Cross-Border Transport and Mobility in the EU
Issues and State of the Art
edited by Aljaž Plevnik, Tom Rye

From Shared Data Towards Joint Information and Vision
Supporting Cross-Border Transport Management and Planning

Riccardo Maratini
Transport engineer, freelance

Andrea Ballarin
EU project manager, freelance

Summary 1 Introduction and Addressed Problem. – 2 Envisaged Approach and Solutions. – 3 Requested Data. – 4 Requested Tools. – 5 Conclusions and Remarks on Cooperation and Multilevel Governance Approach.

1 Introduction and Addressed Problem

Transport planning and management call for a systemic approach, based on technical evaluations to support the decision-making process with quantitative and objective analyses. In fact, decision makers need to be based on comprehensive analyses, encompassing different *what-if* evaluations and scenarios, which are ultimately based on a data collection process that is usually costly and problematic, especially in the case of cross-border areas. In particular, it implies providing different kind of estimations and indicators related to various impacts from different viewpoints, encompassing both internal effects to the transport system (e.g. congestion and travel times) as well as externalities impacting in the environment (e.g. gas and noise emissions).

Edizioni Ca'Foscari

Studi e ricerche 27
e-ISSN 2610-9123 | ISSN 2610-993X
ISBN [ebook] 978-88-6969-546-9 | ISBN [print] 978-88-6969-547-6

Open access
Published 2021-10-12

DOI 10.30687/978-88-6969-546-9/006

In order to properly address the complexity of the transport system where different components co-exist and interact, transport modelling makes use of a conceptual framework where the overall transport system is subdivided into two main components: supply (networks and public transport services) and demand (persons or goods travelling, or aiming to travel, between different zones). Their mutual interactions determine the traffic flows that can be ascertained in the real transport network or estimated through simulations making use of advanced algorithms applying the mathematic theory of graphs.

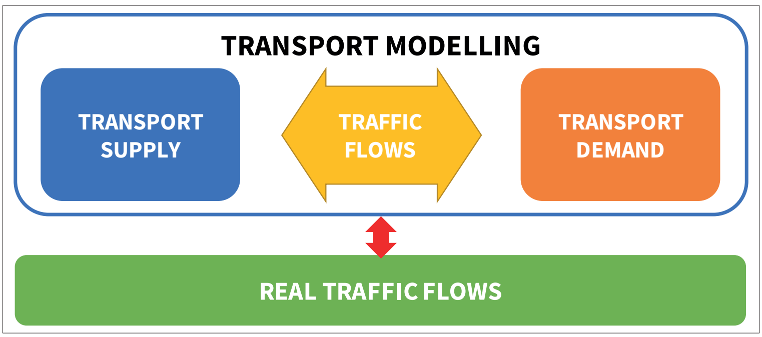

Figure 1 The components of a transport system according to a general modelling framework

Unfortunately, a comprehensive analysis of such a complex framework is usually particularly challenging in terms of requested steps to be performed both as for data collection and for elaborations to be carried out. This is particularly true in the case of the demand side, which (representing the overall mobility needs to be meet by transport policy) should also be the key focus of transport planning activities. However, as well known by practitioners and also more systematically reported in the scientific literature, (e.g. see Yang. et al. 2013), travel demand forecasting in general is subject to great uncertainties.

In fact, in real practice, related data are usually not available apart from generic or outdated estimations (which need to be updated). Moreover, a survey campaign for collecting the related data, implying the interview of an adequate set of travellers (or carriers in the case of freight transport), is usually beyond the limit set by the available resources (especially in case of wide area modelling).

Such situation has also led to the development of estimation techniques (e.g. the well-known Four Steps Model[1]), which in turn request

1 The four steps being Trip generation, Trip distribution, Mode Choice and Route assignment (see also Ortuzar, Willumsen 2011; Cascetta 2009).

relevant efforts in terms of data and modelling and whose obtained outcomes are also affected by inevitable uncertainties. Furthermore, a specific approach is exploiting the fact that traffic flow data related to a specific link are easier to be observed (making use of a growing set of detectors and road monitoring devices) than the flow along an overall path from its specific Origin to the Destination. Hence, different refined techniques for upgrading or updating available transport demand data on the basis of collected traffic flows in the network links have been developed (obviously through indirect estimations, inevitably affected by some error margins).

On the other hand, this situation has also contributed to a tendency to focus on the traffic flows on specific links, without deepening the understanding of the underlying transport demand and mobility needs (i.e. the real needs to be addressed and, also causes to be investigated for the actual flows).

Hence, generalising, this relevant example testifies how the higher or lower availability of certain data affects the typologies of analyses being carried out by practitioners and also stimulates the direction of methodological and scientifical developments.

Moreover, in spite of the refined mathematical models and advance specialised software available, the quality of results of every simulation is always highly relying on a data collection process that is usually costly and problematic (especially, but not only, with reference to the transport demand).

Therefore, data availability can be seen as a key driver representing a fundamental prerequisite (or, when lacking, a concerning bottleneck) for any kind of transport system analysis, ranging from the basic representation of key layers of transport demand and supply to the more complicated modelling and simulation activities.

In this purpose, cross-border areas represent particularly challenging contexts (see also the *Border Orientation Paper* of the Italy-Slovenia Programme issued in May 2019) where both data collection and transport planning activities are usually carried out separately on each side of the border, according to the usual set-up of transport service planning, tendering and organisation. Nonetheless, a smoother coordination, setting the ground for a shared vision, is a key goal to be pursued.

The relevance of the cross-border dimension is also testified by the deal paid at EU level as far as, in addition to the particular support given to the realisation of cross-border section of TEN-T corridors, the attention to re-sewing connectivity and accessibility across the border is evident, for instance, by the “Comprehensive analysis of the existing cross-border rail transport connections and missing links on the internal EU borders” carried out by the EU DG-REGIO in 2018.

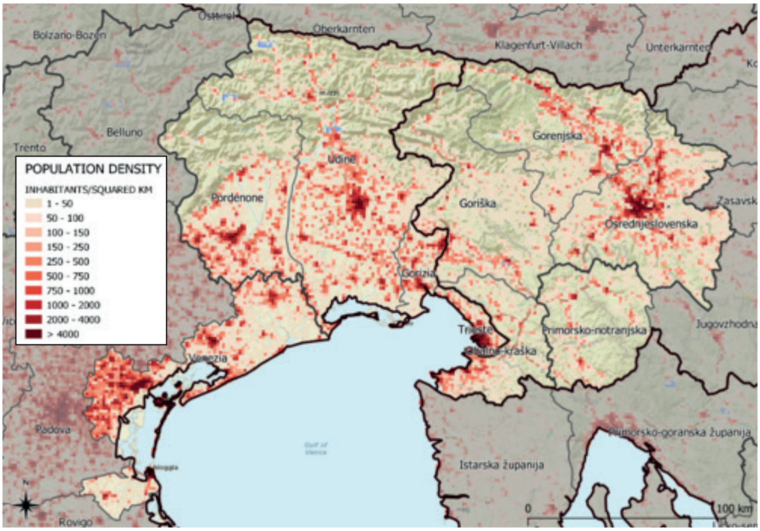

Figure 2 Distribution of population density in the Italy-Slovenia Programme Area (source: ISTAT, SURS, EUROSTAT)

Within this paper, the cross-border dimension is addressed with specific reference to whole IT-SI Cross-border Area as identified by the Italia-Slovenia Interreg cooperation Programme 2014-2020, which extends over a total surface of almost 20,000 km^2 and has a total population of approximately 3 million inhabitants. This area is characterised by a high heterogeneity in terms of geographical characters and density of settlements. In fact, along with several urban areas (Trieste, Udine, Gorizia, Ljubljana, Pordenone, Venice, conurbation Koper-Izola-Piran, Nova Gorica, Kranj and Postojna), a high deal of peripheral and rural contexts (including mountainous ones) is to be reported. Hence, apart from the relevance per se, it allows addressing and showcasing different typologies of contexts (ranging from coastal areas where waterborne transport is to be further developed to mountainous areas with limited accessibility) encompassing remarkable mobility needs of both residents and occasional users or tourists.

Furthermore, the peculiarity and relevance of the IT-SI context is also related to the fact that the IT-SI area is, at least partly, interested by 3 European Macro-regional strategies (out of a total of 4 at European level):[2]

2 Moreover, it is worth mentioning that Slovenia is the only EU country whose territory is fully belonging to 3 macro-regions.

- the EU Strategy for the Alpine Region (EUSALP);
- the EU Strategy for the Adriatic-Ionian Region (EUSAIR);
- the EU Strategy for the Danube Region (EUSDR).

2 Envisaged Approach and Solutions

As said, the objective addressed by the present analysis corresponds to a process meant to support stakeholder dialogue and decision-making through sound technical elements built on actual facts and quantitative evidence. This process, made of different steps, can be associated with the DIKW (Data, Information, Knowledge and Wisdom) pyramid of Information Theory (Rowley 2007).

This approach allows to distinguish between different steps, thus emphasising the specificities and relevance of each stage, which also corresponds to different tools and methodologies to be applied.

Starting from the first one, data can be defined as "discrete, objective facts or observations, which are unorganized and unprocessed and therefore have no meaning or value because of lack of context and interpretation". Information, instead, consists in "organized or structured data, which has been processed in such a way that the information now has relevance for a specific purpose or context, and is therefore meaningful, valuable, useful and relevant". The definition of the last two steps and their differentiation, though being more elusive, are related to actual learning (know-how and know-why), which can be developed through experiences and technical analyses. In particular, wisdom is associated with the ability of making right choices as in the case of future scenarios assessment. Hence, adapting the general schema to the purpose of the present analysis and considering the referencing to common goals shaping transport planning activity, it can be conceived as (or replaced by) a vision shared between different actors or stakeholders **[fig. 3]**.

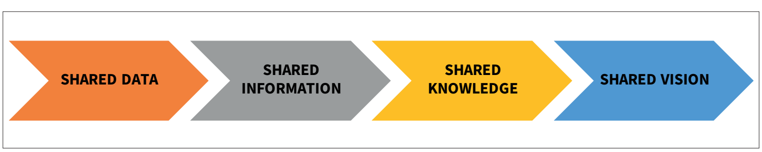

Figure 3 The different steps from shared data to shared vision

Bearing in mind this conceptual framework, the present analysis is focusing on common issues and opportunities that can arise in concrete real-life applications, where typically data from different (heterogenous and scattered) sources are to be gathered, integrated and jointly elaborated on in order to pursue various objectives (e.g. planning new transport solutions, managing existing ones, informing users etc.).

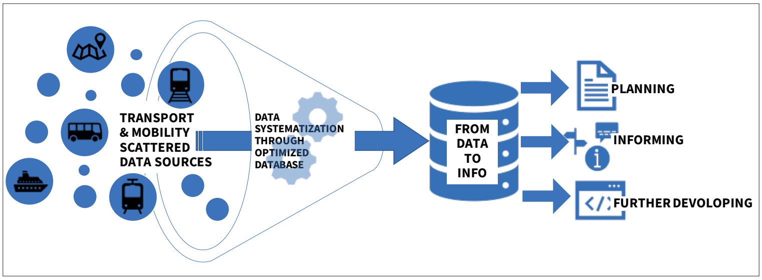

Figure 4 A scheme of a real-world implementation of an information system gathering and elaborating on data from different sources

In particular, it focuses on the first two steps setting the basis for the overall process (thus gathering data and structuring an information system) together with the importance of effective (georeferenced) representations as to easily and effectively make available to users (i.e. stakeholders in this particular case) shared information, knowledge and vision. In this purpose, a particular deal is being paid to innovative opportunities arising from ICT tools, which should be underlined not only with reference to the growing capability of collecting data, but also considering the need for systematising them as to exploit their potential or providing information, knowledge and support the development of a well-grounded shared vision.

In this purpose, the following paragraphs are addressing separately three key components, with particular reference to the cross-border dimension:

- data;
- ICT tools;
- cooperation and multi-level governance approach.

3 Requested Data

Starting from the early stages of the CROSSMOBY project implementation, a screening and data collection of different relevant themes for describing the multimodal transport system have been carried out with the support of the overall partnership. This activity has allowed to have an insight on data availability and heterogeneity at cross-border level.

In this purpose, some brief comments, taking one aspect from each of the two main sides of the transport system (supply and demand) have been reported in the following paragraphs.

As far as the supply component is concerned, a major subdivision is to be made between the multimodal transport network, providing the key infrastructures for all typologies of mobilities (of both people as well as freight) and the description of the public transport system within the specific field of passenger mobility.

Transport networks (belonging to different modes of transport, such as road, railway etc.) are usually modelled and represented through graphs[3] made up of vertices (also called nodes) which are connected by edges (also called links). In fact, a graph representation endowed with relevant attributes (describing the key characteristics of each link) is the key instrument for performing overall network analysis as well as transport modelling. In this purpose, the recent years have registered significant improvements: graph representations can profit from the growing availability of highly detailed digital maps. However, it is to recall that, with particular reference to transport modelling activities allowing to perform traffic simulations, specific attributes (usually absent in general-purpose maps) are requested in order to describe the performance and functional characteristics of each link (e.g the capacity expressing the maximum number of vehicles that can travel across a section of the link during a certain time interval).

On top of that (i.e. the information describing merely infrastructural networks), relevant data about public transport service for transport planning purposes mainly consists of data allowing to describe:

- The public transport network, thus describing not only the links and nodes making up the paths but also the stop points and stations where passengers can board or alight;
- Timetables, according to the planned service (i.e. not taking into account, for the present analysis, real-time monitoring or how the service is facing contingencies).

In general, data on public transport services are made available through different formats and standards, such the TRANSMODEL.[4]

3 A graph is essentially a mathematical structure used to model mutual relations between objects, such as the connectivity between two nodes representing two locations in the analysed area.

4 See `http://www.transmodel-cen.eu/`.

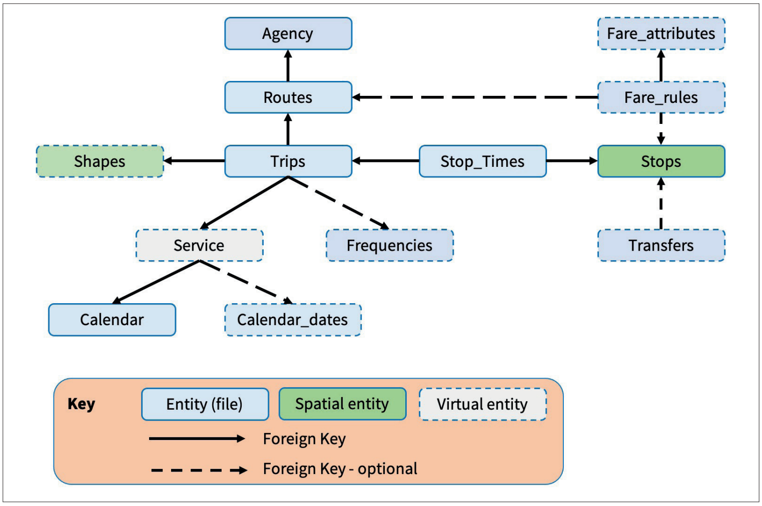

Figure 5 The mandatory and optional files that compose a GTFS feed.
Source: Martin Davis, http://lin-ear-th-inking.blogspot.com.au/2011/09/data-model-diagrams-for-gtfs.html

Nowadays, the public transport service data are also becoming more and more available also through the usage of the General Transit Feed Specification (GTFS), which provides a well-spread common format for public transportation schedules and associated geographic information. A GTFS feed is composed of a limited number of text files, each one addressing a particular aspect (e.g. stops, routes, trips, etc.). In fact, though not providing the comprehensive and articulated structure of agreed standard such as TRANSMODEL, GTFS provides an effective format for sending and sharing data across the internet. Hence, it has facilitated the development of open data made available through online repositories (e.g. `https://transitfeeds.com/`)

In fact, during the data collection process carried-out within CROSSMOBY, a relevant deal of data about public transport services have been made available through the GTFS format.

As far as transport demand is concerned, in order to reach an overall quantitative vision and, in particular, to allow the implementation of the traffic simulation algorithms, it has to be express in form of an Origin-Destination (O-D) matrix (i.e. a tabular dataset in which each cell represents the transport demand from a specific zone to another one).

As already said, transport demand represents the key side of the transport system expressing highlighting the mobility needs to be met. Unfortunately, it proves particularly difficult to have reliable and complete data on this purpose. In fact, available statistics are usually lacking and/or limited to particular areas or components of the overall mobility.

Traditionally, national population census data is representing a key reference ensuring a full territorial coverage. In this purpose, it is to ascertain a changing[5] and heterogenous framework at cross-border and international level, where different typologies of data are collected. As far as mobility demand is concerned, the gathered data are specifically related to commuting behaviours of the population. However. these data are not always included in the dataset and, in case, the information of cross-border trips is collected with a broader level of detail.

In this purpose, it is worth mentioning that the UNECE document (UNECE 2020) proposing general criteria to be implemented at international level, while recognising as 'core topic' the commuting characteristic given by the location of place of work, it specifies that where it "is outside the country it is generally only necessary to code it to the country concerned". Furthermore, it also classifies as 'not core' (thus implying that could be gathered or not depending on the specific Country) the following topics:

- location of school, college or university;
- mode of transport to work (or to place of education);
- distance travelled to work (or to place of education) and time taken.

However, apart from their specific level of update and completeness, it is also to recall that census data, being referred only to the specific aspect of commuters' mobility, are lacking information about other relevant typologies of trips including occasional ones for different purposes (e.g. business, shopping, visits, tourism etc.), which obviously correspond to a relevant part of the overall transport demand. In order to widening the coverage to all these different aspects, a remarkable and innovative opportunity to be further analysed, is nowadays given by the usage of mobile phones cells data. In this purpose, it is to report the experience made in recent years by Friuli Venezia Giulia Region administration, which also allowed producing a report specifically addressing the cross-border mobility patterns (Regione Autonoma Friuli Venezia Giulia 2020).

5 For instance, in Italy the recent years has seen the shift the traditional survey, encompassing the distribution of questionnaires to the whole population of the Country each 10 years (with last survey carried out 2011) to a permanent census campaign, carried out on yearly bases (starting from 2018) on a limited sample of inhabitants and integrating the collected data with others from administrative sources (https://www.istat.it/en/permanent-censuses/population-and-housing).

4 Requested Tools

In order to appropriately and efficiently tackling all the aforementioned challenges, relevant opportunities rely on exploiting the potentials of databases, data storing, organising and elaboration. All of them, especially if implemented by means of advanced database management systems (DBMS), are allowing to extract information and knowledge from raw data. However, by recalling the themes hinted at in the previous paragraph, the information systems to be developed need to address different entities of the transport system, characterised by various mutual relations and whose data should be possibly provided according to well-structured data pattern/models. In this context, the capability of elaborating and querying data made available by the well-consolidated relational model databases still provide a remarkable added value (Codd 1970).

Moreover, information in the transport sector has to be endowed with geo-referenced content, thus implying the development of Geographic Information Systems (GIS). In this purpose, the spatial (and georeferenced) component is allowing for a visual and effective representation of different layers in a digital map, but also establish spatial relationship between data on the basis of their mutual positioning, also by making use of spatial operators (e.g. overlaying, buffering etc.). Hence, various thematic representations of relevant layers supporting a clearer understanding and insight on the transport system can be provided. For instance, the provided datasets of bus transport services in GTFS format allow to map and effectively visualize the gaps affecting the public transport (PT) network in correspondence of the IT-SI border.[6]

In particular, the following figure provides a thematic representation of the gaps expressed in physical distances (in km) between PT services in the Italian and Slovenian side, with referenced to the list of relevant border transit points identified in the Friuli Venezia Giulia Autonomous Region public transport plan.

6 In this purpose, it is to underline that the existing international lines are linking the main centres, thus not providing the usual density of stops and accessibility to the peripheral areas across the border.

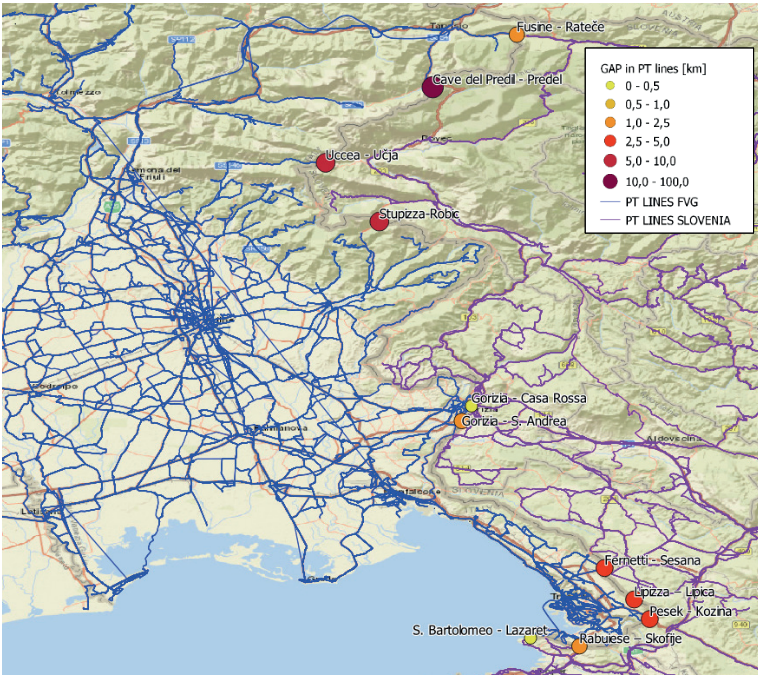

Figure 6 Overview of relevant transit points acknowledged in the Friuli Venezia Giulia regional PT plan

More in general, about 40 crossing (with no PT services) have been identified along the whole IT-SI border. In this purpose, considering that border is stretching over 232 km, it is also to report a limited number of total available cross-border links.

Obviously, the possibility of overlaying different themes allows for developing further comparison and assessment. For instance, the cross-border connectivity, can be compared with the level of cross-border mobility demand originated by each municipality as reported in the census data. This basic example, testify the possibility of merging together data, providing information and enhancing knowledge and understanding even without complicated processes and without implementing advanced algorithms that are usually made available through transport planning specialised software.

Moreover, a further step is made possible through the implementations of webGIS providing online thematic representation through user friendly web-interfaces (which can be accessed through commonly used browser, such as Google Chrome, Mozilla Firefox, etc.). These user-interfaces are then allowing an intuitive and interactive consultation of the georeferenced information by non-specialized users, allowing them to change the visualised area (zoom, pan etc.) and perform basic choices on the elements to be viewed by filtering as well as selecting specific elements and related attributes.

5 Conclusions and Remarks on Cooperation and Multilevel Governance Approach

The possibilities in supporting, through the described tools and data, the dialogue between stakeholders and citizens should be considered as key opportunity for facilitating their involvement according to a transparent and participatory approach. Nonetheless, if technological solutions seem not to be a limit at the time being, still some non-technical barriers are potentially hampering the development of such kind of solutions.

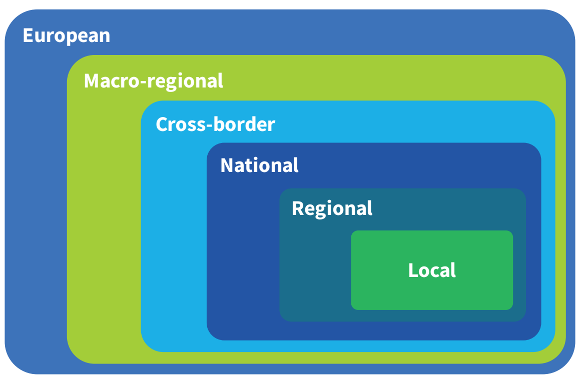

Figure 7 Different governance layers

In fact, data sharing – as one of the main and most important pre-condition – is to be considered more a cultural approach than a technical issue, which is even more relevant when dealing with to different sides of the borders. However, in this purpose it is to register significant improvements making available to the general public a great amount of data (i.e. Open Data).

In developing this cooperative/participatory approach, a wide set of different stakeholders – belonging to different levels – are somehow entitled to influence mobility within the cross-border area, which are inherently synthetized in the figure 7.

Moreover, as far as Cross-border cooperation is concerned, a particularly remarkable role is played by European Grouping for

Territorial Cooperation (EGTC),[7] a European cooperation structure defined by European Law with the objective of facilitating and promoting territorial cooperation by focusing on common projects beneficial for both side of the borders, encouraging good practices and allowing more efficient use of public resources within the different common themes of interest.

In this purpose, for what concerns the cross-border area defined within the Italy-Slovenia Programme, two of them should be mentioned:

- the EGTC "Euregio Senza Confini r.l.- Ohne Grenzen mbH", which is composed by the two Italian regions involved in the IT-SI Programme (Veneto Region and Friuli Venezia Giulia Region) plus the neighbouring Carinthia region in Austria;
- the EGTC "Territory of municipalities: Municipality of Gorizia (IT), Mestna občina Nova Gorica (SI) and Občina Šempeter-Vrtojba (SI)", which is specifically involving a local area across the IT-SI border.

Acknowledgments

This paper summarises key achievement and experiences mainly made within the project CROSSMOBY (Cross-border integrated transport planning and intermodal passenger transport services), a strategic project of the programme Interreg V-A Italy-Slovenia 2014-2020, and in particular through the development of Analyses and Tools supporting the definition of a cross-border strategic framework coordinated by the EGTC "Euregio Senza Confini r.l." to which the authors contributed as consultants.

Moreover, in addition to this main reference, inspiration driving the proposed analysis relies on the wide experience gained in the management of both traditional and strategic projects encompassing several EU Cooperation Programmes dealing with the cross-border dimension of mobility and transport planning.

7 See also https://ec.europa.eu/regional_policy/en/policy/cooperation/european-territorial/egtc/.

References

Cascetta, E. (2009). *Transportation Systems Analysis: Models and Applications*. 2nd ed. New York: Springer-Verlag.

Codd, E.F. (1970). "A Relational Model of Data for Large Shared Data Banks". *Communications of the ACM*, 13(6), 377-87. https://doi.org/10.1145/362384.362685

European Commission (2011). *Roadmap to a Single European Transport Area: Towards a Competitive and Resource Efficient Transport System: White Paper 2011*. Publications Office of the European Union. https://ec.europa.eu/transport/themes/european-strategies/white-paper-2011_en.

Italy – Slovenia Programme (2019). *Border Orientation Paper. Italy-Slovenia*. Ref. Ares(2019)3244965. https://www.ita-slo.eu/sites/default/files/BOP_IT-SI.pdf.

Regione Autonoma Friuli Venezia Giulia (2020). *Mobilità transfrontaliera del Friuli Venezia Giulia: Italia-Slovenia e Italia Austria*. Regione Autonoma Friuli Venezia Giulia – Servizio programmazione, pianificazione strategica, controllo di gestione, statistica e sicurezza sul lavoro. https://www.regione.fvg.it/rafvg/export/sites/default/RAFVG/GEN/statistica/FOGLIA58/allegati/Mobilitx_transfrontaliera_FVG_file_minimo.pdf.

Sippel, L.; Nolte, J.; Maarfield, S.; Wolff, D.; Roux, L. (2018). *Comprehensive Analysis of the Existing Cross-Border Rail Transport Connections and Missing Links on the Internal EU Borders*. European Commission Directorate-General for Regional and Urban Policy. https://ec.europa.eu/regional_policy/en/information/publications/reports/2018/comprehensive-analysis-of-the-existing-cross-border-rail-transport-connections-and-missing-links-on-the-internal-eu-borders.

Ortuzar, J.D.; Willumsen, L.G. (2011). *Modelling Transport*. 4th ed. J. Wiley & Sons Ltd.

Perkmann, M. (2003). "Cross-Border Regions in Europe: Significance and Drivers of Regional Cross-Border Co-Operation". *European Urban and Regional Studies*, 10(2), 153-71. https://doi.org/10.1177/0969776403010002004.

Rowley, J. (2007). "The Wisdom Hierarchy: Representations of the DIKW Hierarchy". *Journal of Information and Communication Science*, 33(2), 163-80. https://doi.org/10.1177/0165551506070706.

UNECE, United Nations Economic Commission for Europe (2020). *Conference of European Statisticians. Recommendations for the 2020 Censuses of Population and Housing*. https://unece.org/DAM/stats/publications/2015/ECECES41_EN.pdf.

Yang, C.; Chen, A.; Xu, X.; Wong, S.C. (2013). "Sensitivity-Based Uncertainty Analysis of a Combined Travel Demand Model". Published by Elsevier within the proceedings of the 20th International Symposium on Transportation and Traffic Theory.