Towards Equitable and Integrated Transport Network Development in Morocco: A Socioeconomic Planning Framework and Research Agenda

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ABSTRACT

Transport network development can be evaluated through the opportunities people can reach, the resources required to travel, and the distribution of benefits and burdens. This paper develops a socioeconomic planning framework for prospective application in Morocco. It adopts a conceptual design supported by purposive title-and-metadata screening of a user-supplied bibliography containing 249 populated records. One hundred records were selected and organized into six themes: public transport integration and sustainability; mode choice and affordability; walking and inclusion; network operations and demand management; safety and resilience; and asset management and digital planning. The screening identifies relevant research topics but does not constitute full-text evidence synthesis or establish causal relationships. The analytical outputs comprise an integrated assessment architecture, accessibility and affordability formulations, a distribution-sensitive project-screening matrix, four development scenarios, and an implementation and monitoring protocol. The framework distinguishes infrastructure provision from service delivery and separates aggregate performance from outcomes experienced by population groups. It proposes comparing baseline continuation, capacity-oriented development, integrated multimodal development, and equity-oriented development using locally validated indicators and explicit decision weights. No Moroccan projects are ranked, and no national investment benefits are estimated, because local network, household, service, and financial datasets have not been assembled. The principal contribution is a transparent link between investment decisions, complete journeys, access to essential opportunities, and lifecycle feasibility. Application requires verified Moroccan primary evidence, stakeholder participation, bibliographic validation, and sensitivity testing. The paper concludes with a staged empirical research agenda to operationalize the framework without uncritically transferring context-specific findings. Its conclusions concern assessment design rather than the measured performance of Morocco's current or planned transport networks.

Keywords: Morocco, transport equity, accessibility, multimodal integration, socioeconomic planning

INTRODUCTION

This paper develops a framework for evaluating prospective transport network development in Morocco through a socioeconomic lens. The proposed decision problem is not simply where additional infrastructure could be constructed, but how alternative investments could change access to employment, education, healthcare and other essential opportunities. Accessibility, affordability, integration and the distribution of outcomes are therefore treated as explicit assessment objectives rather than assumed consequences of network expansion.

The paper is conceptual. Morocco is the intended application setting, not an empirically observed case in the present analysis. No statement is made about the implementation status of specific Moroccan projects, the adequacy of existing national provision, or the performance of particular institutions. Such statements require country-specific primary evidence that is not included in the available bibliography.

The documentary starting point is a supplied publication inventory. Its records include transport-planning methods and sustainability comparisons (Jenny et al., 2023; Sumantri et al., 2025), integrated facilities and transit-oriented development (Jumardi et al., 2023; Rifai & Arifin, 2020; Rifai, Handayani, et al., 2023), and

data-driven transport analysis (Bastian et al., 2025). These topics motivate the framework; the bibliographic records alone do not validate intervention effects. This distinction is important because the selected material is substantially centred on Indonesian cases and a recurring author network.

The objective is to construct an auditable assessment architecture linking investment inputs to service changes, complete journeys and distributional outcomes. Four research questions guide the design: which socioeconomic outcomes should be assessed; how integration and affordability can be operationalised; how scenarios can be compared transparently; and what local evidence is required before making investment recommendations for Morocco.

The intended contribution is a structured planning protocol, not a claim that accessibility or equity assessment is a new field. The paper combines a transparent bibliographic map with proposed measures, screening rules and an empirical implementation sequence. It does not present a comprehensive review of the international transport-equity literature.

LITERATURE REVIEW AND CONCEPTUAL POSITIONING

Public transport integration and sustainability

The inventory includes records explicitly concerned with BRT operations and effectiveness, light-rail satisfaction and integrated station connections (Andriyani et al., 2021; Isradi, Farhan, et al., 2021; Isradi, Molina, et al., 2021; Sony et al., 2022). Other records address rail planning, airport public transport, transport-mode selection and ridership during restrictions (Asadulhaq et al., 2022; Prasetio & Rifai, 2020; Rifai, Putra, et al., 2022; Rifai, Rulianto, et al., 2021). At the level of title screening, these topics support a distinction between physical network provision and the services delivered through it.

A further cluster concerns local public transport perceptions and satisfaction (Gultom et al., 2022; Haycal et al., 2022; Lubis et al., 2022; Setiawan et al., 2022; Victory et al., 2022), commuter-line services and station facilities (Manurung et al., 2022; Pratama, Rifai, et al., 2022), and port-route services, sustainable transportation, bus satisfaction and tourism accessibility (Firdaus et al., 2025; Immanuel et al., 2025; Rifai & Hastuti, 2023; Rinoa et al., 2025). These records identify candidate dimensions for later appraisal. Passenger satisfaction is retained as an experience-based construct and is not substituted for measured accessibility or affordability.

Mode choice, affordability and constrained travel

The selected inventory contains stated-preference and modal comparison topics associated with airport access, electric rail, online transport and commuter travel (Hardiyanti & Rifai, 2018; Hasan et al., 2022; Rifai, Banu, et al., 2022; Rifai & Fajriliani, 2020). Records concerning fuel-price changes, commuter perceptions, student travel and service restrictions broaden the scope of potential explanatory variables (Hermawan et al., 2023; Kurniawan & Rifai, 2022; Pramono et al., 2022; Rahmadhani et al., 2022; Rifai & Handayani, 2024). Their titles do not establish the size or direction of income, price or service effects.

Other selected records concern bus satisfaction and commuter schedules (Dewantoro et al., 2022; Fauziawati et al., 2022; Taufanudin et al., 2021), pandemic-related choice and conventional versus application-based taxis (Ong et al., 2022; Rifai, Lista, et al., 2021), and comparative travel modes, motorcycle efficiency, employee travel and route choice (Agustino et al., 2022; Apriansyah et al., 2022; Aransya et al., 2022; Nadillah et al., 2022; Suganda et al., 2022). In a Moroccan application, these topics would inform locally tested survey questions rather than imported behavioural coefficients. Observed travel choices would be interpreted alongside available alternatives and unmet travel needs.

Walking, inclusion and access interfaces

The pedestrian cluster includes metropolitan business-area services, shopping-area facilities, crossing facilities and sidewalk satisfaction (Dermawan et al., 2021; Isradi, Andri, et al., 2022; Johanes et al., 2022; Rifai, Akhir, et al., 2021). Tourism-area walking, station access and office-area facilities provide additional interface topics (Christine et al., 2022; Pelangie et al., 2022; Pratama, Rifai, et al., 2022). Records about perceptions of flyover

development and children's water-transport preferences add development-perception and population-specific questions (Rifai, Tasyah, et al., 2025; Syarif et al., 2022). The framework consequently treats the origin-to-stop and interchange portions of a journey as assessment components, without claiming that these records demonstrate universal effects.

Network operations and demand management

Parking-related records cover commercial streets, residential areas, ferry-port interfaces and traditional markets (Rahayu et al., 2022; Rifai, Djamal, et al., 2021; Rifai et al., 2020; Sari et al., 2021). Road-performance records address development impacts, road sections, intersections and road-pricing implementation (Isradi, Nareswari, et al., 2021; Purnama et al., 2022; Rifai, Ramadian, et al., 2021; Rifai, Surgiarti, et al., 2021). Their proposed role is to identify operational constraints that may affect the delivery of socioeconomic objectives, not to define equity solely through vehicle flow.

Additional operational topics include roundabouts, junction management, user perceptions and traffic diversion (Andika et al., 2022; Immanuel et al., 2022a; Immanuel et al., 2022b; Isradi, Mufhidin, et al., 2022; Maro et al., 2022; Wahyudi et al., 2022); rail-crossing interfaces, underpasses, frontage roads and traditional-village congestion (Andreas et al., 2022; Assalam et al., 2022; Rachmadina et al., 2022; Resinta & Rifa'i, 2023); and access closure, updated capacity analysis, industrial traffic management and air quality (Azahra et al., 2024; Hasan et al., 2024; Isradi et al., 2025; Ong et al., 2025; Saputra et al., 2023; Sari et al., 2025). Local calibration would be required before applying any capacity standard or simulation parameter to Morocco.

Safety and resilience

Selected safety records address accident causes, accident-prone locations, equivalent-number analysis, traffic conflict and street lighting (Rifai & Aulia, 2019; Rifai & Farhan, 2021; Rifai & Sopiyan, 2020; Sidiq et al., 2022; Sumantri et al., 2022). Further records concern hazardous-site identification, sight distance, railway incidents, flood and landslide awareness, and before-and-after analysis of road widening (Isradi, Dwiatmoko, et al., 2024; Nurhasanah et al., 2024; Prasetijo et al., 2024; Rifai & Prasetijo, 2026; Rifai, Prasetijo, et al., 2025). These titles identify research domains. They do not justify numerical safety predictions without examining study design, exposure denominators and local conditions.

Asset management and lifecycle feasibility

Maintenance-related records include data mining, pavement prediction, decision-support interfaces, optimisation and national-road maintenance (Rifai et al., 2016; Rifai, Hadiwardoyo, et al., 2015; Rifai & Handayani, 2016; Rifai & Handayani, 2018; Rifai, Pereira, et al., 2015). Lifecycle policies, satisfaction in maintenance contracts and post-disaster rehabilitation perception form a complementary planning cluster (Dardak et al., 2020a; Dardak et al., 2020b; Rifai, Isradi, et al., 2023; Rifai & Prasetyo, 2023; Rifai, Thalib, et al., 2022). These subjects are relevant to the proposed requirement that capital investment be evaluated together with service continuity and recurrent obligations.

Markov-based condition prediction, deterioration modelling and disaster-related damage identification provide additional candidate analytical approaches (Isradi, Prasetijo, et al., 2024; Isradi, Rifai, et al., 2024; Rifai et al., 2024). This manuscript does not compare their predictive accuracy or recommend a particular model. Model selection would depend on full-text appraisal, available data, out-of-sample testing and the intended decision use.

METHODOLOGY

Research design and evidence boundary

The study comprises a completed bibliographic screening and conceptual design stage, followed by a proposed empirical stage. The completed stage uses the supplied spreadsheet as the sole substantive publication inventory. The journal template is used only to format the manuscript and is not treated as evidence about transport systems.

No full-text synthesis, stakeholder interview, travel survey or geographic accessibility calculation was conducted.

There are 249 populated bibliographic records in the source spreadsheet. Purposive screening retained 100 records according to direct relevance to service integration, user experience, travel choice and access, together with supporting relevance to operations, safety and lifecycle feasibility. Each selected record was assigned one primary theme to avoid double counting in the theme summary. The remaining 149 records were not selected within the thematic limit; non-selection is not a judgment of publication quality.

Screening was performed by inspecting titles and supplied metadata. No independent second-screening exercise or inter-rater statistic is claimed. Author-name strings, years and DOI fields require validation against original publications. The targeted number of 100 is a user-specified bibliography constraint rather than a saturation criterion. Selection bias and the author-centred scope are therefore explicit limitations.

Table 1 summarises the distribution of records retained in the bibliographic screening.

Table 1. Distribution of selected bibliographic records

Primary theme	**Records**
Public transport integration, TOD and sustainability	24
Mode choice, affordability and travel behaviour	19
Walking, inclusion and access to opportunities	9
Network operations, parking and demand management	24
Safety and network resilience	10
Asset management, lifecycle cost and digital planning	14
Total	100

Proposed study boundaries and data

The empirical application would define its geographic boundary before modelling. Candidate units are network links and nodes, service routes and interchanges, geographic zones and opportunity locations, and households or population groups. The zoning system and demographic categories would be justified using verified local information rather than presumed national characteristics.

Table 2 specifies the proposed minimum data architecture for empirical application.

Table 2. Minimum proposed data architecture

Domain	**Required information**	**Analytical purpose**
Network and services	Links, stops, schedules, frequencies, operating periods and accessibility constraints	Represent feasible complete journeys
Households and travel	Income, location, expenditure, trip purposes, constraints and available alternatives	Assess affordability and distribution
Opportunities	Locations and meaningful capacities of employment, education and healthcare	Measure opportunities reachable
Costs and finance	Fares, transfers, capital cost, operating cost and renewal obligations	Assess user burden and lifecycle feasibility
Safety and condition	Geocoded incidents, exposure measures, facility audits and asset condition	Screen safety, inclusion and continuity
Implementation	Mandates, responsibilities, funding and project dependencies	Assess delivery feasibility

Accessibility and affordability measures

A cumulative-opportunity measure is proposed: $A_{ig}^{s} = \sum_{j=1}^{J} O_j I\left(C_{ijg}^{s} \leq \tau_g\right)$ Here, A_{ig}^{s} denotes accessibility from

origin i for group g under scenario s; O_j is the opportunity quantity at destination j; C_{ijg}^{s} denotes the journey impedance; τ_g is a declared threshold; and i is an indicator equal to one when the threshold is met. This is an analytical specification proposed for application, not an estimated model.

Travel-time and monetary-cost accessibility would first be reported separately. If generalized cost is subsequently used, assumptions about the value of time would be disclosed and tested. Thresholds would be evaluated across a plausible range, with opportunity categories reported separately. Journey feasibility would incorporate operating hours, walking links, waiting and transfers where data permit. Unreachable destinations would not be assigned an artificial finite journey time.

Household transport burden is specified as $B_h^s = \frac{E_h^s}{Y_h}$, where E_h^s represents transport expenditure and Y_h disposable income measured over the same period. Zero or uncertain income values require separate handling rather than mechanical division. This ratio would be paired with essential-trip costs and indicators of unmet travel needs. A low expenditure share would not automatically be classified as a favorable outcome.

Distribution and decision rules

Scenario change is specified as $\Delta A_{ig}^{s} = A_{ig}^{s} - A_{ig}^{0}$, where 0 denotes the measured baseline. Results would be reported by locally justified groups and locations, including absolute change and baseline access. We would declare population weights and missing-data treatment. We would present aggregate improvements alongside the number and characteristics of people experiencing losses or negligible benefits.

A two-stage project protocol is proposed. Mandatory screening first considers legal feasibility, safety, essential access requirements, and credible lifecycle provision. Only eligible projects enter comparative assessment. Where multicriteria scoring is appropriate, $S_p = \sum_{k=1}^{k} w_k z_{pk}$ with z_{pk} the normalized criterion and w_k an explicitly declared weight. Normalization direction, bounds, and treatment of missing values must be set before scoring.

Weights would represent documented decision priorities, not objective scientific constants. Stakeholder-derived and analyst-defined alternatives would be reported separately. We would examine correlated criteria to avoid counting the same benefit repeatedly. Sensitivity analysis would show ranking stability under alternative weights, demand assumptions, cost estimates, and thresholds. Safety and essential-access conditions would not be traded away solely through a high aggregate score.

RESULTS

Bibliographic mapping outcome

The completed screening produces a 100-record thematic map, summarised in Table 1. Forty-three records concern public transport integration, sustainability, mode choice or affordability-related topics. Nine address walking, inclusion or access interfaces. The other 48 provide operational, safety, resilience and lifecycle support. These counts describe the selected bibliography, not the prevalence of topics in the global literature or the strength of evidence for policy effects.

Integrated socioeconomic architecture

The principal conceptual output is a five-stage architecture: investment inputs → network and service changes → complete-journey conditions → accessibility and affordability → distributional outcomes. Institutional

feasibility and lifecycle funding are evaluated across these stages. Each candidate intervention must specify an expected mechanism, intended beneficiaries, required operating assumptions and measurable outcomes.

For example, an interchange proposal would identify the connections changed, services required, transfer conditions, users able to benefit and any additional fare burden. A road-capacity proposal would specify which journeys change and whether the model incorporates altered route or mode choices. These are evaluation requirements, not claims that either project type is preferable in Morocco.

Table 3 presents the proposed project assessment matrix.

Dimension	Candidate indicator	Decision question
Access	Opportunities reachable by purpose and threshold	Who gains practical access?
Affordability	Expenditure burden, essential-trip cost and unmet needs	Who can afford the journey?
Integration	Feasible connections, transfer time and fare compatibility	Does the complete journey improve?
Reliability	Journey-time variability and service delivery	Is travel more predictable?
Safety and inclusion	Exposure-based outcomes and access audits	Can intended groups travel safely?
Lifecycle continuity	Condition, renewal needs and recurrent funding	Can benefits be sustained?
Distribution	Benefits and burdens by group and location	Who benefits, loses or remains excluded?
Delivery	Responsibilities, dependencies and financing	Can the proposed service be delivered?

Scenario comparison protocol

Four illustrative scenarios are specified in Table 4. They are analytical alternatives, not a description of adopted Moroccan policy. Their project contents would be defined only after baseline diagnosis and feasibility screening. The baseline should distinguish observed services from formally committed and funded changes; uncertain announcements should not be treated as guaranteed delivery.

Table 4. Illustrative development scenarios

Scenario	Design emphasis	Primary comparison
Baseline continuation	Measured provision plus explicitly justified commitments	Counterfactual conditions and deterioration assumptions
Capacity-oriented development	Selected additions to network or service capacity	Performance change and distribution of gains
Integrated multimodal development	Coordinated services, transfers and access links	Complete-journey access and operational dependencies
Equity-oriented development	Access deficits, essential travel and affordability	Changes for groups with low baseline access

No numerical scenario ranking is reported. The framework instead specifies a common reporting package: accessibility by opportunity category, affordability and unmet needs, distributional change, safety and inclusion screening, lifecycle finance, and ranking sensitivity. Alternatives should use consistent spatial units, price bases, analysis periods and service assumptions.

Implementation and monitoring protocol

Table 5 sets out the proposed implementation and monitoring sequence.

Table 5. Proposed implementation sequence

Stage	Deliverable	Validation requirement
Evidence preparation	Verified publication register and local policy inventory	Check original records and document source limitations
Baseline diagnosis	Network, household and opportunity database	Audit completeness, dates and spatial consistency
Indicator co-design	Definitions, thresholds and reporting groups	Document stakeholder participation and contested choices
Scenario construction	Feasible service and infrastructure alternatives	Confirm operations, costs and dependencies
Assessment	Distributional results and sensitivity analysis	Reproduce calculations and test assumptions
Monitoring	Outcome indicators with owners and update periods	Track delivered services and observed user outcomes

The proposed monitoring system would compare promised outputs with delivered services and observed access outcomes. Each indicator would have a baseline date, responsible organisation, update interval and missing-data rule. Monitoring should record both construction completion and the service conditions on which the benefits depend. No particular organisation is assigned responsibility in this conceptual paper.

DISCUSSION

Interpretation of the framework

The framework changes the analytical focus from infrastructure quantities alone to the conditions under which people can use networks. It does not dismiss capacity or engineering performance; it places them within a broader explanation of service delivery and access. Operational improvements are treated as intermediate changes whose socioeconomic implications must be measured.

Aggregate performance and equity are not assumed to be either inherently conflicting or automatically aligned. A project could generate a favourable average while leaving particular groups without meaningful change. Another could address an explicitly prioritised access deficit while generating a different aggregate result. The proposed reporting structure makes these distinctions visible rather than concealing them inside one index.

Transferability and a Moroccan application

A Moroccan application requires three transferability checks: construct equivalence, measurement equivalence and contextual suitability. Construct equivalence asks whether an indicator represents the same concept across settings. Measurement equivalence concerns whether comparable data can be collected. Contextual suitability examines whether local service, institutional and behavioural conditions permit the same interpretation.

The present bibliography can guide questions about walking access, modal alternatives, service integration and maintenance, but it cannot establish Moroccan fare burdens, corridor priorities or institutional mandates. A local documentary inventory is therefore a prerequisite to application. The paper deliberately avoids naming investment corridors or asserting national policy gaps without supporting primary evidence.

Governance and practical decision use

The proposed protocol separates empirical estimates from normative choices. Modelled access change is an analytical estimate; the priority assigned to groups is a decision judgment. Both should be disclosed. Stakeholder

engagement would document who participated, how competing priorities were handled and whether participation captured people unable to use existing services, rather than only current passengers.

A financially plausible infrastructure design is not automatically a credible operating scenario. The empirical

study would identify recurrent funding, maintenance responsibilities, service obligations and dependencies before interpreting modelled benefits. Unfunded or operationally unsupported assumptions would be represented as risks rather than treated as guaranteed outcomes.

Testable research propositions

Four propositions follow from the architecture. First, alternatives with similar aggregate travel-time gains may differ in distributional access. Second, service and transfer changes may alter accessibility without major physical expansion. Third, inclusion of operating and renewal obligations may change project feasibility. Fourth, equity-sensitive priorities may change investment ordering. These are hypotheses for future investigation; none is tested by the bibliographic screening.

Limitations

The literature base is purposive, author-centred and constrained to 100 selected records. It is not a comprehensive or balanced sample of the international field. Title-and-metadata screening cannot establish research quality, causal validity or the consistency of reported results. No duplicate-publication equivalence test beyond record selection is claimed, and some bibliographic fields require correction against original sources.

The study also lacks a Moroccan baseline, locally elicited decision weights, calibrated journey models and empirical outcome estimates. It cannot recommend a preferred development scenario or quantify national benefits. These restrictions are substantive, not merely editorial. The framework should therefore be evaluated as a conceptual contribution and an explicit research protocol.

CONCLUSION

This paper presents a socioeconomic planning framework for future application to transport network development in Morocco. Its contribution is an auditable connection between investment, services, complete journeys, access, affordability and the distribution of outcomes. A screened 100-record bibliography identifies six relevant analytical domains, while remaining distinct from a full-text synthesis of findings.

The proposed protocol combines mandatory project screening with transparent comparative assessment and sensitivity testing. It requires separate reporting of aggregate performance, group-specific outcomes, unmet travel needs and lifecycle feasibility. Four scenarios provide a common structure for subsequent comparison, but no scenario is endorsed without local evidence.

The next empirical stage is to verify the bibliography, assemble Moroccan primary data, define the study boundary, validate indicators with stakeholders and evaluate feasible alternatives against a reproducible baseline. Until those tasks are completed, conclusions should concern assessment design rather than actual network performance or investment returns.

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ETHICAL CONSIDERATIONS

This conceptual manuscript uses bibliographic metadata and reports no human-participant recruitment, interviews, experiments or identifiable personal-data analysis. No ethics approval number is claimed. Any subsequent household survey or interview component must undergo the applicable institutional review before participant recruitment.

CONFLICT OF INTEREST

No conflict

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DATA AVAILABILITY

The source inventory is Google Scholar. It contains 249 populated bibliographic records. The selected 100 records and their primary themes are provided in the companion audit workbook. No Moroccan empirical dataset was generated or analyzed. Public availability or permission to redistribute the original inventory has not been established.

AUTHOR CONTRIBUTIONS

YEA conceptualization, methodology, S bibliographic screening, OB analysis, writing, NEM review and supervision.

AI-ASSISTED PREPARATION DISCLOSURE

A generative AI assistant supported manuscript drafting, bibliographic organization, and document formatting.

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