Analyzing Urban Mobility Patterns in Finnish Cities Using Mobile Phone Tracking Data

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The research conducted at the **University of Oulu** by Project Researcher **Marton Magyar** and Research Director **Ossi Kotavaara** from the Regional Excellence research team of **Kerttu Saalasti Institute** together with Postdoctoral Researcher **Terhi Ala-Hulkko** and University Lecturer **Harri Antikainen** from the **Geography Research Unit** in collaboration with Project Manager **Tiina Lankila** from **Oulu Deaconess Institute**, Department of Sports and Exercise Medicine. The research framework has been built in the **Transformative Cities project** together with the project consortium and the research has been conducted in cooperation with **Telia Finland Oyj** and **Telia Crowd Insights**.

Transformative Cities

Introduction

From all forms of transportation, **passenger cars** remain the most common in Finland, accounting for 55% of trips. However, in both inner and outer urban areas, more **sustainable** travel modes, such as public transport, cycling, and walking, have a higher share (Traficom, 2024). Due to significant seasonal variations in weather, the prevalence of travel modes involving physical activity is closely **linked to weather conditions** (Somerpalo et al., 2015).

Urban mobility patterns are evolving in response to **infrastructure investments**, **population changes**, **remote work** and **education**, and the rising adoption of new transportation solutions. **Light mobility options** like e-bikes, e-scooters, and city bikes, for instance, are reshaping short and intermediate-haul travel habits (Oeschger et al., 2020). The willingness to **reduce** personal **environmental footprints** in travel also plays a role. Consequently, urban mobility is a **geographically** and **temporally varying phenomenon** difficult to measure directly without physical sensors or ticket data.

This policy brief illustrates an approach based on **mobile phone tracking data** to monitor mobility across various transport modes. A better understanding of the nature and change of these patterns is crucial for achieving **sustainable transportation goals** and **reducing the carbon emissions** in Finnish cities.

Transformative Cities project has developed a **travel time-based** modal detection method to enrich mobility data by integrating modal information with travel volumes at the intra-city scale. In addition, the approach developed will allow **better monitoring** and **measurement of geographical mobility patterns** by physically active modes of transport, which again are related to the health and well-being of citizens.

The study is conducted together with **Telia Finland Oyj** and **Telia Crowd Insights**. It focuses on modal mobility in the city of Oulu and in the Greater Helsinki region including Helsinki (without Eteläinen suurpiiri), Espoo, Vantaa and Kauniainen. The City of Oulu has done large investments into high-speed cycling ‘Baana’ networks and is one of the **leading cities in winter cycling**. The Greater Helsinki region has the **most extensive and actively used public transport systems** in Finland, and the share of walking and cycling in the region is high as well.

Addressing travel data gaps

In travel surveys, there is **limited information** about actual geographic distributions of travels, and the data related to travel modes is not easily transformable into actual mobility patterns. Traffic counters allow us to **monitor temporal dynamics** and **travel modes**, but they have a very limited geographic coverage. While transport models serve well key planning needs, more **accurate data** is very beneficial for precise monitoring. Mobile phone tracking data complements traditional methodologies by providing better answers to questions about when and where.

How we collect and analyze data for the project

Mobile phone data has been widely used in mobility studies (Järv et al., 2021; Wang et al., 2017). In Finland, **Telia Crowd Insights** serves as a prominent provider of large-scale mobile phone tracking data and analysis services. The mobility data used in the analytical examples for modal mobility research in this policy brief is sourced from Telia, which **collects location data from all mobile phones** on its network. This data includes both active events, such as data transmission or SMS exchange, and passive events, such as cell network switches or availability checks.

The service is designed and built **following** the requirements of the **data protection regulation** (Telia, 2024), ensuring that the provided data is completely **anonymized** and aggregated into a minimum granularity of 500-meter grid cells. The examples described utilize information from weekdays in May 2021.

While the mobility data provides information on the number of trips made, the mode of travel was determined using an accessibility model of urban environments. An accessibility model provides travel time proxies based on infrastructure and public transportation data for common travel modes: **walking, cycling, public transport**, and **private car**. Using the travel time proxies, each observed trip between grid cells was categorized into one of these four travel modes. To increase the certainty of modal differentiation, multi-stage travel time filtering was applied to exclude indistinguishable modes or too short travels. Also, the southern major district of Helsinki (Eteläinen suurpiiri) was excluded, as traffic congestion makes it difficult to distinguish between different modes of transport. In addition, to account for bias due to low user count areas, areas covered mostly by forest or water surface were removed using a CORINE Land Cover based filter.

The share of active mobility on the intra-city scale can be also **visualized as a map**. A generalized pattern of non-car-based active mobilities including walking, cycling, and public transport is visualized for Oulu, Vantaa, Espoo, Kauniainen, and partly for Helsinki.

Key findings of the study

The use of mobile phone tracking data presents a significant opportunity to **enhance urban mobility** in Finnish cities. Through the development of robust data integration techniques and informed urban planning using mobility data, policymakers can develop and also promote of sustainable transportation more efficiently and again create more sustainable urban environments. This strategy is aligned with the goals of **Finland's Recovery and Resilience Plan**, supporting the transition towards carbon neutrality and climate resilience.

Mapping physically active mobilities

The heatmap reveals areas with a predominant share of active mobility. In **Oulu**, neighborhoods along a north-south axis consistently show **higher rates of active mobility**, with residential areas near the center also exhibiting above-average activity. The higher share for active mobility extends from the edge of Kaakkuri in the south to Linnanmaa in the north and Rusko in the northeast.

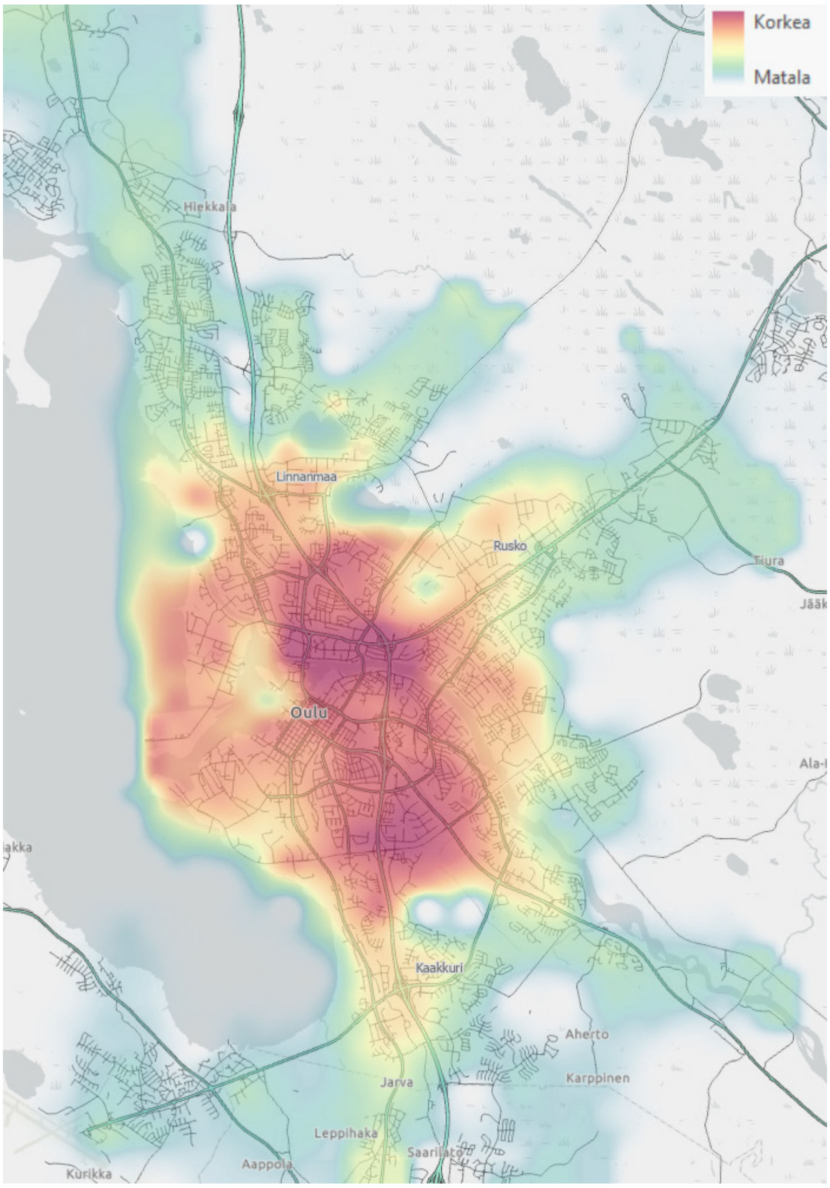

Figure 1: Heatmap showing the share of active mobility in Oulu

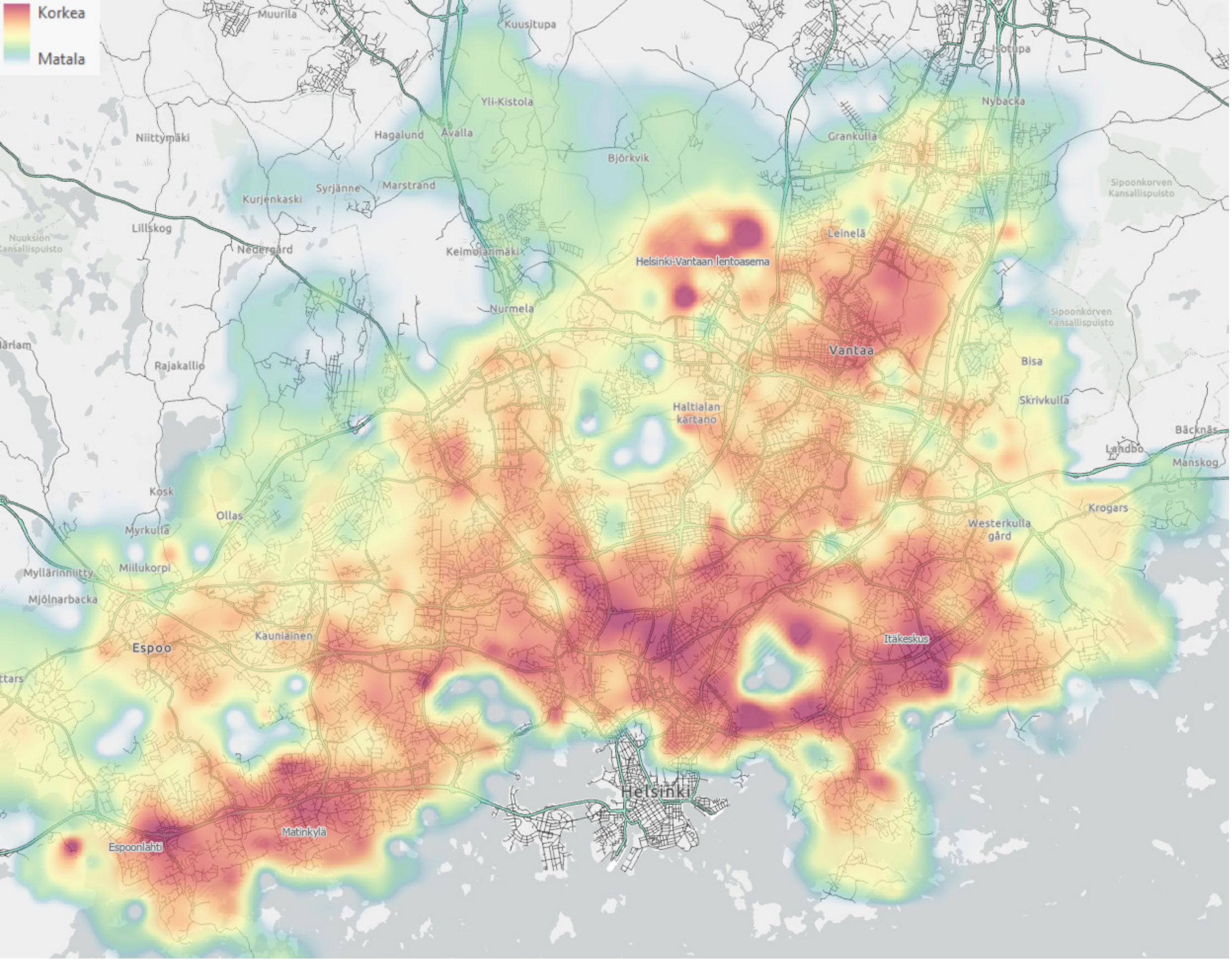

Figure 2: Heatmap showing the share of active mobility in the Greater Helsinki area

In the case of the **Helsinki Metropolitan Area**, the heatmap not only highlights transportation hubs like Espoonlahti, Matinkylä, Itäkeskus, and the international airport in Vantaa, but **also identifies green areas** serving as centers for recreation and leisure activities, such as Kivinokka, Lammassaari, and Keskuspuisto. Alongside these focal points, the results illustrate the overall urban fabric, showing higher car usage in less densely populated areas.

Insights for policymaking

- Transport models currently provide accurate information about **population flows** within infrastructure, estimated mode use, and changes over time. Mobile phone tracking data **offers a more detailed view**, particularly of the intra-city mobility patterns of citizens and the travel modes they use.

- Understanding **physically active mobility patterns**, such as walking, cycling, and public transport use, and the factors influencing modal choice in various conditions helps in **designing more physically active and sustainable transportation** systems. This knowledge supports infrastructure improvement, promotes healthier and environmentally friendly lifestyles, and mitigates environmental impacts.

- Mobile tracking data can be used to monitor **changes induced by transportation infrastructure investments,** including how citizens change their preferred routes and, potentially, their destinations and residences over time.

Conclusion

Finnish cities will have the opportunity to harness **the power of mobile phone tracking data** more effectively in measuring urban mobility with different transport modes. A **better understanding of mobility patterns** can help promote sustainable urban mobility and improve the overall quality of life for residents.

Travel surveys, traffic measurement stations, and ticket data provide comprehensive insights into mobility patterns but are limited in geographic and temporal accuracy. Extending analytical approaches and data sources describing the everyday patterns of citizens with passively sensed – not actively surveyed – mobile phone tracking-based mobility data allows for more **in-depth monitoring and measuring.**

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