ALL-ENCOMPASSING EVALUATION OF COST-BENEFIT ANALYSIS METHODS FOR THE CROWDFUNDING FEATURE OF THE MOBILITYCOIN SYSTEM

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Introduction

- The Agency, the regulatory body of the MobilityCoin system, is responsible for selecting projects that align with one of the main goals of the system: reducing traffic externalities [1].
- Cost-Benefit Analysis (CBA) is a common tool used to evaluate project investments by comparing whether the project's benefits exceed its costs.
- However, CBA faces several key challenges, with five recurring issues identified in the literature, as shown in Figure 1.

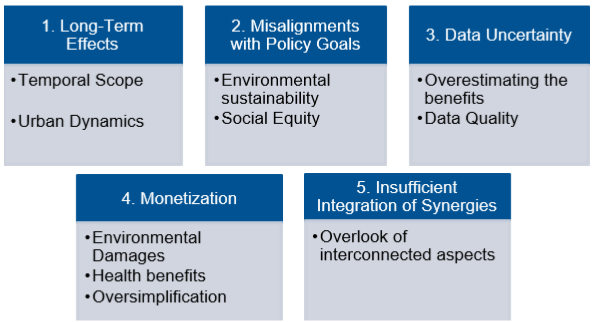

Figure 1. Challenges in the CBA

General Approach

To support the selection of projects that reduce externalities and promote crowdfunding, a decision tree was developed. It incorporates enhanced CBA methodologies tailored to the MobilityCoin System.

Externalities identification

An analysis of current road transport projects identified nine relevant externalities, which were later grouped by issue type to support a more comprehensive evaluation approach. As presented in Figure 2.

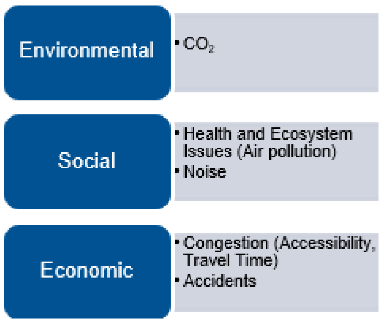

Figure 2. Externalities Addressed in Transport Projects

Methodologies identification

- Methodologies with a direct impact on project evaluation were selected. These include **Life Cycle Assessment** (**LCA**), to address sustainability and account for infrastructure emissions often overlooked in CBA [2]; **Sensitivity Analysis**, to improve data quality in both the LCA and traffic models; and **Monte Carlo Simulation**, to address uncertainty in the monetization process.
- In contrast, methods such as Multicriteria Analysis (MCA), Stakeholder Engagement, Geographic Information Systems (GIS), and Real-time Data Integration were excluded to maintain a focused scope.

Impact Quantification

Studies have shown that these outputs can improve the quantification of externalities, resulting in more accurate data and more granular results, which make the monetization process less subjective.

- **Emissions**: VKM (Vehicle Kilometers Traveled)
- **Noise**: Reliability of results such as Traffic Volume, composition and speed.
- **Congestion**: Total Delay (veh·h)
- **Accidents**: AADT (Annual Average Daily Traffic) to use Safety Performance Functions (SPFs)

Monetization

Methods were selected based on their fit with the MobilityCoin system. For **emissions**, the approach prioritizes local data and characteristics; for **noise**, different methods were applied depending on data availability; **congestion** was measured using the Generalized Cost method to reflect overall impact; and **accidents** were monetized by severity using SPFs.

Deterministic and Stochastic Assessment

As is common in CBA, the **Net Present Value** (**NPV**) is used to determine whether benefits exceed costs. Later, **Monte Carlo Simulation** is applied to address uncertainty in the monetization process by estimating the probability that investment criteria are met.

Results

- The resulting decision tree includes eight stages and addresses most of the main CBA challenges, resulting in a more robust decision-making framework.
- It not only reduces traffic externalities but also ensures that final outcomes align with projections, building trust among users and consequently enhancing crowdfunding. See Figure 3.

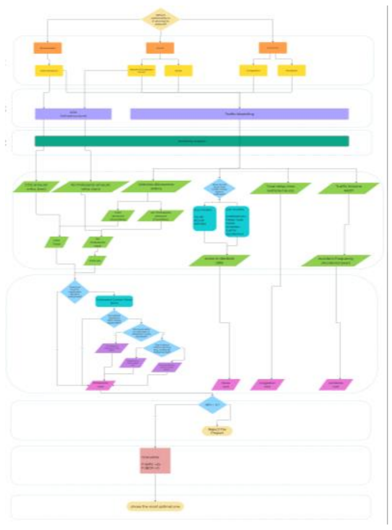

Figure 3. Final decision tree

Future Work

- Analyze distributional impacts to promote equity.
- Integrate dynamic modeling to better capture urban evolution, improving traffic predictions and associated benefits.
- Explore context-specific conversion factors.
- Identify the most effective traffic model for quantifying externalities in the MobilityCoin system, considering cost-effectiveness and outcomes.
- Apply methodologies before and after project evaluation to ensure reliability and user acceptance.

References

[1] BOGENBERGER, KLAUS; PHILIPP BLUM; FLORIAN DANDL; LISA-SOPHIE HAMM; ALLISTER LODER; PATRICK MALCOLM; MARTIN MARGREITER; NATALIE SAUTTER (2021). Mo bilityCoins– A new currency for the multimodal urban transportation system. URL: http://arxiv.org/pdf/2107.13441v2.

[2] DONG,YAN; SIMONA MIRAGLIA; STEFANO MANZO;STYLIANOS GEORGIADIS; HJALTE JOMO DANIELSEN SØRUP; ELENA BORIANI; TINE HALD; SEBASTIAN THÖNS; MICHAEL Z. HAUSCHILD (2018). "Environmental sustainable decision making– The need and ob stacles for integration of LCA into decision analysis". In: Environmental Science & Policy 87, pp. 33–44. ISSN: 14629011. DOI: 10.1016/j.envsci.2018.05.018.