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Challenges for data sharing in freight transport

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An improved version of this paper is published in:

Advances in Transportation Studies: an international Journal as *"T. Moschovou, E.I. Vlahogianni and A. Rentziou (2019) Challenges for data sharing in freight transport, Advances in Transportation Studies: an international Journal, Section B, V. 48, pp: 141-152"*

Working Paper

Abstract

The quantity and quality of data is considered as a critical factor that directly affects the potential output of freight transportation analysis. Reliable and sufficient data enable the detailed analysis for future planning, for both, infrastructure and operation of transport network. Although the significance of transport data is widely acknowledged by researchers and policy decision-makers, several issues still exist, limiting the proper collection but above all the use and sharing of freight data. The existence of various stakeholders and authorities, ranging from national statistical offices to shipping companies and logistics firms as well as the evolution of other non-traditional data sources as key-production "tools" for freight transport data make data collection and sharing a complex and timely consuming procedure. The present paper aims to provide a critical overview of existing sources of data for freight transportation, as well as of existing schemes for sharing these data between public and private sector. Findings reveal indicate the complementarity between public and private sector roles in data collection and sharing data for freight transport. The combination of their roles and activities under a clearly defined partnership could result to mutual benefits for both sectors. The review results to a structured procedure with the form of a framework, which could enable an efficient cooperation among relevant actors for collecting and sharing data for freight transport.

Introduction

Freight transport constitutes a significant share of the total transport operations in Europe. According to the last available data, total freight transport among the European countries was estimated to 3,661 billion t-km in 2016. Road transport accounted for 50% of this total, placing maritime transport (domestic and intra EU operations) as the second most important mode (32%), while rail accounted for 11%, inland waterways for 4%, oil pipelines for 3% and air transport just for 0.1% [1]. Freight transport sector requires access to high-quality data as a means of strengthening the research, analysis and modeling of freight movements. Simply put, it requires the (a) collection, (b) the accessibility and (c) the sharing of the relevant statistical information.

The collection of accurate, reliable and timely data is a basic prerequisite for transport planning and decision-making. It is a time-consuming and frustrating procedure that requires the use of various sources and their consolidation in a unified database. One of the main challenges faced in collecting data is the consistency and comparability among the various databases used. Data is collected, in several cases, through surveys and questionnaires, indicating the need for consistent and appropriately trained team [2]. Lack of or incomplete data, disperse information and figures among different sources or datasets augment the degree of difficulty for extracting accurate and efficient results.

Accessibility of data refers to a set of terms meaning the availability of metadata, of but also to the degree of easiness with which different categories of users can access, understand and manipulate it [3]. Sharing of data generates issues of confidentiality and, consequently, distribution of the available data. Private and public bodies, such as port authorities, shipping or logistics companies collect significant amount of data, in terms of goods transferred. However, the existence of potential data protection rules limits data sharing. Stakeholders underline that the most important for freight transport and the process of collecting data is to know what type of data is available and whether sharing of data is possible [4].

The main barriers met in sharing freight data are legal barriers, meaning the existence of laws that restrict data sharing, resource barriers, i.e. the restrictions in funding and the lack of resources, competition barriers by private firms, institutional barriers between various organizations, public or private, in data collection and their interaction and coordination barriers [5]. Austroads [4] has outlined an approach to improve the collection, transformation as well as the sharing of freight data between different authorities, agencies and companies by including case studies, for implementing such an approach in several steps.

The existence of various stakeholders and authorities, ranging from national statistical offices to shipping companies and logistics firms, generate data sharing issues. The development of a framework, setting guidelines and facilitating cooperation between relevant stakeholders, in terms of data collection is more than essential to face future challenges in freight transport. The present paper aims to provide a critical overview of the existing practices for data collection and sharing in freight transportation. It also addresses the issues and concerns raised when attempting to develop a structured data-sharing plan, as well as the actions that should be taken to ensure a profitable Public-Private Partnerships (PPPs) regarding freight data sharing.

Freight transportation data scene

Freight demand is derived from the need to transport goods from their origin to their destination. The spatial allocation of freight flows in the transportation system has led a variety of research activities to explore multiple methodologies and processes for modeling freight demand. The four-step modeling is a traditional

process applied to forecast transport demand. It requires data usually gathered and collected through data surveys and sources, information of supply chain, traffic counts, etc. Commodity-based models mainly use economic and employment data and traffic counts. Behavioral models depend on the collection of data from surveys to shippers or carriers. Time-series models are based on the existence of historical data [6]. The key parameter for building a transport model is the collection and availability of data. This data will be used as input data in order to estimate the explanatory parameters of the model.

Contrary to modeling passenger flows, various barriers and limitations exist in freight data collection and have a significant impact on model calibration. Among them is the insufficient documentation for recording data, lack of a common form of data for all trips, the existence seasonal variations due to the different nature of trips. Moving freight relates on several parameters: the commodity characteristics, the different types of unitization, the attributes of the relevant transport modes (light or heavy trucks, trains, general cargo or containerships, cargo or combo aircrafts, etc.) and/or the existence of a variety of shipping agents, suppliers and customers allocated to quite a few areas. The unwillingness of firms to share information regarding employment data per sector due to confidentiality restrictions [7], the absence of an affordable budget to conduct surveys or interviews [5] or spatial issues in allocating freight trips due to the multiple locations of production infrastructures [8]. This unavailability of detailed data leads to assumptions and hypotheses that lower the extraction of reasonable models. For such a reason, it is obvious that a key prerequisite for the quality of data is the accuracy of the data sources from which they are retrieved.

Traditional data Sources

The European Statistical System (ESS) of Eurostat has set a number of quality parameters as critical for measuring the quality of statistics; these include relevance (the extent to which data meets users' needs), accuracy (the correctness in computations), timeliness and punctuality, accessibility and clarity, comparability and coherence [9].

Currently, users extract data from "traditional" databases that integrate information from different and disperse sources using different methods, following manual processes or survey-specific instrumentations. Several "traditional" transport-related databases exist both at EU and international level. Eurostat [10, 11] is the official statistical mine of the European Union with main aim to provide high quality data for Europe in several sectors, including, among others, general and regional statistics, economy, transport, population and social conditions, industry and international trade. OECD/ITF statistics portal [12] provides data and comparable statistics to a wide spectrum of contents expressed in TEU and thousand tons per country for inland and maritime containers. UNECE database [13] collects and compiles transport statistics on inland transport for persons and freight movement as well as on road traffic accidents for Europe, North America and Central Asia. Among the regularly used international data sources one can recognize the Commodity Flow Survey CFS as being the primary source of data for goods transported in the USA from their origin to their destinations, the North American Transportation Statistics Database (NATS), which publish transport data statistics for both passenger and freight transport activities within and between the USA, Mexico and Canada, and the Bureau of Transportation Statistics (BTS), the statistical agency of the USA providing information on their transportation system [14, 15, 16]. On the other end, the Australian Bureau of Infrastructure, Transport and Regional Economics (BITRE) provides statistics on infrastructure, transport and regional development for Australian content and the Association of Australian and New Zealand Transport authorities (Austroads) [17, 18]. Table 1 summarizes the above data sources providing valuable information with respect to the geographical coverage (national, international, regional), the frequency of updating existing information,

possible restrictions for data sharing, the provision of raw data, measurements that are included and the modes of transport they are referring to. The meaning of this table is solely to present and not to compare.

Moreover, public authorities, customs, police, transport network operators, as well as ports also keep records depending on their activities (e.g. ports record vessels' arrival and departure time, waiting time at berths, loading/ unloading time operations). Private companies, such as truck, rail, shipping and logistics companies hold significant amount of data relative to operations of transport modes. Data on frequency, travel time, speed, capacity of vessels and existing connections are recorded by private companies, usually used for their own purposes.

Recently, various websites have been developed, providing data on freight transport. One of them, Marine Traffic provides real time information for ships and itineraries permitting the identification of the exact location of ships and the prediction of delays. However, historical data is not provided free of charge. Moreover, data on capacity and speed of containership is also provided online. All information and data from the above-mentioned data sources could be usefully exploited to interact and establish links with statistical authorities and organizations that set data collection as a priority for improved research on freight transport.

In addition to the statistical offices, significant amount of data is also collected through surveys and interviews with the freight community (shippers, carriers, forwarders, stakeholders). Various types of surveys, such as roadside intercept surveys, mail-out/mail-back questionnaires, combined telephone-mail-out/ mail-back questionnaires or telephone interviews, are employed for this scope [19].

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TABLE 1 Specification of main publicly available data sources for freight transportation.

	Eurostat	OECD/ITF	UNECE	CFS	NATS	BTS	BITRE
Parameters							
Geographical Coverage	Varies (EU members, EFTA countries, USA, Japan, North Africa, Middle East	30 member OECD countries (also Brazil, China and Russia)	56 member countries	USA	North America (USA, Canada, Mexico)	USA	Australia
National	✓	✓	✓	✓(ODs)	✓	✓	
International	✓	✓	✓	-	✓(between the 3 countries)	✓	-
Regional	✓ (detailed data)	✓ (limited data)		✓	-	✓ (State and local)	✓ (State and interstate)
Updates	Regularly (e.g. annually for road, every five years for rail transport)	Annually	Annually	Every 5 years	Annually	Regularly	Annually
Restrictions for sharing data	Free online	Free online	Free online	Free online	Free online	Free online	Free online
Provision of raw data	Survey methods and questionnaires from reporting countries (e.g. annually for road, every 5 years for rail)	Transport Ministries, statistical offices and other institution designated as official data source.	National accounts, surveys, collected from national statistical offices	Survey methods through questionnaires (one questionnaire for every calendar quarter of the survey year).	Transport Ministries, National statistical offices, custom services, etc.	Survey, regulatory data collections, administrative data collections (e.g., the border crossing data)	Australian Bureau of Statistics, own surveys, calculations and methodologies
Measurements	t, t-km, v-km, movements	t, t-km	t, t-km, v-km, movements	T, t-miles, values ($),	t-miles/t-km,v-miles/v-km	t, t-miles, v-km, movements	t-km movements
Modes	All modes	Inland modes and short sea shipping	Inland modes	All modes	All modes	All modes	All modes

Alternative data sources

These complexities have led to the establishment of new techniques and methods for collecting freight data. The advent of advanced technology has resulted in the development and use of innovative tools and disruptive mechanisms for data collection. These sources have turned into alternative types of data suppliers (non-traditional data sources) as they generate endless, automated and large volume of data. These non-traditional data sources are classified depending on either their originated form or their collection method. According to PCAST [20] data can be produced from digital or analog means, while OECD/ITF uses a three-system classification of information generating from purposely-sensed, opportunistically-sensed and crowd-sourced data [21]. Blazquez [22] presents a taxonomy in order to provide a designed system for forecasting social and economic behaviors, trends and changes. Prabha and Kabadi [23] provide a systematic overview of traffic data collection methods using ITS according to their different technical characteristics and operation principles. Data coming from alternative data sources can be collected by applying Intelligent Transport Systems technologies meaning by using positioning systems or crowdsourcing techniques for each transportation mode.

Among the positioning system techniques are the radio frequency identification tags (RFIDs), e-sensors and even e-seals. RFIDs are mounted either on the mode or the packaging units and identify the commodity characteristics, measure border crossing and waiting times at ports as well as to track vehicles. E-sensors detect any change to the commodity when transported (e.g. temperature e-sensors that record temperature variations to refrigerated cargo). E-seals are designed to digitally sign the commodity transported and therefore allow authorized protection [24]. Moreover, business administration, wireless communication tracking systems, organization and transaction systems, such as order and inventory control planners and tools (EFR, DRP, EDI) are great suppliers of information on the type of commodity, origin and destination place, transport modes, delivery paths as well as costs [25]. Tolls, license-plate readers, traffic cameras, but also scanner data that provide price and economic data statistics are in this category also. Currently, the use of connected vehicle technology (ITS JPO, no date) is used for information exchange among vehicles and operation centers.

Crowdsourcing techniques employ the power of social networks, internet searches, and open data to gain real-time transport information [26]. They are acting and used as sensors to provide a cost-effective way of collecting transport data on network flows, congestion levels.

This storm of information and knowledge coming from the relatively newly-born alternative sources could simply be ignored or even stay unexploited. In freight transport, the existence of various ways freight data could be provided by individual shippers, forwarders, carriers, private vendors, consultants, and public companies have set new challenges in the way all actors and stakeholders deal with data collection methodologies and exploitation. The integration of both private and public data sources that follows a certain framework, ruling but also limits could lead in shared and ready-to-distribute data.

A Framework for Facilitating Data Sharing

Public- Private Partnership in Data Collection

The existence of various available freight data sources and data - public and private - of different levels provided by individual shippers, forwarders, and carriers, private vendors, consultants, and public companies in combination with the need for precise and suitable, good quality data that could be used in transport planning have set new challenges in the way research and stakeholders deal with data collection for freight transport. Questions on the way private companies could provide information without compromising their competitive advantage, on the identification of the most appropriate data needed to address each problem have intensified the need for new ideas and approaches [28].

Literature underlines that the development of effective Public-Private Partnerships (PPPs) could provide answers to the above-mentioned challenges, ensuring the adequate transport planning, in terms of freight flows and infrastructure - at regional and local level - through the smooth and close cooperation of public and private sector in terms of data collection and sharing [29, 30].

The expansion of the Internet in combination with the use of new logistics technologies and sensors and the increasing integration of supply chains were expected to result into the development of PPPs for data collection, enabling a huge revolution in freight data, i.e. providing new datasets and tools to freight planners. Despite of the fact that the cooperation between the public and private sector is widely acknowledged as having a great, positive impact on data collection, in terms of quantity and quality, PPPs for data collection still remain a promising, but not widespread solution, facing various obstacles towards their implementation. This is usually attributed to the concerns of private sector to share their data [31, 32].

An in-depth analysis and understanding of this emerging type of collaboration would be beneficial for several reasons. The potential improvement in data collection will contribute to the expansion of evidence-based policymaking, especially in developing countries. Moreover, although new technology has affected the collection and storage of data, the impact of this significant amount of available data- known as big data- on people's life is still unexplored. The technology revolution has brought a revolution in people having access to considerable datasets as well. Although in the past, government agencies and NSOs were the main sources of data, based on surveys and census, recently private companies have emerged, containing huge amount of data collected through alternative sources, such as sensors, mobile phone, credit cards, etc., as well as various tools useful in processing these data. Within this framework, the integration of all available data sources government and non-government, in a common "open" and scalable framework is – at least conceptually - of great added value [24].

The framework

The development of a Public-Private Partnership (PPP) for data collection and sharing in freight transportation could have significant benefits in terms of both, type and amount of collected data, and, consequently, on transport planning. However, a non-well designed and implemented PPP would cause more harm than good, including the revealing of confidential data, the inappropriate processing of information and the bad coordination and cooperation among the partners. Therefore, the establishment of a PPP for data collection and sharing should follow a well-define process. The main aspects of this process are described in Figure 1.

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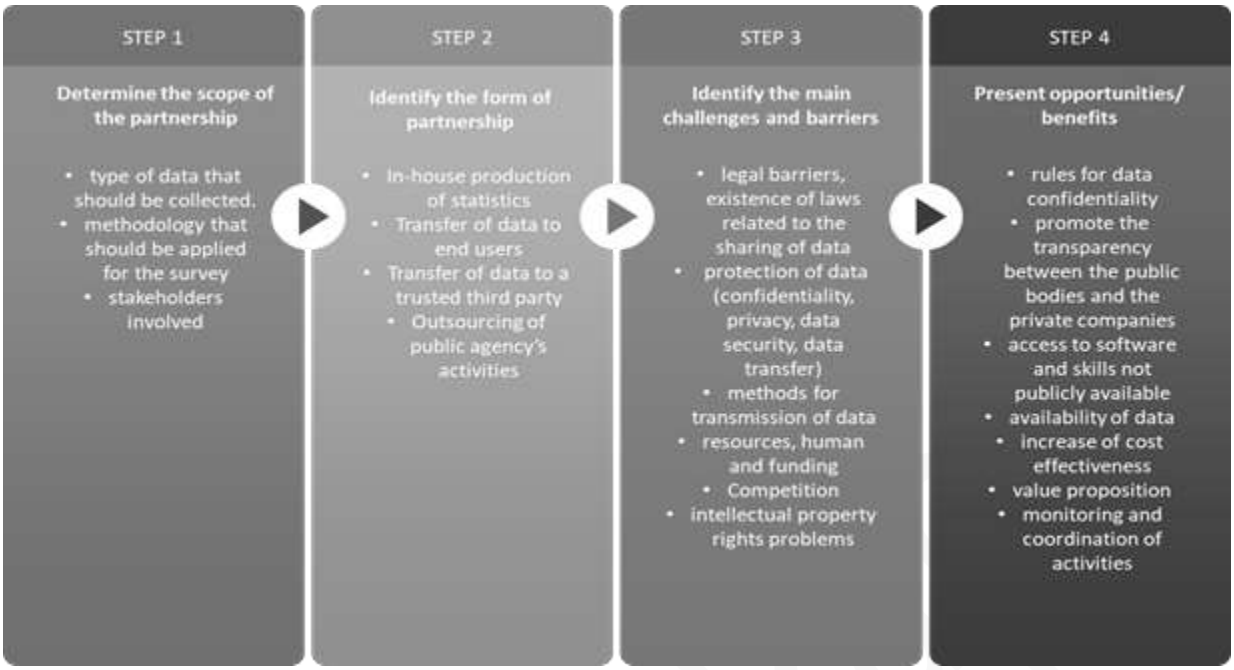

Figure 1: Stepwise framework for establishing PPP for data sharing

Step 1: Determine the scope of the partnership.

This initial step will define three main axes of the partnership:

The type of data that should be collected. The detailed description of the use and the quality of data will prevent future difficulties and misunderstandings within the partnership. Aim of this section is to set the requirements in terms of data's quality and use.
The methodology that should be applied for the survey
The stakeholders involved. Usually, the National Statistical Offices (NSO) are the primary public partner, while other bodies, such as the central bank, relevant ministries, universities or research institutes could also be involved. Regarding the private partners, non-state bodies, including corporations, private companies and non-governmental organizations, could participate. The key for the selection of stakeholders is the collection and production of reliable data and statistics [29].

Step 2: Identify the most suitable form of partnership based on the activities that will take place.

The activities that take place within the PPP to determine its type can be highlighted as follows:

In-house production of statistics: No raw data but only statistical outputs are provided within this framework. In this way, the confidentiality and privacy risks are eliminated while it is possible to control the compliance of the applied methodology with the standards set by the public agencies. Up to now, several companies have followed this approach in sharing their own data [29]. A more open approach would be the case of the public agency having on-site access to the data and the algorithms used.

Transfer of data to end users: Another type of partnership involves the actual transfer of databases to the public agencies, considering the end user, based on an agreement determining the details of the partnership (e.g. purpose, quality of the data, responsibilities and penalties for not respecting these) [33]. Improved review of the results and easily implemented methodological changes by the public agencies are the main advantages of this approach. However, the public agencies usually do not have the required capacity to handle the vast amount of data provided. Moreover, ethical and legal concerns usually impose restrictions in the use of data by the public agencies while the precautions imposed by the private companies also eliminate the quality and applicability of the provided data.

Transfer of data to a trusted third party: This type of partnership involves the intermediary analysis, processing and dissemination of the data by a trusted third party usually a private analytics firm, a regional statistical office, etc. The use of a third party responsible for the analysis and processing of data is very useful and efficient in cases of combining data from various companies, organizations and institutions. Its ability to comply with the official statistical standards, set up either by international organizations or the partnership, and the absence of any particular incentives or reasons leading to mishandling of the data are the main criteria for its selection and use [34].

Outsourcing of public agency's activities: Within this framework, activities, such as traditional data collection, processing of freely available data sources etc., usually conducted by a public agency, are outsourced to a contractor, towards the increase of efficiency. Although it seems similar, this type of partnership varies from the in-house and trusted third party approaches, in the access that the public agency has on the data. This category of PPPs is met more often as the public agencies tend to employ private companies carry out surveys as well as collection and processing of data [31].

Step 3: Identify the main challenges and barriers for the implementation of Public- Private Partnerships.

The major barrier in implementing a PPP for data sharing is the legal barriers and specifically the existence of laws related to the sharing of data, mainly due to the bottlenecks imposed on the information that could be requested and shared and the difficulty in overcoming them. As indicated in a survey carried out by Eurostat [35] on Mobile Network Operators, the regulatory issues were the main concerns in using and sharing data collected for statistics.

Elements relevant to the protection of data, such as confidentiality, privacy, data security, data transfer, and methods for transmission of data should be covered within this part while the respective penalties for revealing confidential data and for unauthorized use of data are considered main challenges to overcome as well.

The lack of resources, human and funding is a usual problem in collecting and sharing data between public and private sector as well as the perception raised from the private sector that the expected benefits gained will not be significant, impose further barriers in data sharing. Competition and privacy issues as well as intellectual property rights problems constitute also significant barriers. Data coming from unofficial sources often do not comply with standards and specific structures, a fact that imposes a great technical and statistical challenge [36, 31].

Step 4: Present opportunities/ benefits and ways to overcome barriers.

The successful development of a Public-Private Partnerships requires the identification of ways that would encourage such an establishment and overcome the barriers presented above. Specified and strong rules that could protect the confidentiality of the data and promote the transparency between the public bodies and the private companies are the keys for a successful public-private partnership for data collection and sharing. The existence of a written contract such as a Non-Disclosure Agreement (NDA) explicitly describing the use of the data and the limitations in any other use

would be the solution. Within the NDA would also contribute to overcome privacy issues, such as the fear of private companies of using their data for regulatory issues.

The benefit that a private sector could bring in a PPP is the access to data, software and skills not publicly available. On the other side, the role of the public sector is based on the availability of data that could be used by the private sector to inform relevant stakeholders and investors regarding relevant issues such as equipment utilization, new markets, and business opportunities [37, 38].

The increase of cost effectiveness could be also one of main benefits of PPPs. The public agencies could reduce cost for data collection, considering that the marginal cost for transferring data from private sector to public agencies could be very low [39], as well as data processing by making use of private sector's resources and expertise instead of investing resources for the use of software and skills. The collaboration of big companies producing extremely large datasets, with small private companies, specialized on processing datasets would be a win-win situation for all. The big companies could significantly reduce their cost per year, while the private ones would be able to re-apply the available technology and tools to similar datasets of other companies. Within this context, apart from cost effectiveness achieved for both companies, new business opportunities emerge, especially for small private companies (SMEs) [40]. Further to the above, the public-private partnerships for data sharing are expected to have great benefits on timeliness and granularity of data, two characteristics determining data's quality, while expanding data collection to new areas is also more feasible. The use of simple, well-known and widely used tools for data recording and sharing has been determined as critical factor in convincing stakeholders to participate in data sharing partnerships, as indicated through a survey conducted in Texas. The stakeholders participating in this survey were more willing to record data through samples developed by Excel or CSV type and share it electronically via email or a secured website [38].

As a last step, one should not forget the future prospect of the partnership. Terms and conditions for the continuity of the partnership should be also included in the framework. A well-coordinated partnership or consortium is the key factor for a successful project. An already formed partnership could easily elaborate a project of similar scope and subject, e.g. collection of data on supply chain or logistics. To enhance this continuity, the roles and responsibilities of each partner in the consortium should be clearly predefined followed by a broad description of projects and activities that could be elaborated in the future. The monitoring of the set-up of a PPP for data sharing is considered as the most critical process towards its successful implementation. This stage may include defining specific indicators, such as number of meetings and level of engagement of partners, for monitoring the overall procedure and the particular activities, setting milestones and regular meetings, evaluating the quality of the delivered data, etc. The monitoring of the procedures requires the involvement of a partner of the PPP that will be responsible for this activity. Dealing with the PPP as a project would be beneficial for its purposes. To this end, as in the case of projects, the partner with the most experience in similar activities will be selected to monitor the particular activities and interfere when needed.

Conclusions

Freight transport constitutes one of the main sectors of entire transport system worldwide. To this end, the use of high-quality, timeliness and precise data is more than essential. Although several traditional data sources exist, usually run by international organizations, e.g. Eurostat, OECD, the incorporation with data from new, alternative data sources could have considerable advantages, especially in cases of analysis new trends (e.g. online trade) and innovative transport solutions. However, the collection of data from various sources is a time-consuming and frustrating procedure that requires the use of various sources and their consolidation in a unified database.

The answer to this challenge could be the set-up of Public-Private Partnerships (PPPs) that would enhance the cooperation among the various companies collecting data for freight transport, enabling the smooth and efficient collection and sharing of the respective data. This partnership would permit the combination of several data sources, overcoming existing issues such as compatibility of data sources and lack or resources for data processing. Although the concept of PPP is well-known, its implementation in data collection and sharing is rather new. The establishment of a partnership aiming to data sharing and production of statistics should be based on specific guidelines in order to overcome the respective barriers due to legislation, lack of resources, confidentiality, cooperation etc.

In this paper, we identified the main barriers, as well as the respective incentives to overcome them to promote the establishment of PPP for data collection in transport sector. The existing types of collaboration and their distinctive characteristics were also presented. Finally, all the aspects examined were combined to form a roadmap, acting as a guideline to companies that would like to set-up a similar PPP.

The need for further analysis of this initiative that would enhance its implementation emerges as more and more alternative data sources are used in transport sector. Future research should focus on the estimation of cost of PPPs for data collection and sharing, as it could be a deterrent factor for its establishment. Moreover, more options in terms of combining the available data sources should be explored especially in the case of merging data from traditional sources, such as the National Statistical Offices and the International Organizations, and alternative data sources, such as traffic sensors, in one dataset [41].

REFERENCE LIST

1. Eurostat (2018) 'Statistical Pocketbook 2018. Publications Office of the European Union', Luxembourg, in https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2018_en (Accessed on 22 September 2018)
2. Meyburg H. A., and J.R. Mbwana. Data Needs in the Changing World of Logistics and Freight Transportation. Conference Synthesis. Transportation Infrastructure Research Consortium, Cornell University, New York, 2002
3. OECD (2007), Glossary of statistical terms, in: https://stats.oecd.org/glossary/index.htm, Access in Jun 2018
4. Austroads. Review of Freight Data Collection and Generation Procedures and Opportunities. AP-R283/06, Sydney, Australia, 2006
5. Samimi A., Mohammadian A., Kawamura K. (2010), A behavioral freight movement microsimulation model: method and data, Transportation Letters: The International Journal of Transportation Research, Vol.2, pp: 53-62
6. Cambridge Systematics Inc., GeoStats, LLP, (2010), Freight –demand modeling to support Public-Sector decision making, NCFRP Report 8, Transportation Research Board, Washington D.C
7. Novak D., Hodgdon Chr., Guo F., (2011), Nationwide freight generation models: A spatial regression approach, Networks and spatial economics, vol. 11, is., 1, pp.: 23-41, DOI: 10.1007/s11067-008-9079-2
8. Bhat Ch. And Zhao H., (2002), The spatial analysis of activity stop generation, Transportation Research Part B: Methodological, vol. 36, is. 6, pp.: 557-575
9. Eurostat. Definition of Quality in Statistics. Methodological Documents, Working Group Assessment of quality in statistics, Luxembourg, 2003
10. Eurostat. Rail Transport statistics methodology – Guidelines for the implementation of Regulation (EC) No 91/2003 of the European Parliament and of the Council on rail transport statistics. Publications Office of the European Union, Luxembourg, 2015
11. Eurostat. Road freight transport methodology. Publications Office of the European Union, Luxembourg, 2016
12. OECD. Quality Framework and Guidelines for OECD Statistical Activities. Version 2011/1, 2011.
13. UNECE. Terms of Reference. Working Party on Transport Statistics (WP.6), 2011
14. Zmud J. Improving methods to enhance data quality and usefulness. Workshop resource papers. *Transportation Research Circular: Commodity Flow Survey Conference*, Boston, Massachusetts, 2005
15. U.S. Department of Transport. North America Transportation Highlights. Washington, D.C., 1999
16. U.S. Department of Transport. BTS Statistical Standards Manual. Washington D.C., 2005
17. Bureau of Infrastructure and Regional Development. Australian road freight estimates. Australia, 2016 (update)
18. Bureau of Infrastructure and Regional Development and Australasian Railway Association. Trainline 4, Statistical Report. Australia, 2016
19. Prozzi, J., C. Wong, and R. Harrison. Texas Truck Data Collection Guidebook. Center for Transportation Research, The University of Texas at Austin for Texas Department of Transportation, Research and Technology Implementation Office, Texas, 2004
20. PCAST, 2014. Big Data and Privacy: A Technological Perspective. s.l.: President's Council of Advisors on Science and Technology: Executive Office of the President

21. ITF (2015), "Big Data and Transport: Understanding and Assessing Options", International Transport Forum Policy Papers, No. 8, OECD Publishing, Paris, https://doi.org/10.1787/5jlwvzdb6r47-en
22. Blazquez, D., (2017), Technological Forecasting & Social Change, In: http://dx.doi.org/10.1016/j.techfore.2017.07.027.
23. Prabha R., Kabadi G.M. (2016), Overview of data collection methods for intelligent transportation system, The International Journal of Engineering and Science, vol.5, is.3, pp.: 16-20.
24. Transportation Research Board. A Concept for a National Freight Data Program. Special Report 276. Committee on Freight Transportation Data: A Framework for Development, Washington D.C., 2003.
25. Altman, M., C. Capps, and R. Prevost. Using New Forms of Information for Official Economic Statistics-Examining the Commodity Flow Survey. Executive Summary for the 1st Workshop in the Census-MIT Big Data Workshop Series, 2015
26. Dennis E.P., Wallace R., Reed B., (2015) Crowdsourcing transportation systems data, Crowdsourcing Transportation systems data, Michigan Department of Transportation and the Center for Automotive Research, No. 159, Connected and Automated Industry coordination
27. ITS JPO (no date), In:https://www.its.dot.gov/research_archives/connected_vehicle/connected_vehicle_standards.htm
28. Hancock, K.L. Freight Transportation Data. Millennium Paper, Transportation Research Board Committee on Freight Transportation Data (A1B09), Washington D.C., 2001
29. Seedah, D., A. Cruz-Ross, B. Sankaran, P. La Fountain, P. Agarwal, H. Kim, M. Cebelak, S. Overmyer, J. Prozzi, Dr. W. J. O'Brien and Dr. C. M. Walton. Integrating Public and Private Data Sources for Freight, Transportation Planning. Technical Report, Center for Transportation Research, The University of Texas at Austin for Texas Department of Transportation, Research and Technology Implementation Office, Texas, 2013.
30. Lachman, Beth E. Public-Private Partnerships for Data Sharing: A Dynamic Environment. Santa Monica, CA: RAND Corporation, 2000. https://www.rand.org/pubs/drafts/DRU2259.html.
31. Robin, N., T. Klein, and J. Jütting. Public-Private Partnerships for Statistics: Lessons Learned, Future Steps. A focus on the use of non-official data sources for national statistics and public policy. OECD Development Co-operation Working Paper 27, 2016
32. NCPPP, 2015, *Public-private partnerships defined*, National Council for Public-Private Partnerships, 2015, viewed 30 November 2017, from http://www.ncppp.org/ppp-basics/7-keys/
33. Landfeld, S. Uses of Big Data for Official Statistics: Privacy, Incentives, Statistical Challenges, and Other Issues. International Conference on Big Data for Official Statistics United Nations Statistics Division (UNSD) and National Bureau of Statistics of China, Beijing, China, 2014.
34. Klein, T. and S. Verhulst (2017), "Access to new data sources for statistics: Business models and incentives for the corporate sector", OECD Statistics Working Papers, No. 2017/06, OECD Publishing, Paris, https://doi.org/10.1787/9a1fa77f-en.
35. Eurostat. Feasibility Study on the Use of Mobile Positioning Data for Tourism Statistics: Report 2. Feasibility of Access. Eurostat contract no. 30501.2012.001-2012.452., 2014.
36. Cambridge Systematics, North River Consulting Group, and University of Washington. NCFRP Report 25: Freight Data Sharing Guidebook. Transportation Research Board, Washington, D.C., 2013. https://doi.org/10.17226/22569
37. TRB (2003), Cybersecurity of freight information systems a scoping study, Transportation Research Board Special Report 274, Committee on Freight Transportation Information Systems Security, Computer Science and Telecommunications Board, Transportation Research Board, National Research Council of the National Academies, Transportation Research Board, Washington, D.C.
38. NCPPP, 2015, *Public-private partnerships defined*, National Council for Public-Private Partnerships, 2015, viewed 30 November 2017, from http://www.ncppp.org/ppp-basics/7-keys/
39. Ballivian, A., and B. Hoffman. Public-Private Partnerships for Data. Issues Paper for Data Revolution Consultation. World Bank, Draft, 2015

40. European Commission. Frequently asked questions: Public-Private Partnership (PPP) for Big Data. MEMO, IP/14/1129, Brussels, 2014.
41. Susha, I., M. Janssen, and S. Verhulst. Data Collaboratives as a New Frontier of Cross-Sector Partnerships in the Age of Open Data: Taxonomy Development, Proceedings of the 50th Hawaii International Conference on System Sciences, 2017.

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