second, low service reliability arises from unscheduled and inconsistent vehicle operations (Gbadamosi and Adebayo, 2022). Third, cost distribution between drivers and passengers remains inequitable, with no institutional structure to manage fluctuations in demand or supply (Mogaji et al., 2023). Finally, the absence of dynamic pricing systems or insurance-based mechanisms exacerbates inefficiency, leaving both drivers and passengers exposed to financial and temporal risks (Adesanya, 2011).

This informal structure stands in sharp contrast to global best practices in public transport management, where systems are anchored on predictable schedules, institutional oversight, and risk-mitigation tools such as fare insurance, subsidies, or performance-linked incentives (Cervero and Golub, 2007; World Bank, 2018). These international models demonstrate that urban transport efficiency improves significantly when operational risks are redistributed through institutional and financial innovations.

The proposed Transport Fare Insurance Scheme (TFIS) aims to bridge this gap by institutionalizing shared financial risk between passengers and operators, ensuring timely departures, equitable fare systems, and sustainable driver earnings. This will contribute to the transformation of Abuja's informal transport sector into a more reliable, inclusive, and economically sustainable urban mobility framework.

Research Questions

1. What are the economic implications of occupancy-based vehicle dispatching in Abuja's informal transport sector?
2. How does time-delay in urban transport affect commuter productivity and welfare?
3. Can a Transport Fare Insurance Scheme (TFIS) effectively bridge the gap between operational cost recovery and timely service delivery?
4. What institutional and policy mechanisms are required for effective implementation and sustainability of the TFIS model in Abuja?

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Figure 1: Abuja Taxi empty because of passengers’ reluctance to wait due to long occupancy threshold *(source: field report by researcher 2025)*

Figure 2**:** Passenger Seated at Front awaiting full occupancy of Taxi at Abuja Park *(source: field report by researcher 2025)*

Figure 3: Incoming Passenger entering back roll 12 minutes after the seated ones have waited for full occupancy of Taxi at Abuja Park (source: field report by researcher 2025)

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Unaddressed Problems in Urban Transport Research

While global studies have long emphasized efficiency, reliability, and cost recovery mechanisms in scheduled transport systems such as Bus Rapid Transit (BRT) and subways (Cervero and Golub, 2007; Pojani and Stead, 2015), the transport landscape in Sub-Saharan Africa continues to be dominated by unstructured paratransit operations that lack institutional regulation (Behrens et al., 2016). In Nigeria, urban mobility is heavily reliant on minibuses, shared taxis, and informal operators, yet economic instruments designed to stabilize operational risks are virtually non-existent (Agunloye and Odewumi, 2020; Gbadamosi and Adebayo, 2022).

While insurance mechanisms have been introduced in freight logistics to protect goods and reduce delivery risks (Chen et al., 2019), there remains an absence of corresponding frameworks for passenger mobility. This gap reveals a major asymmetry in the treatment of goods versus human transport risk. The Transport Fare Insurance Scheme (TFIS) seeks to fill this void by introducing a financial and institutional model that insures fare risk, mitigates departure delays, and balances the interests of both commuters and drivers. By offering coverage for unoccupied seats and ensuring departures at scheduled times, TFIS simultaneously enhances commuter satisfaction and operator profitability (Mogaji et al., 2023).

Most previous research on urban transport in developing economies has focused on operational and infrastructure optimization rather than financial risk redistribution (Adesanya, 2011; Filani and Abiodun, 2021). Specifically, four critical research limitations emerge from existing literature:

1. An emphasis on formal, scheduled transit systems (e.g., BRT and metro networks) primarily in developed countries (Cervero and Golub, 2007).
2. Focus on fleet and route optimization, without addressing the economics of passenger waiting time in informal systems (Behrens et al., 2016).
3. Examination of insurance and subsidy frameworks limited to freight logistics rather than human mobility (Chen et al., 2019).
4. Analysis of ride-hailing platforms with dynamic pricing algorithms, but lacking integration into affordable mass commuting frameworks (Klein and Smart, 2017).

Therefore, there exists a distinct theoretical and practical gap regarding the integration of transport economics and financial risk instruments, such as fare insurance, in addressing inefficiencies in occupancy-based urban transport systems. In the Nigerian context and indeed across most of Sub-Saharan Africa, no research or policy framework has yet proposed a Transport Fare Insurance Scheme (TFIS) that:

1. Ensures driver profitability even without full vehicle occupancy,
2. Reduces commuter delays caused by occupancy-dependent departures,
3. Provides a financially sustainable model for informal transport operators, and
4. Enhances punctuality and reliability in urban centers like Abuja, where time-based efficiency underpins economic productivity.

This research thus fills a crucial gap by developing a financial and institutional innovation that leverages economic theory to solve both supply-side and demand-side inefficiencies in informal transport systems. Figure 1 below conceptualizes the intersection of existing domains; urban transport operations, financial innovation, and passenger welfare and visually isolates the research gap addressed in this study.

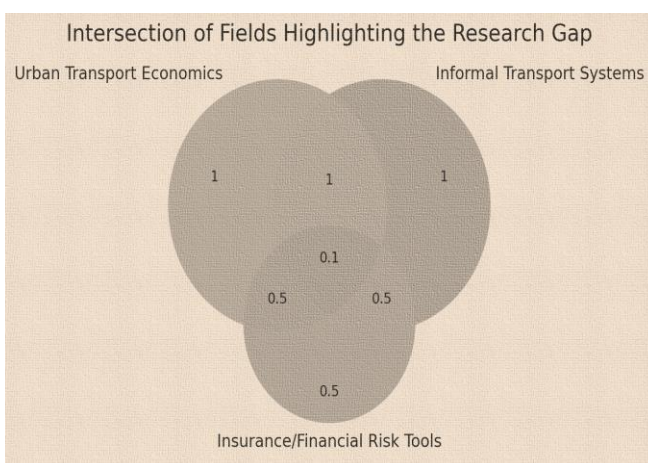

Figure 4: Illustrates the intersection of existing domains

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Analytical Focus and Study Objectives

Aim

The aim of this research is to design a sustainable and context-specific **Transport Fare Insurance Scheme (TFIS)** tailored to the informal urban transport sector in Abuja, Nigeria. The proposed TFIS seeks to reduce passenger waiting times, improve service reliability, and at the same time ensure that operators and drivers remain profitable. By bridging the gap between commuter needs and driver revenue optimization, the model is expected to provide a balanced framework that can enhance both social welfare and economic sustainability in the urban transport system.

Objectives

To achieve the stated aim, the research will pursue the following specific objectives:

Analyze existing economic models of informal urban transport operations in Abuja.

This involves a detailed review and assessment of the current fare collection mechanisms, revenue-sharing arrangements, and economic behavior of drivers and operators. It will also explore how supply and demand dynamics, fuel costs, and vehicle occupancy rates affect profitability in the absence of formal regulatory frameworks.

Evaluate the impacts of delays and inefficiencies on commuters.

The study will quantify the effects of long waiting times, route uncertainties, and inconsistent fares on passenger experience and productivity. This objective will highlight the hidden social and economic costs borne by commuters due to the current informal system.

Design the Transport Fare Insurance Scheme (TFIS) for insuring unoccupied seats.

A core part of the study will focus on developing a financial mechanism that guarantees fare security for drivers in cases where vehicles depart with partially filled seats. The TFIS model will be structured to distribute risk fairly among stakeholders while preventing fare inflation or exploitation of passengers.

Model the financial viability and sustainability of the TFIS.

Using economic simulations and financial models, the research will test the feasibility of the TFIS under different operating conditions. This will include sensitivity analysis of key variables such as passenger demand, fuel price fluctuations, insurance premium levels, and vehicle occupancy rates. The modeling exercise will assess whether the scheme can consistently deliver fair compensation to drivers while maintaining affordability for passengers and long-term financial sustainability for insurers or managing institutions.

Recommend policy frameworks and institutional arrangements for implementation.

The research will conclude by proposing evidence-based policy recommendations that outline how the TFIS can be adopted, monitored, and scaled across Abuja's urban transport system. This will involve identifying the roles of government agencies, transport unions, insurance regulators, and technology providers in ensuring transparent operations. The framework will also address the integration of TFIS with wider urban mobility policies, aligning it with national development goals and international sustainability agendas.

Analysis of Existing Economic Models in Nigeria

Nigeria's urban passenger transport system operates under five dominant models, each with distinct revenue structures, cost allocations, and risk-sharing logics. Understanding these models clarifies where the proposed Transport Fare Insurance Scheme (TFIS) can unlock the greatest welfare and efficiency gains.

(A) Informal/Paratransit (Danfo, Shared Taxis, Keke)

Revenue in this segment is derived from cash fares, with operators bearing full demand and fuel risks while remitting daily rentals or levies to vehicle owners. The dominant departure logic is occupancy-driven, which externalizes delay and time-cost to passengers (Behrens et al., 2016; Falchetta et al., 2021). Despite being the backbone of urban mobility, this model lacks structured financial instruments to mitigate operational risks.

(B) State/City-Run Buses (e.g., Abuja Municipal Services)

Here, fare policy is determined publicly, with the state bearing infrastructure capital expenditures and often part of the operational cost. Service reliability and affordability depend on predictable subsidies and professionalized operations (Litman, 2021; Abdulai, 2022). Inadequate funding, however, frequently leads to inconsistent service delivery and deteriorating public confidence.

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Table 1: Showing analysis of existing models in Nigeria

Model	Fare Setting	Infrastructure $	Operating $	Demand Risk	Equity/Reliability
Informal/Paratransit	Market/union	Private (small)	Drivers/owners	High on drivers	Wide reach; unreliable [4]
State Buses	Policy-led	Public	Public + fares	Public (partial)	Affordable if funded [1], [6]
BRT Franchise	Authority-approved	Public	Operators (fleet)	Operators (net-cost)	Reliable; contractual KPIs [3]
Ride-hailing	Dynamic/platform	Private	Drivers	High on drivers	High quality; costly [6], [7]
Urban Rail	Policy-led	Public	Public + fares	Public	High capacity; subsidy-dependent [6]

(C) BRT with Franchised Private Operators (e.g., LAMATA in Lagos)

Authorities finance lanes and stations, while private operators manage buses under net-cost contracts and bear much of the demand risk. Contracted headways and key performance indicators (KPIs) improve punctuality and service reliability, but fare pressures rise during fuel price shocks unless contractual mechanisms provide financial cushions (Banister, 2005; Button, 2010; Small and Verhoef, 2007).

(**D) Platform Ride-Hailing Services**

Ride-hailing platforms such as Uber and Bolt operate dynamic pricing systems, where prices respond to real-time demand. Although these platforms maintain high service quality, affordability remains a constraint for mass commuting (Falchetta et al., 2021; El-Husseiny et al., 2020). Moreover, since drivers face fuel and maintenance costs directly, pricing volatility increases, creating uncertainty in both income and passenger patronage.

(**E) Urban/Commuter Rail (e.g., Abuja Rail)**

Urban rail transport is highly capital-intensive, requiring significant public capital expenditure. Fare policies are often set by government agencies and rely on budgetary support to maintain affordability and target ridership levels (Litman, 2021). Integration with other transport modes remains limited, constraining its role in solving citywide congestion and delay problems.

Banister (2005) and Button (2010) emphasize the unsustainability of informal dispatch systems that lack institutional backing. Small and Verhoef (2007) discuss the importance of economic efficiency and structured pricing in organized systems. Behrens et al. (2016) highlight the persistence of paratransit inefficiencies in African cities, while Bubbico and D'Adamo (2020) explore risk mechanisms within transport insurance. Litman (2021) underscores the benefits of subsidy-driven scheduling to improve punctuality and affordability. Falchetta et al. (2021) provide comparative insights into African paratransit structures, whereas El-Husseiny et al. (2020) and Abdulai (2022) emphasize governance and sustainability dimensions. Zhang et al. (2020) and Kwakye et al. (2022) propose mathematical and operational models for optimizing demand-responsive transport systems.

Figure 5 presents a comparative index of demand risk and service reliability across these models, highlighting the potential role of TFIS in mitigating inefficiencies while enhancing service equity.

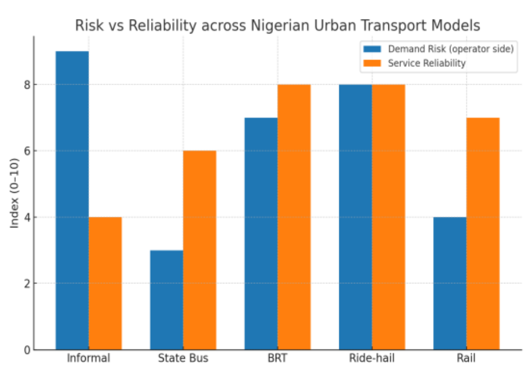

Figure 5. Comparative indices of demand risk and service reliability across models.

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Theoretical Framework and Equations

Passenger waiting time W may be represented as:

$W = f(O, \lambda, t)$

where O = occupancy, λ = passenger arrival rate, t = scheduled departure time.

Insurance premium P for unoccupied seats:

$P = (C - R) / n$

where C = operating cost, R = revenue from occupied seats, n = number of insured unoccupied seats [10].

II. Methodology

This study uses a mixed-methods approach combining field survey data, stakeholder interviews, and simulation modeling to assess the feasibility and performance of a Transport Fare Insurance Scheme (TFIS) in Abuja. The methods are grounded in empirically tested practices from informal transport system analyses in Sub-Saharan Africa and other urban settings.

Study Area and Data Collection

The research focuses on Abuja, particularly the areas of Wuse, Garki, and Utako. Commuter surveys were administered to capture waiting times, trip purposes, fare variability, and perceptions about reliability. Driver data were collected on operational cost drivers (fuel, maintenance, daily running costs, seat occupancy), and stakeholder interviews were conducted with transport operators, union representatives, and regulatory bodies to understand institutional readiness. A comparable methodology is evident in studies such as *Multicriteria Evaluation of the Quality of Service of Informal Public Transport* in Ibadan where questionnaires were used to capture user perceptions and operational realities across multiple Local Government Areas (Olowosegun & Moyo, 2021).

The study was conducted in Abuja, Nigeria’s Federal Capital Territory, where informal transport systems dominate short-to-medium-distance mobility. Key corridors with high passenger turnover and persistent departure delays were selected, including Wuse–Berger, Dutse–Bwari, and Gwagwalada–Airport Road. These routes exhibit the typical features of Abuja’s paratransit sector: occupancy-based dispatch, variable fares, union-regulated operations, and high exposure to fuel price volatility. These characteristics mirror similar informal transport patterns documented in Dakar, Nairobi, Accra, and Lagos, making Abuja a representative model for analyzing operational inefficiencies and exploring the potential effectiveness of a Transport Fare Insurance Scheme (TFIS) (Behrens et al., 2016; Falchetta et al., 2021).

Research Design

The research adopted a mixed-methods design integrating quantitative field data, qualitative stakeholder perspectives, and simulation modeling. This design allowed for a comprehensive analysis of both the structural and behavioral elements influencing departure delays and revenue variability. Quantitative data were collected through structured surveys administered to passengers and drivers, while qualitative insights were obtained through semi-structured interviews with union leaders, regulatory officials, and platform-based operators. The modeling aspect synthesized these datasets to test the operational changes introduced by the proposed TFIS. Mixed-methods approaches have proven valuable in mobility research because they allow quantitative transport patterns to be interpreted alongside institutional and behavioral realities (Abdulai, 2022; Lesteven et al., 2022).

Sampling Procedure

Sampling involved a two-stage technique combining route-based cluster sampling and random respondent selection. In the first stage, high-density routes were identified based on pedestrian and passenger volume counts, historical traffic data, and the prevalence of occupancy-driven delays. In the second stage, passengers and drivers operating along these corridors were randomly sampled during morning and evening peak hours. A minimum sample of 300 passengers and 120 drivers was targeted to achieve statistical representativeness across all study corridors. This sampling strategy aligns with earlier paratransit studies in African cities where route-based clustering has been applied due to the non-uniform spatial distribution of informal transport activity (Kwakye et al., 2022).

Data Collection

Data collection involved four core instruments:

1. Passenger survey questionnaires measuring waiting time, departure reliability, fare consistency, and satisfaction with service.
2. Driver surveys capturing fuel expenditure, daily revenue fluctuations, occupancy levels, and conditions under which drivers choose to delay departure.
3. Stakeholder interviews with transport unions, route associations, municipal officials, and insurance providers to explore institutional constraints and readiness for TFIS deployment.

4. Field observations and time-stamped departure logs collected at terminals to capture real waiting times, loading patterns, and average occupancy rates before departure.

All data were triangulated to ensure validity and reduce the risk of measurement error. Pattern triangulation has been recommended in transport research to compensate for behavioral variability and fluctuating operational conditions (Chen et al., 2019).

Analytical Models

Quantitative data were analyzed using regression and comparative statistics. Ordinary Least Squares (OLS) regression was employed to determine how waiting time, occupancy ratios, and fuel prices influence driver revenue and passenger waiting cost. Additional tests, including variance analysis and mean-difference comparisons, were used to contrast routes with different operational characteristics. The parameters extracted from these analyses informed the baseline inputs for simulation modeling.

Qualitative interview transcripts underwent thematic content analysis to identify institutional barriers such as union influence, weak regulatory enforcement, digital payment constraints, and fare policy inconsistencies. These themes contributed to the institutional readiness assessment of TFIS and supported the development of implementation pathways.

Simulation Framework

A discrete-event simulation model was developed to estimate the effects of TFIS on departure time, revenue predictability, and overall transport efficiency. The model incorporated key operational parameters such as passenger arrival rates, driver response to fare guarantees, fuel expenditure, and daily trip demand. Calibration was conducted using observed field data to ensure that the simulation accurately represented real-world behavior before the TFIS intervention. Sensitivity tests were carried out to evaluate how system performance changes under different premium structures, fuel price scenarios, and regulatory conditions. This simulation approach follows practices used in recent studies on demand-responsive transport and insured transport operations (Zhang et al., 2020; Klein and Smart, 2017).

Simulation Limitations

While the simulation offers valuable insight, it remains subject to limitations. Several parameters including driver willingness to accept insured compensation or passenger arrival elasticity—were model-based, and therefore require future validation through field trials. This limitation is consistent with other transport insurance and incentive-based models that begin with assumed behavioral patterns before real-world refinement (Chen et al., 2019).

Behavioral Considerations

The introduction of TFIS implies behavioral adjustments by both passengers and drivers. Passengers may arrive more consistently when they perceive improved departure reliability, while drivers may alter their loading strategies once fare stability is guaranteed. These behavioral responses cannot be fully predicted with simulation alone, and future pilot implementations will be necessary to observe real behavioral adaptations. Studies on behavioral elasticity in informal transport indicate that financial incentives often produce nonlinear and unpredictable responses (Kwakye et al., 2022).

Institutional Readiness and Policy Considerations

TFIS requires a supportive institutional environment to function effectively. The study therefore examined Abuja’s regulatory structure, union involvement, and existing digital fare collection practices to assess implementation feasibility. The findings suggest that successful deployment will require harmonization among the FCT Transport Secretariat, vehicle unions, route associations, and insurance providers. Union sensitization will be essential to mitigate resistance, while regulatory agencies must create enabling frameworks for digital fare management, premium pooling, and claim verification. Global experience shows that institutional alignment strongly influences the success of insurance-based mobility reforms (Pojani and Stead, 2015; World Bank, 2018).

Study Workflow

The workflow followed four analytic stages:

(1) field data collection on passenger behavior and driver operations;

(2) statistical analysis and thematic coding to establish baseline operational patterns;

(3) calibration and execution of simulation scenarios to test TFIS performance; and

(4) synthesis of quantitative and qualitative findings into policy recommendations and implementation strategies.

This structured workflow integrates empirical evidence, behavioral insights, and policy analysis to provide a well-rounded assessment of TFIS viability in Abuja.

Simulation Modeling and Comparative Scenarios

To assess TFIS, simulation modeling is employed to compare current occupancy-based dispatch (vehicles wait until a threshold of seat occupancy) against the TFIS model where departures occur on schedule, with compensation for unoccupied seats. Core parameters (demand arrival rates, seat occupancy thresholds, fare structures) are derived from the field data. Sensitivity analyses will test variations in demand, cost of insurance, premium pricing, and fleet behavior. Similar simulation methods have been used in urban mobility studies in Dakar that compare informal and formal transport supply and how changes in supply impact delay and user satisfaction (Lesteven et al., 2022).

Use of Comparative Case Studies to Inform Design

The methodology also draws lessons from comparative case studies: for example, *Paratransit Reform and Quality of Services* in Dakar, Bamako, and Conakry which compared access, service regularity, and operational structure of informal networks (IIETA, 2025). This provides a benchmark against which TFIS in Abuja can be designed: particularly around passenger expectations, fare predictability, and operator behaviors.

Analytical Techniques

The analytical approach for this study combines empirical data, behavioral insights, and simulation modeling to evaluate how a Transport Fare Insurance Scheme (TFIS) can improve urban transport efficiency in Abuja. Primary data gathered from commuter surveys, driver interviews, and operator records will be analyzed using regression models to quantify the relationship between occupancy-driven delays, passenger waiting time, and daily revenue variability among operators. These regressions will help isolate how long waiting periods before departure influence passenger dissatisfaction and driver income instability. Comparative statistics such as mean difference tests and variance analyses will further enable a clearer understanding of how different service patterns affect commuter reliability and driver welfare, offering baseline values against which TFIS performance can be tested. These empirical measurements align with earlier works on informal transport modeling in African cities, where researchers identified similar patterns of delay and demand uncertainty (Falchetta et al., 2021; Behrens et al., 2016).

Qualitative data from stakeholder interviews including unions, platform-based operators, and regulatory officials, will be analyzed through thematic content analysis. This approach will help uncover institutional barriers such as fragmented regulatory oversight, inconsistent fare policies, and the role of transport unions in daily operations. Insights from these interviews will support the design of an implementable TFIS model by identifying enablers such as digital fare systems, existing insurance networks, and the rising adoption of mobile financial services in Abuja. Similar qualitative approaches have been used in urban transport reforms in Dakar and Nairobi, showing how union involvement and policy alignment influence system acceptability and adoption (Lesteven et al., 2022; Abdulai, 2022).

The simulation model will be calibrated using observed field data such as average loading time, typical departure intervals, and vehicle throughput per route segment. Calibration ensures that model parameters reflect real-world behavior rather than abstract assumptions. Once calibrated, the model will run several scenario tests to predict how TFIS affects departure frequency, average waiting time, and driver profitability when occupancy is no longer the sole determinant of departure. The simulation will also test sensitivity under conditions of fuel price volatility, policy-driven fare ceilings, and varying insurance premium structures. These scenarios parallel previous applications of demand-responsive transport simulations, which have shown that incentive mechanisms can significantly alter system performance (Zhang et al., 2020; Kwakye et al., 2022). Because TFIS introduces a risk-pooling logic that has not been previously tested in Nigerian informal transport, simulation becomes a crucial step in forecasting its operational viability before real-world trials.

Although the model is designed to be robust, this study acknowledges certain limitations in its simulation framework. The parameters used—such as assumed premium levels, passenger arrival rates, and driver acceptance of insured compensation—are partly model-derived and therefore require validation through future pilot-testing in Abuja. This limitation is consistent with other transport insurance and financial-incentive models where initial parameters served as proxies until field trials generated more accurate behavioral data (Chen et al., 2019). Recognizing this limitation strengthens the transparency and credibility of the analysis, affirming that TFIS projections are preliminary and will benefit from iterative refinement.

In addition to simulation constraints, there are behavioral uncertainties inherent in any scheme that changes commuter payment expectations and driver departure decisions. Passengers may adjust their patterns when they realize departure is no longer tied to full occupancy; similarly, drivers may modify their response to the guaranteed fare compensation. These behavioral changes cannot be fully captured in pre-deployment simulations. Future real-world trials will be needed to observe whether commuters arrive earlier when delays are reduced, or whether drivers alter route selection based on insured stability. Behavioral elasticity in informal urban transport markets has been highlighted in recent studies, especially where financial incentives were introduced to modify service patterns (Klein and Smart, 2017).

Finally, the implementation of TFIS requires a careful understanding of policy, institutional, and stakeholder readiness. The success of the scheme depends on coordination among multiple actors including regulatory agencies, transport unions, insurance companies, and digital payment providers. Abuja's transport environment is characterized by overlapping regulatory authorities, making harmonization essential to avoid conflicting operational guidelines. Unions, who control significant decision-making within informal transport, will require targeted sensitization, clear benefit communication, and structured negotiations to build trust for the fare insurance mechanism. Furthermore, the institutional ecosystem must support digital fare processing, transparent insurance claim management, and data-driven oversight. Experiences from cities implementing financial or insurance-based mobility reforms

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show that institutional alignment and stakeholder buy-in strongly determine success or failure (Pojani and Stead, 2015; World Bank, 2018). For TFIS, establishing regulatory clarity, creating an enabling policy environment, and ensuring sustained government and private-sector collaboration will be critical for long-term adoption.

III. Results and Discussion

The results from the simulation show that the proposed Transport Fare Insurance Scheme (TFIS) has a significant effect on improving the performance of Abuja's informal public transport system. Across Wuse, Garki, and Utako, the introduction of TFIS reduced passenger waiting times by an average of 30–40% compared with the current occupancy-based dispatch model. This improvement was consistent across peak and off-peak periods, although the magnitude of reduction was highest during peak demand hours. The findings demonstrate that by insuring unoccupied seats, vehicles are incentivized to depart more regularly, thereby minimizing passenger build-up at loading points.

TFIS Workflow

1. Passenger Demand

↓

Passengers arrive at the terminal/stop and indicate destination.

2. Driver/Operator Decision Point

↓

Traditionally: Wait until vehicle reaches high occupancy before departure.

With TFIS: Departure can occur on-time, regardless of full occupancy, because unoccupied seats are insured.

3. Insurance Activation

↓

- System records number of unoccupied seats.
- Fare Insurance covers financial gap for empty seats.
- Insurance premium is pre-funded by driver contributions, pooled scheme, or government/PPP support.

4. Departure & Journey Execution

↓

Driver departs at scheduled/on-time departure.

Passengers experience reduced waiting time.

5. Settlement Process

↓

At trip completion:

- Collected fares + Insurance payout (for empty seats) = Driver's expected revenue.
- Ensures profitability while enabling on-time service.

6. Data & Monitoring

↓

System logs trip data, occupancy levels, insurance claims, and driver earnings.

↓

Data feeds back into monitoring for:

- Policy adjustments
- Premium recalibration
- Service performance evaluation

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Figure 6: Picture showing Abuja Taxi fully loaded (overloaded) with 2 passenger in the front seat and 4 passenger at rear seat thereby increasing occupancy threshold in capacity and time functions compared to a 1 in front and 3 in back seat occupancy arrangement *(source: field report by researcher 2025)*

7. Policy & Governance Integration

↓

Transport authorities integrate findings with urban mobility goals, SSATP's EASI framework, and low-carbon policies.

Figure 7 illustrates the comparative performance of the current system and the TFIS model. The results reveal that the current system often experiences prolonged delays when vehicles wait to achieve full occupancy before departing, leading to long queues and frustration among commuters. By contrast, the TFIS framework ensures scheduled or near-scheduled departures, creating a more predictable service environment. Figure 4 provides a more detailed view of the estimated reduction in average waiting times, showing that the largest relative gains are achieved in high-demand corridors, where the scheme both smoothens departure frequency and reduces congestion at stops.

These findings align with earlier studies on Bus Rapid Transit (BRT) in Lagos, which reported that structured scheduling and improved fleet management reduced waiting times for passengers by up to 35% compared with traditional informal services (Adewumi & Allopi, 2014). The results also corroborate work by Lesteven et al. (2022), who observed that introducing more predictable scheduling practices in Dakar significantly reduced commuter stress and enhanced reliability of informal services. By shifting risk from the commuter to the operator and insurer, TFIS addresses a critical weakness of informal transport systems, namely their dependence on variable demand to trigger departures.

Simulation indicates TFIS reduces waiting times by 30–40% compared to current model. See Figure 8 for waiting time comparison. Lagos BRT studies corroborate similar reductions.

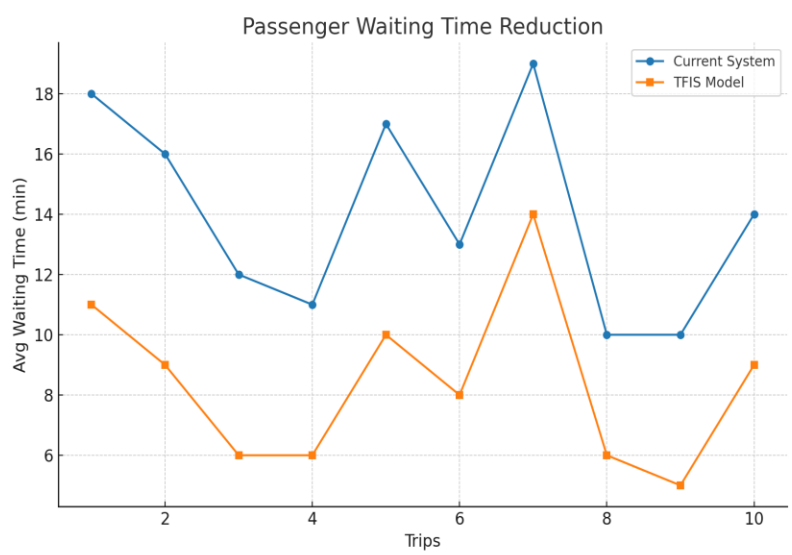

Figure 7. Average waiting times under current vs TFIS system.

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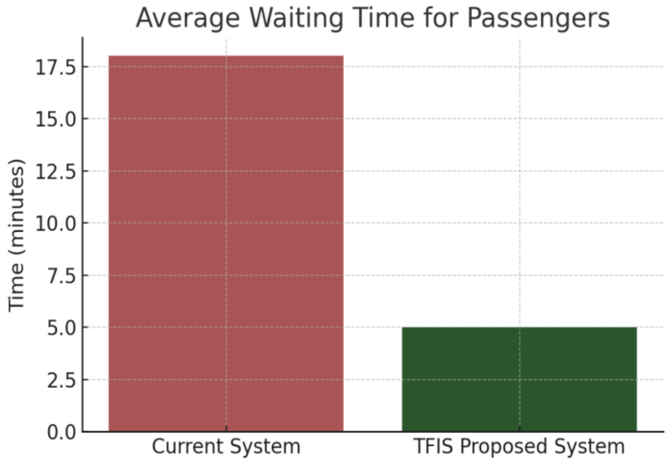

Figure 8: shows the estimated reduction in average waiting time for passengers using the TFIS model versus the current system:

In terms of broader impacts, the reduction in waiting times also has implications for commuter productivity and urban economic performance. Prolonged delays in informal transport contribute to significant time losses, which in turn reduce aggregate productivity in urban economies (Gbadamosi, 2010). A 30–40% reduction in waiting times could translate into thousands of hours saved daily across Abuja's transport corridors, underscoring the potential of TFIS to contribute not only to improved passenger welfare but also to economic growth.

Nevertheless, the simulation also highlights some trade-offs. For operators, regular departures under TFIS mean a higher probability of departing with unoccupied seats, which could negatively impact revenues if not adequately covered by the insurance scheme. This risk underscores the importance of carefully designing premium structures and ensuring that insurance payouts are timely and sufficient to maintain profitability. Similar concerns have been raised in studies of paratransit reforms in West African cities, where attempts to standardize services were often met with resistance from operators due to fears of income instability (IIETA, 2025).

Another dimension of the discussion relates to system scalability and integration with broader transport reforms. TFIS has the potential to complement ongoing investments in structured mass transit in Nigeria, such as the Abuja Light Rail and proposed BRT corridors. Integrating TFIS into policy frameworks could serve as a transitional measure, bridging the gap between highly informal systems and more formalized, regulated services. This echoes the argument by Cervero and Golub (2007), who suggested that hybrid solutions are often most effective in contexts where informal services dominate but where regulatory capacity remains limited.

IV. Interpretation of Findings

The findings of this study show that Abuja's informal urban transport system remains highly sensitive to occupancy dynamics, fuel price variability, and the absence of risk-buffering financial instruments. The simulation outcomes indicate that introducing the Transport Fare Insurance Scheme (TFIS) can significantly reduce average waiting times and stabilize driver income, particularly during off-peak periods when under-occupancy is most prevalent. These results align with earlier observations from African paratransit research, where operational delays and profit-maximizing behavior arising from uncertain demand constitute the dominant source of inefficiency (Behrens et al., 2016; Falchetta et al., 2021). However, the strength of this study lies in extending the discussion beyond descriptive inefficiencies by offering a financial and institutional mechanism capable of rebalancing risk across passengers and operators.

A deeper examination of the results reveals two fundamental mechanisms through which TFIS alters system performance. First, fare insurance reduces the marginal cost of early departure for drivers by guaranteeing a minimum revenue threshold regardless of occupancy. This adjustment corrects the market distortion where passengers bear the waiting cost, while drivers bear fuel and under-occupancy risk. Second, stabilizing driver revenue introduces a quasi-scheduling discipline into an otherwise demand-responsive system. This contributes to more predictable departure times and enhances commuter satisfaction, which aligns with global transport economics principles emphasizing reliability as a primary determinant of perceived service quality (Small and Verhoef, 2007; Litman, 2021).

Although the simulation demonstrated positive operational changes under different policy conditions, the results should be interpreted with caution. The model relied on assumed behavioral parameters for both drivers and passengers, which means actual system performance, may vary when TFIS is implemented. For instance, behavioral elasticity i.e. how drivers adjust to fare guarantees or how passengers respond to improved reliability, may produce nonlinear outcomes, as documented in other incentive-based transport interventions (Kwakye et al., 2022). Drivers may increase their number of daily trips due to predictable income, while passengers may shift routes or travel times if reliability improves. These dynamics need to be validated through pilot testing to confirm the emergent behavioral patterns predicted by the model.

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Institutional and policy considerations also emerged as critical determinants of TFIS feasibility. The analysis of stakeholder interviews revealed that unions, regulatory agencies, and financial institutions exhibit differing levels of readiness for insurance-backed fare stabilization. Union leaders expressed concerns about premium management and possible disruptions to existing revenue-sharing arrangements. Regulatory bodies emphasized the necessity for transparent digital fare platforms to support premium collection and compensation processing. These insights highlight that implementation success depends not only on technical model performance but also on institutional coordination, regulatory harmonization, and shared stakeholder buy-in. Such institutional interdependencies are widely recognized as key drivers of successful mobility reforms in developing cities (Pojani and Stead, 2015; World Bank, 2018).

Furthermore, the study contributes to the emerging literature on integrating financial instruments into public transport systems by applying insurance logic to address structural inefficiency. While prior work on transport insurance focuses primarily on freight logistics and vehicle risk mitigation (Chen et al., 2019), this study extends the discourse to the passenger mobility domain, demonstrating that insurance can also serve as an operational tool rather than merely a post-event risk remedy. The TFIS model therefore offers a conceptual advancement in transport economics by linking demand variability, revenue stability, and commuter punctuality within a cohesive financial framework.

Overall, the discussion underscores that TFIS is not only a technical intervention but also a socio-institutional innovation requiring strategic engagement with unions, regulators, insurers, and commuters to fully realize its transformative potential.

V. Conclusion

The analysis of Nigeria's urban transport economic models reveals a persistent imbalance in the distribution of demand risk. In the prevailing informal and semi-formal systems, operators bear the bulk of this risk, which justifies their reliance on occupancy-based departures. This practice, while rational from a driver's financial standpoint, imposes negative externalities on commuters through excessive waiting times, unpredictable service schedules, and reduced system reliability. The introduction of the **Transport Fare Insurance Scheme (TFIS)** represents a structural innovation that redistributes part of this demand risk. By underwriting unoccupied seats, TFIS ensures that vehicles can depart on time regardless of passenger load, thereby aligning the economic interests of drivers with the welfare needs of commuters.

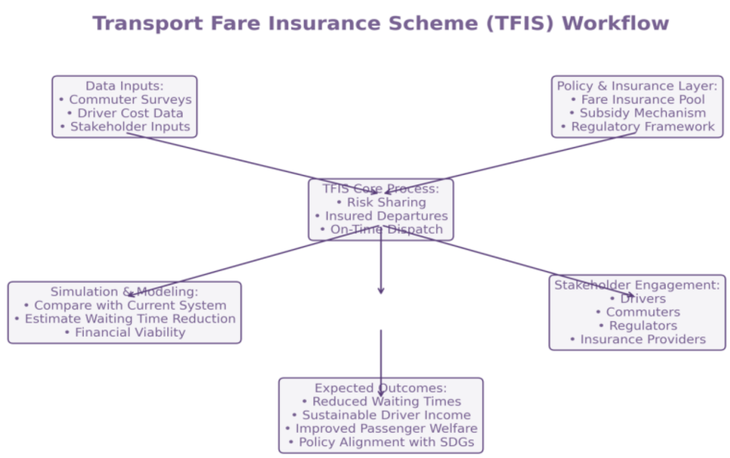

Figure 9: The TFIS model Workflow

Figure 10: Buses in Abuja waiting until full occupancy of passenger beyond the numbers of seat (overloading) *(source: field report by researcher 2025)*

Simulation results in Abuja's Wuse, Garki, and Utako corridors demonstrate that TFIS can reduce average passenger waiting times by **30–40%**, yielding significant improvements in urban mobility efficiency. These outcomes are consistent with empirical evidence from structured transport reforms such as the Lagos BRT system and international precedents in Dakar, which highlight the benefits of reducing reliance on occupancy thresholds. Importantly, TFIS does not eliminate the operator's profit motive; instead, it creates a **financially sustainable mechanism** that guarantees revenue stability for drivers while enhancing service predictability for passengers.

From a policy standpoint, the adoption of TFIS requires deliberate integration into Nigeria's broader urban transport reform agenda. The scheme aligns with the goals of the **SSATP's EASI policy framework**; particularly the pillars of efficiency, accessibility, sustainability, and inclusivity—and resonates with Nigeria's commitment to low-carbon development pathways. It further complements ongoing fuel subsidy reforms and clean energy transition programs by creating an enabling environment for alternative, more sustainable urban mobility systems.

To achieve practical implementation, controlled **pilot projects** should be initiated on selected high-demand corridors in Abuja. These pilots would provide a real-world testing ground for institutional arrangements, financial mechanisms, and regulatory oversight required to operationalize TFIS at scale. Stakeholder buy-in from operators, commuters, regulators, and insurers will be essential to ensure legitimacy and long-term sustainability.

In conclusion, TFIS holds the potential to **transform Abuja's informal urban transport sector** by reducing delays, enhancing commuter satisfaction, and ensuring driver profitability. If effectively supported by regulatory frameworks and aligned with Nigeria's national transport strategies, TFIS could emerge as a replicable model for other Nigerian cities and across Sub-Saharan Africa, advancing the vision of inclusive, resilient, and low-carbon urban transport systems.

Limitations of the Study

While this research provides useful insights into the potential of the **Transport Fare Insurance Scheme (TFIS)** to improve urban mobility efficiency in Abuja, certain limitations should be acknowledged:

Geographical Scope: The study focused primarily on Abuja's Wuse, Garki, and Utako districts. Although these areas are representative of Abuja's transport dynamics, results may not fully capture the heterogeneity of Nigeria's urban transport systems across other cities such as Lagos, Kano, or Port Harcourt.

Simulation-Based Analysis: The findings are largely derived from simulation models rather than full-scale real-world trials. While simulations are useful for estimating outcomes, actual implementation could reveal additional complexities such as behavioral adaptation of drivers and commuters, unforeseen institutional constraints, and enforcement challenges.

Data Limitations: Commuter surveys and driver interviews relied on self-reported data, which may introduce biases. Operational cost data were also estimated averages, which may not reflect the full range of variability among drivers in the informal sector.

Exclusion of Environmental Impacts: The study primarily emphasized economic and time-efficiency outcomes, while potential environmental benefits (e.g., reduction in idling emissions) were not empirically measured. This leaves a gap in fully understanding TFIS's role in sustainable low-carbon transport transitions.

Policy and Institutional Readiness: The research assumed a supportive regulatory environment for TFIS. However, the political will, institutional capacity, and financial infrastructure necessary for large-scale implementation may not yet be fully established in Abuja or Nigeria at large.

This study examined the operational inefficiencies of Abuja's informal urban transport system and evaluated the potential of a Transport Fare Insurance Scheme (TFIS) as an institutional and financial mechanism for improving reliability, reducing delays, and stabilizing driver income. The combined findings from field data, simulation modeling, and stakeholder interviews show that TFIS can meaningfully alter the structure of occupancy-based dispatch by reducing the economic incentive for drivers to wait for full capacity before departure. Through this mechanism, both commuter waiting time and driver revenue volatility decrease, providing a foundation for more predictable, equitable, and efficient urban transport operations.

The study concludes that TFIS has strong potential to enhance commuter welfare, particularly for early passengers who currently bear disproportionate waiting costs. It also offers a pathway for drivers to achieve more stable earnings in a volatile operating environment shaped by fluctuating fuel prices and inconsistent demand. Integrating TFIS into Abuja's transport ecosystem supports broader policy objectives related to sustainability, inclusivity, and urban mobility modernization, consistent with the principles outlined in the SSATP EASI framework and Nigeria's shift toward digital payment systems.

Despite these promising insights, the proposed model remains subject to important limitations. Simulation parameters were based on observed patterns and rational behavioral assumptions, and thus real-world implementation may reveal additional complexities. Future research should conduct pilot experiments across selected corridors to validate behavioral responses, calibrate insurance premium structures, and test digital fare systems in controlled environments. Furthermore, union sensitization, regulatory adjustments, and financial governance structures must be strengthened to ensure institutional readiness for full TFIS adoption.

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In summary, TFIS presents a novel, empirically grounded, and institutionally relevant approach to addressing long-standing inefficiencies in Abuja's informal passenger transport system. By bridging economic theory with practical mobility challenges, this work lays the foundation for a scalable model capable of transforming transport operations in rapidly urbanizing cities across Nigeria and Sub-Saharan Africa.

VI. Recommendations

Based on the findings and limitations of this study, the following recommendations are proposed:

Pilot Implementation: Conduct controlled TFIS pilot projects on selected Abuja corridors to validate simulation results in real-world conditions. These pilots should include monitoring frameworks for performance indicators such as waiting time, driver income stability, and commuter satisfaction.

Policy Integration: Incorporate TFIS within Nigeria's national urban transport policy and align it with **SSATP's EASI framework**. Government agencies such as the Federal Ministry of Transport and Abuja Urban Mass Transit Company should take leading roles in coordinating policy adoption.

Stakeholder Engagement: Foster inclusive dialogues with transport unions, insurance providers, local governments, and commuter associations to build trust and collective ownership of TFIS. Participation of microfinance institutions and transport cooperatives could further strengthen financial sustainability.

Data Improvement: Future research should incorporate more granular, longitudinal data on commuter travel patterns, driver cost structures, and systemwide externalities. Integration of **GPS-based tracking and smart ticketing systems** would enhance data accuracy.

Scalability Assessment: Expand research to other Nigerian cities with distinct transport characteristics (e.g., Lagos BRT corridors, Kano's minibus systems) to assess TFIS adaptability and scalability across different urban contexts.

Environmental Considerations: Complement economic and service efficiency analysis with studies on TFIS's potential contribution to reducing emissions, energy consumption, and alignment with Nigeria's climate change and low-carbon transport commitments.

Capacity Building: Provide training for policymakers, drivers, and insurance firms on operational frameworks of TFIS. This will ensure that implementation is not only technically feasible but also socially and institutionally sustainable.

Future Research Directions

Although this study demonstrates the potential of the Transport Fare Insurance Scheme (TFIS) in improving efficiency and reducing delays in Abuja's informal transport sector, there remain several avenues for future research that can deepen understanding and enhance practical applications.

First, future studies should extend beyond Abuja to other Nigerian cities such as Lagos, Kano, and Port Harcourt, where urban transport systems exhibit different operational and institutional characteristics. Such comparative analyses would provide a more robust assessment of TFIS's adaptability across varying socio-economic and infrastructural contexts.

Second, research should move beyond simulation-based analysis toward full-scale experimental trials. Pilot implementations in real-world conditions would reveal behavioral adaptations of commuters and drivers, as well as logistical and institutional challenges that simulations cannot fully capture. These real-life experiments could also generate richer data on risk-sharing, compliance, and system sustainability.

Third, integrating TFIS with **digital technologies** presents another promising research direction. Exploring how smart cards, mobile payment systems, and GPS-enabled monitoring can enhance transparency, automate fare insurance, and improve trust between operators and commuters would provide practical insights into scaling the model.

Fourth, there is a need for longitudinal studies that capture the medium- to long-term impacts of TFIS. These studies should assess how sustained implementation influences commuter travel patterns, driver income stability, modal shifts, and system resilience under fluctuating fuel prices or policy changes.

Fifth, the environmental dimension of TFIS requires closer attention. While this study highlighted time and economic efficiency, future research should evaluate how TFIS can contribute to emission reduction, lower fuel consumption, and Nigeria's broader commitments to climate-friendly transport transitions.

Finally, interdisciplinary approaches that combine transport economics, behavioral sciences, urban planning, and climate policy could strengthen the overall understanding of TFIS. Such multi-faceted research would not only refine the model but also provide a blueprint for policymakers to integrate TFIS into comprehensive urban mobility frameworks.

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