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A policy-driven multi-scale decision support framework for identifying and prioritising strategic transport and urban development corridors.

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Abstract

This study develops a policy-driven, multi-scale Decision Support Framework (DSF) for the identification, characterisation, and prioritisation of strategic transport and urban development corridors. The methodology operationalises a "policy-first" approach in which policy and strategic objectives are formalised into explicit technical requirements prior to data selection and modelling. This ensures traceability between policy goals, spatial indicators, analytical processes, and ranking outputs.

The framework is structured through a domain model documented in Unified Modelling Language (UML) and aligned with ISO and INSPIRE interoperability standards. It integrates three layers: (1) a motivational layer defining policy objectives and scenarios; (2) a business layer describing analytical workflows and use cases; and (3) an application layer implementing spatial data structures and computational procedures.

The methodological workflow comprises five sequential phases. First, corridor identification translates policy-defined thresholds – such as population coverage and connectivity requirements into spatially explicit corridor envelopes using network modelling, least-cost path analysis, and travel-time accessibility techniques. Second, spatial characterisation applies a structured indicator system derived strictly from policy objectives. Indicators span socio-economic performance, accessibility and logistics, environmental sustainability, demographic development, and security dimensions. Data harmonisation and geoprocessing procedures ensure cross-corridor comparability.

Third, corridors are evaluated using multi-criteria decision analysis (MCDA). Each indicator is associated with a policy-based utility function, and weights are determined either through stakeholder elicitation or analytical weighting schemes. Two complementary ranking techniques are applied: Simple Additive Weighting (SAW) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). Cross-validation between methods enhances the robustness and transparency of results across multiple policy scenarios.

Fourth, stakeholder consultation is integrated to validate quantitative outcomes and refine weighting structures. Fifth, the framework applies a multi-scale refinement process, subdividing selected corridors into grid-based spatial units at a 5×5 km resolution to identify localised intervention priorities and development constraints. This recursive disaggregation is a defining feature of the framework's architecture, enabling targeted analysis below the corridor level.

The methodology is demonstrated through a continental-scale application across Africa, identifying 55 candidate corridors and ranking them under multiple policy scenarios, yielding a prioritised set of 12 strategic investment corridors. Consistent with its UML-based domain model and adherence to ISO and INSPIRE standards, the proposed framework provides an interoperable, transparent, and transferable analytical architecture that bridges policy formulation and spatial modelling, enabling evidence-based corridor prioritisation across scales.

Keywords: Policy modelling, Investment planning, Strategic corridors, Data structure, Multiple criteria spatial decision support