

AN INTELLIGENT LAYER FOR HYBRID URBAN LOGISTICS SYSTEMS AS A TOOL FOR COLLECTIVE DECISION-MAKING IN URBAN POLICY

Milovidova A.A., Lakhmetkina N.Yu.

Dubna State University, Universitetskaya St., 19, Dubna, Moscow Region, 141982, Russian Federation; MIREA – Russian Technological University, Vernadsky Prospekt, 78, Moscow, 119454, Russian Federation Moscow, Russian University of Transport MIIT, Institute of Management and Digital Technologies

Urban logistics in modern megacities has evolved from a problem of operational optimization into a socially and politically significant domain of urban governance. The use of hybrid AI systems combining demand forecasting and adaptive routing increases logistical efficiency but reduces the transparency of algorithmic decisions for logistics operators, municipal authorities, and citizens. Existing approaches in urban logistics and Explainable AI primarily focus on interpreting model outputs and fail to ensure transparency in the formation of goals, criteria, and trade-offs among conflicting stakeholder interests.

The aim of this study is to develop a conceptual architecture of an intelligent wrapper for a hybrid AI-based urban logistics system that ensures procedural transparency, reproducibility, and alignment of collective decision-making. The intelligent wrapper is interpreted as a cognitive–institutional layer built on top of computational AI modules.

The proposed architecture consists of four layers: PROMPT-based interfaces for stakeholder interaction; hierarchical metric conceptual templates (HMCT); a chronomodel for capturing decision-making trajectories over time; and a conflict facilitation module with visual analytics.

The AI components of the system include a demand forecasting module based on recurrent neural networks (LSTM) and an adaptive routing module implemented using a modified ALNS algorithm for the dynamic vehicle routing problem with time windows, as well as an integration layer that aligns demand forecasts with optimization constraints.

HMCTs provide a linkage between stakeholders’ semantic interpretations and AI model parameters and include a semantic core, cognitive frames, a parametric space, scenarios, and trajectories of change.

The study is conceptual in nature and is based on a theoretical analysis of urban logistics, decision support systems, and Explainable AI. Empirical validation and effectiveness evaluation are identified as directions for future research. The proposed approach extends the concept of the “smart city” toward a paradigm of procedurally transparent collective thinking.