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Book of Abstracts

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Research Network on Transportation

Instituto para a Construção Sustentável

ABSTRACTS

(A1)

MS-MRS-RAIL : MULTISCALE MODELLING OF RISK AND SAFETY IN RAILWAY SYSTEMS

Antonio R. Andrade [a]
[a] *IDMEC, IST, University of Lisbon.*
Email: antonio.ramos.andrade@tecnico.ulisboa.pt

Keywords: railway systems; safety; reliability;

Subject area: Railway Systems

Category: Research Projects (funded by FCT or other institutions)

Abstract:
Risk and safety assessments in railway systems are crucial to ensure a competitive railway transport, with high levels of reliability and availability, while minimising the maintenance costs and safety incidents and accidents. The European railway network has consistently maintained a high degree of safety over the years, making it one of the safest in the world. However, the progress has not followed the same pace in terms of their safety levels among the European countries. In 2020, the EU-27 railways recorded 687 fatalities and 469 serious injuries. In Portugal, a train collision occurred in the main line, involving a maintenance vehicle and a long-distance fast passenger train. This accident resulted in 2 fatalities, more than 40 injuries, and a considerable economic impact. The subsequent investigation uncovered that the accident was due to a Signal Passed At Danger (SPAD) caused by an error made by the maintenance vehicle crew. Moreover, it was concluded that the technological evolution of the railway system, as the signalling, communications, and operating systems, lead to a reduction in risk mitigation procedures. Therefore, a better understanding of the numerous factors that influence SPADs occurrence in railways is still needed, through a more comprehensive risk and safety model. Multiscale modelling approaches, common in the literature of solid mechanics and composite materials, can identify the different significant factors that influence reliability, frequency and impacts, for a comprehensive risk assessment at the microscale and at the macroscale levels. First preliminary steps by our research team have been taken at the microscale level, emphasizing the role of drivers' reliability, their experience and the organizational factors in railway companies. Having in mind this need of the public administration organization responsible for the railway safety, IMT or the national safety authority, this exploratory project MS-MRS-RAIL will contribute towards an innovative multiscale model for risk and safety assessments, aiming to achieve a proof of concept that microscale modelling and macroscale modelling can support better decisions in risk and safety management of railway systems.

Date: April 2025 – January 2026

(A2)

AGENDA BE.NEUTRAL: INTEGRATED URBAN ENERGY AND MOBILITY PLANNING THROUGH DIGITAL TWINS IN GUIMARÃES, PORTUGAL

REZA ABBASI [a], ANSELMO CARDOSO [a], SANDRA MELO [a], RICARDO OLIVEIRA [b], RICARDO GOMES [b], PATRÍCIA BAPTISTA

[a] R&D Mobility
CEiiA – Centre for Engineering and Product Development
Email: Sandra.melo@ceiia.com
[b] IN+ Center for Innovation, Technology and Policy Research, LARSyS
Instituto Superior Técnico, Universidade de Lisboa, Portugal
Email: patricia.baptista@tecnico.ulisboa.pt

Keywords: Urban mobility; Vehicle-to-Everything (V2X) systems; Energy management systems; Decarbonization

Subject area: Sustainable Cities and Integrated Urban Energy Systems

Category: Research Projects

Abstract:
A digital twin–based framework was developed to simulate energy and mobility interactions at building and neighbourhood scales, combining geospatial, demographic, and transport data to assess multiple transition scenarios—from Business-as-Usual to low-carbon futures. The approach incorporates Vehicle-to-Everything (V2X) concepts, where electric vehicles (EVs) act as distributed energy storage units, enabling the valorisation of solar energy surpluses through charging, discharging, and load-shifting operations.
Results indicate that while photovoltaic (PV) production alone cannot meet annual energy demand, its integration with ESS improves self-sufficiency (up to 24%) and self-consumption (≈34%). EVs can provide grid support for up to 23% of annual hours (approximately 84 days per year), while shared battery systems could theoretically supply 66–105% of the total annual energy demand in the study area. These findings highlight the potential to create mobility products and services that utilize local renewable excess—such as a shared fleet of light vehicles and bicycles placed in Guimarães.
The research underlines the value of interactive dashboards and decision-support visualizations to communicate energy–mobility synergies to urban planners, fleet operators, and citizens. Future work will focus on expanding the digital twin's capabilities for real-time monitoring, accessibility-based modelling, and integrated policy evaluation to accelerate citywide decarbonization strategies.

Date: April 2023 – December 2025

Acknowledgements: This work was carried out within the scope of the project BE.Neutral – Mobility Agenda for Carbon Neutrality in Cities (contract no. 35), funded by the Plano de Recuperação e Resiliência (PRR) through the European Union's Next Generation EU programme. The authors also acknowledge the financial support of Fundação para a Ciência e a Tecnologia (FCT) through LARSyS (project UIDB/50009/2025).

(A3)

ADVANCING MULTIMODAL TRANSPORT SYSTEM MANAGEMENT THROUGH THE DEVELOPMENT OF DECISION SUPPORT TOOLS

J. HORA[a]✉, J. TEIXEIRA[b]✉, S. FELÍCIO[c], J. ALMEIDA[d], I. SARDINHA[d], M. AFONSO[d], H. ROCHA[b], A.R. COSTA[d], A.R. PEREIRA[ce], T. SOBRAL[ce], R. ROSSETTI[d], A. COUTO[b], J.P. TAVARES[b], M.C. FERREIRA[a], T. GALVÃO DIAS[a]

[a]INESC TEC, Faculdade de Engenharia, Universidade do Porto,
[b]CITTA, Faculdade de Engenharia, Universidade do Porto,
[c]Faculdade de Engenharia, Universidade do Porto,
[d]LIACC, Faculdade de Engenharia, Universidade do Porto,
[e]OPT – Optimização e Planeamento de Transportes S.A.,
✉*Corresponding Authors: joana.hora@fe.up.pt, joaoteixeira@fe.up.pt*

Keywords: Decision Support Tools, Public Transport Planning, Multimodal Transport Systems, Simulation, Optimization

Subject area: Sustainable Urban Mobility

Category: Research Projects

Abstract:
Public transportation systems face ongoing challenges from a decision-making perspective, particularly in attracting and retaining regular passengers in competition with private transport options. Transfer conditions play a crucial role in shaping passenger choices and directly influence the likelihood of frequent public transport use. Understanding and monitoring the evolution of passenger travel patterns is essential to addressing these issues effectively.

This research, conducted by a research group within the AET – Alliance for Energy Transition project, aims to investigate and develop tools that support decision-making in public transport planning at the tactical level. To address this goal, the group focused on developing a platform to support the management of multimodal transport systems. This task is being carried out collaboratively by several project partners.

The contribution of our study group to this effort is structured around the following key activities: a) Implementation of public transport surveys to collect data; b) Data analysis combining newly collected survey data with existing datasets; c) Application of simulation and modeling techniques to represent and evaluate public transport system dynamics; d) Application of optimization methods to improve public transport timetables.

The ongoing research has yielded several important contributions, including synthetic population generation for simulations, timetable synchronization models, explainable AI for urban mobility, reinforcement learning for group travel, behavioral nudging analysis, and passenger segmentation to model intermodal decision-making in multimodal transport systems.

Acknowledgements
This work is a result of Agenda "AET – Alliance for Energy Transition", nr. C644914747-00000023, investment project nr. 56, financed by the Recovery and Resilience Plan (PRR) and by European Union - NextGeneration EU.

Date: September 2023 – September 2025 (ongoing)

(A4)

NUDGING SUSTAINABLE COMMUTING BEHAVIOR

M. AFONSO [a], R. ROSSETTI [b]
Artificial Intelligence and Computer Science Lab (LIACC), Faculty of Engineering, University of Porto
Email: [a] mariam.afonso@fe.up.pt
[b] rossetti@fe.up.pt

Keywords: Sustainability; Urban Mobility; Nudging; Agent-Based Modeling; Socio-Technical Systems

Subject area: Sustainable Urban Mobility

Category: PhD thesis

Abstract:
Grounded in socio-technical systems and sustainable mobility frameworks, this research investigates the effectiveness of subtle behavioral interventions – commonly known as nudging – as softer-control mechanisms to promote sustainable behavior in the context of urban mobility in smart cities. Addressing the challenges of climate change and sustainable urban development requires innovative strategies within socio-technical systems, where the interaction between human behavior, technology, and urban planning shapes both opportunities and barriers to sustainability. Within the triple bottom line (TBL) framework – balancing social progress, environmental equilibrium, and economic growth – achieving systemic change demands shifts in individual decision-making and collective practices. Nudging, as a behavioral insight tool, offers a platform for influencing individual commuting choices based on perceived utility and social awareness, thereby steering the collective behavior within the urban mobility system towards greater sustainability. This study also incorporates ethical and social justice considerations into nudging design and implementation to ensure that behavioral interventions align with principles of fairness and inclusivity in urban mobility policies.

At this stage, the research focuses on developing a conceptual and methodological framework that integrates agent-based modeling (ABM) with sustainability indicators for urban mobility. This framework will enable the simulation of behavioral responses to policy scenarios – such as information framing, default options, or social norm cues – under varying urban contexts. The expected outcome is to identify how small behavioral shifts, when scaled across a population, may contribute to systemic improvements in urban sustainability and mobility efficiency.

Acknowledgments:
This work is a result of Agenda "AET – Alliance for Energy Transition", nr. C644914747-00000023, investment project nr. 56, financed by the Recovery and Resilience Plan (PRR) and by European Union – NextGeneration EU.

Date: Ongoing

(A5)

MOBILITY AS A SERVICE (MAAS): DEFINING THE ROLE OF PUBLIC AUTHORITIES

Mauricio Orozco-Fontalvo [a*], Oscar Oviedo-Trespalacios [b] and Filipe Moura [a]
[a] *CERIS , Instituto Superior Técnico - Universidade de Lisboa, Av Rovisco Pais, Lisbon, Portugal*
Email: Mauricio.orozco@tecnico.ulisboa.pt
[b] *Department of Values, Technology, and Innovation, Faculty of Technology, TU Delft, Delft, The Netherlands*

Keywords: MaaS governance, Multi-level perspective, Metagovernance, Decision tool

Subject area: Transport policy

Category: PhD thesis chapter

Abstract:
A promising strategy for combining many means of transportation into a single digital platform is Mobility as a Service (MaaS). However, MaaS runs the risk of escalating inequality and fueling transportation gentrification if it is mismanaged. Although the literature generally recognizes that public sector participation is necessary to guarantee equitable results, there is still no guidance on how authorities should decide on the proper degree of involvement. By creating a decision-support tool to evaluate and define the role of public transport authorities (PTAs) in MaaS implementation, this study fills this need. The study identifies important institutional, infrastructural, and regulatory aspects that influence the degree of public sector involvement based on an empirical classification of 74 current MaaS and "MaaS-like" systems globally. These ideas are operationalized into a flowchart that facilitates context-specific role definition using the multi-level view on socio-technical transitions and metagovernance theory as the conceptual basis. By giving policymakers a useful framework to match institutional capability with governance initiatives, the suggested tool promotes equitable and sustainable MaaS development.

Date: September 2021 – October 2025

(A6)

THE CONCEPT OF TRANSPORT-ORIENTED DEVELOPMENT (TOD) IN SMALL METROPOLITAN REGIONS: THE CASE OF COIMBRA

JOAO F. BIGOTTE [a,b], PATRÍCIA BRETAS [a]
[a] *Department of Civil Engineering,*
University of Coimbra
Email: jbigotte@dec.uc.pt

[b] *CITTA – Research Center for Territory, Transports, and Environment*

Keywords: Transport-Oriented Development (TOD), Bus Rapid Transit (BRT), Sustainable mobility, Urban development, Metrobus.

Subject area: sustainable mobility, public transport

Category: Master thesis (preferably authors who will continue this research along the PhD; Poster Session)

Abstract:
The concept of Transport-Oriented Development (TOD) aims to address urban planning and sustainable mobility challenges by integrating public transport and land use around stations. Within this framework, the node-place model constitutes an analytical tool to assess the balance between transport functions (node) and urban functions (place).
In Portugal, Bus Rapid Transit (BRT) systems, named Metrobus, are currently under development in several locations, from the large metropolitan areas of Lisbon and Porto to the smaller regions of Coimbra, Braga, and the Algarve.
This work applies the node-place approach to the case of the Metrobus in the Coimbra Region - the first of these systems to become operational in the country and the largest public transport investment in the region in recent decades.
The results show that most suburban stations have low transport supply and low density and diversity of land uses, while urban stations show greater balance. The analysis confirms the relevance of the Coimbra Station Master Plan, reinforcing the need for urban renewal in this area, which encompasses three stations with profound imbalance.
The novelty of the work lies in adapting the node-place model - originally developed for large metropolitan regions and densely populated areas - to the case of small metropolitan regions.
The developed model also proves appropriate for evaluating new developments, such as the claim for a new stop on an existing line or the design of the system expansion.

Date: September 2024 – September 2025

(A7)

GTFShift: an R tool to assist bus lane prioritization using GTFS and OSM data

G. F. MATOS [a,b], R. FÉLIX [a,c] and F. MOURA [a,d]
[a] *U-Shift Research Lab,*
Civil Engineering Research and Innovation for Sustainability (CERIS),
Instituto Superior Técnico, University of Lisbon
[b] *Email: goncaloafmatos@tecnico.ulisboa.pt*
[c] *Email: rosamfelix@tecnico.ulisboa.pt*
[d] *Email: fmoura@tecnico.ulisboa.pt*

Keywords: Bus lanes, GTFS, Transit planning, Decision support tool, R package.

Subject area: Urban planning

Category: Presentation of research activities

Abstract: Bus lanes have the potential to improve the reliability of bus operations by limiting the conflicts with other modes, reducing the variability of travel times and increasing the average commercial speed. However, introducing them on existing infrastructure can't be achieved without affecting other modes, such as private vehicles, which may experience a decrease in the level of service due to reduced allocated space, potentially jeopardizing public acceptance. It is therefore crucial to underlie these interventions on a deep analysis of the network topology, bus frequencies, and traffic dynamics, ensuring that prioritization decisions are supported by quantitative evidence. GTFShift R package uses the General Transit Feed Specification (GTFS) and OpenStreetMap (OSM) open data to perform this analysis, enabling the identification of corridors for any given city where transit benefits are maximized while minimizing negative impacts on other road users, ultimately supporting more balanced and publicly acceptable transport policies. It is complemented by a web-based interface that allows users to interact with the package through any browser without requiring programming skills, which broadens its applicability beyond the research and technical community, empowering public authorities, planners, and non-experts to make data-informed decisions on bus lane implementation and prioritization.

Date: April 2025 – December 2025

(A8)

TRANSFORMING TRANSPORT KNOWLEDGE INTO ACTIONABLE INSIGHTS: DSAIVE - A FRAMEWORK FOR AI-ASSISTED DECISION SUPPORT

J OLIVEIRA [a], A. MENDES [b] and M FERREIRA [c]
[a] *Faculty of Engineering, University of Porto*
Email: up202103305@fe.up.pt
[b] *LEPABE - Laboratory for Process Engineering, Environmental, Biotechnology and Energy, Faculty of Engineering, University of Porto*
Email: mendes@fe.up.pt
[c] *INESC TEC, Faculty of Engineering, University of Porto*
Email: mferreira@fe.up.pt

Keywords: DSAiVE, Artificial Intelligence, MCDMA, Sustainable Transport, Decarbonisation

Subject area: Sustainable Transport

Category: PhD thesis

Abstract

This work investigates how generative artificial intelligence can support knowledge discovery and decision-making in the field of Transport Systems. Early experiments with semantic similarity and vector representations of text revealed that naïve applications of similarity metrics fail to capture domain-specific meaning, yet they highlight valuable paths toward improving holistic understanding while maintaining technical accuracy. Building on these findings, the research evolved toward structuring and interpreting existing scientific knowledge rather than merely accelerating literature reviews. The goal is to bridge the gap between computational language models and evidence-based research across diverse Transport Systems publications.

The proposed framework integrates structured prompting, semantic evaluation, and human-guided validation to transform unstructured transport-related data into concise, factual, and interpretable "atomic units" of knowledge. These atomic facts capture essential relationships and evidence across studies, enabling more consistent comparisons and synthesis of insights. To mitigate the loss of focus and factual drift (commonly referred to as hallucination) observed in large language models (LLMs), the study employs structured output prompts that constrain reasoning to predefined categories such as "Energy Source," "Environmental Impact," and "Application Context." This approach improves coherence, interpretability, and the capacity to handle complex, multidisciplinary datasets.

The findings show that combining structured prompting with expert validation yields more reliable and actionable representations of domain knowledge than purely automated similarity metrics. By converting dispersed scientific evidence into an AI-interpretable knowledge base, the framework lays the groundwork for analytical tools that can support policy design, system modeling, and strategic foresight in sustainable mobility and energy transition planning.

Date: September 2023 – September 2025

(A9)

ROAD SAFETY IN A CHANGING CLIMATE: GLOBAL EVIDENCE ON THE EFFECTS OF EXTREME WEATHER EVENTS

BELZÉNIA A. B. MATSIMBE [a], ANELISE SCHMITZ [b], SARA FERREIRA [a], TATIANA MARIA CECY GADDA[b]
[a] *CITTA, Faculdade de Engenharia da Universidade do Porto*
[b] *UTFR, Universidade Tecnológica Federal do Paraná*
Emails: up2408583@up.pt; anelise.schmitz@utfpr.edu.br ; sara@fe.up.pt; tatianagadda@utfpr.edu.br

Keywords: road safety; extreme weather events; climate change; panel data; clobal risk

Subject area: road safety

Category: PhD Thesis (on going)

Abstract:
Climate change is intensifying extreme weather events such as heat waves, heavy rainfall, storms, floods and snowfalls, which directly affect driving conditions, driver behavior and road infrastructure. These events increase crash risk by reducing visibility, altering surface friction and overloading drainage and maintenance systems. This study investigates how extreme weather events, as expressions of climate change, influence road traffic mortality worldwide.
A mixed and robust methodological framework was developed, combining a structured narrative literature review, synthesized through a cause–effect (Ishikawa) diagram, and an empirical panel data analysis for 178 countries between 2000 and 2019. The econometric model applies two-way fixed effects (country and year), controlling for socioeconomic and institutional factors such as GDP per capita, urbanization, population density and government effectiveness.
Results show a positive and statistically significant association between the frequency of extreme weather events and road traffic mortality. Storms and heavy rainfall present the strongest effects, while snow events show a negative relationship, reflecting reduced mobility during severe winter conditions. Heat waves display a positive though less robust impact. The regions most affected are Africa and South-East Asia, where exposure and vulnerability converge.
The findings highlight that road safety is increasingly climate-sensitive and must be integrated into adaptation strategies. Strengthening infrastructure resilience, improving emergency response and promoting driver awareness under adverse weather are essential to mitigate climate-related road risk and support global road-safety goals for 2030.

Date: April 2025 – December 2025

(A10)

AI-BASED MONITORING SYSTEM FOR FATIGUE DETECTION IN PROFESSIONAL TRUCK DRIVERS: FROM SIMULATION TO REAL-WORLD VALIDATION

T. FONSECA [a, *], S. FERREIRA [a]
[a] *CITTA—Research Centre for Territory, Transports and Environment, Faculty of Engineering, University of Porto, 4200-465 Porto, Portugal*
**Correspondence: tiago.fdafonseca@gmail.com*

Keywords: Driver Fatigue; Monitoring Technology; Machine Learning; Driving Simulator; Road Safety

Subject area: Road Safety

Category: PhD thesis (ongoing or recently concluded)

Abstract:

Driver fatigue is one of the leading causes of road traffic accidents and remains a persistent challenge in professional transport operations. Among occupational groups, truck drivers are particularly exposed due to extended working hours, monotonous routes, tight delivery schedules, and irregular rest patterns. The resulting decline in alertness compromises reaction time, decision-making, and situational awareness, leading to a substantial increase in crash risk. Although several fatigue detection technologies have emerged in recent years, most systems remain generic, insufficiently validated, and poorly adapted to the specific characteristics of professional drivers. Addressing these limitations is essential to improving both road safety and occupational health in the transport sector.

This doctoral research aims to develop and validate an artificial-intelligence-based monitoring system capable of detecting fatigue in professional truck drivers with greater precision and personalization. The system will integrate behavioral, physiological, and vehicle-based data to identify fatigue states and support preventive interventions before performance degradation occurs. The research follows a structured seven-stage methodology that connects theoretical foundations with empirical experimentation and model validation.

The empirical component relies on two complementary data sources. Controlled experiments will be conducted using the TRUST3000 high-fidelity driving simulator at the Faculty of Engineering of the University of Porto (FEUP). Thirty professional truck drivers will perform standardized driving tasks under fatigue-inducing conditions, while behavioral and physiological indicators—such as heart-rate variability, ocular activity, head position, and subjective sleepiness scores—are continuously recorded. In parallel, naturalistic driving data will be obtained through collaboration with WingDriver, a Portuguese company specializing in AI-based driver monitoring systems. The WingDriver platform provides real-world multimodal data, including facial videos and telemetric information, enabling comparison between simulated and operational environments.

The combined dataset will be processed to train and validate machine-learning models designed to classify fatigue states and predict onset patterns. Analytical emphasis will be placed on identifying inter-individual variability, evaluating model robustness, and assessing the feasibility of implementation within fleet-management contexts. Expected outcomes include an AI-driven system capable of adapting to different driver profiles, reducing false alarms, and enhancing the reliability of fatigue detection across diverse working conditions.

By bridging simulator-based experimentation with naturalistic data, this research advances scientific understanding of fatigue mechanisms while promoting practical applications in occupational safety. Ultimately, it aims to reduce fatigue-related incidents among professional drivers, contributing to safer roads and healthier working environments.

Date: September 2024 – September 2028

(A11)

PROFILING DRIVER BEHAVIOURAL PATTERNS FROM MOBILE APP DATA

Nuno Figueiredo [a], António Lobo [b,c], Ana Loureiro [c*], Sara Ferreira [c], and Sérgio Pedro Duarte [c,d]
[a] *Faculdade de Engenharia, Universidade do Porto*
[b] *CITTA, Departamento de Engenharia Civil, Universidade de Coimbra*
[c] *CITTA, Faculdade de Engenharia, Universidade do Porto*
[d] *ICS – Instituto para a Construção Sustentável*
[*] *analoureiro@fe.up.pt*

Keywords: driver behaviour, cluster analysis, distraction, driver monitoring systems, road safety
Subject area: Road safety
Category: Research Projects

Abstract:
As human error remains one of the main causes for road safety, driver monitoring systems (DMS) play an important part in preventive approaches to road safety. Driver monitoring systems have been promoted as a way of increasing vehicle safety, aligned with the Vision Zero strategy of decreasing the number of serious injuries and deaths by halve, until 2030, and achieving zero deaths by 2050. "Safe people" and "Safe vehicles" are examples of the pillars of the Safe System Approach, aiming at encouraging safe and responsible driving behaviour and promoting the development of advanced driving assistance systems (ADAS) that, not only monitor the surrounding environment, but also monitor the driver, offering visual and audio warnings in face of risky behaviours. Distraction appears as a common cause for unsafe driving, and, although there are some DMS alerting the driver through eye tracking and wheel sensing, distracted driving remains a complex phenomenon to identify and measure. Thus, distraction measuring algorithms still need to be improved to better detect distracted driving behaviours. In this context, this research aims to study a large dataset, collected in naturalistic environment, to identify distracted driving patterns concerning driver behaviour and route characteristics.
The opportunistic data is collected through a smartphone-based driver monitoring application, developed by a Portuguese startup company, which warns drivers for distracted driving behaviours. Data is retrieved from both ad-hoc private users and partner fleet operators. In this way, it was possible to include in the analysis not only the drivers' characteristics and behaviour (e.g., speeding), but also the characteristics of the routes (e.g., trip duration, type of road, etc.) and the frequency of distraction alerts. Following the preprocessing steps, such as cleaning, feature engineering, and data enrichment with external data, a cluster analyses was performed with the goal of defining different driving profiles capable of providing insights on driver distraction. Different clustering algorithms (k-means, k-prototypes, GMM, DBSCAN, and HDBSCAN) with different configurations were tested to identify trends in association between features.
The results show that distraction is usually associated with erratic driving behaviours (e.g., speeding, harsh manoeuvres), and both are more common in urban areas. In addition, erratic driving was found to be higher during later segments of the routes. Middle-aged drivers are generally "safer" drivers, while older and younger drivers show higher propensity to distraction and erratic driving. The analysis revealed patterns that corroborate existing research and offer additional insights, showing the potential of this approach to enhance understanding of driver distraction. However, it can still be improved in future work by addressing the limitations related to the opportunistic nature of data (e.g., unavailability of some variables, unbalanced sample of drivers).

Date: January 2025 – July 2026
Acknowledgments: The authors acknowledge WingDriver's collaboration by providing the data used. This work is financially supported by national funds through the FCT/MCTES, under the project 2023.15776.PEX - uRisK - Understanding risky behaviours at the wheel using a driving simulator and the grant with DOI 10.54499/CEECINST/00010/2021/CP1770/CT0003.

(A12)

SPATIAL MODELING OF ACCESSIBILITY IMPACTS ON LOCAL DEVELOPMENT

S. FREIRIA [a], N. SOUSA [b]
[a] *Department of Environment and Planning,*
University of Aveiro
Email: susana.freiria@ua.pt
[b] *Department of Sciences and Technology,*
University Aberta
Email: nuno.Sousa@uab.pt

Keywords: Road accessibility, Local development, Generalized spatial two-stage least-squares regression

Subject area: accessibility models

Category: Presentation of research activities

Abstract:
Over the years, the European Commission has devoted substantial financial resources to the construction of road infrastructure, under the assumption that such investments would stimulate economic development. Nevertheless, there is no consensus regarding whether these policies effectively bring the anticipated benefits. The main objective of this study is to clarify where, and to what extent, accessibility improvements resulting from road infrastructure expansion may contribute to economic development at the local level. The methodology was based on spatial statistics methods, namely a generalized spatial two-stage least-squares regression (GS2SLS) followed by a geographic weighted regression (GWR) regression to test for contrasting effects at the local level. The methodological framework was applied to NUTS2 Center Region of Portugal, where the motorway network road length increased >100% in the years 2001 to 2021, going from 706 km to 1500 km respectively. Findings indicate that accessibility changes generated over 20 years of road infrastructure development generally had a positive influence on municipal-level development in the Center Region. However, the effects vary according to the scale of analysis, with some negative impacts also observed, as well as effects that depend on local characteristics. Some municipalities were positively impacted by accessibility changes, while others were negatively impacted.

Date: January 2024 – January 2026

(A10)

ALLABOARD: INCLUSIVE ACCESSIBILITY IN TRANSPORT HUBS

António Lobo[a*], Marta Campos Ferreira[b], Pedro Mêda[c], Teresa Galvão[b], António Augusto Sousa[b], José Pedro Tavares[d], Fernando Brandão Alves[d], António Coelho[b], Ana Bastos Silva[a], Sérgio Pedro Duarte[d]

[a] *CITTA, Departamento de Engenharia Civil, Universidade de Coimbra*

[b] *INESC TEC, Faculdade de Engenharia Civil, Universidade do Porto*

[c] *CONSTRUCT, Faculdade de Engenharia, Universidade do Porto*

[d] *CITTA, Faculdade de Engenharia, Universidade do Porto*

[*] *lobo@uc.pt*

Keywords: accessibility, service quality, inclusion, public transport

Subject area: Urban mobility

Category: Research Projects (funded by FCT or other institutions)

Abstract:

Mobility is a right expressed in the Universal Declaration of Human Rights as the freedom of movement to accomplish any human activity (work, school, health, leisure, or shopping). Despite the enormous dispersion of individual limits to free mobility, resulting from any disability, temporary impairment, older age, or simply from carrying a dependent or large object, transport systems are required to fit all users' needs.

The rationale for AllAboard is to increase PT attractiveness through the concept of "inclusive accessibility" for people with special mobility needs. AllAboard addresses PT accessibility beyond the physical access to the infrastructure by analysing the easiness of access to the PT service, thus building on the frequent but always unfinished actions towards accessibility. The overarching goal of AllAboard is to promote PT through service accessibility to all, creating an inclusive service.

AllAboard focuses on users with special mobility needs, including people with temporary or permanent physical impairments (e.g., using a wheelchair or crutches), elderly people with reduced physical capabilities, and people with baby strollers, luggage, shopping trolleys, or similar. Despite focusing on users with physical mobility constraints, AllAbroad addresses the perceived accessibility that is related to both physical and non-physical barriers at transport hubs. A broad view of accessibility barriers related to all PT service components (e.g., purchasing/validating a ticket, finding travel information and boarding platform, etc.) is crucial to tackle current societal changes (e.g., ageing population, migration, digitalization) and prevent social exclusion.

AllAboard will follow a systemic approach by considering the PT service offering as a system of "small services" or interactions, the so-called service ecosystem. The configuration of the service system will trigger a gap between the experienced quality (actual value created), and the quality standards imposed by regulatory measures. Thus, our approach enables an overall assessment of service accessibility in a systemic way rather than addressing only the infrastructure dimension. Hence, the design and development of new solutions or retrofitting actions onto a PT system should take into consideration the entire user experience.

In the end, an accessibility assessment tool and guidelines will be developed, resulting from the requirements identified in focus group and from the solutions designed and tested by PT users, in a virtual reality setting.

Date: July 2025 – July 2028

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(A11)

YOUTH4MOBILITY: YOUTH AS AGENTS OF CHANGE FOR INCLUSIVE URBAN MOBILITY IN 15-MINUTE NEIGHBOURHOODS

Antonio R. Andrade [a]
[a] IDMEC, IST, University of Lisbon.
Email: antonio.ramos.andrade@tecnico.ulisboa.pt

Keywords: 15-min city; school commuting; urban mobility.

Subject area: sustainable cities

Category: Research Projects (funded by FCT or other institutions)

Abstract:

The YOUTH4MOBILITY project will explore how to contribute to creating accessible, sustainable, and inclusive 15-minute neighbourhoods (15mC) through co-created and youth-centric mobility systems for children, adolescents, and young adults and empower youth as change agents for active mobility for all. Research will occur in six Urban Living Labs (ULLs): Utrecht, Venice, Lisbon, Kristiansand, Brussels, and Changhua (Taiwan). YOUTH4MOBILITY will first analyse youth mobility lifestyles and the systemic drivers influencing youth mobility through participatory action research with diverse communities. Second, the project will co-create YOUTH4MOBILITY strategies that re-imagine by co-designing and re-invent by implementing infrastructure, street design, community engagement, technology, pricing, and regulation. Interconnected interventions, such as bike hubs, car-free streets, bike libraries, and discounted fares, aim to enhance accessibility and affordability. Third, the project will re-assess by evaluating these youth-led interventions' wider societal impacts. Fourth, the project will establish learning communities to promote knowledge transfer, develop practical tools, and stakeholder engagement. Finally, policy recommendations will be created to guide youth-centred mobility planning for 15mC, advising policymakers and educational institutions on effective, inclusive approaches. These efforts aim for active mobility solutions to meet the needs of young people, particularly those vulnerable to mobility poverty and contribute to sustainable and healthy transportation habits for all.

Date: January 2026 – December 2028

(A15)

YOUTH MOBILITY AND SUSTAINABLE TRANSPORT: THE Y-MOVE EUROPEAN PROJECT

J. MACEDO [a] and M. C. COELHO [b]
[a] *CERIS, Department of Civil Engineering,*
University of Aveiro
Email: jmacedo@ua.pt
[b] *Department of Environment and Planning/Centre for Mechanical Technology and Automation,*
University of Aveiro
Email: margarida.coelho@ua.pt

Keywords: Sustainable mobility, university students, participatory methods, policy recommendations

Subject area: sustainable cities and communities

Category: Research Projects

Abstract:
The European Project Y-MOVE – Youth Mobility & Views for a Sustainable, Equitable and Resilient Future aims to analyse patterns and attitudes towards sustainable mobility among university students in four European countries: Spain, Finland, Poland, and Portugal. This Seed Project is being developed within a consortium of four universities belonging to the ECIU University. It is led by the Autonomous University of Barcelona, in partnership with the University of Aveiro, Lodz University of Technology, and Tampere University.
Through an interdisciplinary and mixed-methods approach, combining surveys and participatory methods, the project seeks to study current behaviours and anticipate future changes in university students' mobility choices. The main goal is to support policymaking and promote education for more sustainable mobility among young adults.
The project's key objectives are: to analyse current mobility patterns and behaviours; to quantify atmospheric emissions resulting from daily mobility choices; to explore future perspectives on sustainable mobility; and to engage the university community in addressing the challenge of sustainable mobility and to develop policy recommendations and campus solutions.
At the University of Aveiro (UA), the diagnostic phase will involve a survey to characterise current mobility choices among UA students. This characterisation will serve as a baseline for future transformations and help to understand students' decisions, taking into account environmental, social, and infrastructural constraints and opportunities. Subsequently, the project will calculate the atmospheric emissions associated with students' daily mobility.
To identify differences in how students envisage sustainable transport in their lives, focus groups will be organised, complemented by participatory techniques such as Photo Voice. These activities will engage the student community in the co-creation of solutions and the design of policies that foster more sustainable mobility practices.
The final outcome will consist of a set of solutions and guidelines that can be implemented at the university level to encourage more sustainable mobility choices and support decision-makers in their adoption.

Date: February 2025 – January 2027

(A16)

METROPOLITAN PLANNING AS A LEVER FOR SUSTAINABLE URBAN MOBILITY TRANSITIONS

J. CARVALHO [a,b], J. PINHO DE SOUSA [a,b], and R. MACÁRIO [c,d]
[a] *INESC TEC*
Email: juliana.carvalho@inesctec.pt
[b] *Faculty of Engineering, University of Porto*
Email: jorge.p.sousa@inesctec.pt
[c] *CiTUA, Instituto Superior Técnico*
[d] *TPR, Faculty of Business and Economics, University of Antwerp*
Email: rosariomacario@tecnico.ulisboa.pt

Keywords: sustainable urban mobility planning; metropolitan governance; collaborative design; accessibility; decision support systems

Subject area: urban mobility

Category: PhD thesis (ongoing or recently concluded)

Abstract:
This research advances collaborative planning approaches for sustainable urban mobility, by developing a conceptual framework to support metropolitan-scale policy roadmap design and promoting accessibility as a central concept to articulate integrated strategic planning practices. Recognizing that functional urban areas require integrated approaches that go beyond municipal boundaries, the study addresses the challenge of conducting transport planning exercises across fragmented governance structures.
Grounded in constructivist institutionalism and communicative planning theories, the research combines an exploratory literature review with comparative case study analysis. Given the scarcity of metropolitan-scale sustainable mobility studies, six diverse cases were examined: Greater Manchester (UK), Bologna (Italy), Nantes (France), Christchurch (New Zealand), Montréal (Canada), and Santiago (Chile). Key planning documents were analysed and semi-structured interviews conducted with front-line planners.
The developed framework acknowledges the importance of examining wider forces and local context before engaging in collaborative processes that connect preparation activities, visioning exercises, exploration of pathways through policy packaging and the three axes of accessibility (proximity, mobility, and connectivity). The resulting collaborative design framework structures planning as a reciprocal learning process that aligns long-term visions with actionable policy pathways. Recommendations are grouped into five iterative categories (envision, explore, experiment and implement, encourage, and evaluate) recognizing that planning practice is cyclical. A complementary multi-criteria assessment tool supports the reflexive self-assessment of the emerging pathways, providing insights that guide roadmap building and facilitate consensus across multiple stakeholders.
The framework identifies critical enabling conditions for successful collaborative processes involving policy entrepreneurs, communities of practice, learning and training opportunities, academic sector involvement, intermediate milestones, institutionalized communication channels, and interdisciplinary teams. An empirical assessment is underway in the Porto Metropolitan Area, using intermunicipal workshops to refine the framework. Preliminary findings suggest collaborative design fosters mutual recognition of interdependence, strengthens commitment to innovative pathways, and enhances strategic communication where planners act as knowledge brokers promoting meaningful participation.

Date: September 2020 – ongoing

(A17)

EMPOWERING ENERGY-EFFICIENT URBAN COMMUNITIES THROUGH SMART LIGHTING

E. MACEDO[a*], J. BANDEIRA[a], T. Tchemisova[b], A. MOURA[c], L. GONÇALVES[d], and C. MARTINS[d]
[a] *Department of Mechanical Engineering, University of Aveiro*
[b] *Department of Mathematics, University of Aveiro*
[c] *Department of Economics, Management, Industrial Engineering and Tourism, University of Aveiro*
[d] *Águeda School of Technology and Management, University of Aveiro*
**Email: macedo@ua.pt*

Keywords: Smart Lighting, Energy Efficiency, Sustainable Mobility, Resilient Cities

Subject area: Smart Street Lighting

Category: Project (INTERREG EUROPE RESONANCE)

Abstract:
Official data from the European Energy Efficiency Platform suggests that street lighting may account for 30-50% of total municipal electricity consumption. This can be considered a burden since there are already some technologies related to the use of LED, and coupling it with adaptive systems that allow for a more efficient use of energy. This implementation can free up the electricity grid to use this energy for other purposes, such as charging electric bicycles or vehicles. The incorporation of sensors for regulating the luminous flux also reduces energy consumption and, at the same time, minimises light pollution in some places and improves safety issues in other spots. The installation of sensors or cameras in a street light pole can be something out-of-the-box, harnessing the whole infrastructure of points of electricity already available. Installation of specific sensors and cameras in the public lighting infrastructure can allow for monitoring different features, such as traffic volume, pollutant or noise emissions, or air quality. Additionally, a street light pole can be upgraded to incorporate an e-charging device either for vehicles or for feeding a bike sharing dock system. The RESONANCE Project - smaRt polEs aS driver Of greeN And eNergy effiCient communitiEs - promotes green, energy-efficient urban and peri-urban areas by deploying smart street lighting systems. These systems integrate traffic and environmental sensors and EV charging points to help cities: 1) Reduce energy use, maintenance costs, and emissions; 2) Improve air quality, road safety, and urban liveability; and 3) Enhance access to clean mobility infrastructure, aiming to transform conventional street lighting into smart, connected infrastructure supporting energy efficiency, mobility, and environmental monitoring. The project is focused on exchanging knowledge and good practices to advance energy-efficient urban development through smart lighting. The project also works to strengthen professional capacity and shape policies that support EU sustainability and climate objectives.

Date: May 2025 - ongoing

(A18)

LOG-in: Rethinking Last-Mile Logistics - Customized Integrated Delivery Strategies for Sustainable E-commerce

T. FONTES [a], A. AMARAL [a], D. CARNEIRO [a], V. SILVA [ab], E. PEIXOTO [a] and R. ROSSETTI [b]
[a] *INESC TEC - Institute for Systems and Computer Engineering, Technology and Science,*
Email: {tania.d.fontes, antonio.m.amaral, davide.r.carneiro, vasco.n.silva, eduardo.f.peixoto}@inesctec.pt
[b] *FEUP - Faculty of Engineering, University of Porto, Artificial intelligence and computer science laboratory*
Email: rossetti@fe.up.pt

Keywords: Last-mile logistics, Urban context, Decision support system, Sustainability, Machine Learning

Subject area: Sustainable cities, Urban Logistics, Transport planning

Category: Research Projects (funded by FCT)

Abstract: Over the past decade, the rapid expansion of e-commerce has significantly intensified the challenges associated with last-mile delivery, which now represents one of the most costly and environmentally detrimental components of urban logistics. Despite the introduction of several innovative last-mile solutions, many fail to account for the diversity of urban contexts, where multiple areas, such as historic centers, suburban districts, and industrial zones, present a set of specific characteristics that pose significant spatial and regulatory constraints shaping the efficiency and sustainability of last-mile delivery. Despite this diversity, logistics operations often rely on uniform, standardized strategies that overlook local conditions, leading to inefficiencies, higher costs, and increased environmental impacts. Therefore, current decision support systems mainly prioritize operational route optimization, overlooking the strategic and context-sensitive planning capabilities required to align delivery strategies with the specific characteristics of each urban environment. In response to these challenges, this research project explores the development of context-aware decision support systems for last-mile logistics. To address these goals, a context-aware decision support system that systematically links urban characteristics with optimal delivery strategies will be designed. Its architecture will integrate four key components: (1) a spatial analytics module that classifies urban contexts using GIS data, demographic patterns, and infrastructure attributes; (2) a dynamic simulation engine that models delivery operations across diverse scenarios; (3) a machine learning layer that learns from historical data to forecast demand and recommend context-specific strategies; and (4) a generative AI interface that translates technical analyses into actionable recommendations for different stakeholder groups. The LOG-in system will be designed to assist both logistics operators and urban policymakers in assessing trade-offs between economic efficiency, environmental sustainability, and social equity. Ultimately, this framework aims to promote the development of more sustainable, efficient, and equitable urban freight systems.

Date: October 2025 – September 2028

Acknowledgments: This work was co-financed by the European Regional Development Fund (FEDER) through the Innovation and Digital Transition Programme (COMPETE 2030) and by national funds through the Portuguese Foundation for Science and Technology (FCT), under the scope of the LOG-in project, reference 15025 (COMPETE2030-FEDER-00867700). Vasco Silva also thanks FCT for the project reference 2023.01212.BD (https://doi.org/10.54499/2023.01212.BD), and Tânia Fontes acknowledges support from the project with application reference 2022.07805.CEECIND.

(A19)

THE POTENTIAL OF A SHARED PARCEL LOCKER NETWORK FOR LAST-MILE LOGISTICS

V. SILVA[a,b,*], T. FONTES[a], A. AMARAL[a,c] and P. AMORIM[a,b]
[a] *INESC TEC - Institute for Systems and Computer Engineering, Technology and Science, Rua Dr. Roberto Frias, Porto 4200-465, Portugal*
[b] *Faculty of Engineering - University of Porto, Rua Dr. Roberto Frias, Porto 4200-465, Portugal*
[c] *School of Engineering - Polytechnic Institute of Porto, Rua Dr. António Bernardino de Almeida, 431, Porto 4249-015, Portugal*
**Email: vasco.n.silva@inesctec.pt*

Keywords: last-mile logistics, urban logistics, parcel lockers, collaboration, simulation

Subject area: sustainable cities, urban logistics, last-mile logistics

Category: PhD thesis (ongoing or recently concluded)

Abstract:
Online shopping has intensified the challenges in last-mile logistics, leading to fragmented and redundant delivery operations that significantly affect urban sustainability. To mitigates these challenges, parcel lockers have emerged as an increasingly popular delivery alternative. However, their adoption by different delivery companies dilutes their benefits, prompting cross-sector discussions on the potential of shared parcel locker systems. Using a microscopic traffic simulation model of the city of Porto, Portugal, this study evaluates the operational and environmental impacts of a shared parcel locker network under different demand levels. The results suggest that, if the lockers are shared, the distance travelled, delivery duration, fuel consumption, and emissions related to last-mile delivery decrease across all demand levels, with benefits reaching nearly 30 % under high-demand conditions. This study culminates with a discussion about the potential of shared parcel lockers as an enabler for coopetition *i.e.*, cooperation between competitors, addressing inefficiencies related to scale, network saturation, and redundancy.

Date: February 2024 – February 2027

Acknowledgements: This work was co-financed by the European Regional Development Fund (FEDER) through the Innovation and Digital Transition Programme (COMPETE 2030) and by national funds through the Portuguese Foundation for Science and Technology (FCT), under the scope of the LOG-in project, reference 15025 (COMPETE2030-FEDER-00867700). Vasco Silva also thanks FCT for the project reference 2023.01212.BD (https://doi.org/10.54499/2023.01212.BD), and Tânia Fontes acknowledges support from the project with application reference 2022.07805.CEECIND.

(A20)

OPTIMIZING TRUCK SCHEDULING AT CONTAINER TERMINALS: A HEURISTIC-BASED APPROACH

JOSÉ LUÍS MOREIRA [a], CATARINA M. MARQUES[b] and JORGE PINHO DE SOUSA [c]
[a] *INESC TEC*
Email: jose.l.moreira@inesctec.pt
[b] *INESC TEC,*
Faculty of Engineering, University of Porto
Email: catarina.m.marques@inesctec.pt
[c] *INESC TEC*
Faculty of Engineering, University of Porto
Email: jorge.p.sousa@inesctec.pt

Keywords: Seaports; container terminals; truck scheduling; heuristic optimization; operational efficiency

Subject area: port logistics

Category: Research Projects (funded by FCT or other institutions)

Abstract:
Maritime freight transport has grown steadily over recent decades, increasing the pressure on container terminals and emphasizing the need for more efficient and sustainable management systems. In seaports, one of the most critical challenges lies in the land-side operations, where the growing number of trucks arriving to collect or deliver containers often leads to congestion, idle times, and imbalanced resource utilization. Traditional appointment systems usually prioritize carrier preferences without sufficiently considering the efficient use of terminals, resulting in suboptimal scheduling and coordination.
This work proposes a heuristic-based optimization model designed to enhance truck scheduling efficiency by integrating carrier preferences, the storage yard structure, container location data, and terminal resource availability. The model jointly addresses two key decisions: the assignment of container pick-ups to pre-defined time-windows, and the sequencing of truck operations within each time-window. Additionally, it introduces a dynamic reallocation mechanism for the containers, that evaluates alternative stacking positions within and across yard blocks. These mechanisms generate trade-off solutions, taking into account travel costs, future penalties for blockages, and operational distances.
Preliminary results demonstrate that this block-aware heuristic significantly reduces container relocations and total handling time, leading to smoother yard operations, lower truck waiting times, and improved terminal throughput. By fostering a better coordination between carrier preferences and terminal constraints, the proposed approach contributes to more efficient and sustainable port operations and supports the broader goals of resilient intermodal transport systems.

Date: March 2025 – On going

Acknowledgments
This work is co-financed by Component 5 – Capitalization and Business Innovation, integrated in the Resilience Dimension of the Recovery and Resilience Plan, within the scope of the Recovery and Resilience Mechanism (MRR) of the European Union (EU), framed in the Next Generation EU, for the period 2021 – 2026, within project NEXUS, with reference 53.

(A21)

RETHINKING PORT AUTOMATION TO DECARBONISE MOBILITY IN PORT ECOSYSTEMS

Mudassar Shafiq [a], Paulo Fernandes [b,c,d], and Margarida C. Coelho [a,c,d]
[a] *Department of Environment and Planning, University of Aveiro, Campus Universitário Santiago, 3810-193, Aveiro, Portugal.*
[b] *Department of Mechanical Engineering, University of Aveiro, Campus Universitário Santiago, 3810-193, Aveiro, Portugal.*
[c] *Centre for Mechanical Technology and Automation (TEMA), University of Aveiro, Campus Universitário Santiago, 3810-193, Aveiro, Portugal.*
[d] *LASI – Associate Laboratory on Intelligent Systems, Guimarães, Portugal.*
Emails: {mudassar.shafiq ; paulo.fernandes ; margarida.coelho}@ua.pt

Keywords: Entropy; Automated Vehicles; Mobility Ecosystem; Ports

Subject area: Sustainable ports

Category: Research Projects (funded by FCT)

Abstract:
Ports are essential hubs for international and local trade and logistics, but they are also major contributors to pollutants and noise emissions, and energy use. As Europe works towards climate neutrality, port automation is emerging as a promising pathway to transition to more efficient and green mobility ecosystems. This research investigates how automation can contribute to reducing emissions and improving sustainability by examining entropy levels associated with ship maneuvers, trains, road, and off-road vehicle movements in a port environment.
For our case study based on the Port of Aveiro, we modelled the ships' trajectories, trains accessing terminal facilities, the movements of road and off-road vehicles, as well as the introduction of autonomous vehicles in the port mobility ecosystem using the microscopic traffic PTV VISSIM. These data were enriched with field traffic, dynamic and topographic measurements to capture and model real-world driving and flow behaviors. To achieve this, a combination of experimental monitoring and microscopic traffic, emission and energy models will be applied. This allowed for a detailed analysis of spatial and speed profiles, acceleration, deceleration, and maneuver patterns of vehicles under different scenarios. A central contribution of this study is the use of entropy as a system-level indicator of port mobility. Entropy provides a measure of unpredictability and volatility in movement patterns, reflecting how dispersed and irregular traffic behaviors translate into higher energy demand and emissions. The expected results will highlight the transformative effect of the introduction of automated vehicles, ensuring smooth traffic flows, reducing abrupt maneuvers, and improving predictability across transport modes. By mitigating volatility, automation enables ports to operate with greater energy efficiency and lower environmental costs.

Acknowledgments: This work is funded by national funds through FCT - Fundação para a Ciência e a Tecnologia, I.P., under the project/contract UID 00481 - Centre for Mechanical Technology and Automation, and by the projects: https://doi.org/10.54499/2023.14870.PEX, funded by FCT . P. Fernandes also thanks FCT/MCTES for the contract granted 2021.02488.CEECIND (https://doi.org/10.54499/2021.02488.CEECIND/CP1659/CT0013)

Date: January 2025 – June 2026

(A22)

MOBILITY IN LOW-DENSITY AREAS: A FRAMEWORK FOR DESIGNING DEMAND RESPONSIVE TRANSPORT SYSTEMS

A. DAUER [a], T. GALVÃO [b], J. PINHO DE SOUSA [c] and B. PRATA [d]
[a] *Faculty of Engineering, University of Porto / INESC TEC*
Email: armandodauer@gmail.com
[b] *Faculty of Engineering, University of Porto / INESC TEC*
Email: tgalvao@fe.up.pt
[c] *Faculty of Engineering, University of Porto / INESC TEC*
Email: jorge.p.sousa@inesctec.pt
[d] *Federal University of Ceará, Brasil*
Email: baprata@ufc.br

Keywords: Demand Responsive Transport; mobility planning; transport flexibility; decision-support systems

Subject area: mobility planning

Category: PhD thesis (ongoing or recently concluded)

Abstract:
Traditional fixed-route, fixed-schedule public transport requires predictable demand to operate effectively. While it can function efficiently in urban areas, it struggles in less dense regions such as rural and peri-urban areas, where demand is often dispersed and heterogeneous. Demand Responsive Transport (DRT) offers a flexible alternative to traditional public transport, dynamically adapting routes, schedules, and fleets to real-time demand.
Despite over 40 years of proven effectiveness in pilots and real operation, large-scale adoption of DTRTs remains limited by configuration complexity, operational uncertainty, and insufficient policy support. Policymakers and planners also often lack the knowledge and tools to identify optimal DRT configurations for specific contexts. The objective of this work is to assist in the design of these systems through a structured, evidence-based framework that supports strategic-level DRT design, with a special focus on low-density areas.
The proposed framework, named APOLO, integrates empirical data, a simulation model, and stakeholder inputs to help decision-makers identify suitable DRT system configurations. Developed through a comprehensive literature review and the analysis of 52 real-world DRT systems, it identifies key configuration variables grouped into three categories — Guiding, Operational, and Service — according to their strategic role. APOLO is organized into three modules: MUSE that assesses the suitability of operational variables for given scenarios; ARTEMIS used to simulate configurations and to generate performance indicators; and DELOS that performs cost-benefit analyses of service variables.
Implemented as a web-based platform, APOLO was presented to authorities and industry representatives, and exploratory case studies were conducted to refine the framework and derive practical insights for future research. The APOLO framework provides a structured, data-driven approach to the strategic design of DRT systems in low-density areas. By integrating empirical evidence, simulation, and stakeholder input, it enables decision-makers to configure flexible, efficient, and context-sensitive transport solutions, supporting the adoption of DRTs in diverse scenarios.

Date: September 2021 – October 2025

(A23)

TOUR4ALL: SOCIALLY-AWARE MULTI-OBJECTIVE TOURIST TRIP PLANNING

J. ALMEIDA, R. ROSSETTI
a Artificial Intelligence and Computer Science Lab (LIACC), Faculty of Engineering, University of Porto
Email: jadna@fe.up.pt, rossetti@fe.up.pt

Keywords: Group Recommendation Systems, Deep Reinforcement Learning, Multi-Objective Route Planning, Smart Tourism

Subject area: Smart and Sustainable Urban Mobility

Category: PhD thesis

Abstract:
The tourist trip design problem (TTDP) refers to a route-planning problem for tourists interested in visiting multiple points of interest (POIs). In touristic routing, the multi-objective routing problem consists in computing routes that maximise the perceived touristic value (e.g. scenic beauty, cultural interest) while minimising travel burdens (e.g. distance, time, cost) under constraints such as a limited time budget or opening hours.

This problem becomes even more complex when we think about groups of tourists sharing the trip. The multi-objective tourist group routing problem is a complex optimisation problem that aims to create the best possible travel itinerary for a group of tourists by simultaneously considering multiple conflicting goals, such as minimising costs and travel time while maximising satisfaction and fairness among the group. It extends the TTDP by adding multiple objectives and handling heterogeneous preferences and uncertainties common in group travel. This problem is often solved using advanced algorithms to generate a set of Pareto-optimal solutions, which represent trade-offs between the objectives.

This PhD project proposal aims to formalise the tourist group trip design problem (TGTDP) to underlie a decision-support system for groups of tourists. It additionally explores the potential applications of techniques such as reinforcement learning (RL) and multi-agent reinforcement learning (MARL) combined with principles of the social choice theory. The ambitoned methodological approach will serve as a means to both optimise multiple objectives of the group and yield social welfare.

Acknowledgments:
This work is a result of Agenda "AET – Alliance for Energy Transition", nr. C644914747-00000023, investment project nr. 56, financed by the Recovery and Resilience Plan (PRR) and by European Union – NextGeneration EU.

Date: Ongoing

(A24)

SAFETY PERCEPTION OF E-SCOOTER USERS IN PORTUGAL

S. S. JESUS [a], S. FERREIRA [b] and C. S. PITOMBO [c]
[a] *Department of Transportation Engineering of São Carlos School of Engineering, University of São Paulo, Brazil*
Email: sergiojesus@usp.br
[b] *CITTA - Department of Civil Engineering and Georesources, Faculty of Engineering University of Porto, Portugal*
Email: sara@fe.up.pt
[c] *Department of Transportation Engineering of São Carlos School of Engineering, University of São Paulo, Brazil*
Email: cirapitombo@usp.br

Keywords: Micromobility; E-scooters; Safety perceptions; Urban planning.

Subject area: Urban mobility.

Category: Presentation of research activities (research center, topics or interests of research, etc.), by Professors or Researchers.

Abstract:

The use of e-scooters as a form of commuting for routine trips, especially over short distances, has increased worldwide. This micromobility equipment tends to complement the existing transport system and is also considered an alternative for mitigating problems related to congestion and reducing the environmental impacts caused by car usage. However, in addition to sharing spaces with pedestrians, cyclists, and cars, issues related to user behavior, such as drivability, speed limits, respect for local and traffic rules and the use of safety equipment, raise the question of how safe this mode of transport is. Added to this is the fact that there is no regulatory standard for the provision of the service in the cities where it is available. Thus, this work aims to formulate questions about the perception of safety related to the use of e-scooters, which will be used in an online questionnaire to identify behavior patterns among users of public transport, ridesourcing (on-demand transport) and e-scooters in Portugal. For this, constructs of safety perception will be identified in the existing literature, followed by constructs identified from a database of accidents by e-scooter in the city of Porto and others deemed necessary. Finally, a pilot questionnaire will be conducted and applied at an event with experts in the field of transport in Portugal. It is expected that constructs will be defined, leading to questions endorsed by experts that can support the safety perception section of the questionnaire to be administered.

Date: September 2023 – July 2027

(A25)

SIMULATOR-BASED STUDIES ASSESSING PHYSIOLOGICAL AND COGNITIVE DEMANDS IN HEAVY VEHICLE DRIVERS, AND THE CASE OF SOLID WASTE TRUCK DRIVERS. A SYSTEMATIC REVIEW

Juana Quito [a, b], Sara Ferreira [c] and Denisse Bustos [d]
[a] *Doctoral Program in Occupational Safety and Health, Faculty of Engineering, University of Porto, Porto, Portugal*
Email: up202401265@edu.fe.up.pt
[b] *Department of Applied Chemistry and Production Systems, Faculty of Chemical Sciences, University of Cuenca, Cuenca, Ecuador*
[c] *CITTA, Faculdade de Engenharia da Universidade do Porto Portugal*
Email: sara@fe.up.pt
[d] *Associate Laboratory for Energy, Transports and Aeronautics—LAETA (PROA), Faculty of Engineering, University of Porto, Porto, Portugal*
Email: ldbs@fe.up.pt

Keywords: Driving Simulator, Truck Driver, Solid Waste Truck Driver, Safety, Systematic Review
Subject area: Traffic safety
Category: PhD thesis (ongoing or recently concluded).

Abstract:
Background: Professional truck drivers are exposed to physiological and cognitive stressors that may compromise their health and safety. Solid waste truck drivers face multiple challenges, as their work also affects the safety of waste collection workers. They must remain alert to surrounding traffic while monitoring the actions of the collection crew. Simulator-based studies offer controlled environments to quantify these risks, but a comprehensive synthesis of the existing evidence is needed to further advance understanding in this area.
Objective: To systematically review existing research using driving simulators to evaluate cognitive and physiological responses in truck drivers, focusing on how mental workload and fatigue have been assessed, and to summarize the methodologies and measures applied in these studies. This review includes different professional truck drivers, as a previous search showed that no particular study focused on solid waste truck drivers.
Methods: The review follows the PRISMA guidelines. Databases including Scopus, TRID and Web of Science will be searched. The defined inclusion criteria involve studies on truck drivers using simulators, reporting physiological (e.g., heart rate, ocular metrics, electrodermal activity) or cognitive outcomes (e.g., attention, fatigue) and driving performance. Data extraction will focus on study design, simulator type, physiological measures, driving scenarios, and driving variables. Narrative synthesis will be performed, and quantitative analysis will be considered if the data allows it.
Expected Results: This study will provide a comprehensive overview of simulator-based research, highlight methodological strengths and limitations, and propose directions for future studies, in particular, for the case of solid waste truck drivers.
Conclusions: As part of an ongoing PhD thesis, this systematic review aims to inform occupational health practices and guide future research in truck operations, with a special focus on solid waste truck drivers.
Date: September 2024 – October 2025

(A26)

ANTICIPATING PUBLIC REACTIONS TO STREET TRANSFORMATIONS THROUGH AN ADAPTIVE PERCEPTION MODELING TOOL

M. ALVES [a], M.I. LOPES [b], G. VALENÇA [c] and F. MOURA [d]
[a] *CERIS, Instituto Superior Técnico, University of Lisbon, Portugal*
Email: miguel.leite.alves@tecnico.ulisboa.pt
[b] *CERIS, Instituto Superior Técnico, University of Lisbon, Portugal*
Email: maria.ines.duarte.lopes@tecnico.ulisboa.pt
[c] *CERIS, Instituto Superior Técnico, University of Lisbon, Portugal*
Email: gabrielvalenca@tecnico.ulisboa.pt
[c] *CERIS, Instituto Superior Técnico, University of Lisbon, Portugal*
Email: fmoura@tecnico.ulisboa.pt

Keywords: urban perception; street design; perceptual colour metrics; participatory planning; exploratory moderation terms.

Subject area: Urban Planning

Category: Master thesis

Abstract: Urban streets are being redesigned to prioritise sustainable mobility, yet planning processes often overlook how citizens visually perceive and emotionally interpret these transformations. This gap can generate resistance towards reallocating street space for active modes or public transport. This work develops an adaptive perception modelling tool that predicts public reactions to street transformations by combining computer vision and structural equation modelling (SEM).

Using temporal pairs of street images, the tool quantified measurable visual variations such as vegetation gain, surface redistribution and chromatic balance through semantic segmentation and perceptual colour metrics. These variables were integrated with survey-derived perceptual ratings to automatically construct SEM-based predictive structures that adapt to the data collected, enabling context-sensitive and scalable modelling of public perception.

Results showed that both colour and segmentation-based predictors captured distinct yet complementary perceptual mechanisms: colour diversity and brightness enhanced liveability and comfort, while balanced functional composition supported perceptions of safety and order. The framework yielded predictions across demographic and behavioural groups, revealing exploratory moderation effects and offering interpretable guidance for design. Despite limitations related to sample scope, illumination variability and segmentation bias, the approach demonstrated the feasibility of operationalising perception within urban analytics.

Overall, the study advanced the integration of visual data and human perception into evidence-based planning, providing a replicable tool to anticipate public reactions and guide participatory, sustainable urban transitions.

Date: February 2025 – October 2025

(A27)

Open OPorto Synthetic Population Pipeline for Multimodal Transport Simulations

Iohan Sardinha, Rosaldo Rossetti, and Ana Paula Rocha
Artificial Intelligence and Computer Science Laboratory,
Faculty of Engineering, University of Porto
Email: iohan@fe.up.pt,
rossetti@fe.up.pt,
arocha@fe.up.pt

Keywords: Simulation, Machine Learning, Transport Planning

Subject area: Multimodal Transport Simulation

Category: PhD thesis

Abstract:

Microscopic transport simulations are versatile tools for analyzing, experimenting with, and planning transport infrastructure, ranging from physical layouts to schedules and pricing. However, these simulations depend on access to extensive data that is often unavailable or restricted. To address this limitation, synthetic populations are generated as simulation inputs, using extrapolated data to replicate real populations while being statistically representative and still preserving individual privacy. Many processes are present in the literature to create these synthetic populations, from which methods can be highlighted, such as Iterative Proportional Fitting, Bayesian Networks, and Generative Adversarial Networks.

This work proposes a modular pipeline that integrates the entire process, from census and survey data to a simulation-ready population, designed to be easily extended, modified, or replaced. This framework aims to facilitate the generation of synthetic populations for future simulation scenarios that rely on diverse data sources and formats.

The proposed pipeline is developed within the context of Open OPorto, a multimodal transport simulation of the city of Porto using MATSim. The project aims to study the existing transport network and propose improvements to it. The pipeline generates a synthetic population with demographic attributes and daily activity chains. Its extensibility enables the selection of the most suitable generation methods and the incorporation of temporal components, allowing the creation of synthetic populations that represent future population states. This capability is particularly valuable for evaluating infrastructure proposals that would only be completed after demographic or behavioral changes have occurred.

Acknowledgments: This work is a result of Agenda "AET – Alliance for Energy Transition", nr. C644914747-00000023, investment project nr. 56, financed by the Recovery and Resilience Plan (PRR) and by European Union – NextGeneration EU.

Date: January 2025 – Ongoing

(A28)

An Explainable Blackboard-Based AI Architecture for Weather-Aware Multimodal Mobility: The Ermesinde Case Study

Soraia Felício[a✉], Thiago Sobral [ac], Rui Camacho[b], Teresa Galvão[b]

[a]Faculty of Engineering, University of Porto, Portugal
[b]INESC TEC, Faculty of Engineering, University of Porto, Portugal
[c]OPT - Optimização e Planeamento de Transportes, Portugal
Emails: {soraiapasf, thiago, rcamacho, tgalvao}@fe.up.pt

Keywords: Blackboard architecture, Explainable AI, Urban planning, Smart mobility, Weather-aware delay

Subject area: Sustainable cities and transport systems

Category: PhD thesis

Date: October 2023 – October 2025

Abstract

This study presents an ongoing research initiative applying a hybrid, explainable Blackboard-based AI architecture, Blackboard Architecture for Explainable AI (BBAX), to the optimization of urban mobility applied to the Ermesinde Train Station in Porto, Portugal. The BBAX platform integrates multiple knowledge sources representing distinct contextual dimensions, such as period of the year, season of the year, meteorological conditions, and transport modes (train and bus), within a shared blackboard environment, enabling to study the correlation between multimodal delay patterns and environmental conditions.

Grounded in the principles of Blackboard architectures, a class of knowledge-based AI systems designed to integrate and coordinate problem-solving among multiple specialized modules (or knowledge sources) through a shared data structure known as the blackboard [1], our BBAX implementation extends this traditional framework with an Explainable AI (XAI) layer. This layer, inspired by recent developments in hybrid explainable systems [2], provides interpretable justifications by linking input knowledge from each source to the resulting delay patterns and timetable adjustments. Furthermore, the decisions coordination employs a utility-based prioritization mechanism inspired by self-adaptive blackboard models [3], ensuring transparent evaluation and traceable reasoning across all blackboard components.

The experimental setup relies on historical datasets combining train and bus schedules with meteorological and seasonal records. The approach aligns with recent data-driven studies on train delay prediction that emphasize the role of environmental and temporal features in delay forecasting [4]. It also analyzes delay patterns across seasonal clusters, following strategies conceptually similar to those employed in public transit optimization under seasonal conditions [5], and incorporates resilience-oriented evaluation under extreme weather conditions [6].

Preliminary findings are consistent with previous studies showing that delays tend to increase during winter months. In line with data-driven analyses of train delay prediction and weather impact assessment, these patterns indicate that low temperatures, precipitation, and seasonal

variations are significant contributors to delay propagation across train and bus services. The BBAX coordination process enhances interpretability by maintaining explicit reasoning traces for each knowledge source, improving transparency in delay prediction and adaptive scheduling.

Future work includes extending the platform with ontologies for multimodal event representation, adaptive rule management, and visual explanation dashboards for transport operators. This research contributes to advancing trustworthy and explainable blackboard-based architectures AI frameworks for sustainable and intelligent urban mobility.

Acknowledgments

This work is a result of Agenda "AET – Alliance for Energy Transition", nr. C644914747-00000023, investment project nr. 56, financed by the Recovery and Resilience Plan (PRR) and by European Union – NextGeneration EU.

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(A29)

HUMAN–AI INTERACTION IN CO-PILOTING MODE: MAPPING COGNITIVE, PSYCHOLOGICAL, TECHNOLOGICAL, LEGAL, AND ETHICAL DIMENSIONS

N.Ilina [a]
[a] *Department of Civil and Georesources Engineering, Faculty of Engineering, University of Porto, 4200-465 Porto, Portugal,*
Email: up202401465@up.pt

Keywords: Human–AI collaboration; cognitive load; trust; ethical AI; autonomous transport

Subject area: Digital Transformation in Logistics and Transport

Category: PhD thesis

Abstract: While public attention is increasingly attracted by autonomous transport, the transitional phase between human-driven and automated freight remains both crucial and insufficiently explored. Professional drivers offer a clear and contained use case, yet the broader implications of human–AI collaboration extend far beyond logistics.

Long-haul trucking still depends on human operators who face high levels of fatigue, isolation, and cognitive load—factors contributing to nearly 13% of large-truck crashes and up to 20% of fatal incidents worldwide [1]. Technological, legal and communication challenges will not allow the autonomous freight to prevail in the next 10-15 years. In this context, AI co-pilots—voice-first, context-aware, and physiologically responsive assistants—represent a promising step toward improving road safety, driver wellbeing, and generating high-quality data for future automation.

Yet their introduction also exposes complex questions of potential cognitive and psychological effects, trust and responsibility, ethical boundaries, general safety and cybersecurity, and legal aspects.

We would like to view AI co-piloting not merely as a technological transition toward autonomy, but as a multidimensional research domain that requires deeper scientific exploration. We explore the key psychological, technological, legal, and ethical challenges that arise when intelligent systems share roles traditionally held by humans.

From the psychological impact on trust and cognitive load to the technological complexities of seamless human–machine communication, from the legal frameworks defining responsibility to the ethical boundaries of AI intervention—these dimensions form the foundation of a new field of study. By examining these challenges, we aim to outline the critical questions and research pathways that will guide the responsible development of human–AI collaboration in the coming decade.

Date: September 2025 – September 2028

(A30)

OPTIMIZING COOPERATIVE MULTI-AGENT SYSTEMS THROUGH MECHANISM DESIGN AND LEARNING-BASED APPROACHES

António Ribeiro da COSTA [a], Rosaldo J. F. ROSSETTI [a]
[a] *Artificial Intelligence and Computer Science Laboratory, Faculty of Engineering, University of Porto*
Email: {amrpcosta, rossetti}@fe.up.pt

Keywords: Cooperative Multi-Agent Systems, Mechanism Design, Multi-Agent Reinforcement Learning (MARL), Dynamic Urban Mobility

Subject area: Intelligent Transportation Systems, Smart Mobility

Category: PhD thesis

Abstract:
Urban mobility and energy systems are inherently dynamic: demand for transport fluctuates daily, renewable energy supply varies with the weather, and infrastructure conditions are constantly evolving. Coordinating the decisions of various actors – passengers, fleet operators, electric vehicle owners, and network managers – within this constantly changing landscape is critical to achieving sustainability, efficiency, and resilience. However, existing optimization approaches often assume static environments or centralized control, ignoring both strategic behaviour and the need for adaptability.

This doctoral research proposes a framework that integrates *the design of mechanisms* with *learning-based methods* to optimize cooperative multi-agent systems in dynamic environments. The design of mechanisms ensures the alignment of incentives, encouraging the sharing of truthful information and cooperation, even when agents pursue private goals. Learning-based approaches, particularly multi-agent reinforcement learning (MARL) and bandit algorithms, provide the adaptability necessary to handle non-stationary environments and evolving agent populations. Urban mobility is formalized as an *Agent-Environment-Mechanism* model: agents interact in a spatiotemporal environment regulated by adaptive and learnable rules. Four objectives guide this work: (1) to develop scalable MARL algorithms capable of handling partial observability and multi-objectives in dynamic environments; (2) incorporate incentive-compatible mechanisms directly into learning, evolving beyond static designs to adaptive and parameterized rules; (3) formalize sustainability and equity as explicit and competing objectives, producing adaptive and Pareto-optimal policies; and (4) compare performance with classical optimization methods to demonstrate robustness and scalability.

The contributions are twofold: ***theoretical,*** promoting multi-agent cooperative learning under strategic and dynamic constraints; and ***practical,*** providing decision support tools for planners and operators. By aligning individual incentives with collective goals in real time, this research establishes bases for sustainable, adaptable, and resilient urban mobility systems.

Acknowledgements:
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Date: October 2023 – ...

(A31)

UNDERSTANDING E-SCOOTER USE IN URBAN CONTEXTS: A COMMUNICATION PERSPECTIVE

A. BRUNO CARDOSO[a], B. SARA FERREIRA[b], C. PEDRO MÊDA[c], and D. LUCIANO MOREIRA[d]
[a] *CITTA - Research Centre for Territory, Transports and Environment, CETAPS - Centre for English, Translation, and Anglo-Portuguese Studies, Faculty of Engineering of the University of Porto*
Email: brunocardoso@fe.up.pt
[b] *CITTA - Research Centre for Territory, Transports and Environment, Faculty of Engineering of the University of Porto*
Email: sara@fe.up.pt
[c] *ICS - Instituto para a Construção Sustentável, Faculty of Engineering of the University of Porto*
Email: pmeda@fe.up.pt
[d] *CETAPS - Centre for English, Translation, and Anglo-Portuguese Studies, Faculty of Arts and Humanities of the University of Porto*
Email: lucianomoreira@letras.up.pt

Keywords: E-scooters, social representations, data visualization, R, digital humanities

Subject area: (sustainable cities)

Category: PhD thesis (ongoing)

Abstract:
The use of e-scooters as an alternative means of transportation has gained significant attention in recent years. However, their implications for transportation systems still require investigation. This presentation focuses on an ongoing multidisciplinary PhD project that aims to analyse e-scooters under the digital humanities lens. It seeks to provide a different perspective, less explored in e-scooter studies.
More specifically, this research aims to conduct a comprehensive study on the communicational processes, user patterns, and sociocultural meanings associated with e-scooter use in urban contexts, using the city of Porto, Portugal, as case study. By combining data analysis, social representation theory, and spatial mapping, this project aims to explore how mobility data can be interpreted beyond its statistical analysis, revealing insights that are not immediately evident in the dataset itself.
The study relies on three different phases: (i) the collection and comparison of social representations of e-scooters circulating across different media, which has already been completed and whose results will be presented; (ii) the analysis of e-scooter trip data provided by the private company Bird, one of the main operators in Porto, to map the city according to trends and patterns; and (iii) the comparison of the social representations circulating within each zone of this map. There will be a focus on contextual factors such as tourist activity, social housing areas, and the proximity of key urban landmarks, as these variables may provide additional insight regarding user behaviours and perceptions.
The project will also focus on the complex dynamics surrounding different social groups and their relationships with this novel technology. By identifying how groups such as riders, non-riders, residents, and tourists make sense of this micromobility vehicle, we will be able to reflect on how e-scooters are used, perceived, and integrated into urban mobility, whether as tools of convenience, symbols of sustainability, or elements of urban inequality.
Finally, the results will contribute to the development of a communication framework to aid stakeholders, particularly the Municipality of Porto, to improve communication efforts with users and better inform policies that promote the sustainable and equitable development of urban transportation systems.

Date: September 2023 – September 2027

(A32)

CONCRETE SENSORS INCORPORATING CARBON BLACK FOR TRAFFIC AND INFRASTRUCTURE MONITORING

P. CACHIM [a] and J. MACEDO [b]
[a] *CERIS, Department of Civil Engineering, University of Aveiro*
Email: pcachim@ua.pt
[b] *CERIS, Department of Civil Engineering, University of Aveiro*
Email: jmacedo@ua.pt

Keywords: Smart infrastructure, self-sensing concrete, carbon black, piezoresistive composites, traffic monitoring

Subject area: Traffic monitoring and management

Category: Research Projects

Abstract:
Smart infrastructures combine sensing, data analysis, and feedback mechanisms to improve the performance and sustainability of built environments. Transport infrastructures, particularly road networks, are critical systems where efficient monitoring can reduce congestion, emissions, and maintenance costs. Embedding sensors directly into construction materials offers an innovative approach to real-time traffic and structural monitoring.
Concrete remains the most widely used construction material due to its durability, availability, and cost-effectiveness. When enhanced with functional additives, it can become a "smart" material capable of responding to external stimuli such as stress or temperature. Carbon-based materials—such as carbon nanotubes, graphene, carbon fibres, and carbon black (CB)—are known to improve the electrical conductivity and self-sensing capabilities of cementitious composites, enabling them to act as intrinsic sensors.
This study presents ongoing research on the development of piezoresistive cement-based composites incorporating carbon black for traffic monitoring applications. Several cementitious formulations with varying CB contents and electrode configuration were produced and tested to evaluate their electrical and mechanical performance. Cyclic uniaxial loading tests were performed while continuously recording electrical resistivity to assess the correlation between deformation and electrical response.
The results demonstrate a reversible and repeatable piezoresistive effect, with a quasi-linear relationship between fractional change in resistivity (FCR) and compressive strain. The sensitivity was influenced by both the applied load level and electrode configuration. These findings indicate that CB-modified cement composites can reliably detect strain variations induced by traffic loads.
Overall, this research highlights the potential of carbon black–based cement composites as cost-effective, durable, and easily integrable sensors for real-time monitoring of road pavements and other concrete infrastructures, contributing to the advancement of smart and sustainable transportation systems.

Date: February 2025 – July 2026

(P1)

FUTURE SCENARIOS OF URBAN MOBILITY WITH AUTONOMOUS VEHICLES THROUGH MULTI-AGENT SIMULATION

JOÃO AMORIM [a], PATRÍCIA BAPTISTA [b], TIAGO FARIAS [c]
[a] *Instituto Superior Técnico, Universidade de Lisboa, Portugal*
Email: joao.m.amorim@tecnico.ulisboa.pt
[b] *IN+ Center for Innovation, Technology and Policy Research, LARSyS*
Instituto Superior Técnico, Universidade de Lisboa, Portugal
Email: patricia.baptista@tecnico.ulisboa.pt
[c] *•IDMEC, Instituto Superior Técnico, Universidade de Lisboa, Lisboa, Portugal*
Email: tiago.farias@tecnico.ulisboa.pt

Keywords: Urban mobility; Agent-based modelling; Autonomous vehicles; Impacts of autonomous mobility

Subject area: Sustainable Cities and Urban Mobility Planning

Category: Master thesis (Poster Session)

Abstract:
Autonomous vehicles (AVs) are expected to play a central role in shaping future urban mobility systems. However, the lack of robust empirical data, stemming from the limited technological maturity and scarcity of large-scale pilot project, highlights the need for simulation models capable of anticipating the potential impacts of AV deployment in urban environments. Such models can support policymakers and planners in designing and evaluating transport strategies to prepare for the imminent disruption brought by autonomous mobility.
Among the available methodologies, agent-based models (ABMs) stand out as a promising approach for representing increasingly complex transport systems and heterogeneous user behavior. This ongoing research aims to assess the energy and environmental implications of introducing autonomous vehicles into urban contexts using the MATSim multi-agent simulation platform.
Beyond commonly explored aspects in the literature — such as fleet renewal, changes in land use, and variations in vehicle-kilometers travelled (VKT) — this study also considers the potential influence of AVs on daily mobility behaviors, particularly among dependent user groups such as children, the elderly, and people with reduced mobility. Accordingly, the research proposes a differentiated analysis of AV adoption impacts across multiple stakeholder groups, contributing to a more inclusive and sustainable vision of autonomous urban mobility.

Date: July 2025 – December 2025

Acknowledgements: This work was carried out within the scope of the project BE.Neutral – Mobility Agenda for Carbon Neutrality in Cities (contract no. 35), funded by the Plano de Recuperação e Resiliência (PRR) through the European Union's Next Generation EU programme. The authors also acknowledge the financial support of Fundação para a Ciência e a Tecnologia (FCT) through LAETA (project UID/50022/2025) and LARSyS (project UIDB/50009/2025).

(P2)

OPTIMIZATION OF HOP-ON HOP-OFF TOURIST TRANSPORT SERVICE: APPLICATION TO THE CITY OF COIMBRA

JOAO F. BIGOTTE [a,b], MARIANA FERNANDES [a]
[a] *Department of Civil Engineering,*
University of Coimbra
Email: jbigotte@dec.uc.pt

[b] *CITTA – Research Center for Territory, Transports, and Environment*

Keywords: tourist mobility, intra-destination mobility, urban mobility, routing problem, traveling salesman

Subject area: tourist mobility, urban mobility

Category: Master thesis (preferably authors who will continue this research along the PhD; Poster Session)

Abstract:
Studies on tourist mobility have primarily focused on travel between origin and final destination. In contrast, studies on tourist mobility at the destination are scarce, especially regarding specific transport services for tourists. Among the various intra-destination tourist transport options, one of the most common is the Hop-on Hop-off (HOHO) service.
Among the issues most directly associated with the quality and success of a HOHO service are route design, points of interest served, and service frequency.
This work explores the application of optimization models, such as the Traveling Salesman Problem (TSP), to (re)design HOHO transport services, using the city of Coimbra as a case study.
The city of Coimbra is an interesting case for several reasons: i) it is a medium-sized city with significant tourism; ii) the HOHO service has existed since 2004, but has never been able to establish itself, and has undergone several changes, suspensions, and service restarts over the years; and iii) it is expected that the start of operation of the new BRT system will have implications for the entire city's transportation system, including tourism.
The results demonstrate that it is possible to optimize the route and increase service frequency, using the same resources (vehicles and drivers), while maintaining the value of the points of interest covered (accommodation and tourist attractions).

Date: September 2024 – September 2025

(P3)

UNDERSTANDING ROAD ACCIDENT SEVERITY AND HOTSPOTS IN PORTUGAL THROUGH DATA ANALYTICS

E. MACEDO[a*], E. FERREIRA[a] , A. PASCALE[b] and P. FERNANDES[a]
[a] *Department of Mechanical Engineering,*
University of Aveiro
[b] *Department of Environment and Planning,*
University of Aveiro
**Email: macedo@ua.pt*

Keywords: road crash data analysis, vulnerable road users, crash hotspots, resilient cities

Subject area: road safety

Category: Poster Session

Abstract:
Road accidents remain a major public health challenge in Portugal, with a significant economic and social cost (€7.2 billion in 2023, or 3.0% of GDP). In 2023, Portugal recorded 36,595 accidents with victims, resulting in 642 fatalities. The majority of fatalities were drivers (66.7%), and most accidents occurred in good weather. Despite progress, the number of accidents with victims in Portugal is above the European average. This study aims to use a data-driven approach to understand crash patterns better and inform targeted interventions. We exploit the national database of road accidents from 2019 to 2023, focusing on key variables to extract meaningful information. In this database, crash severity is classified into three distinct categories: minor injury, serious injury, and fatality. The main objectives is to: 1) Identifying High-Risk Zones: Use data analysis to pinpoint geographical "hotspots" of accidents, allowing for priority interventions; 2) Understanding Crash Dynamics: Explore the relationships between factors like road conditions, vehicle types, and luminosity to better understand why and how accidents occur; 3) Understanding Severity: Develop models to predict the severity of an accident based on atmospheric factors, road structures, and collision types, among other variables; and 4) Informing Policy: Provide actionable, evidence-based insights to support decision-making for road safety authorities. The research questions are as follows:
- What is the distribution of crash severity (minor, serious, fatal) for each type of road structure (e.g., Tunnel, Viaduct/Bridge)?
- Is there a strong correlation between the road conservation status and the severity of an accident? Are accidents on "poorly maintained" roads more likely to result in fatalities or serious injuries?
- How does the nature of the collision (e.g., "head-on collision" vs. "simple run-off") affect the number of fatalities and serious injuries?
- Are certain types of intersections (e.g., "At a roundabout" vs. "At a crossing") associated with a higher frequency or severity of accidents?
- Is there a difference in the types of accidents (e.g., rear-end vs. head-on) that occur during the day versus at night?
The findings aim to support evidence-based decision-making, guiding authorities in prioritizing interventions and improving road safety outcomes.

Date: August 2025 - ongoing

(P4)

Operationalising the Airport Metabolism Framework: Evidence from a Mid-Size European Airport

María Santos-Alfageme [a*] · Rosário Macário [a] · Patrícia Baptista [b]

[a] *CiTUA, Centre for Innovation in Territory, Urbanism and Architecture, Instituto Superior Técnico, University of Lisbon, Portugal*

* Corresponding author: maria.santos.alfageme@tecnico.ulisboa.pt

[b] *IN+ Centre for Innovation, Technology and Policy Research, LARSYS, Instituto Superior Técnico, University of Lisbon, Portugal*

Abstract

Greenhouse gas emissions and material consumption continue to increase worldwide, with airports – as complex infrastructures within both mobility and the built environment – playing a significant role in this trend. However, current decarbonisation projects at airports are not coupled with plans to reduce its materiality in absolute terms and fall short in recognising the potential of the circular economy as a driver of change. To amend this, this paper tests the airport metabolism framework as a decision-support tool for airport decarbonisation plans. Drawing on empirical data from a mid-sized European airport in 2023, the research quantifies material and energy flows, respectively linking them to the Material Circularity Indicator and Airport Carbon Accreditation. It operationalises this novel theory, offering an opportunity to bridge gaps in environmental plans and address climate change from a multidimensional perspective. By integrating material and energy perspectives and embedding a system-dynamics approach, the framework enables scenario testing, identification of leverage points, and assessment of long-term impacts for more resource-conscious airport decarbonisation management.

(P5)

Through the Bus Driver's Eye: Linking Operational Data and Driver Perspectives to Bus Services Monitoring and Planning

G. F. MATOS [a,c], R. FÉLIX [a,b,d] and F. MOURA [a,b,e]
[a] *U-Shift Research Lab,*
Civil Engineering Research and Innovation for Sustainability (CERIS),
Instituto Superior Técnico, University of Lisbon
[b] *Supervisor*
[c] *Email: goncaloafmatos@tecnico.ulisboa.pt*
[d] *Email: rosamfelix@tecnico.ulisboa.pt*
[e] *Email: fmoura@tecnico.ulisboa.pt*

Keywords: Transit monitoring, Transit policy, Transit network planning, Bus drivers, Stakeholder engagement.

Subject area: Transit planning and operations

Category: Master thesis

Abstract: Bus transit services are essential to urban mobility, yet in many cities they are perceived as unreliable and inefficient. This thesis focuses on this problem, trying to understand it from a perspective that has received little attention by the literature: through the bus drivers' eyes. The research explores how drivers' tacit insights can complement explicit operational data to enhance network monitoring and planning. Semi-structured interviews with controllers from different cities provided an overview of the state-of-the-practice, followed by a case study of Lisbon's bus operator, Carris. A focus group with eight bus drivers revealed their perceptions on performance, factors impacting it and improvement opportunities. Thematic and ranking analyses were conducted to identify their priorities and awareness across operational, tactical, and strategic planning dimensions. In parallel, more than 270,000 operational messages and 32 million events from Carris' operating assistance system were analysed using text mining and spatial aggregation, and their interrelations examined to contextualize drivers' observations and identify recurrent operational patterns. Results demonstrate that this methodology can improve communication efficiency in operational monitoring. Also, it shows that drivers hold valuable knowledge about systemic inefficiencies (such as unrealistic schedules, inadequate infrastructure or ineffective communication systems) that align with operational data patterns. The study concludes that integrating drivers' feedback and field observations can strengthen and inform monitoring and planning decisions. It advocates for a participatory framework where human and technological resources complement each other, bridging the gap between quantitative monitoring and qualitative operational understanding.

Date: February 2025 – October 2025

(P6)

BENCHMARKING FOR SUSTAINABLE URBAN MOBILITY: A CLUSTER ANALYSIS APPROACH

CARLOS SAMPAIO [a], LÍGIA CONCEIÇÃO [b, c] and ANDRÉ M. CARVALHO [a]
[a] *UNIDEMI, Department of Mechanical and Industrial Engineering, NOVA School of Science and Technology, Universidade NOVA de Lisboa*
Email: {cj.sampaio; ame.carvalho}@fct.unl.pt
[b] *Artificial Intelligence and Computer Science Laboratory, Faculty of Engineering, University of Porto*
[c] *School of Business Administration, Polytechnic Institute of Setúbal, Portugal*
Email: ligia.conceicao@esce.ips.pt

Keywords: SUMP; Cluster Analysis; Urban Planning; Sustainable Urban Mobility.

Subject area: Sustainable cities.

Category: Research Projects (funded by FCT or other institutions).

Abstract:

Sustainable urban mobility is a core municipal policy domain in Portugal, but planning practices, perceived challenges and priorities vary across contexts. Sustainable Urban Mobility Plans (SUMPs) are one relevant instrument within this landscape, but municipalities also act through other planning and policy channels. This study aims to identify municipal typologies for mobility planning and to enable benchmarking across peers.

We use a national survey with mixed data: ordinal context variables (CAR) and Likert-type items on perceived utility of planning instruments (UTI), perceived challenges (DES), and importance of objectives of sustainable urban mobility (OBJ). The dataset covers 54 municipalities, surveyed in 2025. 39 indicators were derived from the questionnaire. Prior to clustering, we conduct indicators screening to ensure variability and reduce redundancy, retaining a balanced set of 15–20 indicators. Pairwise Gower distances accommodate mixed scales and groups are derived via PAM (k-medoids). The silhouette coefficient guides the choice of k, complemented by expert judgment to ensure policy interpretability. Post-hoc, η^2 (ANOVA) for Likert items and Cramér's V for ordinal variables identify the most discriminative indicators. Medoid municipalities are reported as practical reference cases for benchmarking.

Preliminary exploration suggests three to four interpretable groups differing mainly in perceived challenges and strategic priorities rather than the mere presence of formal plans. The study produces compact, interpretable cluster profiles, a short list of indicators that best separate municipal approaches, and exemplar medoids to support peer-to-peer learning and targeted capacity-building. Overall, the study offers a practical framework to compare, learn, and target support where it can have the greatest impact.
The authors gratefully acknowledge support from the FCT — Fundação para a Ciência e a Tecnologia under grant reference 2023.14917.PEX.

Date: February 2025 – August 2026

(P7)

AN OSM-BASED REPRODUCIBLE METHOD TO MEASURE LINK AND PLACE STREET FUNCTIONS AT THE CITY-SCALE

M. PIRES [a] and G. VALENÇA [b]
[a] *CERIS, Instituto Superior Técnico, University of Lisbon.*
Email: miguelpcrpires@
[b] *Department of Computer Science,*
University of XXX
Email:
[c] *Center of Transportation Studies*
Email:

Keywords: macroscopic street functional classification; link; place; OpenStreetMap

Subject area: transport planning; urban planning

Category: Master thesis

Abstract: This work proposes a reproducible, city-scale and context-specific method to quantify the link and place functions of streets using only OpenStreetMap (OSM) data and open-source Python packages. While conceptual models recognizing streets as both mobility corridors and social destinations are well-established, their translation into scalable quantitative frameworks remains limited, with most applications occurring microscopically, through detailed street-level assessments. This study addresses that gap by defining a transparent and generalizable methodology that calculates link and place indicators for every street segment in a city, requiring no external inputs beyond freely accessible geospatial information. The link function is measured through edge-betweenness centrality and capacity estimates on a simplified centerline network derived from OSM highway features, capturing each street's ability to act as a through movement corridor. The place function is quantified through the assessment of density, diversity and design of street sections, providing a comparable metric of destination activity potential. Applied to the Portuguese municipality of Lisbon as a case study, the method yields a continuous distribution of link and place values and a typology matrix that reveals structural mobility corridors, local activity clusters, and mixed-function urban avenues. By relying exclusively on open data and open-source computational workflows, this approach enables replication across any territory with OSM coverage and supports early-stage policy-making by offering a clear, interpretable, and scalable diagnostic tool for screening street functions. Future work should refine proxies on street form, and apply the methodology to other case studies for a comparative analysis.

Date: February 2025 – December 2025

(P8)

NUMERICAL DECISION-SUPPORT TOOL FOR FLEET DECARBONIZATION: ANALYSIS OF ENERGY CONSUMPTION AND POLLUTANT EMISSIONS IN URBAN BUS FLEETS

DINIS PAULINO [a], PATRÍCIA BAPTISTA [b], TIAGO FARIAS [c]
[a] *Instituto Superior Técnico, Universidade de Lisboa, Portugal*
Email: dinis.paulino@tecnico.ulisboa.pt
[b] *IN+ Center for Innovation, Technology and Policy Research, LARSyS*
Instituto Superior Técnico, Universidade de Lisboa, Portugal
Email: patricia.baptista@tecnico.ulisboa.pt
[c] *IDMEC, Instituto Superior Técnico, Universidade de Lisboa, Lisboa, Portugal*
Email: tiago.farias@tecnico.ulisboa.pt

Keywords: Public transport; Decarbonization; Fleet management; Energy consumption

Subject area: Sustainable Cities

Category: Master thesis (Poster Session)

Abstract:
Road-based public transport is a cornerstone of urban mobility and a major contributor to greenhouse gas emissions. The transition towards low- or zero-emission bus fleets and the adoption of alternative propulsion technologies pose significant challenges for operators, who require data-driven decision-support tools to identify effective decarbonization pathways. This work presents the development of a numerical tool designed to estimate energy consumption and pollutant emissions for urban bus fleets. The tool enables public transport operators to simulate and compare fleet composition and operational strategies, supporting decisions aimed at reducing energy use, emissions, and costs.
The methodological framework integrates a robust emissions database (based on COPERT software), with customizable input parameters such as vehicle segment, Euro emissions standard, occupancy rate, driving cycle, and annual mileage. The software architecture is modular and flexible, allowing the assessment of diverse fleet compositions and route allocations across urban, rural, and highway contexts.
Case studies using real-world operational data from Portuguese bus operators demonstrate the tool's applicability in identifying critical factors influencing energy demand and emissions, as well as in optimizing vehicle deployment. Results emphasize the influence of energy source, propulsion systems, commercial speed, vehicle age, and segment on fleet performance. Hypothetical scenarios revealed potential reductions of over 90% in well-to-wheel CO_2 emissions and more than 60% in energy costs.

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(P9)

EVALUATING THE IMPACT OF COOPERATIVE ADAPTIVE CRUISE CONTROL IN RAMP METERING SYSTEMS

Telmo Costa Botelho [a b *], Rafael Vieira [c], Sérgio Pedro Duarte [a b], José Pedro Tavares [b]
[a] *ICS – Instituto para a Construção Sustentável, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal*
[b] *CITTA, Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto Portugal*
[c] *Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal*
[*]tcbotelho@fe.up.pt

Keywords: Cooperative Intelligent Transport Systems (C-ITS), Cooperative Adaptive Cruise Control (CACC), Ramp Metering Systems (RMS), Gap Detection, Microsimulation

Subject area: Traffic Management

Category: Published Papers along 2025

Abstract: Effective ramp control is essential to maintaining motorway performance under increasing traffic demand, especially at merging sections where congestion and instability often originate. This paper introduces a cooperative ramp control framework that integrates ramp metering (RMS), gap detection, and Cooperative Adaptive Cruise Control (CACC) within a microsimulation environment. The approach combines macroscopic inflow regulation with microscopic vehicle coordination to improve flow stability and throughput at on-ramp merges. The control logic was implemented in Python and coupled with PTV VISSIM via a COM interface, enabling real-time data exchange and adaptive decision-making based on traffic-state measurements.

The control strategy was tested on a real motorway segment of the A16 in Rotterdam, Netherlands, using empirical traffic data from the National Data Warehouse. Traffic demand was scaled to represent varying congestion levels at 125% and 150% of observed volumes, while additional low-demand scenarios (100% and 75%) were used to evaluate robustness under free-flow conditions. Multiple simulation configurations were developed, ranging from uncontrolled conditions to complete cooperative control, with CACC penetration rates between 10% and 100%. Each configuration was evaluated for both morning and afternoon peaks based on total travel time, total delay, and average speed.

Results show that conventional ramp metering alone produced only marginal benefits under heavy congestion. In contrast, integrating CACC and gap detection led to significant performance improvements. At 150% demand, the total delay decreased by roughly one-third compared with the base case, while the average mainline speed increased from around 80 km/h to over 100 km/h. These improvements became significant once CACC penetration exceeded 40%, indicating a nonlinear transition in network efficiency. The dedicated-lane configuration, tested with up to 50% CACC penetration, provided no additional gains due to reduced lane flexibility.

Overall, the findings demonstrate that combining macroscopic ramp control with microscopic vehicle cooperation enhances motorway stability and throughput without infrastructure modification. The control strategy remains inactive under uncongested conditions, ensuring efficiency and scalability for gradual deployment in mixed-traffic environments. These results support the progressive integration of cooperative control within future intelligent transport systems.

Date: January 2024 – November 2025

(P10)

A DATA-DRIVEN MACHINE LEARNING FRAMEWORK FOR DRIVING BEHAVIOUR MODELLING AND CLASSIFICATION

P. FERNANDES [a,b*], E. FERREIRA[a,b] , E. MACEDO[a,b]
[a] Department of Mechanical Engineering,University of Aveiro
[b] *LASI - Intelligent Systems Associate Laboratory*
*Email: paulo.fernandes@ua.pt

Keywords: driving behaviour classification; data-driven, clustering; prediction; Machine Learning;

Subject area: driving behaviour classification

Category: Research Projects (funded by FCT or other institutions)

Abstract: Aggressive driving behaviours are a major concern for public authorities due to their negative impacts on road safety and energy consumption. With recent advances in large-scale vehicle data collection, data-driven approaches have become powerful tools for analysing driving patterns. Although several studies have applied machine learning methods for driving behaviour classification, most rely on databases with limited road coverage, weather conditions, and driver variability. Moreover, the existing research often neglects the combined effects of driving dynamics, volatility, and energy features. In the context of the IDRIVE (Incorporating Driving Volatility Information into a Rating system to Inform drivers about Vehicle Emission rates) project, this study proposes a generalised framework for developing predictive models able of classifying driving behaviours using a comprehensive set of trip characteristics based on drivers, vehicles, weather, road sections, fuel/energy use and measures of driving volatility. Unsupervised clustering methods are first applied to find driving behaviour clusters, which are then used to train supervised machine learning algorithms. The research questions are as follows:

1. How many distinct patterns of driving behaviour can be identified in the data-driven parameters?
2. Are clusters more influenced by contextual factors or behaviour-related ones?
3. What are the defining characteristics of each cluster?

An OBD-II device was connected to a vehicle and collected 1 Hz vehicle speed and acceleration, GPS data, and engine data, including fuel flow rate, engine load, and engine speed. Driving trips were conducted by 31 volunteers, aged 23–61 years, with driving experience ranging from 3 to 35 years; and a sample of 45 vehicles. The dataset comprises 2.78 million records, covering 43,014 km of road and 1,962 trips collected in Portugal, Spain, France, Switzerland, and the United Kingdom. Eleven variables expressed as a percentage of total trip time are used to ensure comparability across trips of different durations. The hierarchical and K-means clustering analyses identified four distinct driving behaviour profiles: Urban Rainy (13.4%), Urban Weak Visibility (16.7%), Urban Normal (43.7%), and Rural-Highway (26.2%) trips, each reflecting specific behavioural, driving state and contextual patterns. Statistical tests showed that contextual variables such as urban environment driving, and wet and poor visibility conditions had the strongest discriminative power among clusters, while behavioural variables like vehicular jerk and acceleration violations, and aggressive fuel/energy use show less discriminative power. The main contribution of the study is that it employs exhaustive feature extraction methods to build models from high-time resolution data (second-by-second), resulting in robust and generalisable classifiers. By classifying driving behaviour, drivers may be encouraged to adopt more responsible and eco-friendly behaviours, reducing their social and energy-related impacts. Models can also be incorporated in electronic car units and important implications for the design of driver monitoring and feedback systems.

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(P11)

TRAVEL EXPERIENCE - CONNECTION BETWEEN TERRITORY AND LANDSCAPE

L. CAMPOS [b]
[b] *Department of Civil Engineering and Georesources, University of Porto*
Email: liviapcampos28@gmail.com

Keywords: travel experience, sensory experience, affective experience, lived space, public transport

Subject area: transport planning

Category: Master thesis

Abstract: The urban landscape is the stage and raw material for the human beings who inhabit and transform it. Although the current debate on urban mobility often focuses on technical terms such as "sustainable mobility" or "green infrastructure," this dissertation argues that travel transcends functional connection, being a lived experience that traverses sensations, memories, the body, and the landscape. The main objective of this research is to analyze how city design impacts the travel experience, understanding urban space as a social product where micro-perceptions construct unique atmospheres. The research is structured around Lefebvre's spatial triad— conceived, perceived and lived space—seeking to investigate how this triad manifests itself in the travel experience, exploring the role of the subject (*flâneur*) in absorbing landscapes in motion, and considering the experience beyond the visual, as bodily and affective. The methodological approach is phenomenological, using participant observation as a cross-cutting technique. The empirical field compares two bus lines in Porto: the 205 and the 500; the 205 marked by friction and a road-based logic, running along a highway and dense buildings, and the 500 permeating the sea and riverfront, characterized by fluidity and flirtation with the landscape. The dissertation articulates the three spatial dimensions through conceived space (technical analysis of infrastructure and planning), perceived space (sensory approach using graphics to map noise, comfort, and visual openings), and lived space (synthesis through affective cartography). Although it is not a question of choosing the "best" line, Line 205 is objective and functional, with a straight route and high speeds that narrow the ability to perceive the surroundings, transforming the Circunvalação Road into a "scar on the urban fabric." In contrast, Line 500 offers a more immersive and hedonistic experience; its organic layout and rhythm provide unity and a landscape and sensory repertoire, alternating between intimate and monumental stretches. Studies indicate that the scenic quality, prominent on the 500, affects well-being and provides restorative settings that increase the ability to concentrate. The disparity is reinforced by urban planning, with the 500 historically at the center of high-value symbolic and qualifying works, while the 205 has remained marginalized. To promote the necessary structural break, the focus must be on the experience at its core—ensuring the right to the full urban experience. The true contribution of this research lies in demonstrating that Lefebvre's three spheres—the conceived, the perceived, and the lived—are inseparable in the travel experience and must be integrated into the design of cities, as the body that inhabits these spaces is one. Recognizing the body in its depth as a measure of space is what is needed to transform public transportation into experience.

Date: September 2024 – September 2025