Innovating Sustainable Urban Logistics through the E-Laas Project

The ENUAC project E-Laas explores how energy-based planning can improve the sustainability of multimodal urban logistics systems.

Societal fairness, customer preferences, research agenda

One recent study looked at how different companies could schedule EV charging fairly when using third-party charging stations. The work introduces a cooperative scheduling method tested in Gothenburg and highlights the importance of balancing fairness with infrastructure efficiency [1].

Another line of work focuses on flexible last-mile delivery, where customers' preferences are considered by offering alternative drop-off points and time windows. The proposed model balances service flexibility with operational efficiency, enabling more sustainable and user-centric last-mile delivery [2].

The project also contributes to methodological innovation with a structured review of machine learning methods for routing. It introduces a taxonomy of approaches and highlights how ML can support more adaptive and efficient urban logistics planning [3].

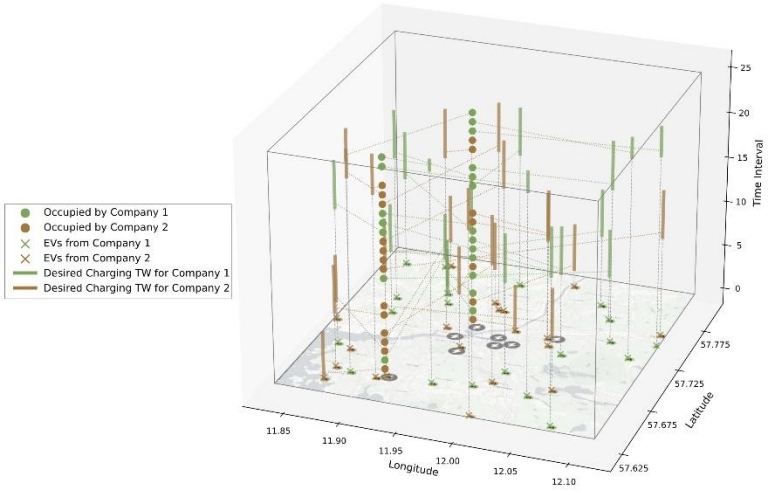

Figure. 3D visualization of EV charging schedules across time and space in the Gothenburg case study [1].

Hybrid simulation approach for last mile logistics investigation and energy expenditure assessment

An important component of the E-Laas project involves providing practical guidance for cities in shaping their sustainable urban logistics strategies and transport policies. Urban areas differ significantly in terms of spatial and infrastructural characteristics, population density, travel behaviour, as well as the types and availability of transport modes and infrastructure. Not every city has the capacity or resources to conduct extensive research or develop advanced transport models. To address this challenge, we are developing a scalable methodology based on hybrid simulation (integrating micro- and macroscopic approaches) aimed at accurately and efficiently modelling urban logistics flows using representative patterns of Traffic Analysis Zones (TAZs).

As part of the project, a comprehensive survey was conducted among 2,427 respondents, including 244 representatives of local authorities, 238 logistics operators, 1,082 delivery workers, and 863 users. The survey covered diverse TAZs and cities characterized by various spatial and functional attributes. These

data enabled us to develop analyses of user behaviour 0 and assess the functioning of urban logistics from the perspective of local governments 0.

The collected survey data, along with spatial datasets, provide a basis for exploring the behaviour of urban freight system stakeholders and integrating these behaviours into simulation environments. Currently, we are working on simulation models and developing a methodology for scaling microsimulation outputs to macroscopic representations. The identification of similarities between TAZs allows for accelerated analysis of logistics performance across cities by utilizing reference zones and approximation functions. For the GZM Metropolis, we investigated the fragmentation of urban zones and the feasibility of scaling their characteristics 0. Fig. 2 illustrates the clustering of this area into reference TAZs for simulation purposes. Initial simulation models and similarity-based approximation functions were developed for selected zone in the GZM area (Fig. 3), demonstrating the applicability of microsimulation to assess energy demand across different delivery configurations 0 and the potential for scaling these results to macro-level assessments in similar zones 0.

		10 clusters			
		Cluster centroid k			
Map colour	Cluster	1: housing	2: work	3: other	4: freight
	1	0,0086	0,0063	0,0004	0,3243
	2	0,0933	0,0257	0,0130	0,0476
	3	0,0166	0,0225	0,0083	0,1835
	4	0,1678	0,0362	0,0244	0,0741
	5	0,0049	0,0010	0,0006	0,0039
	6	0,0150	0,0064	0,0017	0,0391
	7	0,0135	0,0122	0,0033	0,0948
	8	0,2734	0,1025	0,0070	0,1443
	9	0,0349	0,0077	0,0049	0,0193
	10	0,0017	0,0023	0,0076	0,5654

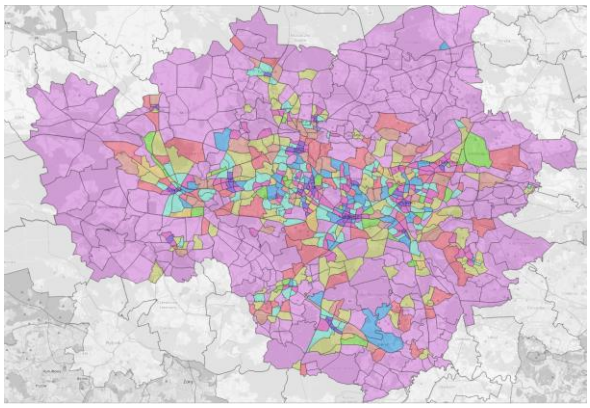

Fig. 2. TAZ map of references clusters for GZM Metropolis 0.

Fig. 3. The Podlasie housing estate in Katowice (GZM Metropolis) as represented in the simulation model 0.

Another important aspect of our work is the focus on the assessment of energy consumption within delivery systems and its integration into the hybrid simulation framework. The application of predictive modeling methods enhances the accuracy of energy usage estimations for urban logistics operations 0, while

macroscopic models enable spatial distribution analyses to support the formulation of sustainable logistics policies 0.

References

[1] F Zhou, B Kulcsar, J Wu, Collaborative Charging Scheduling via Balanced Bounding Box Methods, arXiv:2506.14461, 2025.

[2] *This work is currently under double-blind submission. Feel free to reach out for more details at kulcsar@chalmers.se*

[3] F Zhou, A Lischka, B Kulcsar, J Wu, MH Chehreghani, G Laporte, Learning for routing: A guided review of recent developments and future directions, to appear, Transportation Research Part E: Logistics and Transportation Review, 2025.

[4]Paszkowski, J., & Żochowska, R. (2025). Estimating car travel demand associated with parcel locker pickups. *Archives of Transport, 74*(2). Under review.

[5] Paszkowski, J. (2025). *Research on implementing sustainable urban logistics measures in Poland*. To be presented at the *European Transport Conference (ETC 2025)*, University of Antwerp, Antwerp, Belgium, 17–19 September 2025.

[6] Paszkowski, J., Murawski, J., & Gao, J. (2025). *Scaling traffic behaviour: Traffic Analysis Zones clustering using traffic motivation data – estimating the optimal cluster quantity*. To be presented at the *9th Conference on Models and Technologies for Intelligent Transportation Systems (MT-ITS)*, Kirchberg Campus, University of Luxembourg, Luxembourg, 8–10 September 2025.

[7] Kłodawski, M., Lewczuk, K., & Gao, J. (2025). *Last-mile delivery energy consumption: Insights from a simulation-based analysis*. To be presented at the *14th Asia-Pacific Conference on Transportation and the Environment (APTE)*, Hangzhou, China, 9–11 August 2025.

[8] Szczepański, E., Paszkowski, J., Jacyna, M., Wang, K., & Gao, J. (2025). *Scaling urban logistics microsimulation: Traffic analysis zone similarity assessment to estimate simulation results*. To be presented at the *14th Asia-Pacific Conference on Transportation and the Environment (APTE)*, Hangzhou, China, 9–11 August 2025.

[9] Izdebski, M., & Jacyna, M. (2025). *Predictive models of energy expenditure of electric delivery vehicles in urban service enterprises*. To be presented at the *14th Asia-Pacific Conference on Transportation and the Environment (APTE)*, Hangzhou, China, 9–11 August 2025.

[10] Paszkowski, J., Szczepański, E. (2025) *Analysis of the urban logistics energy usage and pollutant emission based on a macroscopic model data for GZM Metropolis, Poland.* Article in preparation.