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ANALYZING TRANSPORT POLICIES EFFECTS IN DEVELOPING COUNTRIES

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ABSTRACT

This dissertation explores urban travel mode choices in developing countries, using an agent-based model simulation, with a case study in Cali, Colombia. This study investigates policy implications on individual decisions and the overall transportation system, incorporating motorcycles as a crucial mode of transport in developing regions. A survey was designed and conducted to gather sociocultural information used to represent agents and their travel behavior in the model. Survey data analysis reveals distinct preferences: low/middle-income groups prioritize cost and time, favoring motorcycles, while high-income individuals prioritize travel time, comfort and security, opting for cars. Preliminary policy simulations indicate positive impacts of interventions such as free public transportation, increased public transport capacity, and enhanced user security. This research informs the crafting of effective and sustainable urban transportation policies in the Global South, emphasizing the importance of tailored strategies for diverse commuter groups.

1 INTRODUCTION

Rapid urbanization and economic growth are driving increased demand for transportation, with private vehicle ownership projected to double by 2050 (World Bank 2017). This trend presents significant environmental and socioeconomic challenges for urban areas. Developing sustainable transport systems requires public policies addressing road safety, environmental impact, and congestion. Policy effectiveness depends on pre-implementation impact evaluation, for which Agent-Based Modeling (ABM) is a valuable tool. ABM helps unravel transportation system complexities, providing insights into individual and collective travel behaviors, thus informing effective urban transportation policies (Gilbert 2005).

Research on travel behavior and mode choices has employed various methods, from traditional statistical approaches (Rajanandhini and Elangovan 2022) to machine learning techniques (Abulibdeh 2023). However, these methods often struggle with nonlinear relationships, individual heterogeneity, and dynamic system states. ABM simulations effectively address these challenges (Bazzan and Klügl 2014). While ABM has been used to analyze transport mode choices (Faboya et al. 2020; Kagho et al. 2020), its application has primarily focused on developed economies, often overlooking motorcycles (Cadavid and Salazar 2021). In developing countries, motorcycles are a preferred mode for middle- and low-income individuals due to affordability and efficiency. The prevalence of motorcycles, combined with limited public transit, leads to congestion, accidents, and pollution (Suatmadi 2019). Effective public policies are crucial for addressing these issues in the Global South.

This dissertation research examines urban commuter travel mode choices in developing countries, with a focus on policy impacts. The primary objective is to understand how policies influence factors affecting individual mode choices and their broader implications for the overall transportation system. To achieve this, an agent-based model simulation is being developed in NetLogo, informed by both quantitative and qualitative data collected through surveys and focus groups in a Colombian case study city. A key innovation of the model is the explicit inclusion of motorcycles as a significant transportation mode, addressing a critical gap in existing transport models for developing countries. This research not only

contributes to academic knowledge but also serves as a practical tool for analyzing and evaluating transport policies in the Global South. The insights generated will enable policymakers to craft more effective, targeted strategies for diverse commuter groups based on their specific behaviors, preferences, and socioeconomic characteristics.

2 METHODS

Data collection: Cali, Colombia's third-largest city, faces high road accident rates, exacerbated by a rapid increase in motorcycles, which now constitute over 63% of the total vehicles in the country, exciding 12 million (ANDEMOS 2024). To understand mobility dynamics, census data, accident records, vehicle registries, focus groups, and surveys were utilized. The results underwent descriptive and inferential statistical analyses, with multinomial logit models (MNL) applied to determine the factors influencing mode choice that would be included in the simulation.

Simulation model: The model simulates mode choices (car, motorcycle, and bus) while considering different demographic characteristics of travelers. Individuals optimize their commute satisfaction by evaluating seven transport attributes using the CONSUMAT approach (Jager and Janssen 2012). In the face of uncertainty regarding transport modes, people gather information from their peers; this social influence is represented through a scale-free network. Metrics such as road accidents, CO2 emissions, modal share, and average speed are calculated over time steps to assess the system's state. The model was validated by comparing the simulation patterns with historical data and the Bass diffusion model for the forecasted years.

Policy interventions: The impacts of free public transportation, increased capacity, and enhanced security perceptions have been evaluated so far in the case study city.

3 CONCLUSIONS

MNL models indicate socioeconomic attributes significantly influence mode choice. User perceptions, also crucial determinants, vary among socioeconomic groups. These variables incorporated and parameterized in the simulation model reflect how factors like long travel times and perceived insecurity in public transit drive individuals toward private options. Notably, low/middle-income groups prioritize time and cost, favoring motorcycles, while high-income individuals prioritize personal safety, travel time, and comfort, opting for cars. Preliminary results show that the evaluated policies have positive impacts promoting use of massive transportation, therefore, reducing accidents, CO2 emissions and congestion.

REFERENCES

Abulibdeh, A. 2023. “Analysis of Mode Choice Affects from the Introduction of Doha Metro Using Machine Learning and Statistical Analysis”. *Transportation Research Interdisciplinary Perspectives* 20(7):100852.

ANDEMOS. 2024. Cifras y Estadísticas. https://www.andemos.org/informesinteractivos, accessed 12th June.

Bazzan, A. L. and F. Klügl. 2014. “A Review on Agent-Based Technology for Traffic and Transportation”. *The Knowledge Engineering Review* 29(3):375–403.

Cadavid L. and K. Salazar-Serna. 2021 “Mapping the Research Landscape for the Motorcycle Market Policies: Sustainability as a Trend—a Systematic Literature Review”. *Sustainability* 13(19):10813.

Faboya, O. T., B. Ryan, G. P. Figueredo, and P.-O. Siebers. 2020. “Using Agent-Based Modelling for Investigating Modal Shift: The Case of University Travel”. *Computers & Industrial Engineering* 139:106077.

Gilbert, N. and K. Troitzsch. 2005. *Simulation for the Social Scientist*. 2nd ed. London: McGraw-Hill Education.

Jager, W. and M. Janssen. 2012. “An Updated Conceptual Framework for Integrated Modeling of Human Decision Making: The Consumat II”. *In the Workshop Complexity in the Real World@ ECCS*, September 5th-6th, Brussels, Belgium, 1–18.

Kagho, G. O., M. Balac, and K. W. Axhausen. 2020. “Agent-Based Models in Transport Planning: Current State, Issues, and Expectations”. *Procedia Computer Science* 170:726–732.

Rajanandhini, V. and G. Elangovan. 2022. “Mode Choice Behaviours of Commuters Using Multinomial Logit Model and Soft Computing Technologies: A Case Study Analysis”. *Journal of Intelligent & Fuzzy Systems* 43(3):3373–3391.

Suatmadi, A. Y., F. Creutzig, and I. M. Otto. 2019. “On-Demand Motorcycle Taxis Improve Mobility, Not Sustainability”. *Case Studies on Transport Policy* 7(2):218–229.

World Bank. 2017. Global Mobility Report. https://acortar.link/tcYe5E , accessed 30th May.