solutions plus

INTEGRATING E-MOBILITY INTO MULTIMODAL TRANSPORTATION SYSTEMS FROM A DESIGN AND URBAN PLANNING PERSPECTIVE

This project has received funding from the Europeans Union Horizon 2020 research and innovation programme under grant agreement No. 875041

Imprint

About:
This Orientation Paper has been prepared for the Project SOLUTIONSplus. The project has received funding from the European Union´s Horizon 2020 under the grant agreement no 875041

Title:
Integrating e-mobility into multimodal transportation systems from a design and urban planning perspective

Author(s):
Jakub Galuszka

Reviewer(s):
Tim Hanawalt, Judith Owigar

Acknowledgement:
This publication is made possible thanks to the contributions made by organisations involved in the SOLUTIONSplus, all of whom are credited for their respective contributions. Additionally, the following individuals supported the project through their participation in the design studio process, serving as students, facilitators, and external experts: Professor dr Oliver Lah, Dr Alphonse Nkurunziza, Dr Shritu Shrestha, Maria Rosa Munoz Barriga, Emilie Martin, Alvin Mejia, Juan Pedro Carriquiry, Jaqueline Senyagwa, Yasin Imran Rony, Liv Lees, Alejandro Orduz, Nere Guarrotxena, Pia Schauder, Björn Langer, Carolina Moreno Londoño, Maram Ismail, Hannes Steinhauer, Yagmur Durak, Maryam Mokhtariafjedi, Kuang-Yu Niu, Zeal Shah, David Per Hugo Svensson, Azada Taheri, Emilia Gröne, Nora Stellwag, Jana Wechtenbruch, Buxin Guo, Yuki Tominaga, Zhuoran Zhang, Anne Welter, Vasco Rummenhöller, Isabelle Almeida Quinton.

Layout:
Maria Giannisi

September 2023

Project Partners

Contents

List of Abbreviations

CPTED – Crime prevention through environmental design
ICE – Internal combustion engine
NMT – Non-motorised-transport
TOD – Transit-oriented development

Executive Summary

E-mobility is a crucial component supporting the transition of cities towards sustainability. The electrification of public transport fleets, in particular, holds the potential to increase the quality of urban space by reducing pollution and noise and creating new mobility opportunities for users. This process impacts the existing use and design of public spaces and transport systems. As such, it requires significant planning effort to properly capitalize on its potential and ensure the useful integration of e-mobility into the existing spatial context. This Policy Advice Paper reflects on this problem, focusing on integration of public transportation-oriented e-mobility modes into the current transportation system from urban planning and design perspective. Building upon a series on conceptual design processes in SOLUTIONSplus partner cities, it provides key recommendations for integrating e-mobility. These recommendations elaborate critical steps for the diagnosis and planning of e-mobility as tools for placemaking, integrated development across key urban sectors and socio-economic inclusion.

Purpose	**This deliverable aims to provide policy advice from the SOLUTIONS+ consortium partners to local municipalities**
Coordination	**Technical University of Berlin (TUB)**
SOLUTIONSplus partners	**UN-Habitat, Urban Electric Mobility Initiative (UEMI), Wuppertal Institut**
Contributors	**Jakub Galuszka**
Reviewers	**Tim Hanawalt, Judith Owigar**

Background

photo © Jakub Galuszka

The development of sustainable transportation has been increasingly recognised in international agendas and local policies as a crucial step towards economic prosperity, climate adaptation and social well-being. The well-designed and attractive space plays a pivotal role in reinforcing these qualities and is currently seen as a critical component of the integrated planning of urban solutions. Such an approach resonates with the New Urban Agenda's ambition of well-designed street networks which prioritise personal safety, quality public spaces, human-scale development and fostering formal and informal economic activities in addition to functional transport (New Urban Agenda, 2016: 25). The agenda reinforces transportation development as an element of an integrated urban planning which considers mobility in relation to housing, economic activities and matters of social inclusion.

E-mobility interventions, apart from contributing to a reduction of CO2, can improve these other aspects of urban planning and reinforce the principles of the Avoid-Shift-Improve approach. The introduction of e-mobility into the urban system as a form of last-mile connectivity encourages multimodal solutions, seamless mobility and optimises the existing road network (TUMI, 2019). This approach to mobility will help municipalities to achieve principles of 'the 15-minute city' (Pozoukidou & Chatziyiannaki, 2021) or Transit-oriented development (TOD) by enabling users to move more efficiently and encouraging proximity, multimodal solutions, non-motorised transportation, and inclusive design of public spaces.

As many governments are making efforts to phase out ICE vehicles, e-mobility offers efficient alternatives in the form of electric buses and micro-mobility including modes such as e-bikes and e-scooters. Existing public transportation fleets can either be upgraded and supplemented by a diverse and dynamic range of options including mini-buses, three-wheelers and moto-taxis as well as larger vehicles such as full size electric buses. Similarly, conventional ICE vehicles can be replaced by EVs for municipal and small-scale logistical services, as documented in the Pasig Living Lab with its postal delivery system (SOLUTIONSplus, 2022).However, the development of e-mobility opportunities also involves risks and potential conflicts with the existing uses of spaces which must be responsibly navigated (UN-Habitat, 2022).

The process may require spatial development of existing infrastructure to accommodate new additions to multimodal systems including the integration of e-mobility through comfortable walkways, functional parking bays, drop-off points, proper signage and attractive waiting areas. Additional infrastructure is essential for electric vehicles and their upkeep, including charging stations and battery swapping facilities. Consequently, the development of electric public transportation requires consideration of its potential impact on the existing spatial structures, urban design and land use. With proper planning, it can generate numerous benefits beyond reducing pollution and contribute to urban liveability, accessibility, and the creation of livelihood opportunities for the local population.

Approach

This paper builds upon the series of design studios facilitated by the Technical University of Berlin in direct cooperation with the SOLUTIONSplus partner cities between 2020-2023. In a series of intensive 5-month engagements several groups of international students and experts worked on plans in seven locations worldwide. Based on local spatial and socio-economic analysis, design solutions for various transportation modes were developed in the participating cities (see Figure 1). With integration of e-mobility as a starting point, the proposed approaches and interventions aimed at broader goals of increasing aesthetic quality, supporting social inclusion, and stimulating economic activities on a broader scale of target neighbourhoods.

Each of the projects have undergone evaluation by the partner city representatives through a series of meetings and presentations delivered to a multidisciplinary jury. Elements of specific design processes have been utilised in SOLUTIONSplus guidebooks and training processes and fed into activities facilitated by the partner municipalities on the ground. While integrating diverse cases and transportation modalities, a cohesive approach emerged out of these engagements leading to the definition of the presented policy recommendation across spatial and urban planning domains.

Figure 1

Outline of SOLUTIONplus design focus areas and partners

Quito, Ecuador

Focus
Multimodal e-mobility corridors, last mile-connectivity, and urban logistics in the historic city centre

Key local partners
Quito Municipality: Mobility Secretariat, Environment Secretariat, Secretariat of Territory, Habitat and Housing, District Administration of the Historic Center, Metropolitan Institute for Heritage, Metropolitan Institute for Urban Planning, Metropolitan Public Company of Mobility

Hamburg, Germnay

Focus
Multimodal transport hubs and integrating e-scooters

Key local partners
Hamburger Hochbahn

Pasig, the Philippines

Focus
Multifunctional charging micro-hub model in Pasig City

Key local partners
Department of Transportation, City of Pasig

Kathmandu, Nepal

Focus
Multimodal transport hub and integrating e-mobility three-wheelers

Key local partners
Lalitpur Metropolitan City, Sajha Yatayat Sahakaari Sansthaa

Montevideo, Uruguay

Focus
Charging facility for e-buses and bus stop model in the context of the revitalisation the historic city centre

Key local partners
City of Montevideo, Transport Division, Mobility Department,
Universidad de la República de Uruguay

Kigali, Rwanda

Focus
E-mobility integration model and road safety issues in the context of bus-station, residential area, and peri-urban context

Key local partners
City of Kigali, Ministry of Infrastructure, University of Rwanda.

Dar es Salaam, Tanzania

Focus
Modular concept for the integration of e-mobility into BRT stations across Dar es Salaam

Key local partners
DART – Dar Rapid Transit Agency

Design and planning for integration of e-mobility

Despite the consensus over the need to plan e-mobility as an interdisciplinary, multilevel endeavour, its introduction into urban spaces often follows a haphazard and potentially problematic pattern of implementation.

The space that new e-mobility infrastructure requires is a key issue of the process of implementing e-mobility projects. A typical example of poor allocation of space for e-mobility is the spread of abandoned e-scooters on the pavements of European cities. The level of nuisance caused by this phenomenon led cities like Paris to consider a complete ban on rental e-scooters from its boundaries (The Guardian, 2023). In other instances, well-organised parking spots for various forms of e-mobility provides the opportunity to effectively link with existing modes and support multimodal transportation (figure 2).

Figure 2

Car parking transformed into a space for shared e-mobility (bikes, e-scooters) and charging facility in direct connection with S-Bahn station (city rail) in Berlin, Germany.

Without proper guidelines from the public sector and with low availability of vacant spaces, private sector developments are likely to be carried out predominantly based on commercial interests, rather than as a concerted and planned effort. This modality of development is dependent on existing spatial opportunities and may cause sparse interconnectivity and integration with different transport modes.

Similar problems exist with the introduction of charging facilities. Typically, these charging points are established for convenience and space availability. Private entities often develop these points near parking lots, supermarkets, and petrol stations, where they can provide the necessary land, oversight, and maintenance. Even though pragmatic, such developments typically have poor or neutral visual quality (see figure 3).

Figure 3

Charging station located in a supermarket parking lot in Wedding district, Berlin, 2023

> “Beyond the clear spatial aspect, the introduction of e-mobility needs to be considered in the context of their socio-economic impact.”

Beyond the clear spatial aspect, the introduction of e-mobility needs to be considered in the context of their socio-economic impact. While holding great potential for inclusivity, they can also lead to gentrification when implemented as part of greening initiatives, which in the long run may be associated with an increase in rental and housing prices (Rice at al., 2016). Similarly, phasing-out of some technologies and older vehicles may be perceived as a threat to the livelihoods of independent operators (Galuszka et al., 2021) and result in resistance to the transformation processes. Upgrading the functionality and connectivity of public spaces must be community sensitive, otherwise it may be hampered in these situations by lack of acceptance from the local population and service providers.

The design and planning approach outlined in this Policy Advice Paper aims to promote the adoption of e-mobility in public transportation. This approach seeks to leverage its potential benefits and foster positive outcomes in various sectors, all while addressing the associated risks thoughtfully.

The key element of each of the proposals developed within the design studio process was a thorough analysis of spatial and socio-economic contexts in case study areas. In practical terms this included: analysis of urban densities, current transportation network, outreach of potential feeder system across diverse socio-economic groups, main points of interests, mapping of formal/ informal economic activities in the target neighbourhoods, viewshed analysis, and heritage conservation rules. In specific contexts, this translates to the formulation of guidelines regarding the placement of particular e-mobility related services (see Table 1 for an example of potential charging hubs in Pasig).

Table 1

Criteria for the location of charging hubs in Pasig City, Philippines (Lees & Rony, 2020)

	Purgold Ligaya	Caltex Saltolan	St Joseph	Tricity Medical Centre	Mercedes Plaza	Passig City Hall	Pinagbuhatan High School
Urban setting?	Edge of mixed use area-lively	Loose industrial commercial-not lively	Loose industrial commercial-not lively	mixed use area lively	mixed use area lively	mixed use area very busy spread out	mixed use area lively, informal
Multi-modality?	2 bus, Jeepney community bus	2 bus, Jeepney	3 bus, Jeepney	3 bus, Jeepney, ferry	3 bus, Jeepney, bike sharing	all buses, Jeep-neys etc	bus, Jeepney
Light or emobility?	no	no	no	no	no	yes, in corona	no
Commercial	yes	yes	yes	yes	yes	yes main market	yes
Parking bay or similar?	yes + in front of shops/right turn bay	yes + in front of shops/right turn bay	xing	yes in front of shops	yes in front of shops + right turn bay	surely	yes in front of shops in curve
Pedestrian friendly?	zebra + pedestrian pedestrian xing	zebra crossing	no	no xing	yes xing		busy but zebra xing
Bus lanes?	no	no	no	no	no	at hub	no
Light mobility lanes?	no	no	no	no	no	no	no
Traffic?	main road	main road	highway	main road	main road	main road. 1-way	main road
Other?			mall and post office nearby	delivery industry hospital nearby	delivery industry shopping	civic centre main market	high school lmc areas

Figure 4

The mobility archipelago concept for Quito historic centre combining e-mobility infrastructure with public spaces in a network of complementary uses (Guarrotxena & Orduz, 2020).

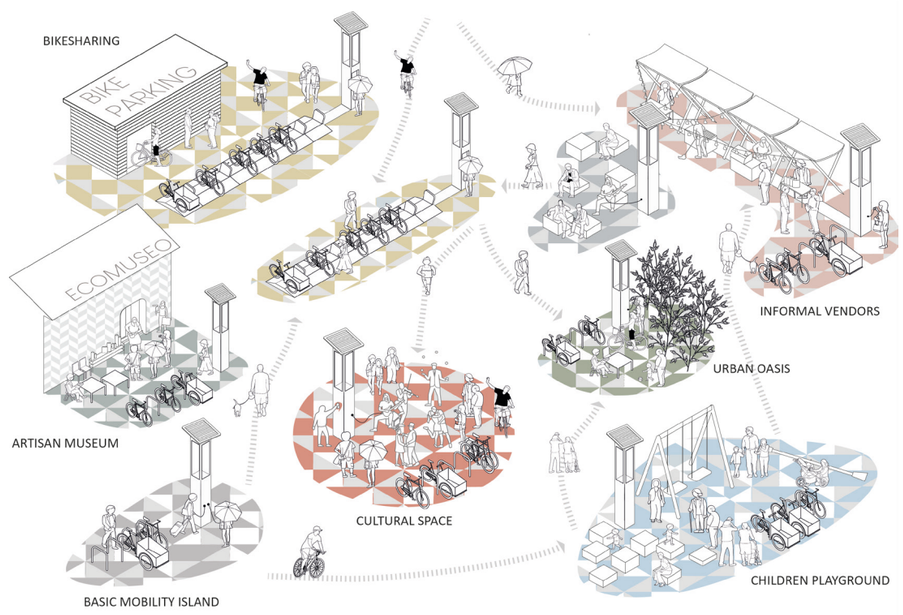
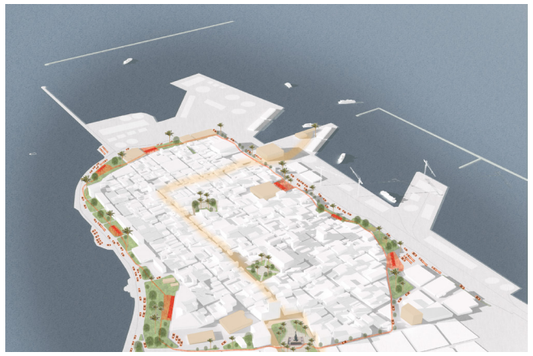


Figure 5

Proposal for a green public space corridor organised around public transportation in the historic city centre of Montevideo (Langer & Schauder, 2021)



The design approach prioritises developing multifunctional spaces, supporting the sense of local ownership and facilitating the use of public spaces. This approach promotes a common visual language, which is manifested in the design of surfaces, street furniture, signs, and colour schemes, combined with specific functions that public spaces might adopt. This was elaborated in the context of the Quito living lab proposal which focused on multimodal corridors, organised in the historic city centre where the development of e-mobility infrastructure was envisaged as a place-making exercise (fig. 4).

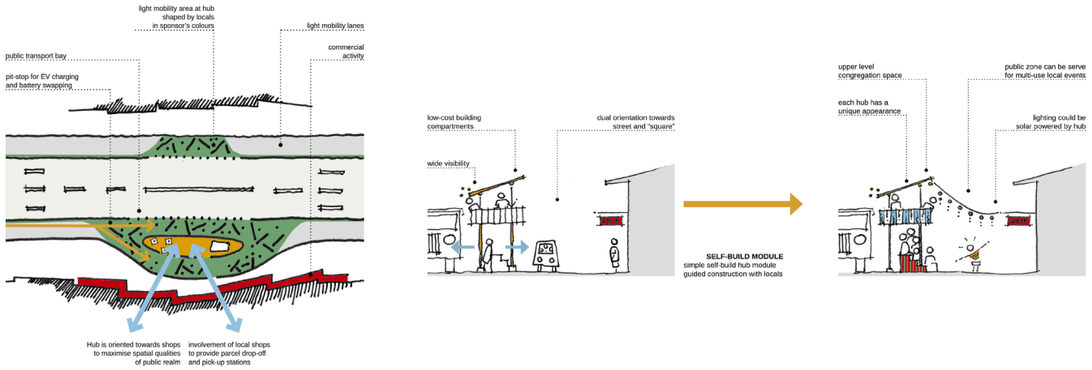
Other projects used the design studio process as an opportunity to reinforce NMT, road safety and greening the city as seen in Montevideo, Quito and Kigali proposals. In particular, the Montevideo proposal utilised the task of transformation of the charging depot as an opportunity to enhance walkability in-between a network of bus stops in the historic part of the city (fig. 5).

The economics of the developments play a significant role in the proposals in Quito, Dar es Salaam and Pasig, where local ownership of the space was reinforced by the introduction of spaces for informal, semi-formal trading and facilities open for public use. For instance, the charging and battery-swapping hubs in Pasig were considered as a community space powered by solar panels (fig. 6).

The pitfalls and opportunities highlighted by these projects reinforce the necessity of proper and sensitive planning of the implementation of e-mobility in cities. Using knowledge gained from design studios facilitated by the Technical University of Berlin, this paper suggests policy recommendations that will help to ensure an equitable, efficient, and environmentally conscious implementation of e-mobility at a local level.

Figure 6

Proposal Pinagbuhatan charging station, Pasig, Metro Manila (Lees & Rony, 2020).



Policy Recommendations

1
Use E-mobility infrastructure as a placemaking tool.

The introduction of e-mobility infrastructure, when combined with different transportation modes, including NMT, holds a large potential for improving the quality of urban space. As a rule, different modes of transport should be within visual proximity of each other to ease transfers between different modes and a clear visual identity in urban design can create public spaces that more effectively serve their users and integrate into the surrounding community (Strojanovski, 2020). Likewise, the principles of safe space design (CPTED) remain essential for contexts with recognized safety deficiencies. While conventionally large multimodal nodes facilitate commercial activities, the minor intersection of nodes and e-mobility as last-mile connectivity can also create inclusive public spaces. A range of uses such as playgrounds, information points, trading, and cultural activities (see figure 4) increase the local ownership of the spaces and ensure the area's safety through the 'eyes on the street principle'.

2
Facilitate integrated planning as a mobility development approach.

The development of last-mile connectivity and multimodal nodes should reflect on integrated planning principles across key urban sectors, including housing, public space, urban economy, and mobility. The design of transport corridors needs to reflect on these various sectors and incorporate, whenever possible, principles of participatory planning. In practical terms, this translates to the analytical implementation approach, which defines the locations of new nodes and corridors based on the following criteria:

- Connectivity with existing modes of public transportation, including rapid mass transit, public sector-based transport operators, and paratransit providers.
- Land use analysis and the location of the main point of interest (Zeng et al., 2017) in neighbourhood and city scales.
- Analysis of small-scale logistical services and routes on a neighbourhood scale.
- Availability and location of charging infrastructure for the public sector and private providers.
- Viewshed analysis and heritage conservation regulations.
- Socio-economic data analysis and transport justice principles towards including under-serviced low-income areas.
- Land ownership and potential for future area development align with TOD principles, including housing densification and creating mix-use areas.

3
Multimodality as an instrument of socio-economic inclusion.

The development of multimodal nodes is typically considered to offer viable opportunities for the economic activation of urban spaces, mainly when Transit-oriented development is applied as a policy of choice. This includes densification approaches and introducing transit-friendly land uses (Strojanovski, 2020). However, several principles should be considered to ensure these processes benefit a broad array of citizens.

• Firstly, connectivity between multimodal nodes and low-income areas needs to be ensured through a system incorporating e-mobility. This means accommodating private operators into the nodes, including various modalities of paratransit in the contexts where they operate.

• Secondly, the design of public spaces around nodes needs to consider the characteristic of the current economic activities. For instance, in contexts with informal and semi-formal economic activities, including street vending, space for such activity should be considered in the design of the space. While typically associated with more haphazard uses of spaces, such an approach may ensure inclusive regularisation of the sector and increase public safety (see Warwick Junction project for reference) (Project for Public Spaces, 2015).

• Thirdly, in the face of land use changes, potential densification processes and the introduction of housing and commercial space, a principle of land value capture should be considered. This approach focuses on the redistribution of private sector' financial increments secured through transportation investment facilitated from the public sector resources. Such increments are then reinvested into further public facilities benefiting general population (Medda, 2012).

• Lastly, charging facilities should be considered a potential zone of socio-economic activation with the potential introduction of additional social functions such as community spaces (see figure 6).

4
Reinforcing NMT, road safety and green spaces.

The introduction of micro-mobility zones and stations can be effectively connected with the development of NMT and urban greenery (UN-Habitat, 2022). However, introducing green spaces requires allocating sufficient budgets for maintaining these spaces and ensuring a permanent level of public safety in the area. Additionally, these interventions must actively consider Recommendations 2 and 3 mentioned in this Policy Advice Paper and be sensitive to the risk of gentrification and displacement issues.

5
Design spatial guidelines for decentralised initiatives.

Flexible city-specific design guidelines should be developed to facilitate common visual language and signage of charging and swapping facilities, sharing stations (e-bikes, e-scooters) and parking bays developed by the private and public sector. Guidelines might look like technical specifications and easily adaptable templates that private stakeholders can utilise in practice. Similarly, the public sector should facilitate mapping exercises to help identify available/preferred locations or guidelines for the location of these facilities. This task emerges as particularly relevant in the contexts where transitions to e-mobility are facilitated by private sector which competes in one market and locates their services solely based on commercial criteria.

Conclusion

Introduction of e-mobility infrastructure into densely build up areas is a task requiring reflection beyond pure transportation function and should reflect social and community needs. While in technical and business terms its development is shared by the public sector and private entities, purely organic introduction of e-mobility services into urban space bears significant risks. These include issues such as haphazard development of spaces, poor connectivity with different modes of public transportation, and omission of areas of the city which could benefit from the development of new feeder services and last mile connectivity. However, with a proper guidance, backed up by spatial and socio-economic analysis, the integration of e-mobility may resonate positively across multiple facets of urban development. The key principles capturing that approach are integrated development paradigm, placemaking, multimodality, urban ecology and socio-economic inclusion.

References

Galuszka, J., Martin, E., Nkurunziza, A., Achieng'Oginga, J., Senyagwa, J., Teko, E., & Lah, O. (2021). East Africa's policy and stakeholder integration of informal operators in electric mobility transitions—Kigali, Nairobi, Kisumu and Dar es Salaam. Sustainability, 13(4), 1703.

Guarrotxena N., Orduz A. (2020) Urban Change Makers. Rethinking multimodal urban mobilities design studio - Quito. Habitat Unit, Technical University of Berlin, Design Studio.

Langer & Schauder (2021) Urban Mobility Living Labs Cross-sectorial projects for better connectivity and accessibility design studio – Montevideo. Habitat Unit, Technical University of Berlin.

Lees O., Rony Y.I. (2020) Urban Change Makers. Rethinking multimodal urban mobilities design studio - Pasig. Habitat Unit, Technical University of Berlin.

Medda, F. (2012). Land value capture finance for transport accessibility: a review. Journal of Transport Geography, 25, 154-161.

Pozoukidou, G., & Chatziyiannaki, Z. (2021). 15-Minute City: Decomposing the new urban planning eutopia. Sustainability, 13(2), 928.

Project for Public Spaces (2015) Warwic Junction, https://www.pps.org/places/warwick-junction (access 04.02.2022).

Rice, J. L., Cohen, D. A., Long, J., & Jurjevich, J. R. (2020). Contradictions of the climate-friendly city: new perspectives on eco-gentrification and housing justice. International journal of urban and regional research, 44(1), 145-165.

SOLUTIONSplus (2022). Demonstration City: Pasig, https://www.solutionsplus.eu/pasig

Stojanovski, T. (2020). Urban design and public transportation–public spaces, visual proximity and Transit-Oriented Development (TOD). Journal of Urban Design, 25(1), 134-154.

Transformative Urban Mobility Initiative (TUMI) (2019). Sustainable Urban Transport: Avoid-Shift-Improve (A-S-I), Eschborn: GIZ

UN-Habitat (2022) Integration is key: the role of electric mobility for low-carbon and sustainable cities. Un-Habitat.

Zeng, W., Fu, C. W., Arisona, S. M., Schubiger, S., Burkhard, R., & Ma, K. L. (2017). Visualizing the relationship between human mobility and points of interest. IEEE Transactions on Intelligent Transportation Systems, 18(8), 2271-2284.

www.solutionsplus.eu

This project has received funding from the European Union´s Horizon 2020 research and innovation programme under grant agreement no. 875041