Urban Pathways

Factsheet

Big Data for Mobility Planning

Wuppertal Institut

UN HABITAT
FOR A BETTER URBAN FUTURE

UN environment

Authors/Contributors:
Judith Owigar (UN-Habitat)

Editor: Oliver Lah (UEMI)

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The graphic design was prepared by Barbara Lah
(UEMI)

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Author
Editor

Urban Pathways Secretariat

team@urban-pathways.org

Oliver Lah
Coordinator
+49 (0)30 2887458-16
oliver.lah@urban-pathways.org

Urban Pathways

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The Urban Pathways project helps delivering on the Paris Agreement and the NDCs in the context of the New Urban Agenda and the Sustainable Development Goals. It has established a facility in close cooperation with other organisations and networks active in this area to support national and local governments to develop action plans and concrete implementation measures to boost low-carbon urban development. This builds on UN-Habitat's role as "a focal point on sustainable urbanisation and human settlements including in the implementation and follow-up and review of the New Urban Agenda". The project develops national action plans and local implementation concepts in key emerging economies with a high mitigation potential. The local implementation concepts are being developed into bankable projects, focusing on the access to urban basic services to create a direct link between climate change mitigation and sustainable development goals.

Project concept

The project follows a structured approach to boost Low Carbon Plans for urban mobility, energy and waste management services that deliver on the Paris Agreement and the New Urban Agenda. The project works on concrete steps towards a maximum impact with regards to the contribution of urban basic services (mobility, energy and waste management) in cities to global climate change mitigation efforts and sustainable and inclusive urban development. This project makes an active contribution to achieve global climate change targets to a 1.5°C stabilisation pathway by unlocking the global emission reduction potential of urban energy, transport and resource sectors. The project will contribute to a direct emission reduction in the pilot and outreach countries, which will trigger a longer term emission reduction with the aim to replicate this regionally and globally to make a substantial contribution to the overall emission reduction potential.

Project aims

This project implements integrated urban services solutions as proposed in the New Urban Agenda providing access to jobs and public services in urban areas, contributing to equality and social coherence and deliver on the Paris Agreement and the Sustainable Development Goals. This is the first dedicated implementation action oriented project, led by UN-Habitat to deliver on inclusive, low-carbon urban services. Securing sustainability and multiplier effect, the project aims to leverage domestic and international funding for the implementation projects that will follow from this initiative.

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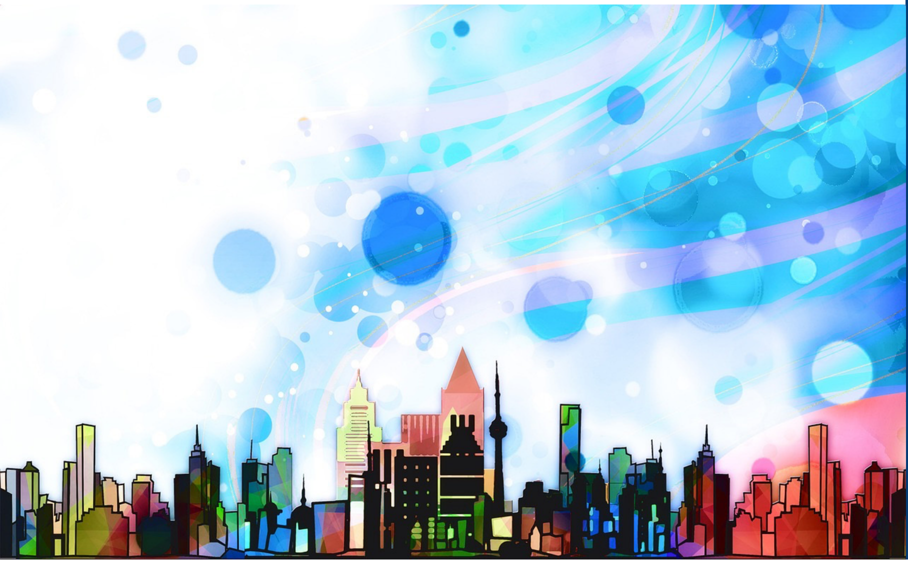


Introduction

Data is being generated from multiple sources resulting in the formation of what is currently known as big data. Data sources are around us everywhere, smartphones, computers, environmental sensors, cameras, Geographical Positioning Systems (GPS), and even people. Various applications like social media sites, digital pictures and videos, commercial transactions, advertising applications, games, mobile phone activities, location-based positioning information, online activities and many more have helped accelerate data generation in the past few years.

As digitization has become an integral part of everyday life, data collection has resulted in the accumulation of huge amounts of data- big data- that can be used in various beneficial application domains.The analysis of Big Data, could provide considerable insight and opportunities for addressing societal challenges from health to security to transport. Yet, its full potential remains untapped, particularly in public sector decision-making. Effective analysis and utilization of big data is now a key factor for success in government, business and service domains.

Strategic mobility planning in cities can benefit from such information, and often real-time cross-thematic, data collection, processing, integration and sharing through inter-operable services. However, such information utilisation requires appropriate software tools, services and technologies to collect, store, analyse and visualise large amounts of data from the city environment, citizens and various departments and agencies at city scale.

Uses of Big Data in Mobility Planning

Big data analytics can be used to achieve the objectives of sustainable mobility planning[1] which include:
- Ensure all citizens are offered transport options that enable access to key destinations and services;

- Improve safety and security;

- Reduce air and noise pollution, greenhouse gas emissions and energy consumption;

- Improve the efficiency and cost-effectiveness of the transportation of persons and goods;

- Contribute to enhancing the attractiveness and quality of the urban environment and urban design for the benefits of citizens, the economy and society as a whole.

1 http://www.eltis.org/guidelines/what-sustainable-urban-mobility-plan

Access to Key Destinations and Services

Accurate and timely traffic flow information is important for the successful deployment of intelligent transportation systems. An intelligent transportation system (ITS)[2] is an advanced application which, without embodying intelligence as such, aims to provide innovative services relating to different modes of transport and traffic management and enable users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.

Intelligent transport systems vary in technologies applied, from basic management systems such as car navigation; traffic signal control systems; container management systems; variable message signs; automatic number plate recognition or speed cameras to monitor applications, such as security CCTV systems; and to more advanced applications that integrate live data and feedback from a number of other sources, such as parking guidance and information systems; weather information; bridge deicing systems; and the like. Additionally, predictive techniques are being developed to allow advanced modelling and comparison with historical baseline data.

Accurate and timely traffic flow information is currently strongly needed for individual travelers, business sectors, and government agencies[3] . It has the potential to help road users make better travel decisions, alleviate traffic congestion, reduce carbon emissions, and improve traffic operation efficiency.

Data Collection Methods

Floating Cellular Data

This method uses cellular network data (CDMA, GSM, UMTS, GPRS) to collect localized data, speed, direction of travel and time information from mobile phones in vehicles that are being driven. Every switched-on mobile phone becomes a traffic probe and is as such an anonymous source of information. In contrast to traffic cameras, number plate recognition systems, and induction loops embedded in the roadway, no additional hardware on the road network is necessary.

Sensing Technologies

Sensing systems for ITS are vehicle-based and infrastructure-based networked systems. Infrastructure sensors are devices that are installed or embedded in the road or surrounding the road (e.g., on buildings, posts, and signs), as required, and may be manually disseminated during preventive road construction maintenance or by sensor injection machinery for

2 https://en.wikipedia.org/wiki/Intelligent_transportation_system

3 https://ieeexplore.ieee.org/document/4747604

rapid deployment. Vehicle-sensing systems include deployment of infrastructure-to-vehicle and vehicle-to-infrastructure electronic beacons for identification communications and may also employ video automatic number plate recognition or vehicle magnetic signature detection technologies at desired intervals to increase sustained monitoring of vehicles operating in critical zones.

Inductive loop detection
Inductive loops can be placed in a roadbed to detect vehicles as they pass through the loop's magnetic field. The simplest detectors simply count the number of vehicles during a unit of time that pass over the loop, while more sophisticated sensors estimate the speed, length, and class of vehicles and the distance between them.

Video vehicle detection
Traffic-flow measurement and automatic incident detection using video cameras is another form of vehicle detection.Video from cameras is fed into processors that analyse the changing characteristics of the video image as vehicles pass. The cameras are typically mounted on poles or structures above or adjacent to the roadway.

Bluetooth detection
Bluetooth devices in passing vehicles are detected by sensing devices along the road. If these sensors are interconnected they are able to calculate travel time and provide data for origin and destination matrices.

Smart Transport Applications[1]

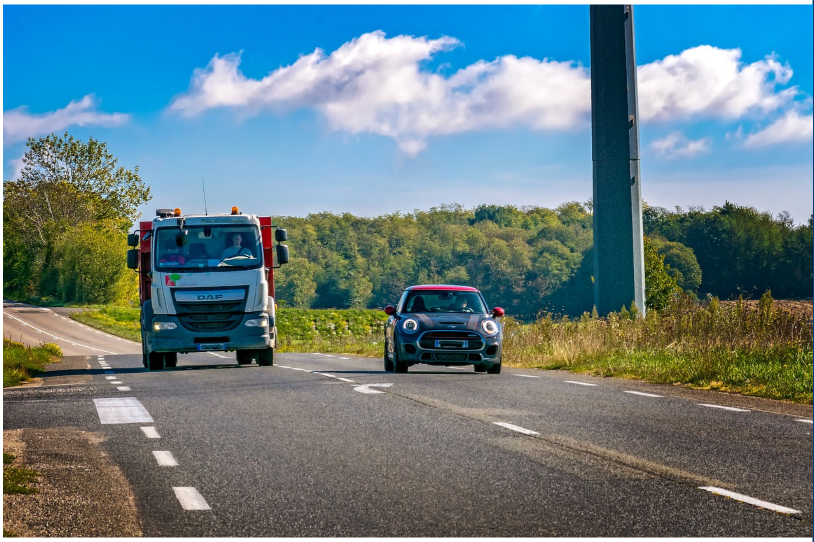
1. Recognize traffic patterns by investigating real time data
2. Reduce main city roads' congestion by predicting traffic conditions and adjusting traffic controls. Through big data, the smart city will be able to reduce traffic and accidents by opening new roads, enhancing the infrastructure based on congestion data, and collecting information on car parking and alternative roads.
3. Reduce supply chain waste by associating deliveries and optimizing shipping movements.
4. Enable data streaming to process and communicate traffic information collected through sensors, smart traffic lights and on-vehicle devices to drivers via smartphones or other communication devices.
5. Big data can be used to send feedback for specific entities to take action to alleviate or resolve a traffic problem.

1 https://jisajournal.springeropen.com/articles/10.1186/s13174-015-0041-5

Safety and Security

Road crashes kill about 1.3 million people worldwide every year and severely injure an estimated 50 million. Out of ten lives lost in traffic, nine are lost in low- and middle- income countries. But the number of road deaths is on the rise again even in some countries with impressive road safety improvements. The increasing share of vulnerable road users such as seniors, pedestrian, cyclists and motorcyclists that become victims of road traffic raises particular concerns. Reliable data on traffic crashes is crucial for effective action on road safety. Without hard facts about the scale of the problem, the exposure to crash risks and the effectiveness of policies the problems cannot be addressed at the core. Collection and analysis of data helps in understanding trends and shaping better road safety policies[4] .

The visibility of the tragedy on the world's roads and the sense of urgency to achieve significant reductions in the number of road deaths globally has been much strengthened by inclusion of road safety targets in the UN Sustainable Development Goals (SDGs). SDG 3.2 aspires to reduce global road traffic deaths and injuries by 50% by the year 2020, compared to their 2010 levels. SDG 11.2 calls to "provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons" by 2030.



4 http://www.sipotra.it/wp-content/uploads/2017/10/Road-Safety-Annual-Report-2017.pdf

Big Data applications in Safety and Security[1]

Analysis of the reasons for existing road safety performance with a view to adapt road safety policies. This data can be used to monitor trends of the increase or decrease in the number of road fatalities. Through the analysis of comprehensive fatality data can be used to guide policy decisions and implement corrective measures and use the data for trend forecasting.

Strengthen efforts to improve the road safety data available for low- and middle income countries. Reliable and timely road safety data are essential components of sound road safety policies. Most high-income countries have functioning crash data collection systems. Huge efforts are needed in most low- and middle-income countries to ensure a minimum set of data is collected to allow a robust diagnosis of the respective road safety situation.

Support efforts to collect more accurate data on serious injuries from road crashes. Road safety data collection and analysis should not be limited to fatality data. Around 50 million people are seriously injured in the world every year, but reliable data on serious injuries are very scarce even in the best performing countries. To seriously address the human suffering and economic loss associated with the current levels of serious injury from road crashes, all countries need to improve their collection and analysis of serious injury data.

Air Pollution Monitoring[2]

Urban air pollution from road transport is a growing concern in a large number of developing country cities. With rising income, the use of motorized transport is expected to continue to increase in the coming years and this contributes to potentially worsening air quality. Poor air quality in turn has been shown to have seriously adverse effects on public health. The World Health Organization estimated that 650,000 people died prematurely from urban air pollution in developing countries in 2000.

Data on traffic related pollutants is needed to measure and monitor their impact on cities. The management of air quality requires the identification of small-scale pockets of air pollutants in an area. Access to detailed comparisons in air quality variations encountered when commuting through a city offers the urban traveller more informed choice on how to minimise personal exposure to inhalable pollutants.

1 http://www.sipotra.it/wp-content/uploads/2017/10/Road-Safety-Annual-Report-2017.pdf page 10
2 http://www.esmap.org/sites/default/files/esmap-files/urban%20pollution%20entire%20report.pdf

Data collection for Air Quality Monitoring

Highly accurate monitors, also known as reference monitors, used by many countries for regulatory purposes, can cost upwards of US$100,000 to purchase and are expensive to routinely maintain. This places them out of the reach of most low and middle income countries. In the United States, air quality has traditionally been measured according to a metric established by the United States Environmental Protection Agency (USEPA) using equipment that implement a federal reference method (FRM) or federal equivalent method (FEM). These devices cost tens of thousands of dollars and require significant infrastructure and trained personnel to operate [1].

Within the last ten years, miniaturization and other technological advances have brought to market a number of low-cost (<$3000) sensors designed to measure atmospheric particles and gases. Although sensors cannot replace traditional reference monitors, these sensors have created new opportunities for broadening access to ambient air quality monitoring and can fill in the gaps in the understanding of air pollution for developing countries where few high-quality instruments exist.

Uses of Big data on Air Quality Monitoring

Many countries use raw data to develop an air quality index (Good, Moderate, Bad, Very Bad) that gives the public an intuitive understanding of the air they breathe and allows them to issue warnings when the air quality is very bad and to provide recommendations about what people can do (for example, not to exercise outdoors)[5] .

In addition to informing the public, these extensive air quality observation data can also be used for policy purposes such as to determine the status and trends of air quality in each respective city and identify non-attainment cities. This detailed data can be used by researchers and policy makers to investigate the impact of different forms of mobility and industries on cities' air quality and how this contributes to environment and health indicators.

Air Quality monitoring over long periods can be used to ensure pollutant concentrations remain below levels that are considered safe for human exposure and consistently assess how pollutant concentrations compare with government air quality standards (or develop government air quality standards if none exist).

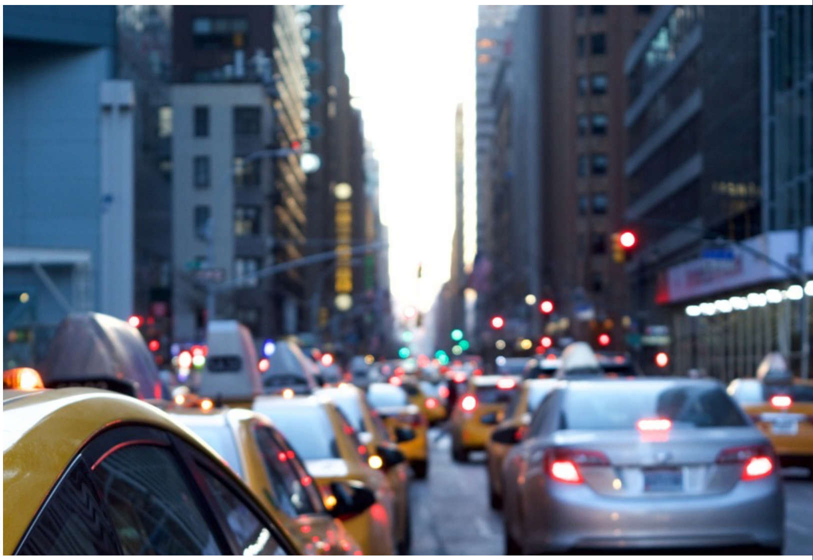
5 https://www.theelephant.info/features/2018/07/05/every-breath-you-take-who-is-monitoring-air-quality-in-kenya/

Noise Pollution Monitoring

According to the World Health Organisation (WHO), noise is second only to air pollution in the impact it has on health. It is a major cause, not only of hearing loss, but also of heart disease, learning problems in children and sleep disturbance. Yet traffic noise could easily be halved, with existing technology, if more stringent limits were adopted. Traffic noise is dependent on a number of issues: traffic volume, traffic speed, vehicle content, road surface and surrounding area. Documenting and measuring traffic noise levels over defined time periods can be used to develop and evaluate abatement and noise control plans.

According to a CE Delft study on Traffic Noise Reduction in Europe (2007)[6] at present, some 210 million Europeans are regularly exposed to road traffic noise levels exceeding 55 decibels and 35 million are exposed to similar levels of rail noise, according to recent studies. Around 50,000 people in the European Union die prematurely each year from heart attacks caused by traffic noise. An additional almost 200,000 suffer from all types of cardiovascular disease linked to traffic noise. For people living in streets with average noise levels above 65-70dB(A), the average risk of heart disease is 20% higher than for people living in quieter streets. And while perceptions of noise problems can get better as people feel they are getting used to them, noise-related cardiovascular problems show no signs of improving with time.

Policy makers in can act on the impact of traffic noise pollution by develop policies that mitigate the effects of traffic noise pollution. This will call for countries and cities to measure the effects of their policies on the public by ensuring they have baseline data that acts a reference point that they measure their data against.



6 https://www.transportenvironment.org/what-we-do/vehicle-noise/what-science-says

Energy Consumption

Global energy requirements are continuously increasing. Conventional methods of producing more energy to meet this growth pose a great threat to the environment. CO_2 emissions and other bi-products of energy production and distribution processes have dire consequences for the environment. Efficient use of energy is one of the main tools to restrain energy consumption growth without compromising on the user requirements[7] .

Automated, connected, electric and/or shared vehicles have the opportunity to reduce energy consumption in transportation by harnessing connected and automated technologies to enable ride sharing, drive smoothing, and vehicle resizing. Conversely they could also increase energy consumption by increasing easier travel and accessibility.

Energy efficiency can help to curtail production of energy to meet growth in demand. To achieve this we need to understand and improve the energy efficiency at both producer and consumer ends. ICT enabled smart energy grids and devices are being installed globally to measure energy consumption and improve energy efficiency. These smart devices produce large volumes of data. The data generated by different devices is in different formats.

For the purpose of knowledge discovery, this data needs to be collected, stored and analysed. The extracted insights from the analysis need to be visualised for easy and effective understanding. The challenge gets even tougher when data needs to be collected and analysed in real time. Then with the time, volume of data and scope of analysis is expected to increase. In order to respond to the above mentioned challenges, a highly scalable and flexible data analysis platform is required that can automate the whole process.

The use of pervasive ubiquitous computing is driving the smart energy solutions. The smart energy devices as part of this ecosystem generate high volumes of data. This data needs to be instantaneously transferred, stored, analysed and visualised for knowledge discovery and improvements of services.

There is also a new emerging research area that will examine how electric vehicles, renewable energy, and smart building energy management systems might be more closely coordinated to reduce energy costs and emissions, with the ultimate goal of making buildings

7 https://aaltodoc.aalto.fi/bitstream/handle/123456789/13899/master_Ahmed_Hussnain_2014.pdf?sequence=1&isAllowed=y

energy neutral. The term ‘vehicle-to-grid’, or V2G, is not new. The idea of using car batteries as a source of power in grid services has been seen as attractive for several years, not only because of the growing lithium-ion capacity tied up in EVs, but also because much of that energy is not being used a great deal of the time[8].

Efficiency and Cost effectiveness of transport

It has been widely commented that big data will make public transport more efficient and effective. Data plays a crucial role as it allows cities and transportation providers to precisely analyze how things work today and where opportunities for greater convenience lie[9] . With the availability of large amounts of data cities and policy makers can measure the impact of specific improvements such as highways or a transit service in relation to specific objectives. This objectives could range from air pollution reduction, creation of new jobs, or improving mobility for physically, economically and socially disadvantaged people.

Quality of the urban environment

The opportunities an urban environment offers to its residents constitute a major concern in urban planning. An important aspect of spatial opportunities is the accessibility of locations, which is generally defined as the relative ease by which the locations of activities, for example working, shopping, recreation and other service-based activities, can be reached from a given location. Originally, measures of accessibility have been based on average distance or travel time to conduct a particular activity. GIS are ideally suited to spatially represent individual activity patterns and calculate attributes of routes and locations involved in these patterns by means of buffer analysis and overlay analysis combining several layers of attribute data[10] .

Data on measuring the quality of the urban environment varies from case to case depending on the need of the policy makers or the project owner. Ultimately

8 https://internetofbusiness.com/smart-energy-why-vehicle-to-grid-technology-is-on-the-move/
9 https://www.techrepublic.com/article/big-data-will-make-public-transportation-more-efficient-and-effective/
10 https://link.springer.com/article/10.1007/s12061-009-9024-x

such an exercise calls for collecting large amounts of data from cities and applying a technology tool that can analyse this data in order examine the state of populated areas in detail and to reveal weak areas that need to be addressed.

Examples of Implementations of Big Data in Mobility

Mobike, a bike sharing service based in China, makes use of the 30 terabytes of data generated via their smart lock technology. The Mobike 'Magic Cube' artificial intelligence platform interprets this information and helps them to effectively distribute Mobikes to areas of high use. When considering investing in bike lanes, special parking areas or other bicycle-friendly projects, local municipalities have benefitted from the knowledge Mobike provides them regarding the routes and destinations that are most popular among cyclists. The Beijing Municipal Institute of City Planning and Design has begun using their data to conduct it's first-ever evidence-based research on the construction of future bike lanes .

MindRider is a head-based wearable that tracks, in real time, how people's rides, movement, and location engage your mind. Through their location analytics system (Multimer), Mindrider is the first biosensor developed to collect human experience data and process it in a large-scale, location-aware context. The MindRider team have carried out a book-length study called MindRider Maps Manhattan that explores applications for urban and transit planning.

Apple Maps recently included bike sharing scheme data for selected cities so that cyclists could know where to pick up and return bikes. This localized data is available in 178 cities. Apple has got this information by creating a partnership with Ito World, which launched its bike share data feed late last year. This data is makes cycling around a range of cities much more straightforward .

The popular ride sharing service Uber collects data from every interaction on the transportation platform from driver and rider locations and destinations, to restaurant orders and payment transactions. Data powers Uber's global marketplace, enabling more reliable and seamless user experiences across their products for riders, drivers, and eaters worldwide, as well as empowering their own employees to more efficiently do their jobs .

Google Maps works with public transportation services that are open to the public, and operates with fixed schedules and routes, to partner in their information sharing services. In addition to driving and walking directions,Google Maps catalogs public transit information — including bus, train, ferry, and tram schedules — from over 100 countries and 25,000 towns. Along with finding the optimal transport mode for a person's daily commute, Maps makes it easy for one to find transit information when visiting a new city .

In Singapore, the tapping of information communication technologies for transportation planning has been seminal in the milestone achievement of My Transport Singapore mobile application. Through it, commuters are able to plan their trips more efficiently by having real-time updates for bus and train arrival information. The development of a world-class transportation infrastructure entails the provision of information in allowing commuters to make informed decisions[11] .

11 https://lkyspp.nus.edu.sg/gia/article/challenges-and-improvements-in-singapore-s-urban-mobility

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