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Databases: Ebsco, Elsevier, FIRST, Google scholar, IEEE, OECD, Science direct, Springer, Taylor & Francis online, Transport agencies, Transport research centres, TRB, Wiley online,

Search Terms: Big data, Change, Data analytics, Data collection, Data technology, Demand model, Enhanced train crowding model (ETCM), IoT, Modelling, Planning, Predictive data, Public transport, Public transport project model (PTPM), Research, Sydney strategic transport model (STM), Transport, Transport activity base modelling, Transport forecasting.

1. A framework for monitoring the performance of travel demand management and vehicle miles traveled (VMT) reduction activities
Hallenbeck, Mark; Steward, Orion; Moudon, Anne Vernez
This report presents a framework to support performance monitoring for demand management related to VMT reduction. The framework consists of performance monitoring measures and a system for their collection and dissemination. The report also provides the context within which the framework would exist, and describes how it will support a wide variety of other statewide and regional needs, thus providing additional incentive for its adoption. The intent of the Framework is to not only meet the requirements of Washington state's legislative requirement to reduce VMT per capita (RCW 47.01.440), but to do so in a way that provides WSDOT and its partner agencies with information that supports planning and programming. The report also provides an excellent framework for developing and reporting congestion-related performance measures in support of MAP-21. (FIRST) (TRB)
https://www.wsdot.wa.gov/research/reports/fullreports/806.1.pdf

2. A study on benefit estimation that considers the values of travel time and travel time reliability in road networks
Kato, T; Uchida, K
This study proposes a benefit estimation method that considers travel time reliability. The proposed method is based on a network model that is formulated as a utility maximization problem with constraints. Since this utility maximization problem has the same equilibrium conditions as a multi-class user equilibrium traffic assignment problem with elastic demand, both transport demand forecasting and benefit estimation can be carried out in the same framework. By assuming a certain form for the utility function, the road network model can estimate the prohibitive price, so the proposed method is convenient for estimating opportunity loss due to disruption of origin-destination connection in the event of a natural disaster. Furthermore, the values of travel time and travel time reliability are estimated endogenously in the proposed method; thus, changes in these values can be reflected in the benefit estimation. A numerical experiment demonstrates the method presented in this study. (Ebsco)

3. Activity-based travel demand models: a primer
Castiglione, Joe; Bradley, Mark; Gliebe, John
TRB, SHRP 2 report #S2-C46-RR-1, 2015, 181 p.
A Primer explores ways to inform policymakers’ decisions about developing and using activity-based travel demand models to better understand how people plan and schedule their daily travel. The document is
4. Advanced data analytics in transport – machine learning perspective
CSIRO, Data61, 2015
Transport data analysis and modelling are being transformed with the help from machine learning techniques and the Big Data platform. Machine learning techniques make it possible to derive patterns and models from large volume, high dimensional data. The Big Data platform leverages distributed file system and parallel computing to enable fast processing of data. With the two being combined for transport analysis, it is capable of making sense of large real-time traffic data streams as well as supporting large-scale traffic simulation. (Website) https://research.csiro.au/data61/advanced-data-analytics-in-transport-machine-learning-perspective/

5. Advanced public transport and intelligent transport systems: new modelling challenges
Nuzzolo, Agostino; Comi, Antonio
Transit system 'big data' collecting and processing, and bidirectional communication between transit travellers and information centres are emerging as two factors that enhance the tools supporting short-term forecasting of network status for transit operations control and for traveller information. However, the current methodologies applied in these tools do not seem to have reached the level of research in the field of transit network modelling. Therefore, several methodological issues connected to the development of such tools are analysed in this paper. These issues concern application and development of real-time on-board load short-term forecasting methods, real-time best path advice, real-time transit assignment modelling, individual path choice modelling, and real-time updating and upgrading of demand and supply model parameters. (Ebsco)

6. Big data and analytics in travel and transportation : beyond the hype: solutions that deliver

7. Big Data: Issues and Challenges Moving Forward
Kaisler, Stephen; Armour, Frank; Espinosa, Alberto J; Money, William
System Sciences (HICSS), 2013 46th Hawaii International Conference 7-10 Jan. 2013
Big data refers to data volumes in the range of exabytes (1018) and beyond. Such volumes exceed the capacity of current on-line storage systems and processing systems. Data, information, and knowledge are being created and collected at a rate that is rapidly approaching the exabyte/year range. But, its creation and aggregation are accelerating and will approach the zettabyte/year range within a few years. Volume is only one aspect of big data; other attributes are variety, velocity, value, and complexity. Storage and data transport are technology issues, which seem to be solvable in the near-term, but represent long term challenges that require research and new paradigms. We analyze the issues and challenges as we begin a collaborative research program into methodologies for big data analysis and design. (IEEE) http://ieeexplore.ieee.org/abstract/document/6479953/?reload=true

8. Cloud-Based Software Platform for Big Data Analytics in Smart Grids
Simmhan, Yogesh; Aman, Saima; Kumbhare, Alok; Liu, Rongyang; Stevens, Sam; Zhou, Qunzhi; Prasanna, Viktor
This article focuses on a scalable software platform for the Smart Grid cyber-physical system using cloud technologies. Dynamic Demand Response (D2R) is a challenge-application to perform intelligent demand-side management and relieve peak load in Smart Power Grids. The platform offers an adaptive information integration pipeline for ingesting dynamic data; a secure repository for researchers to share knowledge; scalable machine-learning models trained over massive datasets for agile demand forecasting; and a portal for visualizing consumption patterns, and validated at the University of Southern California's campus microgrid. The article examines the role of clouds and their tradeoffs for use in the Smart Grid Cyber-Physical Sagileystem. (IEEE) http://ieeexplore.ieee.org/abstract/document/6475927/

9. Extracting potential bus lines of Customized City Bus Service based on public transport big data
Ren, Yibin; Chen, Ge; Han, Yong; Zheng, Huangcheng
Customized City Bus Service (CCBS) can reduce the traffic congestion and environmental pollution that caused by the increasing in private cars, effectively. This study aims to extract the potential bus lines and each line's passenger density of CCBS by mining the public transport big data. The datasets used in this study are mainly Smart Card Data (SCD) and bus GPS data of Qingdao, China, from October 11th and November 7th 2015. Firstly, we compute the temporal-origin-destination (TOD) of passengers by mining SCD and bus GPS data.

LITERATURE REVIEW
Compared with the traditional OD, TOD not only has the spatial location, but also contains the trip's boarding time. Secondly, based on the traditional DBSCAN algorithm, we put forwards an algorithm, named TOD-DBSCAN, combined with the spatial-temporal features of TOD. TOD-DBSCAN is used to cluster the TOD trajectories in peak hours of all working days. Then, we define two variables P and N to describe the possibility and passenger destiny of a potential CCBS line. P is the probability of the CCBS line. And N represents the potential passenger destiny of the line. Lastly, we visualize the potential CCBS lines extracted by our procedure on the map and analyse relationship between potential CCBS lines and the urban spatial structure. 

10. **Heuristic approach in a multimodal travel planner to support local authorities in urban traffic management**

Sierpiński, Grzegorz; Staniek, Marcin

*Transportation Research Procedia, 2017, Vol. 27, No.1, pp.640-647*

Effective urban traffic management requires knowledge about current situation and tools to transfer information between local authorities and transport systems users. From this point of view, individual user route planning should correspond with general traffic flow management. During recent years significant increase of interest of web-based travel planners was observed. Authors suggest to connect the above issues. For this reason, Green Travelling Planner (GT Planner) was implemented. What the tool allows, among others, is optimum route planning (four optimisation criteria: quicker, shorter, cheaper and greener) using one of the eleven travel modes (including multimodal combinations). It may be used as an official urban multimodal travel planner and can be controlled by local authorities. The heuristic approach which was implemented in GT Planner makes it possible to support urban traffic management by adding specified factors as attributes of links in the graph of transport network. This solution can also be used to optimise the transport systems and public transport planning based on actual travel needs collected as Big Data as GT Planner is used. (Ebsco) 

https://www.toi.no/transport-models/category1261.html

11. **Intersections of transportation and telecommunications**

TRR Transportation research record. 2017, Vol 2658

This issues consists of 7 papers that explore the connection between telecommunications and transportation, including:

- Modeling the Demand for New Transportation Services and Technologies
- Modeling the Impact of Communications Technologies on Travel Behavior and Land Use
- Telecommuting and Its Impact on Activity–Time Use Patterns of Dual-Earner Households
- Conceptual Models of the Effect of Information and Communications Technology on Long-Distance Travel Demand
- Framework for Real-Time Traffic Management with Case Studies
- Telecommunications- and Information Technology—Inspired Analyses: Review of an Intelligent Transportation Systems Experience
- Real-Time Riders: A First Look at User Interaction Data from the Back End of a Transit and Shared Mobility Smartphone App

http://trrjournalonline.trb.org/toc/trr/2658/

12. **Leveraging Big Data for the Development of Transport Sustainability Indicators**

Cottrill, Caitlin D; Derrible, Sybil

*Journal of Urban Technology, 2015, Vol. 22, No. 1, pp. 45-64*

While increasing transportation sustainability is an ongoing effort, measuring the results of these efforts is not a trivial task. Not only is indicator selection challenging, but efforts made to design useful indicators are often hampered by the presence of erroneous or incomplete data. Nevertheless, in this era of Big Data, the significant penetration of new technologies such as smartphones and smart infrastructure could hold the key to developing more relevant and comprehensive indicators. Here, we recall commonly used indicators and discuss the limitations of the data upon which they are built. We then describe several new technologies that hold promise for collection of more pertinent and accurate data sets for indicator development. Finally, we illustrate potential benefits and concerns of these approaches via discussion of possible indicator development from a one-day GPS trace. While the first and obvious application of new technologies will be to improve much needed accuracy, successfully combining different sources together could hold much potential from model calibration to real-time operations. (Taylor & Francis online) 

http://www.tandfonline.com/doi/abs/10.1080/10630732.2014.942094

13. **Modeling the Demand for New Transportation Services and Technologies**

Miller, Eric J

TRR Transportation research record. 2017, Vol. 2658, No. 1, pp.1-7

This paper briefly discusses the current state of the art of urban travel demand modeling and research needs in the field. Special emphasis is given to both the challenges and the opportunities posed by modern information technology and the data, transportation services, and travel behaviors that this technology is generating. Travel
demand modeling has made very significant strides over the past 20 years, especially in the development of operational activity- and tour-based regional travel demand forecasting systems. These model systems represent first-generation agent-based microsimulation models. Considerable need, opportunity, and scope exist for the development of significantly more powerful second-generation agent-based microsimulation models that build upon emerging big data sets (among other information sources) and high-performance computing. This task, however, will involve the development of new behavioral representations and computational algorithms implemented within much more flexible software environments that both fully exploit available computing power and enable flexible experimentation with and extension of representations of new transportation modes and services and evolving travel behavior. (TRB) http://trrjournalonline.trb.org/doi/pdf/10.3141/2658-01

14. **Modelling of technological options for Melbourne's transport system**
Johnson, Bruce; Pike, Lucy; Cox, Andrew
2017 AITM National Traffic and Transport Conference, August 15-18 – Melbourne Convention and Exhibition Centre) Australian Institute of Traffic Planning and Management, Arup
The paper summarises key issues relating to transport modelling of new technology, in particular Advanced Traffic Management (ATM) and Autonomous Vehicles (AVs). These technologies, in parallel with new paradigms of mobility services and broader demand management policies, could profoundly change the use and performance of future transport systems. The paper references the authors' work on behalf of Infrastructure Victoria to inform option assessment of policy reforms and infrastructure projects to prepare Victoria's 30-year Infrastructure Strategy. Strategic transport modelling included preliminary assessment of ATM, AVs, and road pricing alongside traditional major transport infrastructure projects, enabling a direct comparison of the respective impacts on a Melbourne wide scale. The AV and ATM scenarios investigated had significant implications for network performance. The paper highlights issues and limitations of current modelling processes inherent with strategic transport models, with particular reference to the Victorian Integrated Transport Model (VITM), in the context of testing impacts of new technologies. This sets the context for how the VITM was able to be used to develop scenarios and compare performance of new and traditional options. The paper identifies suggested areas for ongoing improvement of transport modelling approaches and for dealing with the inherent uncertainty of emerging technology on transport systems and travel behaviour. (Google scholar)

Gentile, Guido, Noekel, Klaus (Eds.)
Compares results of different methods using the same sample transport network, facilitating the comparison of their advantages and disadvantages. This book shows how transit assignment models can be used to describe and predict the patterns of network patronage in public transport systems. It provides a fundamental technical tool that can be employed in the process of designing, implementing and evaluating measures and/or policies to improve the current state of transport systems within given financial, technical and social constraints. The book offers a unique methodological contribution to the field of transit assignment because, moving beyond "traditional" models, it describes more evolved variants that can reproduce:• intermodal networks with high- and low-frequency services;• realistic behavioural hypotheses underpinning route choice;• time dependency in frequency-based models; and• assumptions about the knowledge that users have of network conditions that are consistent with the present and future level of information that intelligent transport systems (ITS) can provide. The book also considers the practical perspective of practitioners and public transport operators who need to model and manage transit systems; for example, the role of ITS is explained with regard to their potential in data collection for modelling purposes and validation techniques, as well as with regard to the additional data on network patronage and passengers' preferences that influences the network-management and control strategies implemented. In addition, it explains how the different aspects of network operations can be incorporated in traditional models and identifies the advantages and disadvantages of doing so. Lastly, the book provides practical information on state-of-the-art implementations of the different models and the commercial packages that are currently available for transit modelling. Showcasing original work done under the aegis of the COST Action TU1004 (TransITs), the book provides a broad readership, ranging from Master and PhD students to researchers and from policy makers to practitioners, with a comprehensive tool for understanding transit assignment models. (Springer) http://www.springer.com/gp/book/9783319250809

16. **New services, new travelers, old models? Directions to pioneer public transport models in the era of big data**
Fonzone, Achille; Schmöcker, Jan-Dirk; Viti, Francesco
Public transport in the era of big data. The ubiquitous availability of information is arguably the distinctive feature of the 21st-century developed world. The organization of flows affects our lives increasingly more than the organization of spaces. However, even in the digital era, not everything is digital. Therefore, high-quality
transportation systems are still a crucial asset for our contemporary network society. Information and communication technology (ICT) is radically changing our concept of mobility, causing a shift from the regime of the automobiles to the regime of multimobilities, where travelers can easily swap between physical and virtual mobility and traveling is not alternative to doing something else. The traditional "system-based" demand, in which travelers buy tickets for specific means of transport, progressively gives way to a new "service-based" demand, where travelers purchase bundles of mobility services defined by different levels of waiting time, reliability, comfort, and price. Private cars become less important. Millennials, the prevailing cohort of travelers in the not-so-distant futures, like public transport because it offers opportunities for digital socialization and work. Besides more reliability, they ask for user-friendly real-time information and provision of WiFi. Sharing information, as well as sharing resources, seems to be the characteristic of the future mobility. As a consequence, the definition of "public" transport is also collected by such systems, initially used only to increase the efficiency of management and operations, has become the raw material to generate information for the passengers. In the United States, almost half of the large agencies disseminate real-time information on service arrival through their own website, and one-third through an app and/or Google Transit. Real-time information, possibly elaborated by journey planners, makes the systems more visible to passengers and thus, if the supply system is sufficiently complex, it widens the user choice sets. The capillary dissemination enabled by the pervasive diffusion of smartphones and WiFi technology has crucially increased the potential impact of RTI. Smartphones have also transformed the role of passengers: Similar to what is happening in the public transport industry where travelers are no longer only consumers but also providers of mobility, nowadays passengers have become passive (through their global positioning systems [GPS], Bluetooth, and WiFi footprints) and active (through their interactions via new social media and networks, such as blogs, Twitter, Facebook; or through apps like Citymapper) system sensors. However, the information shared by passengers is often unstructured and not complete, and this reduces the value to operators and passengers. Big data and the Internet-of-Things (IoT) are destined to revolutionize the way public transport will be able to adapt to passengers’ mobility needs, and will optimize transit planning, scheduling, and operations. Consideration of the possibilities generated by ubiquitous real-time information and the more detailed description of the system components provided by big data calls for a new generation of public transport models. Collecting and promoting advances in models to predict passenger flows in the era of big data was one of the aims of the COST Action TU1004 “Modelling Public Transport Passenger Flows in the Era of ITS." The COST Action has recently published a book with a chapter concerning the use of new data. However, we soon realized that passenger flow models are still far from capturing the characteristics of the new public transport systems with the level of sophistication enabled by big data. The call for papers of this special issue was an attempt to nudge the academia in this sense. (Taylor & Francis)

17. Predicting Short-Term Public Transport Demand via Inhomogeneous Poisson Processes
Conference: the 2017 ACM
Menon, Aditya Krishna; Lee, Young
Forecasting short term passenger demand for public transport is a core problem in urban mobility. Typically, this is addressed using Poisson regression or homogeneous Poisson processes. However, such approaches have several limitations, including susceptibility to noise at fine time granularities, and the inability to capture complex non-stationary trends. In this paper, we show how such short term demand can be accurately modelled with an inhomogeneous Poisson process, using a neural network as the underlying intensity. This choice of intensity subsumes existing models as special cases, and is powerful enough to capture certain stylised facts of real-world demand. Experiments on real-world bus arrival data from a large metropolitan area in Australia validate our approach. (Researchgate)

18. Reimagining Transportation the IoT Way
TATA consultancy services
In an increasingly competitive business environment and with sharply rising demands for passenger and cargo mobility, the global transportation industry is going through a challenging time. Industry players need to look for innovative ways to improve operational efficiencies, contain costs, and retain market share, while nurturing customer delight. The Internet of Things (IoT) holds great promise in the transportation industry, and can help pave the way for a 'smart' future. While connected ecosystems will help counter industry challenges, stakeholder expectation management will be the key to ensuring success in the longer term.

19. Special issue on public transport modelling
Gentile, Guido; Cats, Oded (editors)
Euro journal on Public transport modelling, 2017, Vol. 6 No. 3 pp. 219 - 288
In this issue (4 articles)
Introduction to the special issue on public transport modelling. (Guido Gentile, Oded Cats, pp. 219-220)
Multimodal route choice models of public transport passengers in the Greater Copenhagen Area. (Marie Karen Anderson, Otto Anker Nielse. Pp.221-245)


20. The fourth wave of digitization and public transport

Davidsson, P
We investigate the opportunities and challenges of the forth wave of digitalization, also referred to as the Internet of Things (IoT), with respect to public transport and how it can support sustainable development of society. Environmental, economical, and social perspectives are considered through analysis of the existing literature and explorative studies. We conclude that there are great opportunities for both transport operators and planners, as well as for the travelers. We describe and analyze a number of concrete opportunities for each of these actors. However, in order to realize these opportunities, there are also a number of challenges that needs to be addressed. There are both technical challenges, such as data collection issues, interoperability, scalability and information security, and non-technical challenges such as business models, usability, privacy issues, and deployment. (Google scholar)

21. The ITF Modelling Framework

International transport forum, OECD, 2018
The International Transport Forum has developed a set of modelling tools to build its own forward-looking scenarios of transport activity. Covering all modes of transport, freight and passenger, the tools are unified under a single framework. In contrast to existing transport and energy models, the ITF framework first estimates the demand for transport, based on a set of socio-economic drivers (population, Gross Domestic Product, trade, etc.) before analysing the way this demand may be satisfied. This second step includes a detailed modelling of mode choice. Finally, the models compute the CO2 emissions linked to transport and, depending on the sector, other transport-related variables. For instance, the urban module estimates emissions of local pollutants; the international freight model is able to assess congestion at ports. The ITF framework can assess the effect of a large range of policies and exogenous impacts. In all models, policies which may impact transport demand or the related CO2 emissions become input parameters. Particular attention was paid to urban policies, such as transit infrastructure provision, parking or land-use strategies, and to their impact on mode shares. 


22. The path most traveled: Travel demand estimation using big data resources

Toole, Jameson L; Colak, Serdar; Sturt, Bradley; Alexander, Lauren P; Evsukoff, Alexandre; González, Marta C
Rapid urbanization is placing increasing stress on already burdened transportation infrastructure. Ubiquitous mobile computing and the massive data it generates presents new opportunities to measure the demand for this infrastructure, diagnose problems, and plan for the future. However, before these benefits can be realized, methods and models must be updated to integrate these new data sources into existing urban and transportation planning frameworks for estimating travel demand and infrastructure usage. While recent work has made great progress extracting valid and useful measurements from new data resources, few present end-to-end solutions that transform and integrate raw, massive data into estimates of travel demand and infrastructure performance. Here we present a flexible, modular, and computationally efficient software system to fill this gap. Our system estimates multiple aspects of travel demand using call detail records (CDRs) from mobile phones in conjunction with open- and crowdsourced geospatial data, census records, and surveys. We bring together numerous existing and new algorithms to generate representative origin–destination matrices, route trips through road networks constructed using open and crowd-sourced data repositories, and perform analytics on the system’s output. We also present an online, interactive visualization platform to communicate these results to researchers, policy makers, and the public. We demonstrate the flexibility of this system by performing analyses on multiple cities around the globe. We hope this work will serve as unified and comprehensive guide to integrating new big data resources into customary transportation demand modeling. (Elsevier)


23. The role of big data in smart city

Hashem, Ibrahim Abaker Targio; Chang, Victor; Anuar, Nor Badrul; Adewole, Kayode; Yaqoob, Ibrar; Gani, Abdullah; Ahmed, Ejaz; Chiroma, Haruna
The expansion of big data and the evolution of Internet of Things (IoT) technologies have played an important role in the feasibility of smart city initiatives. Big data offer the potential for cities to obtain valuable insights from a large amount of data collected through various sources, and the IoT allows the integration of sensors, radio-
frequency identification, and Bluetooth in the real-world environment using highly networked services. The combination of the IoT and big data is an unexplored research area that has brought new and interesting challenges for achieving the goal of future smart cities. These new challenges focus primarily on problems related to business and technology that enable cities to actualize the vision, principles, and requirements of the applications of smart cities by realizing the main smart environment characteristics. In this paper, we describe the state-of-the-art communication technologies and smart-based applications used within the context of smart cities. The visions of big data analytics to support smart cities are discussed by focusing on how big data can fundamentally change urban populations at different levels. Moreover, a future business model of big data for smart cities is proposed, and the business and technological research challenges are identified. This study can serve as a benchmark for researchers and industries for the future progress and development of smart cities in the context of big data. (Elsevier) 

https://ac.els-cdn.com/S0268401216302778/1-s2.0-S0268401216302778-main.pdf?_tid=54e2d190-0626-11e8-be86-00000aacb360&acdnat=1517362414_6567c2d765c26fa30e56e5f6f9153361

24. Transport modelling review – final report
Talpin, John; Taylor, Michael; Biermann, Sharon
Planning and Transport Research Centre (PATREC), 2014, 131 p.
This Transport Modelling Review Report examines the transport modelling practices in Perth, Western Australia and benchmarks them against best practice in Australia and overseas. It offers a framework for the evaluation of modelling approaches, a comparison of the two current transport models STEM and ROM24 and other practical approaches around the world, analyses three possible options for model development in WA, and suggests a pathway for a new best practice approach. (Google scholar) 

25. Transport Models
The transport model group (Institute of Transport Economics, Norwegian Centre for Transport Research)
Use of transport models is an important element in all transport planning and central when calculating the effects of various measures. The Transport model group covers theoretical and practical development of new and existing transport models for passenger and freight transport, and the use of the models in specific analyzes. The group contributes to the improvement of the transport authorities' model system, consisting of The National passenger transport model (NTM6), The Regional passenger model (RTM) and The National freight transport model. We also develop new types of models, including a new market potential model for RUTER (MPM) and an activity-based model for Trondheim.

26. Urban planning and building smart cities based on the Internet of Things using Big Data analytics
Rathore, M. Mazhar; Ahmad, Awais; Paul, Anand; Rho, Seungmin
The rapid growth in the population density in urban cities demands that services and an infrastructure be provided to meet the needs of city inhabitants. Thus, there has been an increase in the request for embedded devices, such as sensors, actuators, and smartphones, leading to considerable business potential for the new era of the Internet of Things (IoT), in which all devices are capable of interconnecting and communicating with each other over the Internet. Thus, Internet technologies provide a way of integrating and sharing a common communication medium. With this knowledge, in this paper, we propose a combined IoT-based system for smart city development and urban planning using Big Data analytics. We propose a complete system consisting of various types of sensor deployment, including smart home sensors, vehicular networking, weather and water sensors, smart parking sensors, and surveillance objects. A four-tier architecture is proposed that includes 1) Bottom tier-1, which is responsible for IoT sources and data generation and collection, 2) Intermediate tier-1, which is responsible for all types of communication between, for instance, sensors, relays, base stations, and the Internet, 3) Intermediate tier 2, which is responsible for data management and processing using a Hadoop framework, and 4) Top tier, which is responsible for application and usage of the data analysis and the results generated. The system implementation consists of various steps that begin with data generation and move to collection, aggregation, filtration, classification, preprocessing, computing and decision making. The proposed system is implemented using Hadoop with Spark, voltDB, Storm or S4 for real time processing of the IoT data to generate results to establish the smart city. For urban planning or city future development, the offline historical data are analyzed with Hadoop using MapReduce programming. IoT datasets generated by smart homes, smart parking weather, pollution, and vehicle data sets are used for analysis and evaluation. This type of system with full functionality does not currently exist. Similarly, the results demonstrate that the proposed system is more scalable and efficient than existing systems. Moreover, system efficiency is measured in terms of throughput and processing time. (Google Scholar)

27. Using smart card and GPS data for policy and planning: The case of Transantiago
Gschwendner, Antonio; Munizaga, Marcela; Simonetti, Carolina
The introduction in 2007 of a new public transport system in Santiago, Chile, brought to us an unexpected gift: the availability of Big Data; massive amounts of passive data obtained from technological devices installed to control the operation of buses and to administer the fare collection process. Many other cities in the world have experienced the same, and sooner or later, this is likely to happen everywhere. Seeing this opportunity, many researchers have developed tools to obtain valuable information from the available data. However, the case of Transantiago is particularly advantageous because all buses have GPS devices and the smart card presents an overall 97% penetration rate. (Ebsco)