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Investigating Urban Cycling Demand Utilising Crowdsourced Data

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Introduction

Global efforts are being made to promote active travel modes and reduce the reliance on motorized traffic. These efforts aim to address issues such as **congestion and air pollution**, decrease energy dependency, and enhance equity and accessibility for all. To effectively plan for active modes and assess related promotion policies, city and transport authorities depend heavily on data.

However, obtaining sufficient data for cycling is more challenging compared to other modes; available data typically originates from detectors or counters, covering only a limited period and a small area. This challenge of data scarcity can be addressed by exploiting novel data sources, such as **crowdsourced data**. This specific research focuses on utilizing **"Strava Metro"** cycling trips data to demonstrate a framework intended to understand and model the spatiotemporal aspects of cycling trips.

Objectives

The overarching **objective** of this research is to leverage a better understanding of cycling demand patterns to guide infrastructure and safety priorities.

Specifically, the objectives are:

1. To **demonstrate a framework** to utilize "Strava Metro" data to understand and model spatiotemporal aspects of cycling trips.

2. To develop a **mathematical model** using crowdsourced cycling data.

3. To identify key factors influencing **cycling demand**.

4. To identify environments that support both **higher demand** and should be prioritized by policymakers and transport engineers for targeted cycling safety improvements

Methodology

Data Collection and Scope

The study collected cycling activity data from the "Strava Metro" platform for the years 2021 and 2022.

- **Study Area**: The data covered 11,446 road segments within two adjacent municipalities in Athens, Greece: Chalandri and Vrillisia. These municipalities were specifically selected due to their developed cycling network and the higher cycling traffic present.
- **Data Enrichment:** The raw Strava data was spatially represented using a Geographic Information System (GIS). It was then enriched by integrating additional data related to:
  - Road characteristics (e.g., road types, segment lengths).
  - Surrounding land uses.
- **External Data Sources:** The road characteristics and land use data were sourced from OpenStreetMap and processed using QGIS.

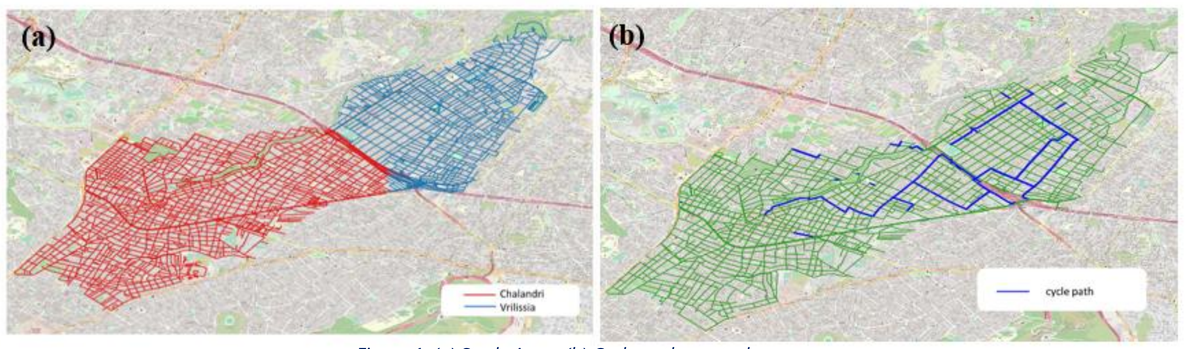

Figure 1: (a) Study Areas (b) Cycle path on study areas

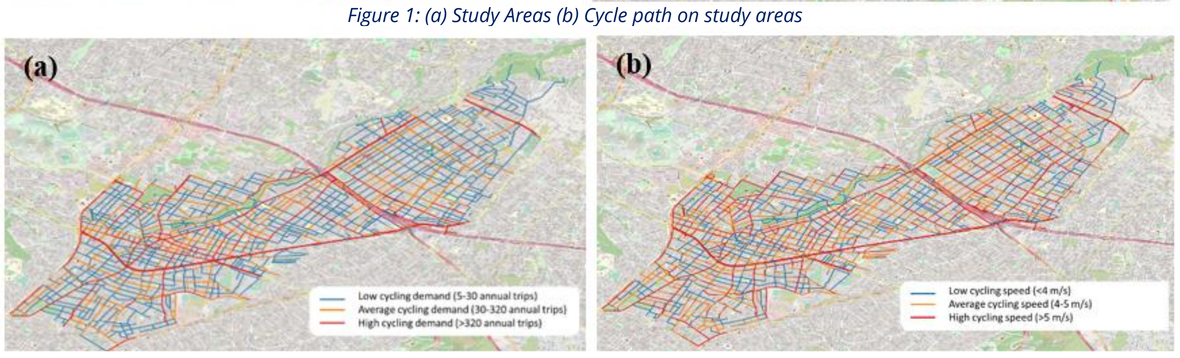

Figure 2: (a) Cycling demand heatmap (b) Cycling speed heatmap

Modeling and Analysis

The primary analytical step involved developing a mathematical model to identify key factors influencing cycling demand.

- **Model Type**: The researchers developed a general **log-normal regression model**.
- **Performance:** This model achieved a satisfactory $R^2 = 0.66$.
- **Statistical Validation:** All independent variables included in the model were found to be statistically significant at a 95% confidence level.
- **Complementary Analysis:** To provide further context and interpret the model results, elasticity analyses were also conducted.

Results

The findings are strongly aligned with international literature, confirming that **infrastructure quality, connectivity, and proximity** to cycling-supportive amenities significantly influence cycling behavior.

Influence of Cycling Speed

The analysis revealed a strong connection between speed and demand:

• Higher average cycling speeds on road segments are associated significantly with increased cycling activity.

• An elasticity analysis showed that a 1% increase in the recorded cycling speed resulted in a 2.7% increase in cycling trips.

Influence of Road Category and Segment Length

• Primary, secondary, and tertiary roads are associated with higher cycling demand compared to cycleways.

• Segment length negatively affects cycling activity, suggesting that longer segments may deter cycling due to increased exposure to traffic and a lack of intermediate safe crossing points.

Influence of Amenities and Time

• Cycling trips were more frequent when routes were closer to bicycle parking facilities and public transport stops.

• Proximity to amenities like leisure parks and education areas was positively associated with cycling activity.

• The analysis found lower cycling activity in 2022 compared to 2021, which corresponds with the return to pre-pandemic travel habits following the initial surge in outdoor activities driven by COVID-19 restrictions.

Variable		Reference Category	Estimate	t. value	elasticity	
					e	e*
Intercept		-	↑ 5.8204	55.513	-	-
Average Cycling Speed		-	↑ 0.0510	7.509	0.002	2.656
Road Category	pedestrian zone	cycleway	↓ -2.3461	19.675	-0.151	-25.555
	residential		↓ -2.2292	29.326	-0.045	-7.550
	motorway		↓ -1.9854	4.254	-0.119	-20.169
	primary		↑ 2.7203	8.730	0.024	4.067
	secondary		↑ 2.4350	26.258	0.024	4.087
	tertiary		↑ 0.2683	3.180	0.006	1.000
	unclassified		↓ -2.8992	11.166	-0.237	-40.083
Road Segment Length (m)		-	↓ -0.0019	3.822	-0.001	-1.198
Proximity to land uses (m)	proximity to bicycle parking spots	-	↓ -0.0004	8.898	-0.004	-4.490
	proximity to education areas	-	↑ 0.0004	2.289	0.001	1.000
	proximity to leisure parks	-	↑ 0.0008	4.747	0.001	1.442
	proximity to public transport	-	↓ -0.0008	3.213	-0.001	-1.087
2022 year		2021 year	↓ -0.7537	55.070	-0.019	-3.195

Table 1: Results of lognormal cycling demand model.

Conclusions

The study developed a model highlighting how **infrastructure type, cycling speed, and proximity to urban amenities affect cycling demand**.

Mismatch Between Demand and Safety

• Cyclists are **more likely to use major roads** (primary, secondary, and tertiary) over cycleways. This reveals a potential mismatch between demand and safe infrastructure.

• The use of these major roads **raises serious safety concerns** because they are typically shared with motorized traffic and lack dedicated cycling infrastructure.

Safety Priority based on Demand

• The **positive association** between cycling demand and average speed, which is commonly used as a key indicator of cycling risk, suggests that high-demand segments may also pose safety concerns.

• The **identification of environments** that support higher demand means these areas should be prioritized by policymakers and transport engineers for targeted cycling safety improvements.

Policy Guidance

• The insights generated by the model demonstrate how cycling demand data can guide infrastructure and safety priorities.

• The positive association with proximity to amenities (like bike parking, schools, and parks) emphasizes the **need to connect infrastructure with everyday destinations**. However, this proximity requires careful design to ensure safe access.

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