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The effect of big data analysis for sustainable transportation

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Highlights
- Big data are integrated into daily life all over the world.
- It helps transportation to efiicient use of resources and traffic problems.
- Use of big data is promising for taxation, accident information and recycling.

Abstract

We produce and store large amounts of data in daily life, with or without awareness, through technological tools such as mobile phones, sensors, cameras, and the internet. If they are not used, these data, which are garbage, make important contributions to sustainable transportation if used properly. Considering the increase in demand in road transportation and the environmental impacts associated with it, it has become imperative to reuse enormous amounts of data produced continuously in the world for the economy, time, and sustainable life. In the study, the examples of sustainable transportation and big data are discussed with examples from the world, how to use this big data in the transportation sector and the economic, technical and environmental gains that this benefit will provide are made and suggestions are made regarding the use of big data.

Keywords: big data, sustainable transportation, ecological footprint

1. Sustainable Transportation

Thoughtlessly consumption brings the natural capital of the world to a point where we endanger our future well-being. If our demands on the planet continue at the same rate, we will need a double-sized planet to meet our needs to maintain our living standards by the mid-2030s. As stated in the living planet report, the ecological footprint of humanity has increased approximately 2.5 times from 1961 to 2005 and continues to increase rapidly [1]. Undoubtedly, the biggest contribution to the ecological footprint is fossil fuel use.

As stated in Pardo [2]; transportation, which is the second-largest sector after the energy sector that contributes to global carbon dioxide emissions caused by fossil fuel combustion, is the sector with the highest emission increase rate. The biggest share in the transportation sector belongs to road transportation with 73%.

Considering the long term, sustainable transportation, which is based on renewable energy, is becoming more and more popular, rather than fossil fuels with a limited lifetime and decreasing natural resources [3]. As stated in Leyden et al [4], sustainability in transportation; going to reduce greenhouse gas emissions can be achieved by avoiding practices that endanger human health and quality of life.

However, by 2050, the number of vehicles around the world will reach about set to double to two billion [5], which means that the ecological footprint of humanity is inevitable due to transportation.

With such increased vehicle speed, great demands will also develop on the global transportation infrastructure and networks designed to support them [5]. To meet these demands, it is of great importance how quickly countries can integrate into sustainable transportation. The most important way to integrate and contribute to sustainable transportation is undoubtedly the orientation towards renewable energy sources, but it is also

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important to produce solutions that will reduce fossil fuel dependency.

For example; Many cities in developed countries are trying to get rid of an automobile's dominant development era by stopping building more infrastructure for private vehicles and re-allocating space for public transport and non-motorized transport [2].

Undoubtedly, the right way of sustainable transportation is to use non-motorized vehicles, but this may not be possible at all times and under all conditions. One of the methods used to support sustainable transportation in the world is to use big data in the transportation sector.

1.1. Some overseas examples of how to get help from technology and related data in sustainable transportation

In the city of Sao Paulo; With big data collected in real-time such as how many people use public transportation, which routes provide timely transportation, the demands can be met correctly and the efficiency of the routes can be increased [6]. In this way, problems such as delay problems and increased fuel consumption can be eliminated with the help of data.

Using big data analytics in Singapore, in addition to solving traffic jams, getting information about the need to empty garbage with sensors placed in the trash cans has enabled the use of garbage collection vehicles on the right routes at the right time. Also, incident response teams have succeeded in increasing connectivity with specially designed mobile phone applications between the authorities and the public, thereby again achieving timely transportation, minimum traffic disruption, and emission reduction [7].

By analysing the big data it collects, the Melbourne tram system can automatically rearrange routes for sudden problems or difficulties such as major city events or natural disasters. By receiving data from the locations where sensors such as tram vehicles and rails are deployed, a certain section can be detected when maintenance is required, so that the crew can be sent to the place to be repaired quickly and ensure that the tram system continues to operate smoothly [6]. In this way, it contributes to the relief of road traffic, reduction of fuel consumption and associated emission reduction as well as increasing safety.

As can be understood from the examples, by processing large data, problem solutions become easier, temporal, and consequently economic gains increase, and most importantly, environmental gains are achieved by reducing emissions. For all these achievements, firstly, what is Big Data and how to obtain it is necessary to answer questions.

2. Big Data

The main idea behind the term big data; Everything we do in our lives leaves a digital trace (or data) that can be used and analysed [8], so these data that we are part of everyday touch every moment of our lives.

Radio Frequency Identification technology and sensor technologies are becoming increasingly common and collecting continuous data on the environments they are connected to. taking advantage of this big data, which is generated by many different ways such as driving statistics [9] collected by cars, weighing data for freight vehicles, traffic lights or traffic safety equipment sensor data, internet usage for route information, means our ability to collect and analyse the enormous amount of data we produce [8].

In all these mentioned data, the data collected and stored as a requirement of a particular service, as well as data that seem unnecessary, are growing as a very high accelerated avalanche [10].

Data that is not quickly grasped is only trash in the real business world. If they serve no purpose, they are digital waste [11]. In the previous periods, it has been understood that these data, which are called as information dumpster and which cannot be used because they are not structural, actually contain a great treasure thanks to technological developments. If interpreted with the correct analysis methods, using these data [10]; all services offered by the state can be improved and services can be offered better. Accordingly, public spending can be improved, thereby increasing welfare throughout the country and individuals [12]. Besides, big data helps governments improve their data-making decision-making capabilities and develop new ways to solve complex social problems [13].

2.1. The benefits that can be provided in the transportation sector with big data analysis

Reducing accidents; It can be shared with traffic users by using the traffic data in advance, by knowing about the traffic situation in advance in certain regions and using different routes or recommendations that can help reduce accidents caused by congestion [7, 14].

Fuel cost and time savings; It can help analyse the fuel consumption and precious time lost due to traffic congestion [7]. By providing traffic information to the drivers according to their needs, it can be ensured that the drivers save time on the road and reach the destination satisfactorily [15].

Future trends; Big data analytics, based on old and current real-time traffic data, can help understand future trends. It can help to understand the seasonality of traffic models, day and night traffic movement, and location.

Estimating the speed and volume of traffic; Data communities from multiple devices such as cameras, detectors, Bluetooth, mobile and social media can help to identify and measure traffic speed and volume on city roads.

Traffic and behaviour models; Obtaining performance data can help analyse historical data to understand traffic and accident behaviour.

Road Maintenance; With sensors and cameras on the roads, analysts can analyse which roads need maintenance [7].

Real-time information sharing between infrastructure systems and vehicles can increase the level of satisfaction among road users by improving the quality of road conditions [15].

Also, structural integrity monitoring can be easily done with sensor data to be placed in transportation structures such as bridges, tunnels, and art structures, thus preventing the disruption of transportation with precautionary measures [16].
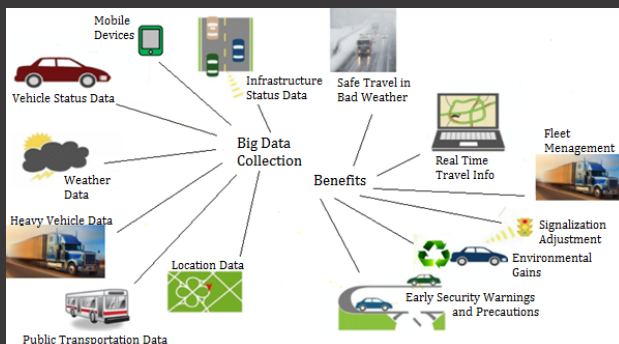

Figure 1. Gains of big data to the transportation sector [17]

3. Conclusion and Recommendation

As a result, if big data can be processed correctly, it will help the some issues to transportation sector such as; fewer vehicles driving in traffic, planning of signalling more effectively, planning road construction and maintenance works correctly, reducing congestion, reducing accidents, directing public transportation and response teams.

Depending on all these benefits big data will be a great supporter of sustainable transportation with the reduction of carbon dioxide emission, correct and economical use of natural resources, less destruction of the earth.

Some suggestions on the use of big data in the transportation sector and its contribution to sustainability:

With the sensors to be placed on the vehicles, the accident and km information of the vehicle can be

transmitted to the insurance companies and authorized institutions simultaneously and without being changed. Accident response times can be shortened and second-hand reliability can be provided in the purchase and sale of vehicles.

Taxation and insurance transactions can be made by following the real emission emissions of vehicles and their use within a certain tax period. The use of vehicles with low environmental impact and less use of individual vehicles can be encouraged.

With the sensors to be placed in the road scraping vehicle for recycling, what kind of material is scraped from which road at what depth and length can be collected in a data system? In this system, if the previous construction, maintenance, and repair information of this road are also found, the nature of the scraped material can be determined quickly and environmentally friendly recovery can be achieved by providing maximum benefit from the correct storage and recycled material.

As stated by David Buckingham; 'data is the new oil. We need to find it, extract it, refine it, distribute it, and monetize it" [18].

Declaration of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author Contribution Statement

S. Terzi: Conceptualization, Data Curation, Investigation, Methodology, Validation, Draft writing, Review&Editing – **K. M. Erten:** Conceptualization, Data Curation, Investigation, Methodology, Draft writing, Review&Editing

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