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Using PEST as a framework for analyzing open mobility data

Samaneh Hosseinzadeh[1*], Marlies Van der Wee[1], Sven Vlassenroot[2], Sofie Verbrugge[1]

1. Ghent University – iMinds, Belgium

2. Vlaams Instituut voor Mobiliteit, Belgium

Corresponding author: saminbahrini@intec.ugent.be

Abstract

The growing availability of big data, i.e. accurate, continuously and real-time available data, poses both challenges and opportunities for many companies and markets. In the mobility sector, these data allow for better and more continuous monitoring of mobility of people, vehicles and freight. An important discussion in the debate on big data focuses on the need for and potential issues with opening access to data for more widespread use. The goal of this paper is to combine the domains of mobility data and open data to identify the current and future challenges for open mobility data. Learning from real-life examples across Europe and assessing them using the PEST (political, economic, socio-cultural and technical) framework, allows providing some clear recommendations and guidelines for handling, offering and using open mobility data.

Keywords:

PEST; techno-economic analysis; open mobility data

1 Introduction and motivation

The digital evolution is accompanied by an exponential growth of collected data; covering multiple application domains, originating from different sources, aggregated at different levels [1]. In the near future, these data will be of great importance for the logistics and mobility sector, as the use of traffic, movement and source-destination data opens up new opportunities for businesses, authorities and individuals alike, in analyzing problems related to accessibility, safety and quality of life.

Many recent studies focus on the technological trends and how they will allow the collection of more, and more accurate data. Think about the data collected by inductive loops, sensor networks and Internet of Things (IoT) in general [2]-[6]. Little research however can be found on the challenges on data management, ownership and access that arise from these new technological opportunities. Apart from providing an overview of these challenges, this paper focuses specifically on the analysis of *open mobility data*, and the potential costs and benefits they entail.

Open data is data that can be “freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to attribute and share alike” [7]. Many recent studies focus on the application of open data in different fields of studies [8]-[11].

Open data is a relatively new concept to practice and there are little (if any) documented recommendations on why and how to go about opening up available mobility data. This lack of a

concrete platform to guide government in making data open, has been identified by the Rotterdam Open Data project which is a consortium of municipalities, universities and local businesses set up to understand the opportunities and barriers implications of opening up Rotterdam's public data [12].
Encouraging private and public institutions to share and open up the data both in the aggregated level and with consumers individually, is encouraged by growing open data initiatives. The latter argue that the potential economic and social value from sharing and merging public and private sector data sources can be huge. Sharing data can be considered as a win-win situation. By allowing consumers to access detailed data of their behaviors and preferences, businesses may obtain richer and more accurate data than the data they could collect without their customers' cooperation. Moreover, if organizations provide access to their data, creative developers will be able to build applications for new innovative uses. For individuals, the promise of benefits and value sharing propositions will incentivize them to share their own data for more profits [13]. Other practical benefits such as ability to fill out online forms with just one click could be an incentive for consumers even if they would never sell their personal data [14].
Determining the overall value of open data is not easy and it could be a barrier for more openness. The companies that are building their business on open data still belong to a niche, which makes it too early to measure their success. Moreover, because some of these companies use open governmental data as just one source for their business and integrate it with other sources of non-open data, it is hard to detect how much open data contributes to their business.
It is beyond doubt that open data can be a valuable business resource, but the question that remains is how it can be used most cost effectively. There is still a large amount of barriers to overcome and problems to be solved before one can determine the value of open mobility data and make a well-underpinned decision whether it is needed to invest in open data platforms. The aim of this paper is to summarize these issues and barriers, based on an application of the PEST framework on real-life cases (see section 2 to 4, respectively) as to provide recommendations and guidelines for the handling and offering open mobility data (section 5).

2 A short introduction to the PEST framework

PEST analysis is a widely used framework with the aim to identify the parameters that have impact on the organization or business by recognizing them as Political, Economic, Social and Technological influences. This helps to understand the "big picture" of forces that businesses are exposed to [15].
A PEST analysis can be used to survey companies, industry sectors, services and products. It has been widely and frequently applied in the past in both public and industry environments. Pepsi, for example, successfully applied this analysis method to investigate political aspects such as federal regulations and political stability, economics issues like cost of raw materials and cost of fuels, social factors such as lifestyle and finally the role of modern manufacturing techniques applicable to their business as technological factors [16].
All large businesses should apply this type of analysis because businesses are influenced by the

environment that they are in and all the situational factors that change the circumstances. Therefore, businesses need to keep a check and constantly analyze the environment which they run their trade and business. The main factors that spring to mind when performing a PEST analysis for transportation sector are [17]:

- Political aspects: funding and support, legislation, government term and change, regulation
- Economic aspects: international trends, national trends, costs, revenue, business models
- Socio-cultural aspects: demographic changes, trends in the way people live and work, changes in cultural transportation need, public support, public priorities, new cultural trends (access to technology), focus on environmental issues, lack of the time and seeking for the most efficient ways of mobility
- Technological aspects: technical advances (new technologies), traffic control systems, communication and computer technologies

3 Example cases using open mobility data

Many recent studies focus on the application of open data in different fields of study to present the value of open public data. Generally, the value of open mobility data can be based on better planning and management, more efficient trip planning for travelers (consumers) because of real time information and optimization of investment in infrastructure and services. These reasons have provided the incentive for national and local authorities to open up their data. A growing number of small or large companies setup to use public open data to create services and business models mostly in north America and western Europe [18]. This section describes some (recent) examples of countries/regions where open data is (freely) available, which can be used as an input for the analysis in section 4.

3.1 Transport for London

In the United Kingdom, one of the leading governments in the field of open data, over 5,000 application developers have registered to use the free of charge open data feeds of Transport for London. This local government organization is a pubic institution responsible for the majority of the public transport in the greater London area [19]. Over 200 apps have been created based on about 30 feeds of open data covering all modes of public transports and roads [20]. Examples include ITO World Ltd which has services based on official Transport for London data [21] or Placr, a company aiming at creating a single UK source of traveling information by merging timetables, live departures and also disruption information for all public transport modes (bus, rail, metro and ferry services) [22].

3.2 Open data in Finland

Finland was the first in the world to start developing an open platform for door-to-door mobility services. Door-to-door mobility services enable travelers to see, book, pay, and follow the optimal solution of travel chain according to their own needs. The door-to-door mobility services can be offered to users by ‘mobility operators’ but need the help of modern digital solutions to be operational. These digital solutions require access to the timetables, real-time location information, and payment systems of

existing transport service providers, such that underground, bus, train, tram, taxi, ride sharing, and city bike services can be merged into one smartphone application [23].

The Helsinki Regional Transport Authority not only offers free access to open mobility data, but has recently also developed an intelligent route planner, which can be easily be transferred to other cities because of its open source, license-free approach [24]. As a demonstrator for the success of the open data platform, Sakari et al. (2013) studied the impacts of a bicycle sharing system (BSS) on public transport travel times by the available open data and public transport routing interface [25]. Apart from their results about reducing public transport travel times (10% on a single trip in Greater Helsinki on average) by using the BSS system, they emphasized the importance of access to open data sources on urban transport information for analysis of multimodal urban mobility patterns.

3.3 The National Data Warehouse in the Netherlands

Open Data FWD is a corporation of the department of Infrastructure, Traffic & Transportation (DIVV) and the Waag Society [26] in the Netherlands. The project wants to use open data in three themes: parking, bicycling and public transport to find digital solutions for issues in these three fields. Opening up more data in the largest four municipalities (Amsterdam, Utrecht, Rotterdam, and The Hague) aims at stimulating app development and smart usage of mobility data. According to the results of an interactive session for web developers and municipalities, the availability of whole data sets is not the first, nor most important issue. Following the time-consuming process for developing mobility apps, the main focus areas are (1) obtaining a clear understanding of the cost structure, (2) standardization of data and (3) knowing what kind of data is needed [27]. Open Data FWD looks for open data applications with social and economic values which can help policy makers save costs and increase efficiency in their policy making process. Helping government with mapping cyclists flow or helping to solve bicycle traffic jams, helping drivers to find a parking spot quicker and providing relevant information about the routes situations and delays are some of these examples [28].

3.4 Approach for open data in Belgium and the example of the Ghent portal

The fourth and last case study tackles the open data policy in Belgium, and more specifically the city of Ghent, since the latter is the authors' daily environment and a city that clearly invests in the digital future (e.g. Ghent Living Lab, support for startups, etc.). With 43% of its public data open, Belgium ranked 35th of the 122 reviewed countries in 2015 [29]. Generally, most Open Data and Open Knowledge initiatives in Belgium started from local and regional governments. Some cities like Antwerp, Ghent and Kortrijk have open data policies. The incentives for these authorities to provide open data, can be linked to the study performed by Agoria. This Belgian sector federation for the technology industry has calculated a huge economic potential: opening up data could have "net earnings of around 900 million euros" for Belgium, they estimated [30].

As one example of a Belgian city that publishes governmental data for free, we here refer to the example of Ghent. The city allows everyone to use their collected data (e.g. underground parking occupancy, travel times during events, taxi locations, etc.). The city's open data platform monitors the number of

apps that make use of the offered open data, about 20 for mobility data, ranging from finding the nearest parking spot to finding the nearest public toilet [31].

4 Applying PEST analysis for open mobility data

From the overview of available open data sources and platforms described above, it is clear that already a high number of authorities and market players recognize the value and opportunities of open mobility data [32]. For most governments, the main driver for opening up their data is linked to empowering innovation and stimulating developers to create their own businesses using the open data as a resource. Making data open can create also value for governments in return. For example, open public transport data can be used by passengers for useful applications which can result in greater number of passengers and more income for public transport authorities. When data is openly available, data users can help to detect mistakes, inaccuracies and inconsistencies between datasets, which in turn leads to better quality of data. Having one or streamlined data sets to rely on furthermore increases harmonization and collaboration within the city [33].

Some cities, such as Helsinki and Ghent, link the availability of open (mobility) data to their strive for becoming a "smart city", where ICT and IoT are used for productivity improvements, cost and resource reductions and an increase in interactivity in urban services [34]. However, before reaping the benefits of these opportunities, there are quite some hurdles to be overcome. Using the input and experience from the cases described above, this section will analyze the barriers for open mobility data using the PEST framework as introduced in section 2. An overview of the analysis can be found in Table 1.

Table 1: Challenges and barriers for open data platforms, following the PEST framework

	Political	Economic	Socio-cultural	Technical
Transport for London, London, UK	* protecting privacy and intellectual property by licenses * apps should be in line with policy goals * driver = social and economic benefits of open governmental data	* budget cuts related to the economic crisis	* social attitudes * accessibility and format require technical expertise	* data gaps * limited traffic requests per app
Open data portal, Helsinki, Finland				* technological change * barriers to innovation transfer * lack of suitable places to publish

				opened data
Open Data FWD (corporation of the department of Infrastructure, Traffic & Transportation and the Waag Society)	* privacy * Dutch policy: all data must be open unless not allowed by law		* trust issues	* quality of data * data completeness * acquiring new datasets * continuity of data streams * different formats and sources of data
Open data portal, Ghent, Belgium	* policy: Open by Default	* cost for opening third party data		
Other cases in EU	* unwillingness to give up data for free (or at all). * open data/apps counter local government policy * data protection low	* market size (sufficient number of users) * viability of business models	* lack of demand for open data (due to city size or small user group) * data ownership * social learning * bottom-up citizen open data movements	* maintain quality of the data *data availability * standardization * data reliability

4.1 Political

Deciding about opening up mobility data, what sorts, types and how much is mainly a political issue. The European Directive on the re-use of public sector information (PSI) that entered into force on 17 July 2013, provides a common legal framework for a European market for governmental data using transparency and fair competition as the key pillars [35]. It encourages the Member States to provide as much information as possible for re-use through legal and soft law measures. It addresses public sector information, at national, regional and local levels. The Directive covers written texts, databases, audio and video files; however, it does not apply to the educational, scientific, and broadcasting sectors [35].

Based on the cases described in this paper, as well as other examples, privacy is an important issue to be addressed. Public data may contain personal information of citizens and hence should be shared in an aggregate or fully de-identified way to protect citizens' privacy [35]. Governments should play their role by have an impact on the data economy by using their power in the data market as a motivator of innovation and promoter of privacy and security in the data exchange [38].

Both the Netherlands and Belgium recently adopted an "Open by default" policy, indicating that all data must be open unless not allowed by law [36]. The subject of data ownership and data protection are also important to be discussed more. This sort of barriers however should not be the reason for unwillingness to open up data freely and accessibly to all data users.

Another political barrier is that, the providers of open data are mainly governments or other authorities,

while users of open data (developers or private companies) do not necessarily have the same goals because of different cultures and missions. When the developers are forced into business models to comply with governmental policies, there could be a cause for conflict. There is a need for more clear corporation and dialogue between public and private sector, as examples prove that both parties not necessarily have to aim for contradictory goals (e.g. car sharing apps can have a monetary benefit for developers and are in line with governmental concerns about the environment).

Finally, the social and economic benefits of open governmental data from governmental side should be identified before a concrete vision for financial support for opening and promoting the use of open data sets can be targeted.

4.2 Economic

Though the decision to open up available mobility data is in most cases a political decision, the economic impact of the estimated costs, expected revenues and impact on economic sectors and markets can be seen as one of the most important drivers for this decision.

On the cost side, it has to be made very clear that the cost of opening up data is not just about building and providing the open data facility but also relates to the ongoing costs of maintaining the platform (update/refresh the data once it is published). The city of Ghent mentioned that opening their own data was not a big investment, as this data is formatted and stored for internal use anyhow. On the other hand, opening up third party data does present a relatively high investment cost, and the city's opinion is that they will only add extra data to the platform as soon as they have confirmation of a positive business potential. It is clear that government agencies play an important role here: when they select which data to make public, they also prioritize which types of data are most important for business use, and specify the offered formats (see also the technical assessment further down).

On the revenue side, the benefits that can be obtained from business innovations strongly depend on the quality of the data. Different data collectors do not always have the same goals, which often results in a lack of transparency. Sufficient revenue (be it direct monetary revenue for the app developers and hence the local economy, or indirect benefits in the form on better traffic flows and/or less accidents) strongly depends on the uptake of the services and applications developed: if there are not sufficient active users, the investment might not be worth it.

Finally, the business plans and business models for both the open data platform as well as the related services and apps should include a detailed, long-term assessment of growth opportunities and cost and technical uncertainties. As open data platforms only started recently, it is too early to draw solid conclusions about their success.

4.3 Socio-cultural

According to Table 1 and input from reviewing surveys and interviews, social barriers for applications of open data all relate to each other: social attitudes, trust issues, lack of public knowledge about open data and data ownership. Lack of public knowledge causes the issue that data sets require sufficient technical skills, such that only developers can use the free resource in an efficient way. This barrier also

causes trust issues and shapes the social attitude because people may fear violation of their privacy and security by opening up public data. Lack of demand for open data due to limited city size or user group is another issue. By proposing interactive sessions and workshops about the benefits of open data for society, these kind of barriers can be overcome.

The complexity of the public open data nature makes it also challenging to find the available types of data and what could be done with this sort of data. Therefore, some learning programs can be proposed to potential data users to overcome the lack of specific and needed knowledge required to interpret the data. Introducing developers to successful applications using open mobility data can help to expand the demand for mobility data to larger and other communities.

4.4 Technical

Table 1 clearly shows that all cases encountered similar technical barriers, related to data availability, quality, continuity, storage and standardization. First of all, if there is no data collected, the data cannot be made available (availability). Secondly, the data that is opened up should be reliable and complete (quality) and continuously or at least periodically be updated based on new feeds (continuity). The third technical question that needs to be answered is how the data will be handled in terms of location, redundancy, etc. (storage). Finally, although data from different sources is offered on the same platform, it is easiest for developers to be able to base their development code on one specific data format (standardization). Furthermore, open data platform developers should take into account future technological evolutions (e.g. IoT, sensor networks, etc.) and adjust the data platform when needed to potential new sources of data, more accurate or more frequent data, etc. Another option is to limit the amount of data requests to the server (e.g. 300 per minute per app for Transport for London), as not to run into technological barriers.

Although the technical issues presented above are very real, they are in most cases not the limiting factor for deciding on setting up or extending the data platform, the costs related to these technological issues can be seen as insurmountable.

5 Summary and recommendations

The amount of mobility data that is collected by dedicated sensors, roadside equipment and people's smartphones is huge and growing every minute. The debate about the value of these types of data, and the best practices for handling, storing and using them is ongoing on different levels. This paper discusses one specific issue in the debate by analyzing the current and future challenges of *open mobility data.*

By applying the PEST (political, economic, socio-cultural and technical) framework on a number of real-life European open data platforms, this paper identified the most important barriers for opening mobility data.

It is clear that open data can be good for both public and private sectors, what is needed now is an open dialogue between data-holders and data-users. Each data-user (mostly private companies) should be

clear about what data it uses or wants to use, how useful each dataset is, and how data could be improved. This kind of feedback will help the data-holders (mainly governments) to identify the business potential from opening their data, justify the investment and prioritize the most important datasets.

References

[1] Cisco (2015). *Cisco Visual Networking Index: Forecast and Methodology*, 2014–2019. http://www.cisco.com/c/en/us/solutions/collateral/service-provider/ip-ngn-ip-next-generation-network/white_paper_c11-481360.html

[2] Gajda, J., Piwowar, P., Sroka, R., Stencel, M., & Zeglen, T. (2012). Application of inductive loops as wheel detectors. *Transportation Research Part C: Emerging Technologies*, 21(1), 57-66.

[3] Gaur, A., Scotney, B., Parr, G., & McClean, S. (2015). Smart City Architecture and its Applications Based on IoT. *Procedia Computer Science*, 52, 1089-1094.

[4] Koo, D., Piratla, K., & Matthews, C. J. (2015). Towards Sustainable Water Supply: Schematic Development of Big Data Collection Using Internet of Things (IoT). *Procedia Engineering*, 118, 489-497.

[5] Rathore, M. M., Paul, A., Ahmad, A., & Rho, S. (2016). Urban planning and building smart cities based on the internet of things using big data analytics. *Computer Networks*.

[6] Ammari, H. M. (2016). A unified framework for k-coverage and data collection in heterogeneous wireless sensor networks. *Journal of Parallel and Distributed Computing*, 89, 37-49.

[7] *What is Open Data?* http://opendatahandbook.org/guide/en/what-is-open-data/

[8] Jung, K., & Park, H. W. (2015). A semantic (TRIZ) network analysis of South Korea's "Open Public Data" policy. *Government Information Quarterly*, 32(3), 353-358.

[9] Sieber, R. E., & Johnson, P. A. (2015). Civic open data at a crossroads: Dominant models and current challenges. *Government Information Quarterly*, 32(3), 308-315.

[10] Gopinath, G. (2015). Free data and Open Source Concept for Near Real Time Monitoring of Vegetation Health of Northern Kerala, India. *Aquatic Procedia*, 4, 1461-1468.

[11] Davies, T. (2010). Open data, democracy and public sector reform. *Look Open Gov. Data Use Data Gov Uk*.

[12] Polis (2013) The Move towards Open Data in the local transport domain.

[13] Tene, O., & Polonetsky, J. (2012). Big data for all: Privacy and user control in the age of analytics. *Nw. J. Tech. & Intell. Prop.*, 11, xxvii.

[14] *Go Sell Yourself: Adventures on the Open Data Market – C Space*. https://www.cspace.com/blog/go-sell-yourself-adventures-on-the-open-data-market/

[15] *PEST Analysis* https://www.mindtools.com/pages/article/newTMC_09.htm

[16] *SWOT and PEST analysis of Pepsi Co - World leader in convenient snacks.* http://hubpages.com/education/SWOT-and-PEST-analysis-of-Pepsi-Co.

[17] *PESTLE analysis. What is environmental analysis?* http://pestleanalysis.com/what-is-environmental-analysis/

[18] Stott, A. (2014) *Open data for economic growth*.

[19] Transport for London (2016) *Open Data Users*. https://tfl.gov.uk/info-for/open-data-users/

[20] UITP (n.d.) *Opening up transport data in London* http://www.uitp.org/opening-transport-data-london

[21] *ITO World | Data - Communication - Insight*. http://www.itoworld.com/

[22] Placr (2016) *Case Studies | Open Data Institute*. https://theodi.org/case-studies/placr-case-study.

[23] TEKES. *Mobility as a Service*. https://www.tekes.fi/en/programmes-and-services/tekes-programmes/mobility-as-a-service/

[24] UITP (2014) *Open source travel planning*. http://www.uitp.org/open-source-travel-planning

[25] Jäppinen, S., Toivonen, T., & Salonen, M. (2013). Modelling the potential effect of shared bicycles on public transport travel times in Greater Helsinki: An open data approach. *Applied Geography*, 43, 13-24.

[26] *Open Data FWD launch event | European Public Sector Information Platform*. http://www.epsiplatform.eu/content/open-data-fwd-launch-event.

[27] Digital Steden Agenda (2014) *Terugblik: Bijeenkomst Slimme mobiliteit, open data*.

[28] Waag Society. *Open data FWD*. http://waag.org/en/project/open-data-fwd

[29] Belgium (2016) *Open Data in Belgium*. http://www.openknowledge.be/open-data-in-belgium/

[30] Proximus (2015) *Open Data: an ambitious federal strategy* http://www.proximus.be/en/id_b_cl_opendata/large-companies-and-public-sector/discover/blog/customer-stories/open-data.html

[31] Gent (2016) *Open data portal*. https://data.stad.gent/

[32] European Commission and Deloitte (2011) *Pricing Of Public Sector Information Study*.

[33] ODDC. (2014) *Open Data in Developing Countries, Emerging Insights from Phase I.*

[34] *European smart cities*. http://www.smart-cities.eu/

[35] European Commission *European legislation on reuse of public sector information*. https://ec.europa.eu/digital-single-market/en/european-legislation-reuse-public-sector-information

[36] Open data bij de Vlaamse overheid http://overheid.vlaanderen.be/open-data-bij-de-vlaamse-overheid

[37] European Commission. *CORDIS : Projects & Results Service : Periodic Report Summary*

[38] *Data as the new currency* – Dupress.