Can Big Data Analytics Help Improve the Public Transportation systems of Rural Areas?

Abstract **- For many, public transport is a necessary part of living in rural communities, however the availability and quality of such services lags behind those found in urban built-up areas. As technology and data analytics help improve the efficiency of transportation systems in large cities, it is worth investigating how similar approaches can be implemented in rural areas to improve the provision and efficiency of such a valuable service. Telematics and consumer data can be collected such that traveller patterns can be identified and more intelligent public transportation solutions can be introduced. Most promisingly, ride-sharing and demand responsive transport schemes can be used to improve the user experience and reduce the environmental effect.**

I. Introduction

The needs of people living in rural areas vary from those in urban areas. Residents of such areas typically are on lower income making it unfeasible for many to rely on their own car for travelling due to the high cost of owning and running one. This is a particular problem for the elderly who rely on public transport as a lack of such services could lead to social isolation. Public transport is also vital for young people to travel to work and training. Furthermore, the larger distance of such residential areas from main transport links means that those without a car must travel further and more frequently causing rural communities to contribute disproportionately to carbon emissions. It can be seen then that there are both environmental and social reasons for investment in rural public transportation and Big Data can play a role in the improvement and modernization of such systems.

II. Data collection

In order to improve the efficiency of transportation networks, the current systems and traveller patterns must be understood such that areas for improvement can be identified.

Intelligent transportation systems (ITS) use information gathered from cameras and microcontrollers to monitor road activity and environmental factors. This information can be gathered from fixed or dynamic sensors and incudes location coordinates so data can be used to analyse the traffic network of specific areas. Fixed sensors such as traffic cameras are permanently installed and are used to provide real-time dynamics of the area such as vehicle speed, distance between vehicles or even CO_2 emissions [1]. Sensors could even be embedded into the road surface such as loop detectors which measure traffic flow through variations in circuit conductivity caused by passing vehicles [2]. While these sensors can gather a considerable amount of useful data, they are limited by the large investment required to install and maintain them, as well as the high transmission costs associated with connecting such sensors to a central system.

These constraints make it unfeasible to invest in such systems on a large scale.

Furthermore, it is likely not worthwhile to implement fixed sensors on many rural roads as the low amount of traffic flow does not justify the high cost; in such cases portable data-gathering technologies can be used instead. The use of crowdsourced data can help complement data collected by roadside sensors and provide a clear view of transit patterns at a lower cost. Phones and vehicle telematics can be used to transmit an individual’s travel information which can then be aggregated with other road users to gather information about the traffic as a whole. In 2013 Rio de Janeiro became the first city to collect real-time data from both road users travelling by car (via Google’s navigation app Wave) and public transport (via the app Moovit) and used it to supplement the information collected from the various sensors and cameras around the city [3]. However, the success of the telematics approach relies heavily on the amount of user input and therefore may not be as effective in rural areas.

To make up for this, data from other sources such as census and consumer data [4] could also be used to improve understanding of expected traveller patterns. Census data would help develop understanding of the demographic of rural areas and assess the likely needs (e.g. an ageing population will likely be more reliant on public transport). Consumer data can be used to monitor the behaviour of individuals by cross-referencing spatial and temporal data relating to their activities. Data from social media, retail transactions and customer records can all be used to understand problems in transport geography such that services can be provided that best meet the needs of consumers.

III. Data analysis and transport solutions

Over time, sufficient information can be collected such that transit models can be created for specific areas and optimised solutions for public transit can be generated and tested. A successful example of this was carried out in 2011 by the MIT SENSEable City Lab in partnership with Audi and General Electric and was called HubCap. In an effort to learn more about collective mobility, this initiative mapped out the pick-up and drop-off locations of the 170 million taxi journeys over one year in New York City and used geo-spatial analysis to split the city up into 200,000 street segments generating over one trillion flow combinations [5]. By identifying commuter patterns, public transport systems can be designed more efficiently. This can be through designing more efficient fixed routes based on popular destinations, or identifying areas that could benefit from an on-demand transport service.

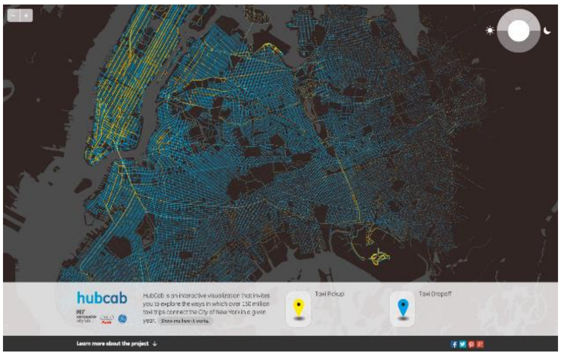

Figure 1 - Screenshot of HubCab showing all taxi trips in New York City over one year [6]

A trial of on-demand bus services took place in 2019 in Sutton aiming to increase public transport use in areas of London with typically higher car use [7]. Demand-responsive travel and ride-sharing taxi schemes [8] have been proposed as a solution for areas where it is more difficult to get around and low housing density makes dedicated public transport routes impractical. These services see users booking their spot on the vehicle through an app and aims to be more efficient as multiple vehicles will not be sent to the same area to serve the same customers. Several similar promising trials are ongoing in the UK and worldwide so that the approach can be refined before it is adopted on a larger scale [9].

IV. Conclusion

Overall, demand-responsive transport solutions seem the most beneficial for rural communities, and big data analytics can be applied in order to deliver this in the most efficient way possible. The use of telematics and consumer data appear to be the most effective way of gathering such data however ethical controls and security measures need to be in place in order to protect the privacy of the public whose data is being shared. Once systems are in place, relevant data must still be collected such that performance measures can be developed allowing the system to continually improve [10]. A successful implementation could see an improvement in transport provision and a reduction in CO2 emissions in rural areas positively impacting both the environment and the lifestyle of residents in these communities.

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