



Discrepancies in Public Transport Fare Proposals in Ghana: A PRISMA Systematic Literature Review of Methods, Governance, and Stakeholder Dynamics

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Abstract

Public transport fare setting remains a critical yet contested policy issue, especially in developing countries where fares directly affect affordability, operator viability, and public trust. This PRISMA-guided systematic literature review synthesizes evidence on fare-setting principles, analytical models, governance structures, stakeholder dynamics, and emerging computational approaches to identify the sources of discrepancies between proposed, approved, and implemented fares. The review draws on 88 selected studies from an initial pool of 1117 records and shows that existing fare models are dominated by cost-recovery, optimization, econometric, and simulation approaches, with limited integration of governance, transparency, and behavioral factors. A major gap identified is the absence of holistic frameworks that jointly incorporate macroeconomic cost drivers, equity concerns, stakeholder power asymmetries, negotiation processes, and real-world enforcement conditions. The review further finds that institutional fragmentation, weak consultation mechanisms, and poor compliance often undermine technically sound pricing models. To address these limitations, the study proposes a hybrid, data-driven and governance-aware fare framework anchored in game-theoretic and multi-objective decision support, capable of balancing affordability, cost recovery, transparency, and stakeholder interests.

Subject Areas

Public Transportation Systems, Transport Fare Negotiation

Keywords

Public Transport Fares, Fare Discrepancies, Stakeholder Dynamics, Game Theory Modeling, Transport Pricing Systems

1. Introduction

Public road transport plays a central role in urban mobility systems, particularly in developing countries where it serves as the primary means of travel for a large proportion of the population [1] [2]. Despite its importance, the process of determining and adjusting public transport fares remains complex and often contested. Across many contexts, fare-setting is influenced by a combination of cost considerations, economic indicators, institutional arrangements, and stakeholder negotiations [3] [4]. However, these elements are not always applied consistently or transparently, leading to discrepancies between proposed, agreed, and implemented fares. Such inconsistencies have significant implications for affordability, operational sustainability, and public trust in transport systems [5].

Prior empirical work on fare structures and elasticities [6]-[8], equity and distance-based pricing [9] [10], demand determinants [11] [12], technology adoption and integrated ticketing [13] [14], fare-free/fare-reduction policies [15] [16], and mobility-as-a-service [17] [18]. The broader context considers cost drivers such as oil price, exchange rate, inflation often cited by operators [19] and stakeholder tensions arising from fare reforms [20]-[22].

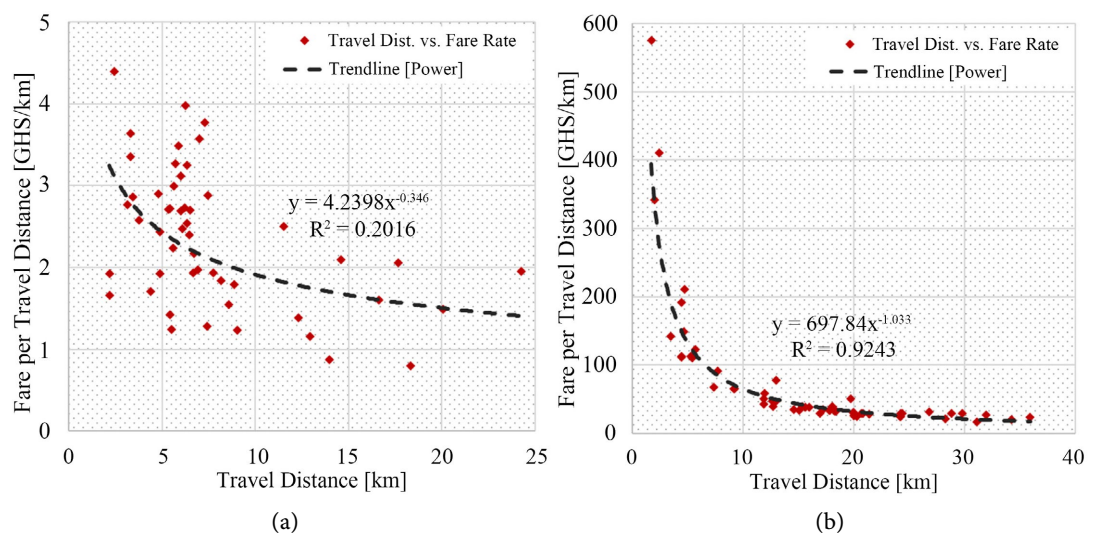
Existing literature on public transport fare-setting highlights a wide range of approaches, including cost-recovery models, inflation-indexed adjustments, and more recent computational and optimization-based methods [5] [23]. While these approaches provide useful analytical foundations, they often overlook the governance structures and stakeholder dynamics that shape real-world decision-making processes. Limited attention has been given to how institutional practices, negotiation mechanisms, and perceptions of fairness and trust contribute to disagreements and resistance to fare adjustments [24] [25]. This gap is especially evident in developing country contexts, where informal systems, fragmented regulation, and power asymmetries among stakeholders further complicate fare determination [1] [2].

In response to these challenges, this study conducts a PRISMA-guided systematic literature review to synthesize existing knowledge on public transport fare setting, with a specific focus on identifying the sources of discrepancies in fare proposals. The review examines key themes, including fare-setting principles and cost components, analytical methods and data inputs, governance and institutional frameworks, stakeholder roles and interactions, and issues of transparency, fairness, and trust. By integrating insights across these dimensions, the review aims to provide a comprehensive understanding of the limitations in current approaches and to identify critical gaps that inform the development of a more trans-

parent, consistent, and evidence-based framework for public transport fare determination. The following subsections will briefly review the main research questions topics.

1.1. Fare Determination Principles

Fare determination in public transport systems is traditionally grounded in cost-recovery and affordability principles. Cost-based approaches emphasize the need to cover operational and capital expenditures, including fuel, labor, maintenance, and depreciation [3]. However, purely cost-recovery models often conflict with social equity objectives, particularly in low-income contexts [5]. As a result, hybrid models incorporating subsidies and cross-financing mechanisms have emerged [4]. Distance-based and flat-fare systems reflect different policy priorities [22]. In developing countries, fare principles are often shaped by informal practices [1]. Furthermore, pricing strategies are increasingly designed to maintain financial sustainability under changing economic conditions [26]. The findings of [27] on distance-based fare determination shows that travel distance has a consistent diminishing return to fare rate in Accra and Dar es Salaam as indicated in **Figure 1**. The authors implied that longer travel distances are associated with lower fare rates and vice versa. This finding does not provide fairness on traveler's transit fare computations.



Source: <https://ccsenet.org/journal/index.php/jsd/article/view/0/51479>.

Figure 1. Distance-based fare rate based on scatter plot results [27]. (a) Accra - Ghana; (b) Dar es Salaam - Tanzania.

1.2. Analytical Methods

Analytical methods for fare setting have evolved from simple accounting-based calculations to more advanced quantitative and decision-support models. Traditional approaches rely on cost allocation and break-even analysis to determine minimum viable fares [3]. More recent studies incorporate decision-support frame-

works and stakeholder-driven approaches to inform fare policy design [25]. Simulation models and scenario analysis are increasingly used to assess the impacts of fare changes under varying conditions [24]. However, these methods often depend on high-quality data, which is limited in many developing countries [2]. Additionally, there is often a disconnect between analytical outputs and actual decision-making due to political and institutional constraints [26]. Thus, while analytical methods have advanced significantly, their practical application remains uneven.

1.3. Stakeholder Dynamics

Stakeholder dynamics play a critical role in shaping public transport fare decisions, particularly in contexts characterized by fragmented governance. Key stakeholders typically include government agencies, transport operators, unions, and passengers, each with competing interests [1]. Operators often advocate for higher fares to cover rising costs, while users resist increases due to affordability concerns [5]. Government authorities are frequently tasked with balancing efficiency and equity considerations in fare policy design [4]. In many developing countries, informal transport unions wield significant influence over fare negotiations, often leading to non-transparent outcomes [2]. Power asymmetries among stakeholders can result in decisions that favor dominant groups, undermining equity and accountability [25]. Moreover, limited structured engagement mechanisms contribute to conflicts and delays in fare adjustments [26]. The literature highlights the need for more inclusive and institutionalized stakeholder engagement mechanisms.

1.4. Computational Approach

Computational approaches to fare setting have gained prominence with advances in data analytics and optimization techniques. Mathematical programming models are used to determine fare structures that balance efficiency and financial sustainability under given constraints [3]. Advanced optimization and data-driven approaches enable more adaptive and responsive pricing strategies [24]. Stakeholder-oriented and decision-support models are also applied to evaluate policy outcomes in complex transport systems [25]. However, the adoption of computational methods is limited in many developing countries due to data scarcity and technical capacity constraints [2]. Additionally, concerns about transparency and interpretability of analytical outputs remain significant [26]. Despite these challenges, computational approaches offer promising avenues for improving evidence-based fare determination.

2. Methodology

This review was performed in accordance with the PRISMA (Preferred Reporting Item for Systematic Reviews and Meta-Analysis) guidelines. A PRISMA flow diagram for a systematic review was successfully developed using an official applica-

tion called DocHub [28] (weblink: <https://www.dochub.com/fillable-form/20354-prisma-diagram-generator>) as shown in **Figure 2**.

1) Data source: Harzing's Publish or Perish (Window GUI Edition) 8.19.5300.9483 scholarly application tool was used to generate scientific journals from the database of Google Scholar, Crossref Search and OpenAlex Search as shown in **Figure 3**. Other literature databases require access, hence could not be used for literature collection. A total of 1094 publications were extracted with studies published between 2000 and 2026. In searching for right literature from the database, we used keywords such as stakeholder fare negotiations, public road transport, fare adjustment and inflation, transport pricing and governance and fare transparency and trust. We, however, gave in relevance to older literature such as [6] [7] [20] [21] [27] [29] based on contributions to the entire review process. Each database collected literature was entered into an excel sheet for article screening process.

2) Article Screening: Records identified from the searched databases were copied into an MS excel sheet and screened, and those that were duplicates, irrelevant to the study, lacked full-text access, were inaccessible, or were published in languages other than English were excluded from the final dataset. **Table 1** shows the respective database platforms and the number of literatures searched with the results found. With the aid of Microsoft Copilot and proficient prompt engineering skills, the 1094 records extracted from the three databases were screened and reduced to 586 records of articles. We manually selected 89 most relevant literature for the review.

Table 1. Article database search result.

Database platforms	Literature database			
	Maximum article search	Year range	Total article found	Articles screened
Google Scholar	100	2000-2026	44	38
Crossref Search	1000	2000-2026	1000	690
OpenAlex Search	50	2010-2026	50	42
Online Search	23	Not specified	23	23
Total	1117		1117	793

3) Article inclusion & exclusion: The inclusion and exclusion criteria were established in line with PRISMA guidelines to ensure the selection of relevant and high-quality studies aligned with the review objectives. A temporal scope of 2000-2026 was applied to capture contemporary developments in fare-setting practices, excluding outdated studies. The geographic scope included global studies and those from developing countries, with particular emphasis on Sub-Saharan Africa and Ghana to ensure contextual relevance. Studies from developed countries were retained where they offered transferable insights. Eligible study types included empir-

ical, policy, and modeling research, as well as conceptually robust theoretical contributions. Studies lacking methodological rigor, clear geographic focus, or relevance to public transport were excluded. Non-peer-reviewed and purely opinion-based work was also omitted to maintain quality standards. Overall, these criteria ensured a balanced, rigorous, and context-sensitive evidence base for the review.

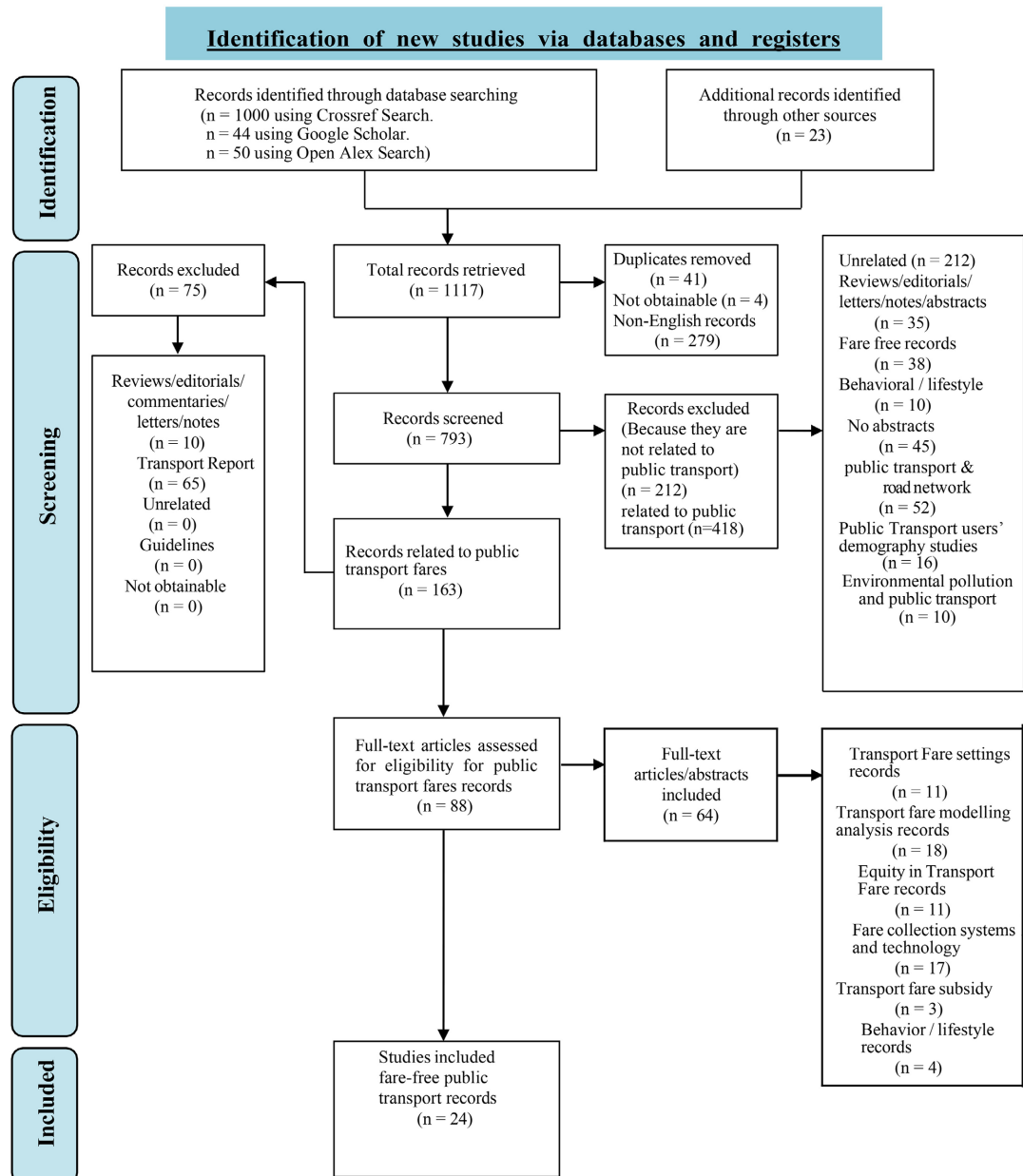


Figure 2. PRISMA flow diagram of current studies [28].

4) Descriptive Overview of Selected Studies: The selected literature was systematically obtained through multiple data sources, followed by structured article screening and clearly defined inclusion and exclusion criteria to ensure relevance and quality. Studies were selected based on their focus on public transport fare systems, mod-

eling approaches, technological applications, and equity considerations, while unrelated or low-quality studies were excluded. The reviewed articles were then organized into four thematic categories: public transport fare setting, transport fare modelling, fare collection systems and technology, and equity in transport fares. This classification enables a comprehensive understanding of both theoretical and practical dimensions of fare determination, highlighting key methodologies, stakeholder perspectives, and existing research gaps across the domains.

3. Framework for Public Transport Fare Setting and Collection System

This section discusses existing literature on transport fare settings and negotiation models that work to improve transparency. The section will probe fare adjustments and inflation situations, stakeholder negotiations, fare transparency and trust as well as game theory transport pricing.

3.1. Public Transport Fare Setting

On the premises of fare settings, [6] [7] treated the setting of fare as an optimization problem by maximizing revenue, passenger miles or social welfare which are all subject to budget constraints. While [6] used elasticity-based demand function to compute peak and off-peak prices, [7] used a linear demand function to compute fares for different modes. Though most transport fares are computed on distance-based approach for both inter-city and intra-city trips, transport operators and their unions consider other primary components such as oil price, exchange rate and inflation on spare parts [19]. On cost determination, [30] and [31] show that operating costs (fuel, maintenance, labor), capital costs, and demand levels are central to fare calculation. This is further discussed under section 4.1.3.

In a quest to harness an all-inclusive public transport system, some stakeholders will hold offenses if they feel it does not lure to their benefit. For example, the changing of differentiated-fare structure system to a flat-fare structure system to provide low-cost transportation to lower income earners as well as simplify fare collection sparked transit fiscal crises in the US [20]-[22].

Early and conceptual works such as Fare structures by [32] and [33] establish that fare systems are traditionally guided by principles of cost recovery, efficiency, and equity. These principles are operationalized through institutional arrangements involving regulators and operators, as further emphasized in the [34] report on fare integration, which highlights governance structures and coordination challenges. However, these studies largely reflect global practices, indicating a gap in documenting localized institutional evolution, particularly in contexts like Ghana.

Quantitative indicators such as cost revenue balance, demand elasticity, and ridership levels are frequently used to justify fare adjustments [35]. These studies rely heavily on econometric modeling and cost-based frameworks, suggesting that fare decisions are often grounded in measurable economic variables, though they

may insufficiently account for social and equity considerations.

Methodologically, the literature demonstrates the use of statistical analysis, simulation models, and cost-based estimation techniques to inform fare adjustments [36] [37]. Emerging work such as the [38] further illustrates the role of real-time data and digital tools in enhancing transparency and decision-making, pointing toward computational approaches for fare determination. Details of these literature findings are found in **Table 2**.

Stakeholder dynamics are implicitly addressed across studies. Government agencies, transport operators, and passengers are identified as key actors, with interactions often involving trade-offs between financial sustainability and affordability [31] [39]. However, explicit analysis of consultation processes, perceived fairness, and compliance remains limited. Evidence suggests that fare changes can face resistance when perceived as inequitable or inadequately justified, especially in cases of fare increases or subsidy removal.

Overall, the literature highlights the importance of integrating cost data, demand analysis, and institutional coordination in fare setting while revealing gaps in stakeholder engagement and transparency. These gaps underscore the need for a data-driven, transparent computational framework to support evidence-based negotiations and improve trust in fare adjustment processes.

3.2. Transport Pricing and Governance

Literature consistently emphasizes that public transport fare setting is both an economic and institutional process, influenced by pricing principles and governance frameworks. Early conceptual work [32] [33] establishes that fare structures are designed to balance cost recovery, efficiency, and equity, while accommodating demand variations. Fare setting is rarely arbitrary; it requires coordination among operators, regulators, and policymakers, highlighting the governance dimension.

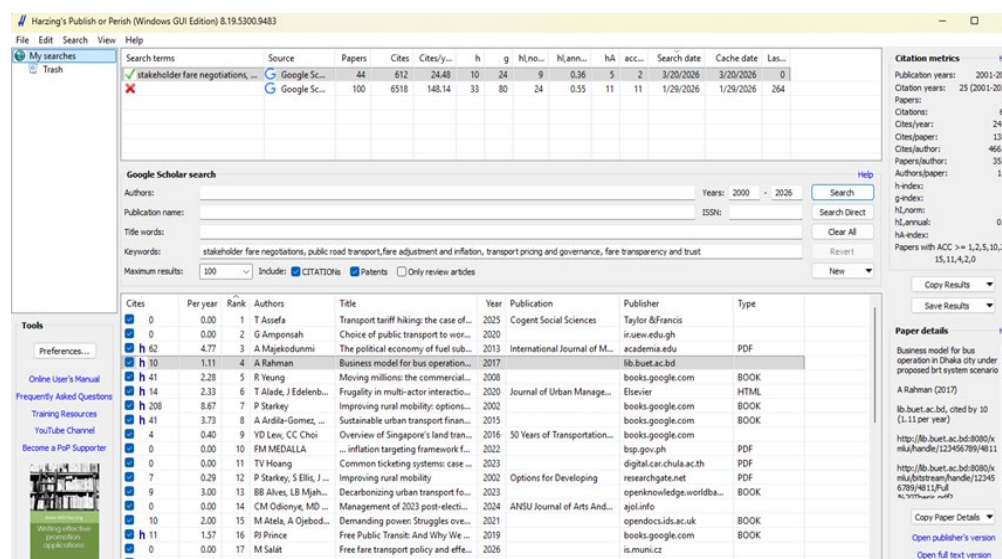


Figure 3. Harzing's publish or perish Google Scholar search interface.

Cost-based analyses, such as [30] and [31], illustrate that operating costs, capital expenditure, and demand projections are central to determining fares. SSRN studies [35] [37] demonstrate the use of quantitative economic indicators such as cost revenue balance and elasticity of demand to justify pricing decisions. These approaches are embedded within institutional frameworks that regulate fare increases, subsidies, and integration across modes, as noted in [34] report on Poland's fare integration.

Table 2. Data extraction matrix for transport fare settings.

Id	Author(s) & year	Country/region	Study objective	Methodology	Data type	Fare setting approach	Key variables	Key stakeholders considered	Key findings	Identifies gap	Relevance to study
1	Kim <i>et al.</i> (2017). [30]	South Korea	Estimate DRT fare for bus users	Contingent valuation method; Tobit model for WTP	Survey data/Stated Preference	WTP based DRT fare estimation	WTP for DRT fare, demographic data	Rural residents, current bus users etc.	AVG. WTP for DRT was 1639.22 won one way	No guideline for appropriate fare determination	Useful for fare settings research
2	Dandapat <i>et al.</i> (2017) [31]	India (likely)	Assess fare increases for viability	Statistical/economic analysis	Quantitative	Fare increase policy	Fare level, revenue, cost	Private operators, passengers	Fare hikes improve viability but reduce ridership	Equity concerns not fully addressed	Trade-off insight
3	Batarce & Mulley (2016) [32]	Global	Discuss fare structures	Conceptual analysis	Qualitative	Zonal, distance-based	Fare zones, distance	Operators, planners	Defines structure types	Lacks empirical backing	Theoretical foundation
4	Güzel <i>et al.</i> (2025). [33]	Global	Systematic review of PWYW pricing literature	PRISMA systematic literature review	Secondary data	Pay-What-You-Want participatory pricing	Consumer behavior, payment amount, fairness	Consumers, firms, researchers.	PWYW enhances transparency and customer engagement	Limited theoretical grounding and lack of studies	Supports alternative pricing and fare negotiation
5	World Bank (2016) [34]	Poland	Address fare integration barriers	Policy analysis	Qualitative	Integrated fare system	Institutional factors, pricing	Government, agencies	Integration improves accessibility	Institutional challenges	Important for multimodal systems
6	Gu <i>et al.</i> (2024) [35]	Not specified	Analyze fare structure impact on demand	Econometric modeling	Quantitative	General fare structures	Fare level, demand, elasticity	Passengers, policymakers	Fare structure strongly affects demand	Limited real-world validation	Supports demand-responsive pricing
7	Maadi & Schmöcker (2020) [36]	Not specified (like Europe)	Assess shift from zones to distance fares	Modeling, simulation	Quantitative	Distance-based vs zonal	Route choice, fare	Passengers, planners	Fare structure affects route choice	Context-specific findings	Behavioral insights
8	Vázquez-Grenno <i>et al.</i> (2025) [37]	Not specified	Examine impact of fare reductions	Econometric analysis	Quantitative	Fare reduction	Fare price, ridership	Passengers, government	Fare reduction increases usage	Long-term sustainability unclear	Useful for subsidy policies
9	Kumar <i>et al.</i> (2025) [38]	Not specified (likely global)	Develop real-time fare comparison platform	System design, platform development	Mixed (system + secondary data)	Dynamic/real-time fare comparison	Fare prices, routes, interoperability	Passengers, operators, platform providers	Improve transparency in fare systems	Limited empirical validation	Useful for digital fare optimization
10	Tomeš <i>et al.</i> (2022) [39]	Central Europe	Study discounts/free fares	Case study	Mixed	Discount/free fare	Fare level, ridership, subsidies	Government, passengers	Free fares boost ridership	High fiscal burden	Equity and policy relevance

Table 3. Data extraction matrix for transport fare collection system.

Id	Author(s) & year	Country/region	Study objective	Methodology	Data type	Fare setting approach	Key variables	Key stakeholders considered	Key findings	Identifies gap	Relevance to study
1	Mesbah & Khanali (2021) [40]	Global	Review of fare collection systems	Literature review	Secondary sources	Multiple	Technology, governance	Authorities, operators	Comprehensive AFC overview	No empirical modeling	Foundational AFC reference
2	Arslan <i>et al.</i> (2016) [41]	Türkiye	NFC-based fare payment	Mobile NFC	Smartphone data	Automated	NFC tags	Passengers	Fast transactions	Device compatibility	Mobile AFC
3	Konain (2023) [42]	India	Low-cost fare monitoring	Hardware prototyping	Sensor data	Automated	Biometric ID	Passengers, operators	Low-cost monitoring	Security limitations	Budget AFC systems
4	Anand <i>et al.</i> (2025) [43]	India	Distance-based AFC system	IoT sensors & automation	Prototype data	Distance-based	Distance, sensors	Passengers, operators	Efficient automated fare	Scalability issues	AFC system design
5	Gill <i>et al.</i> (2023) [44]	India	IoT-based AFC	IoT architecture	Sensor data	Automated	Distance, sensors	Passengers, operators	Fraud reduction	Reliability issues	Smart AFC
6	Dhamodhiran <i>et al.</i> (2024) [45]	India	Secure AFC system	IoT & encryption	System data	Secure automated	Authentication	Passengers, operators	High security	Cost barriers	Secure AFC
7	Siniutsich (2022) [46]	Belarus	Fare payment development	Case study	System data	Automated	Payment systems	Government	Service improvement	Funding limits	Regional AFC
8	Bieler <i>et al.</i> (2022) [47]	Global	Survey of AFC technologies	Comparative review	System data	Automated	Interoperability, standards	Authorities, operators	Rapid AFC evolution	Integration challenges	Core AFC survey
9	Chauhan (2025) [48]	Global	Blockchain fare payments	Blockchain framework	Ledger data	Blockchain-based	Transactions	Passengers, operators	Secure transparency	High complexity	Future AFC
10	Hollnagel & Fook (2019) [49]	LAC	Future fare media	Technology foresight	Industry data	Digital AFC	Fare media	Cities, operators	Shift to digital	Adoption barriers	Strategic planning
11	Fadeev & Alhusseini (2019) [50]	Russia	AFC data for demand	Data analytics	AFC records	Analytical	Trip patterns	Operators	Demand insights	Limited AI use	Analytics potential
12	Ingvardson <i>et al.</i> (2025) [51]	Global	Trip purpose estimation	Machine learning comparison	Big AFC data	Analytical	Trip purpose vars	Planners	ML improves accuracy	Needs real-time data	Advanced analytics
13	Arroyo <i>et al.</i> (2022) [52]	Africa	Innovation in fare payment	Policy & case review	Case studies	Multiple	Digital payments	Cities, operators	Mobile payments grow	Infrastructure gaps	African context

Table 4. Data extraction matrix for transport fare modeling.

Id	Author (s) & year	Country /region	Study objective	Methodology	Data type	Fare setting approach	Key variables	Key stakeholders	Key findings	Identified gap	Relevance
1	Liu & Lv (2015) [63]	China	Dynamic metro fare using game theory	Game theory modeling	Demand data	Dynamic fare	Passenger behavior, cost	Passengers, operators	Game theory improves adaptability	Assumes rational actors	Relevant for game-theoretic fares
2	Batarce & Galilea (2018) [66]	Chile	Estimate bus system cost & fares	Cost modeling	Operational data	Cost-based fare	Operating cost, demand	Operators, agencies	Accurate cost models guide pricing	Limited passenger behavior factors	Relevant for cost-based fare
3	Tirachini & Antoniou (2020) [67]	Global	Assess economics of automated public transport	Economic modeling	Cost models	Automation impact on fare	Cost, travel time	Agencies, policymakers	Automation reduces costs, affects pricing	Future-focused assumptions	Useful for tech-impact analysis

Continued

4	Huang <i>et al.</i> (2016) [68]	China	Optimize transit fare structures	Optimization modeling	Transit data	Optimized fare structure	Cost, demand	Planners, operators	Optimization improves revenue & ridership balance	Lacks behavioral detail	Core for fare structure optimization
5	Yao <i>et al.</i> (2016) [69]	China	Optimize taxi fleet & fare	Dynamic optimization	Taxi demand data	Dynamic fare	Demand, fleet size	Taxi operators	Dynamic fare improves system performance	Focus on taxis only	Useful for dynamic fare theory
6	Losin & Bulychева (2022) [70]	Russia	Study fare impact on demand	Mathematical modeling	Demand data	Demand-based fare	Price elasticity, ridership	Passengers, operators	Fare strongly affects ridership	Simplified assumptions	Supports demand-sensitive fare
7	Sánchez-Martínez (2017) [71]	USA	Estimate fare evasion & noninteraction	Data analytics	Fare transaction data	Compliance-focused fare	Transaction patterns	Operators	Model detects evasion effectively	Not generalizable	Useful for enforcement design
8	Katyal <i>et al.</i> , (2019) [72]	Global/India	Study perceived fare fairness	Behavioral research	Survey data	Fair fare perception	Price fairness, user perception	Passengers	Fairness & unfairness differ psychologically	No operational integration	Useful for acceptability analysis
9	Hadas <i>et al.</i> (2023) [73]	Israel	Assess attitudes toward dynamic fares based on crowding	Survey & modeling	Survey + stated preference	Crowding-based dynamic fare	Crowding, waiting time	Passengers	Users accept dynamic pricing with clarity	Small sample size	Supports crowding-based fare
10	Saghian <i>et al.</i> (2022) [74]	Iran	Develop dynamic subway fare pricing	Fuzzy bi-level programming	Modeling data	Dynamic pricing	Passenger heterogeneity, demand	Passengers, operators	Dynamic fares improve efficiency	Limited empirical validation	Relevant for dynamic fare modeling
11	Popović <i>et al.</i> (2018) [75]	Serbia	Select optimal fare system	Multi-criteria analysis	Transport system data	Optimal fare selection	Criteria weights	Authorities, planners	MCDM helps choose best system	Subjective criteria weighting	Useful for system comparison
12	Eriskin (2024) [76]	Global	Game-theoretic optimization of fare policies	Collaborative game theory	Model data	Dynamic/sustainable fare	Utility, sustainability	Passengers, operators, authorities	Game collaboration improves sustainability	Needs real-world validation	Highly relevant for sustainable fare design
13	Tepmanee & Siridhara (2020) [77]	Thailand	Improve transportation fare structure on Koh Chang	Case study, survey	Survey data	Flat fare improvement	Passenger demand, cost	Local authorities, passengers	Improved fare structure boosts usability	Lacks advanced modeling	Useful for regional fare reforms
14	Wu (2017) [78]	China	Simulate fare collection area adaptability	Simulation modeling	Station facility data	Operational/collection design	Passenger flow, facilities	Operators, station designers	Simulation improves layout planning	Focuses only on facilities	Relevant for station fare collection

Governance mechanisms are critical for ensuring transparency and coordination. The reviewed studies indicate that integrated fare systems require formal rules and institutional oversight, which reduce fragmentation and enable predictable, fair pricing. Emerging digital platforms like [38] exemplify how real-time data and interoperable systems can enhance governance by enabling evidence-based pricing and providing transparency to both operators and passengers.

However, the literature also highlights gaps. While cost and demand considerations are well documented, the evolution of institutional practices and local governance structures particularly in specific national contexts like Ghana remains underexplored. Likewise, there is limited empirical evidence on how governance

arrangements affect the implementation and acceptance of fare policies. In sum, existing research underscores that effective transport pricing depends on robust governance, coordination among stakeholders, and integration of economic indicators, forming a foundation for more transparent and evidence-based fare policies.

Table 5. Data extraction matrix for equity in transport fare.

Id	Author(s) & year	Country/region	Study objective	Methodology	Data type	Fare setting approach	Key variables	Key stakeholders	Key findings	Identified gap	Relevance
1	Šipuš <i>et al.</i> (2023) [81]	EU	Rank equity criteria	MCDA	Expert judgments	Equity ranking	Criteria weights	Planners	Accessibility most critical	No operational testing	Supports policy
2	Šipuš <i>et al.</i> (2022) [95]	Croatia/EU	Define equity criteria for fare zones	MCDA/AHP	Expert data	Zone-based	Criteria weights	Planners, authorities	Criteria improve fairness	Needs empirical validation	Useful for zoning
3	Calderón & Agüero-Valverde (2021) [102]	Costa Rica	Assess fare inequities	Statistical analysis	Income/fare data	Flat fare	Income burden	Passengers	Low-income groups overpay	No dynamic modeling	Shows inequity issues
4	Zhao & Zhang (2019) [103]	China	Effects of fare increase	Econometric modeling	Smartcard + income data	Distance-based	Income, distance	Passengers	Poor riders hit hardest	No alternative tested	Evidence on fare hikes
5	Harmony (2018) [104]	USA	Affordability vs cost recovery	Policy equity analysis	Socioeconomic data	Equity-adjusted	Income, cost recovery	Low-income riders	Trade-off identified	Lacks computational models	Foundation for equity
6	Silver <i>et al.</i> (2023). [105]	Portugal	Inequality effects of fare reform	GIS + socioeconomic modeling	Spatial & income data	Reformed zone system	Distance, income	Passengers	Reform reduced inequality	Long-term impacts unknown	Strong evidence on reform
7	Šipuš <i>et al.</i> (2019) [106]	EU	Identify equity factors	Factor analysis	Survey & operator data	Integrated fare	Service factors, income	Operators, planners	Integration improves equity	Lacks causal modeling	Supports integrated systems
8	Tiznado-Aitken <i>et al.</i> (2021) [107]	Chile	Assess distance-based beneficiaries	Accessibility modeling	Land-use & accessibility data	Distance-based	Urban form, distance	Commuters	Suburban benefit more	Lacks dynamic modeling	Spatial equity insights

3.3. Fare Collection Systems and Technology

The evolution of fare collection systems has accelerated significantly over the past decade, shifting from manual and paper-based systems to sophisticated Automatic Fare Collection (AFC) platforms. As shown in **Table 5**, this body of literature spans multiple technological paradigms, including sensing technologies, digital payment platforms, blockchain, IoT, and machine-learning-driven analytics.

Early and foundational works describe AFC as a sociotechnical infrastructure that automates fare processing, improves revenue security, and reduces transaction time [40]. Subsequent empirical studies expand on this by assessing technological efficiency and feasibility. For example, NFC-based mobile fare systems demonstrate the advantages of smartphone-enabled ticketing [41], while Arduino and fingerprint-based prototypes highlight low-cost local innovations aimed at improving monitoring and reducing fare evasion [42].

A major trend across the literature is the move toward distance-based and sensor-supported AFC, where IoT technologies calculate fares dynamically [43] [44]. These

systems increase accuracy, reduce manual errors, and offer scalable alternatives to flat-fare structures. Similarly, high-security AFC models integrating encryption demonstrate the growing need for data protection in digital mobility environments [45]. More advanced literature emphasizes systemwide modernization and interoperability, especially in contexts such as Poland [34] and Belarus [46]. Surveys of AFC technologies globally also point to fragmentation across standards and the urgent need to harmonize solutions [47]. Emerging innovations include blockchain-based fare transactions [48] and digital-first fare media for Latin America [49]. **Table 3** presents a collection of literature of fare collection systems.

Finally, AFC data has become a major analytical asset. Studies now use AFC datasets to model demand [50] and even infer trip purpose using comparative machine-learning approaches [51]. Overall, the literature demonstrates that AFC systems are transitioning from simple payment tools to data-driven, integrated mobility platforms central to modern public transport operations.

4. Fare Setting Models

4.1. Cost-Recovery Models

Public transport fare is a critical component in transit planning hence demands careful consideration from the viewpoints of both transit service providers, users and state-actors [10] [22]. [10] indicated that fares are direct and flexible instruments in influencing passenger behavior and therefore cost recovery and setting fares is therefore a basic challenge for public transport operators. Meanwhile, [22] indicated that the major source of revenue for transit agencies is the fare collected from users. Transport fare is a direct and flexible instrument in influencing passenger's behavioral and cost-minded recovery in the patronage of public transport services [10]. Fare setting is a primary problem for companies that operate public transport services.

According to [10], single/monthly ticket fare system seems to be more operator-friendly while the distance-dependent fare system seems to be more customer-oriented [9] [10]. [9] proposed that distance-based fare seems to effectively alleviate the disparate impacts caused by a flat fare on low-income and minority households. [52] stipulated how woefully an automated fare collection system failed in five sub-Saharan African cities due to the changes in business model that will enable collective rather than individualized fleet management. [52] responded to passenger demands with appropriate data-driven service plans that maximize average load factors. This confirms how rationally different stakeholders of the public transport system demonstrate their respective interests and biases in respect to fare adjustments and increments.

4.2. Subsidy vs Market-Based Pricing

Subsidy levels for public transport differ significantly across regions worldwide. In developed countries, these subsidies tend to be substantial, covering approximately 65% of operational costs in the largest 20 cities in the United States, 45%

in the main 26 European cities, 60% in the top five Australian cities, and 40% in Toronto [3]. In some instances, cities have extended these policies further by implementing fully free public transport systems [53]. In contrast, subsidies are generally less prevalent in developing regions, particularly in Latin America, although notable exceptions exist. For example, subsidy levels reach about 50% in Buenos Aires, 40% in São Paulo, 40% in Santiago, and between 40% and 50% in Bogotá.

From a theoretical perspective, [54] examine optimal fare-setting strategies from a social welfare standpoint, incorporating externalities such as congestion, pollution, accidents, economies of scale, and adjustments in service provision by transit agencies. Their findings suggest that fare subsidies exceeding 50% of operating costs can enhance welfare in cities such as Washington, D.C., Los Angeles, and London. Building on this framework, [55] apply the same model to Bogotá and demonstrate that optimal subsidy levels can vary considerably, ranging from 20% to 100%, depending on key modeling assumptions such as demand elasticities and the extent of modal shifts from private vehicles to public buses as fares decrease. However, a key limitation of these models is their inability to simultaneously account for price changes across multiple transport modes. As a result, they may permit certain high-value trips to occur while also enabling trips that would not be undertaken if users were charged the full social marginal cost. [3] modelled a densely populated city center as shown in **Figure 4** using data from London and Santiago while simulating different policy scenarios. The authors found that subsidizing transport fares does not influence mode switch to public transport compared to bus dedicated lanes and congestion pricing.

4.3. Operating Cost and Pricing

Fuel costs have historically constituted the most immediate and dominant driver of public transport fares, both globally and within Ghana [56] [57]. The sector's heavy reliance on petroleum products makes fuel price fluctuations highly visible and directly transmissible to fare adjustments [56]. Empirical evidence across Sub-Saharan Africa shows that high fuel prices, inefficient and ageing vehicle fleets, and poor road conditions collectively elevate variable operating costs [57]. In Southern Africa, fuel alone accounts for approximately 40% - 50% of total operating costs [58]. Reflecting this centrality, Ghana's fare-setting framework explicitly ties fare increases to fuel price movements, with agreed adjustments triggered when fuel prices rise by at least 10% [59].

As transport systems evolved, maintenance-related expenditures emerged as the next critical cost layer. Vehicle maintenance covering spare parts, tyres, and lubricants has become particularly burdensome in Ghana due to its import-dependent structure [60]. Rising inflation and persistently high spare part costs have sustained elevated fares even during periods of fuel price decline [61]. Notably, the weak responsiveness of spare part prices to exchange rate improvements suggests deeper structural inefficiencies in supply chains [62]. Comparative studies further indicate that operational inefficiencies, such as higher mechanical break-

down rates in Accra relative to Dar es Salaam, exacerbate cost pressures and influence fare-setting decisions [27].

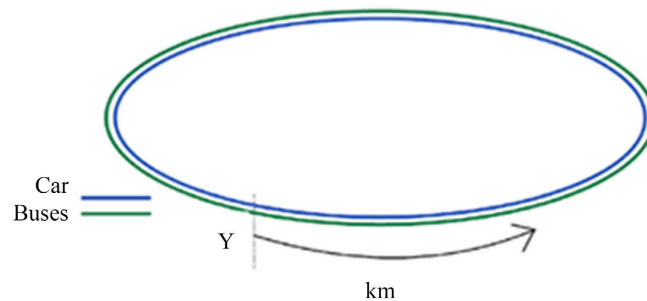


Figure 4. Representative network bassio Sotz & silva Montalva (2023) [3].

Labor costs, although significant, present a structural paradox within the African transport context. While the sector is labor-intensive, relatively low wages should theoretically reduce total costs. However, this advantage is offset by high variable costs, resulting in fare levels [57] comparable to those in developed economies like China [63]. In Ghana's largely informal and owner-operated system, labor cost dynamics are further shaped by regulatory constraints and government-controlled fare regimes that prioritize social considerations over strict cost recovery [64].

Infrastructure conditions introduce an additional structural dimension by indirectly amplifying operating costs. Poor road networks increase fuel consumption, accelerate vehicle wear and tears, reduce tyre lifespan, and lower operational efficiency [65]. In Ghana, studies consistently link high transport costs to deteriorating road infrastructure, alongside factors such as informal charges, fuel price volatility, and rising input costs [1] [2]. Policy responses, including internationally supported road improvement programs, have aimed to reduce vehicle operating costs and travel time as mechanisms for moderating transport fares. However, the effectiveness of these interventions remains constrained by institutional and market inefficiencies.

Finally, long-term structural pressures such as fleet ageing, capital replacement constraints, and rising overhead costs reinforce the persistence of high transport fares. Ageing vehicles increase fuel consumption and maintenance requirements, while limited access to finance constrains fleet renewal in many developing transport systems [1] [2]. Concurrently, insurance costs, licensing fees, and statutory levies contribute to the cumulative cost burden. Evidence from Ghana indicates that fare adjustments are typically the outcome of negotiations between transport unions and government authorities, reflecting multiple interrelated cost components, particularly fuel and operational expenses [59].

4.4. Analytical Models for Fare Adjustment

This section examines analytical models used to support fare adjustment decisions in public transport systems. It highlights how quantitative approaches such as optimization, econometric, and simulation models capture cost dynamics, demand

responses, and policy constraints. The section further evaluates their effectiveness in guiding systematic and evidence-based fare revisions.

4.4.1. Inflation-Based Adjustment

Direct inflation-indexed fare models do not appear in the reviewed literature. However, several studies incorporate cost-based mathematical modeling that implicitly reflects inflationary pressures.

[66] use a cost estimation function that computes operational costs $C = f(Q, p_i)$, where Q is service quantity and p_i includes cost parameters such as fuel and labor variables typically affected by inflation. While not explicitly modeling inflation, the structure allows fares to be recalibrated as costs rise. Similarly, [67] employ economic cost modeling, where operator cost functions and marginal cost equations capture long-run cost escalation, providing a computational foundation for inflation-adjusted fare calculations over time. [68] use an optimization function balancing operating cost, demand, and fare, expressed as:

$$\max_F \Pi(F) = R(F) - C(F) \quad (1)$$

where F is fare and $R(F)$ represent revenue as a function of fare. Cost terms can be inflation-adjusted, offering indirect application to inflationary settings. None of the studies presents a dedicated inflation indexation rule, CPI-linked model, or long-run inflation forecasting equation. Inflation is treated only implicitly as part of generic operating costs, leaving a methodological gap for systems requiring formal inflation-indexed fare formulas.

4.4.2. Indexation Models (Fuel Price, CPI)

A review of the selected studies shows that none of the authors propose a formal CPI-indexed or fuel-indexed fare adjustment formula. However, several works present cost-based mathematical structures that could support indexation, even if they do not explicitly implement it.

[66] estimate bus operating costs using a cost function that depends on multiple cost drivers, including fuel and labor. Although not expressed as an indexing formula, their model can be extended into a fuel-linked indexation framework. Their cost structure can be represented as:

$$C = f(Q, p_i) \quad (2)$$

where:

- Q = service quantity
- p_i = vector of cost parameters (fuel, labor, maintenance), typically inflation-sensitive

[69] use a dynamic optimization model for taxi operations. While their work focuses on fleet size and fare optimization rather than indexation, the underlying cost component often dominated by fuel could be indexed. Their objective function is:

$$\min_{F,n} Z(F, n) = C(n) - R(F, n) \quad (3)$$

where:

- F = fare
- n = fleet size
- $C(n)$ = operational cost (fuel-dependent)
- $R(F, n)$ = revenue

[67] model long-run automated transit costs. While no CPI or fuel index is applied, their economic cost structure allows indexing by embedding CPI or fuel price components into input prices. Hence, existing literature lacks any empirical evaluation of index-based fare adjustment mechanisms, despite the presence of models capable of supporting them.

4.4.3. Econometric and Forecasting Models

Econometric and forecasting approaches appear in several studies that examine fare impacts on demand or user behavior. [70] utilize mathematical modeling to estimate how fare changes influence transport demand, effectively serving as an econometric elasticity-based framework. By modeling demand relationships, their work functions as a forecasting tool for evaluating future ridership under different fare levels such as:

$$Q = a - bF \quad (4)$$

Which forecast ridership at alternative fare levels. In this model, Q denotes passenger demand, F represents the fare level, a is the baseline demand intercept, and b is the fare-sensitivity parameter. The negative sign indicates that demand decreases as fares increase, reflecting the price elasticity effect on public transport use. [71] models fare evasion using transaction-level probabilistic analysis, effectively functioning as a predictive model for noncompliance. [72], apply psychometric statistical modeling using structural comparisons of perceived fairness vs. unfairness, while [73] use stated-preference discrete choice models, typically written as:

$$P(i) = \frac{e^{V_i}}{\sum_j e^{V_j}} \quad (5)$$

where V_i includes variables such as fare and crowdedness and $P(i)$ is the probability of choosing alternative i . These models forecast passenger behavior under alternative pricing schemes but do not integrate systemwide econometric forecasting across operations, revenue, and ridership simultaneously. None of the studies presents a comprehensive econometric fare-demand-revenue forecasting model, nor do they integrate long-run macroeconomic variables (CPI, fuel index, GDP). Literature lacks a unified forecast model for holistic fare policy evaluation.

4.4.4. Multi-Objective Optimization

[74] propose a fuzzy bi-level programming model for dynamic subway pricing, optimizing operator revenue at the upper level while meeting passenger equilibrium conditions at the lower level. The bi-level structure inherently reflects multi-

objective tradeoffs among service efficiency, fairness, and congestion with fuzzy parameters to handle uncertainty in passenger heterogeneity.

Upper level:

$$\max_F (F) \quad (6)$$

Lower level (passenger equilibrium):

$$\min_x Z(x, F) \quad (7)$$

where F is the fare, $R(F)$ is the revenue as a function of fare, x is passenger decision and $Z(x, F)$ is passenger equilibrium objective function.

[68] use an optimization decision model incorporating both operator cost and demand effects. [69] apply dynamic optimization, jointly optimizing taxi fare and fleet size. [75] employ multi-criteria decision-making (MCDM), mathematically expressed as:

$$S_i = \sum w_j r_{ij} \quad (8)$$

where w_j are weights and r_{ij} criterion scores.

[76] used a collaborative game-theoretic multi-objective optimization model, maximizing joint utility across passengers, operators, and authorities. Most models assume perfect rationality, complete information, and lack real-world calibration. Multi-objective models rarely incorporate behavioral unpredictability, inflation, or macroeconomic constraints, leaving a gap for more realistic hybrid optimization frameworks.

4.4.5. Qualitative vs Quantitative vs Computational Modeling

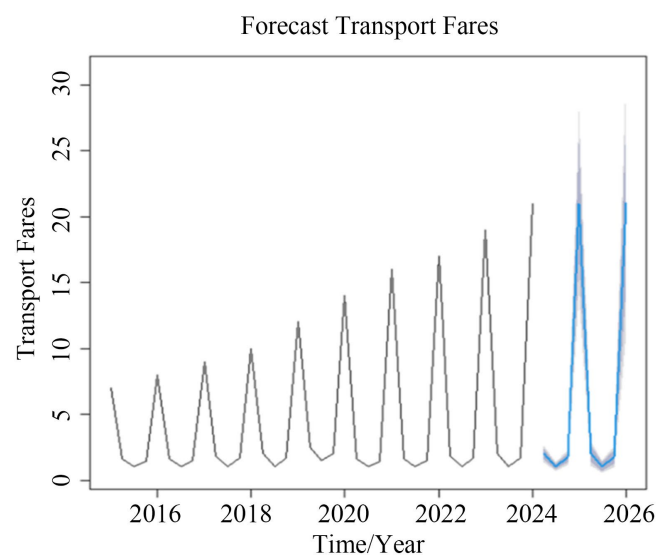
Table 4 presents Literature that demonstrates a strong dominance of quantitative and computational modeling approaches in public transport fare studies, while qualitative analyses appear less frequently and typically serve supportive roles. Qualitative work is exemplified by [77], who use interviews and contextual assessments to evaluate fare structure challenges in Koh Chang. [72] also apply qualitative reasoning within a behavioral pricing framework, examining psychological perceptions of fairness and unfairness through survey-based subjective responses. These studies contribute valuable user-centric insights but do not develop mathematical fare-setting formulas.

In contrast, most studies employ quantitative, optimization, or computational models. [74] use a fuzzy bi-level mathematical model, integrating operator revenue optimization with passenger equilibrium behavior. [68] apply structured optimization models balancing cost recovery and demand. Multi-objective frameworks appear in [76] through collaborative game-theoretic optimization, while [75] utilize multi-criteria decision-making (MCDM) to assess fare system alternatives. Forecasting and demand modeling approaches include [70] mathematical elasticity model and [73] discrete choice stated-preference models. Computational simulations also feature prominently in [78], who evaluates fare collection area performance through simulation modeling. [79] applied a regression model

with ARIMA errors to analyze transport fares in the Kumasi metropolitan area. Their findings indicate that both median and mean trip distances (5.3 km and 5.7 km, respectively) significantly influence fare determination. This result aligns with existing literature suggesting that fare structures in Ghana are generally distance-sensitive, although they may vary across routes and operating conditions. Additionally, the study provides a forecast of transport costs in Kumasi, as illustrated in **Figure 5**. Quantitative models dominate fare studies, but lack mixed methods integration and real-world validation, highlighting gaps in combining optimization with qualitative insights. This model explains the exponential rate at which transport fares grow and the potential effect on public transport users.

4.5. Emerging Computational and Data-Driven Approaches

Recent research demonstrates a clear transition from traditional cost-plus or flat-fare strategies toward computational, data-driven, and algorithmic models that allow transit agencies to incorporate demand patterns, equity considerations, and multi-stakeholder trade-offs into fare decision-making. A major advance is the adoption of machine learning and real-time data analytics for predicting passenger demand and evaluating sentiment toward fare changes. For instance, the [38] integrates real-time fare comparison across modes using interoperable data streams, highlighting the emergence of ML-powered mobility decision-support systems. Similarly, [35] leverage large-scale transit datasets to model fare elasticity and behavioral responses, demonstrating ML's potential for forecasting demand under alternative fare structures.



Source: <http://article.sapub.org/10.5923.j.ijtte.20261501.01.html>

Figure 5. Forecast for regression with ARIMA (5, 1, 0) [79].

Simulation models also play a prominent role in exploring fare adjustments and passenger behavior. [36] use simulation to evaluate route-choice changes when transitioning from zonal to distance-based fares, revealing how computational

network models capture behavioral nuances better than static approaches. In the same vein, estimation methods for sightseeing rail fares [30] apply cost-simulation techniques to compute unit fares, reflecting a growing reliance on computational pricing tools.

Game theory especially bi-level and cooperative formulations, is increasingly used to resolve conflicts among stakeholders. [74] apply fuzzy bi-level programming, where operators optimize fares while passengers respond in the lower level. Emerging work in the broader fare-policy field includes the use of Shapley-value-based allocation methods for equitable revenue sharing in integrated networks, although not directly implemented in the included studies, the methodological trajectory points toward cooperative game-theoretic negotiation frameworks.

Sub-topics such as multi-stakeholder optimization and decision-support systems are also gaining prominence. Studies on fare differentiation in Rome [80], fare integration barriers [34], and fare discounts in Central Europe [39] emphasize the need for computational tools that simultaneously optimize affordability, cost recovery, and equity. These models increasingly incorporate multi-criteria evaluation (e.g., [81]) and system-level optimization to support evidence-based fare setting.

5. Stakeholders Roles and Negotiation Dynamics

Public road transport fare setting is a fundamentally contested process, shaped by the interplay of competing stakeholder interests, institutional power, and negotiation dynamics. In Ghana, three principal actor groups transport unions, government agencies, and commuters interact within a tripartite governance arrangement that is characterized by structural power asymmetries, periodic conflicts, and uneven representation [82].

5.1. Transport Unions

Transport unions, particularly the Ghana Private Road Transport Union (GPRTU), occupy a central and historically dominant position in Ghana's fare-setting process. Formed from colonial-era driver associations dating to the 1930s, the GPRTU evolved to define routes and set standardized fares across the country [83]. Today, the GPRTU holds de facto gatekeeping power over fare adjustments; a position reinforced by its capacity to mobilize drivers in industrial action. The Ghana Road Transport Coordinating Council (GRTCC) serves as a coordinating body for commercial road transport unions in Ghana, facilitating dialogue and acting as a liaison between transport operators and the Ministry of Transport. [84] observe that transport unions in developing countries derive negotiation leverage not only from formal institutional membership but from their capacity to coordinate collective action, including strikes and service withdrawals, as tools of pressure in fare negotiations. This dynamic is clearly evidenced in Ghana, where the GPRTU has repeatedly threatened nationwide strikes to compel government concessions on fuel levies and fare approval timelines [85]. Inter-union rivalry including dis-

putes between the GPRTU and the Concerned Drivers Association of Ghana further complicates the negotiation landscape, undermining the coherence of the union bloc and reducing its bargaining effectiveness [86].

5.2. Government Agency: Ministry of Transport (MoT)

The Ministry of Transport (MoT) plays a central regulatory and coordination role in the fare-setting process, facilitating stakeholder negotiations and representing public interest within the transport governance framework. [87] in his analytical model of negotiation symmetry and asymmetry, notes that the stronger party in a negotiation typically seeks to impose its preferred outcome, while the weaker party pursues symmetry through institutional channels or collective action. In Ghana, government agencies nominally hold regulatory authority but are constrained by political economy considerations including the electoral sensitivity of fare increases which frequently result in delayed approvals and incomplete enforcement of approved fare structures [88]. [82] identifies weak institutional capacity as a defining challenge for transport regulators across Sub-Saharan Africa, noting that effective fare governance requires not only legal authority but technical capacity, continuity, and genuine stakeholder engagement qualities that Ghana's regulatory architecture has inconsistently demonstrated.

5.3. Commuters

Commuters represent the most diffuse and least institutionally organized actor in Ghana's fare negotiations. Despite being the primary users of public transport, their interests are structurally marginalized in the tripartite process, which formally includes only operators and government [89]. In practice, commuter influence is exercised indirectly through public protest, media pressure, and advocacy by civil society groups rather than through formal representation. [90] documents how commuters in peri-urban areas such as Ajamasu and Buoho face artificial vehicle scarcity and inflated fares with virtually no formal recourse, revealing a fundamental equity gap in the fare governance structure. [91] noted that without explicit mechanisms for commuter representation in fare-setting processes, outcomes tend to systematically favor operator cost recovery over affordability and social equity.

5.4. Power Asymmetry

Power asymmetry is a defining feature of Ghana's transport fare negotiations. [87] establishes that asymmetric power relations shape both the process and outcomes of negotiations, with stronger parties able to steer outcomes in their preferred direction. In Ghana's context, the GPRTU's dominance over vehicle supply gives it considerable coercive leverage, enabling it to implement unauthorized fare increases or withhold services when negotiations stall. Government agencies, while formally superior in regulatory authority, are constrained by their dependence on private operators to deliver most urban transport services; a structural depend-

ency that limits their enforcement capacity. [92] documents how the government was compelled to summon union officials and deploy state operators following fare manipulation incidents, reflecting the limits of regulatory authority in a sector dominated by private, union-organized provision. Commuters, lacking organizational representation, occupy the weakest position in this asymmetric arrangement.

5.5. Conflict and Dispute Patterns

Conflict in Ghana's transport fare governance manifests in several recurring patterns. First, inter-union disputes, such as the disagreement between the GPRTU and its sister unions over the timing and magnitude of fare adjustments, fragment the operator block and create confusion among commuters [86]. Second, government-operator conflicts emerge when unions perceive regulatory decisions as undermining their financial viability as illustrated by the GPRTU's accusation in 2025 that the government's imposition of a fuel levy immediately following an agreed fare reduction constituted a deliberate betrayal [85]. Third, operator-commuter conflicts arise through practices such as artificial vehicle scarcity, route abandonment, and fare overcharging, which commuters are largely powerless to contest within the existing institutional framework [93]. Collectively, these conflict patterns point to a governance deficit in which the absence of transparent, binding, and equitably enforced fare-setting rules creates persistent instability for all stakeholders. [87] notes that asymmetric negotiations tend toward instability unless mechanisms are developed to equalize procedural access a reform that Ghana's transport governance has yet to fully achieve.

5.6. Transparency, Fairness and Trust

Transparency is fundamental to building trust and legitimacy in fare-setting, as opaque or poorly justified decisions often lead to public resistance and non-compliance [5]. Clear communication and perceived fairness enhance acceptance, yet these are frequently constrained by limited data availability and weak institutional capacity [2] [5]. Trust is further shaped by past experiences and the consistency of previous fare decisions [25]. While advanced analytical tools can support more accountable decision-making [24], transparency alone is insufficient without meaningful public participation and feedback mechanisms [26]. More broadly, the legitimacy of fare policies depends not only on technical soundness but also on fairness, openness, and effective communication [94]. This is particularly critical in contexts such as Ghana, where commuters are often excluded from formal negotiations and discrepancies persist between announced and implemented fares. In **Figure 6**, transport unions expressed been betrayed for lack for fairness in government re-introduction of fuel levy after their reduction in fare rates due to reduction in fuel prices by government.

5.6.1. Perceived Fairness in Pricing

Perceived fairness in transport pricing is a multi-dimensional construct that en-

compasses distributional equity, procedural justice, and the proportionality of cost burdens relative to service quality. [94] demonstrate that transport pricing policies are evaluated as fairer and more acceptable when outcomes are perceived to affect all users equally and to serve collective rather than individual interests a finding with direct implications for Ghana, where fare increases disproportionately burden low-income urban and peri-urban commuters. [95] further distinguishes between horizontal equity equal treatment of users with similar needs and vertical equity, which requires that disadvantaged groups receive a more significant share of transport resources. Ghana's fare structure, driven primarily by operator cost recovery rather than affordability thresholds, has historically failed to meet standard. [96] articulated this perception gap explicitly, arguing that commuters struggling with the high cost of living have a legitimate fairness expectation that reductions in fuel prices be passed on directly as fare reductions an expectation that was widely violated following the 2025 fare reduction announcement. [89] affirms that a fair fare policy is one that maximizes access to public transport for as many people as possible, with affordability as a non-negotiable design criterion rather than an afterthought.

5.6.2. Public Trust in Fare Decision

Fuel Levy a betrayal after fare reduction – GPRTU accuses government

Source: myjoyonline.com
 6 June 2025 9:53am



Figure 6. GPRTU accusing government of betrayal [85].

Public trust in transport fare decisions is a function of both the outcome and the process through which decisions are reached. Ghana's Minister of State for Government Communications explicitly acknowledged that non-compliant operators were "undermining trust in the public transport system" by charging unapproved fares and creating artificial vehicle scarcity [97]. This observation reflects a growing recognition in policy discourse that fare governance is not merely a technical pricing exercise but a trust-building exercise with significant political and social

consequences. [98] establishes that transit fare affordability is deeply intertwined with perceived institutional reliability when commuters cannot predict or verify whether announced fares will be honored, and their trust in the entire fare governance apparatus erodes. [99] in a study of transit user perceptions across several cities found that service reliability and fare predictability are the two strongest predictors of trust in public transport institutions. Ghana's recurring pattern of unilateral fare increases, mid-period revisions, and operator non-compliance with approved reductions directly undermines both dimensions, creating a chronic trust deficit between commuters and the tripartite fare-setting system.

5.6.3. Communication and Consultation

Effective communication and genuine stakeholder consultation are prerequisites for the social legitimacy of fare decisions. [82] identifies real consultation and collaboration with key stakeholders, especially operators and affected communities, as a non-negotiable element of effective transport regulatory frameworks. In Ghana, however, the communication of fare decisions to the public is typically unidirectional and reactive: announcements are made after negotiations conclude, without prior public engagement or impact assessment. The GPRTU's Deputy General Secretary acknowledged in 2025 that the union communicated the 15% fare reduction by informing its registered members but conceded that drivers outside formal union structures remained beyond the reach of its communication channels, requiring law enforcement intervention to achieve compliance [85]. [89] recommends that fare-setting authorities adopt principles of transparency, inclusivity, and flexibility in their communication strategies, combining quantitative fare data with qualitative explanation of the cost drivers behind adjustments. Public transport policies often emphasize multi-stakeholder engagement in decision-making; however, this commitment is not always consistently reflected in actual fare-setting practices.

5.7. Behavioral Responses: Acceptance and Resistance

Behavioral responses to fare decisions range from passive acceptance through active resistance, and are shaped by perceived fairness, trust levels, and the availability of alternatives. [94] shows that the acceptability of transport pricing policies is significantly higher when respondents perceive that policy outcomes protect collective interests and are equitably distributed and conversely, that policies perceived as serving operator or government interests at the public's expense generate systematic resistance. In Ghana, commuter resistance to fare increases has historically been expressed through public protest, media outcry, and political pressure rather than formal institutional channels, reflecting the absence of structured commuter representation in the fare-setting process [89]. Conversely, where fare reductions are announced, acceptance is tempered by skepticism about actual implementation. [90] documents widespread commuter confusion and frustration following the May 2025 fare reduction, with many passengers unsure of the cor-

rect fares and unable to enforce compliance against overcharging drivers. This behavioral ambiguity, neither full acceptance nor organized resistance, reflects a governance environment in which commuters lack both information and institutional recourse.

5.8. Compliance vs Noncompliance

The compliance dimension of fare governance in Ghana reveals a structural enforcement gap that directly undermines transparency and trust [100] [101]. Following the May 2025 tripartite-approved 15% fare reduction, the GPRTU reported that while its registered members were largely compliant, “a few members of unregistered unions have decided not to comply”, calling on law enforcement agencies to sanction non-compliant drivers [85]. [95] notes that fare evasion and non-compliance in public transport systems produce not only economic losses but social inequity and heightened insecurity, eroding the foundations of a legitimate fare system. In Ghana’s context, non-compliance is compounded by the large proportion of “floating vehicles” operators outside formal union structures who are structurally beyond the reach of the tripartite governance arrangement [101]. [96] proposed a three-pronged response: empowering Metropolitan, Municipal, and District Assemblies to revoke operating licenses of non-compliant drivers; issuing compliance stickers to facilitate police identification; and deploying public university buses as temporary alternatives during periods of operator non-compliance. These proposals highlight the extent to which fare transparency and compliance are ultimately governance challenges requiring institutional reform rather than simply better communication.

5.9. Public Acceptance and Social Impacts of Public Transport Fare Policies

Public acceptance of fare policies is closely tied to affordability, equity, and broader social welfare outcomes as shown in the literature collection in Table 5. Across the literature, affordability emerges as a central determinant of acceptance, especially for low-income groups who experience disproportionate cost burdens under flat or distance-based fare regimes. Studies in Costa Rica show that uniform flat fares result in regressive impacts, where lower-income riders pay a higher share of income for mobility, undermining public support for the fare system [102]. Similarly, fare increases in Beijing disproportionately affected low-income users, reducing affordability and generating negative public response [103]. These findings align with broader debates on fare negotiations where tensions between cost recovery and user affordability shape political and social acceptance [104].

Equity impacts are another major driver of social acceptance [102]. Evidence from Lisbon’s fare reform demonstrates that adjusting fare structures toward integrated or zone-based models can mitigate inequality and improve access for underserved communities [105]. In contrast, shifting to a flat fare often disadvantages short-distance, lower-income riders, creating perceptions of unfairness

and lowering acceptance [4]. Research on integrated systems shows that equitable fare structures must consider multiple dimensions income, accessibility, and urban form to ensure socially acceptable outcomes [106] [107]

The broader social welfare implications of fare adjustments indicate that well-designed policies can enhance mobility, reduce disparities, and support social inclusion. Optimization-based evaluations of fare-free or reduced-fare periods show improvements in social equity, particularly when aligned with peak needs [108]. Likewise, dynamic or data-driven models can balance operational revenue with societal benefits, increasing public trust and policy acceptability [74].

Known literature underscores that fare acceptance is strongest when policies enhance affordability, demonstrate distributive fairness, and contribute meaningfully to social welfare objectives. The key overarching gap is the lack of a holistic, multi-dimensional fare-setting framework that integrates affordability, equity impacts, public acceptance, operational sustainability, and social welfare into a single decision-support model.

5.10. Transport Fares Negotiation Styles

Transport fare negotiation has evolved from ad hoc decision-making to more structured analytical frameworks incorporating economic, behavioral, and institutional perspectives. In public transport systems, fare determination reflects a multi-stakeholder negotiation problem, where regulators, operators, and passengers pursue competing objectives such as cost recovery, affordability, and service quality. Recent studies apply game-theoretic and multi-objective optimization models to formalize these interactions, demonstrating how equilibrium fares emerge from strategic interdependence among stakeholders [74] [76].

However, compared to other domains, transport fare negotiation remains less theoretically mature. In international relations, negotiation models explicitly incorporate multilateral bargaining and ratification constraints, showing how outcomes depend on coalition formation and institutional constraints [109]. Similarly, project management literature conceptualizes negotiation as a systematic conflict-resolution process, emphasizing structured decision-making, stakeholder alignment, and iterative bargaining [110]. These approaches highlight the importance of clearly defined objectives, constraints, and negotiation protocols elements often underdeveloped in transport contexts. Behavioral insights further enrich negotiation theory. Studies on negotiation styles demonstrate how competitive, cooperative, and compromise strategies influence agreement outcomes and the risk of deadlock as cited in the work of Calum Coburn of the Harvard Medical School.

(<https://hms.harvard.edu/sites/default/files/assets/Sites/Ombuds/files/NegotiationStyles.Understanding%20the%20Five%20Negotiation%20Styles.by%20Calum%20Coburn.pdf>).

Foundational negotiation models also emphasize the tension between individual interests and mutual dependence, suggesting that effective agreements require

balancing efficiency with fairness [111]. Despite these advances, a gap remains in integrating formal negotiation theory with the practical realities of transport systems, particularly in developing countries where institutional fragmentation and informal practices dominate. Existing literature suggests the need for hybrid models that combine game-theoretic optimization, behavioral considerations, and governance structures to support transparent and sustainable fare negotiation processes.

6. Conclusions and Future Work

The review reveals that discrepancies in public transport fare systems arise from a complex interaction of economic, institutional, and methodological limitations. Fare systems often fail not due to the absence of analytical models, but because of weak alignment between theoretical frameworks and real-world governance structures. While cost-recovery, demand elasticity, and optimization models provide structured approaches to pricing, their effectiveness is undermined by fragmented institutional arrangements, informal practices, and limited enforcement capacity particularly in developing contexts. These failures are further amplified by power asymmetries among stakeholders, where dominant actors such as transport unions or operators can override formal pricing mechanisms, leading to inconsistencies between proposed and implemented fares.

Mismatches occur at multiple levels. First, there is a disconnect between analytical outputs and policy decisions, as quantitative models often fail to incorporate political constraints, negotiation dynamics, and behavioral responses. Second, discrepancies arise between cost drivers (e.g., fuel prices, inflation, exchange rates) and actual fare adjustments, which are frequently delayed, partially implemented, or selectively enforced. Third, gaps exist between announced fares and on-the-ground practices due to non-compliance and weak regulatory oversight. Finally, there is a misalignment between affordability objectives and cost-recovery goals, resulting in fare structures that are perceived as inequitable and lacking transparency.

Existing models are limited by their narrow focus on isolated components of the fare-setting problem. Most models emphasize either cost optimization, demand forecasting, or equity analysis, but rarely integrate all dimensions into a unified framework. Notably, there is a lack of formal indexation models that explicitly incorporate inflation or fuel price dynamics, as well as an absence of comprehensive econometric frameworks that jointly model demand, revenue, and macroeconomic variables. Furthermore, current approaches insufficiently account for stakeholder behavior, negotiation processes, and institutional constraints, limiting their applicability in practice.

The review identifies key quantitative economic indicators used in fare evaluation, including operating and capital costs, fuel prices, inflation, demand elasticity, ridership levels, revenue-cost ratios, and subsidy levels. These indicators form the basis for justifying fare adjustments, although their application is often incon-

sistent. Also, data inputs such as operational cost data, passenger demand data, AFC datasets, and survey-based behavioral data are analyzed using methods including econometric modeling, optimization techniques, simulation models, and machine learning approaches. However, the application of these methods remains uneven, with significant gaps in data quality, integration, and real-world implementation.

Literature underscores the need for a holistic, data-driven, and governance-aware framework that integrates economic indicators, computational methods, and stakeholder dynamics to reduce discrepancies and enhance transparency, fairness, and trust in public transport fare systems. A hybrid game-theoretic fare model is recommended to address discrepancies by capturing stakeholder interactions, power asymmetry, and negotiation dynamics. Using cooperative or bi-level frameworks, it ensures balanced decision-making. When integrated with economic data inputs, it enables fair, transparent, and evidence-based fare adjustments, improving consistency, stakeholder trust, and overall system efficiency.

Authors' Contribution

S.A.O.: drafted the original manuscript (introduction to conclusion), while C.A.A.: supervised, reviewed and edited the manuscript.

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Data of collected literature is available upon reasonable request.

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Conflicts of Interest

To the best of our knowledge, we the authors declare no conflict of interest.

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