AI-AUGMENTED DECISION-SUPPORT FRAMEWORK FOR TRANSPORTATION AGENCY FISCAL SUSTAINABILITY

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ABSTRACT

Transportation agencies increasingly use forecasting, optimization, and financial models. However, fiscal gaps persist in part because the capabilities of existing decision-support systems are often fragmented, opaque, and weakly integrated. These limitations constrain agencies' ability to identify, compare, and time fiscal responses across revenue policy, grant capture, and capital financing obligations. This dissertation reframes transportation fiscal sustainability as partly endogenous to the quality of decision support, compared with a function of revenue inadequacy or modeling accuracy. The dissertation develops an AI-augmented decision-support framework, implemented as the AI-Augmented Transportation Fiscal Intelligence System (ATFIS), that pairs multiple deterministic quantitative modules with a large language model interpretive layer activated through computational context injection. The framework integrates three analytical modules that address the primary financial levers of a transportation agency. Module 1 outputs forecast state-level fuel tax revenue erosion under vehicle electrification using time-series and diffusion models. Its outputs project severe long-horizon losses and quantify the per-vehicle fees required to restore revenue neutrality. The outputs of Module 2 formulate federal grant portfolio optimization as a binary integer program; The outputs demonstrate that structured project-to-program pairing improves federal grant capture and lowers state cash requirements compared with unstructured assignment. Module 3 quantifies government contingent liability exposure in transportation public private partnership projects, applying a correlated competing-risk Monte Carlo simulation. Its outputs show that adverse-case exposure can exceed the deterministic point estimate by a wide margin. A cross-module integration layer reads from a shared scenario state to answer fiscal questions, addressing interdependencies among multiple modules across a shared-budget environment. The framework is demonstrated using U.S. transportation cases. However, it is adaptable to other revenue systems, grant structures, and financing arrangements, making it relevant to transportation agencies across different international and institutional contexts. The framework constitutes a foundational step toward AI-integrated budgeting practices in transportation agencies.