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Big Data Management in Transport & Logistics Industry: A Literature Review

Shuo Dang
Management School, University of Liverpool, Liverpool, UK.

Jing Shi
Management School, University of Liverpool; Guangxi Liugang Logistics Co., Ltd. to_shijing@163.com

Yang Li
Department of Computer Science, University of Liverpool

Abstract

Nowadays, the amount of data produced from transport & logistics industry appears significant increase. Meanwhile, under the worldwide competition, professionals are struggling in dealing with the huge data. Thus, the adoption of new information technologies has become essential for most of transport & logistics businesses to improve their activities with the investigation of how to produce, capture and analyse data. Big Data Management is one of the best techniques which can help them in overcoming their problems (Tiwari, et al., 2018). Realizing its benefits, this paper will provide a literature review of big data in the transport & logistics industry to demonstrate its knowledge and understanding of related research in recent five years, especially the application cases. During the analysis, this paper will discuss the strength, weakness, opportunities and threats of adopting big data, to identify the research directions for future study in transport & logistics domains.

Keywords: Big Data Management, Transport, Logistics

1. Introduction

The widespread using of information technologies in transport & logistics industry leads to the fast increase of data sources (Nguyen, et al., 2017). And, this increasingly massive amount of data also provides logistics companies with lots of opportunities for exploring new values and the challenges, which could raise powerful competitive advantages in terms of management and analysis. In academic area, researchers have given a new concept as Big Data in this practice, which also has been a new trend of application in the field of transport & logistics (Tiwari, et al., 2018). Thus, this paper will perform a comprehensive literature review for the

related articles in recent five years to investigate and critically analyse the knowledge and application cases of big data in transport & logistics industry.

The structure of this paper is organized as follows. Firstly, in section II, the overall background of transport & logistics industry will be given. Then, in section III, this paper will analyse the strength, weakness, opportunities and threats of Big Data in transport & logistics, with relevant cases to support. At last, a brief review of some prospects of Big Data in transport & logistics and limitations of this paper will be concluded in section IV.

2. Background

Generally, the logistics operations include freight transport, supply chain management, e-commerce, inventory, delivery, handling, reverse logistics and so on. According to Tan (2015), the methodological advancements and analytical capabilities of Big Data technologies play a vital role in new business models and the improvement of customer experience, when applied in transport & logistics chains. For example, new data-driven businesses and opportunities appear across global forwarding networks based on the development of analytics capabilities in Big Data (Govindan, et al., 2018). The data captured along the forwarding networks including cargo, size, weight, location and destination by professionals from millions of shipments around the world every day, promotes to the optimization of operation efficiency and business models. Besides, now, transport & logistics industry has been considered as an important data source, which can develop these Big Data applications to a new level as well.

3. Literature Analysis

The adoption of Big Data in transport & logistics industry can usually refer to three dimensions: operational efficiency, customer experience and new business models (Nguyen, et al., 2017). In this section, the strength, weakness, opportunities and threats of Big Data are discussed in detail referring to transport & logistics issues.

3.1 Strength Analysis

A. Big Data Technology

The Big Data technology generally involve commercial and open-source platforms and services for storage, security, access and processing of data (Hopkins & Hawking, 2018). Cloud computing is one of the widely used Big Data technologies and internet-based. With the cloud computing, users can access files to share or process data from any device that can access the Internet. Besides, cloud computing is also a good tool that support the processing of this huge amount of unstructured data and turn it into actionable business intelligence (Misbahuddin, et al., 2015). In another word, Cloud offers everything as a service business model for IoT (Internet of Things) and big data. And, the investigation of cloud computing, big data and IoT has been well adopted in the Intelligent Transport Systems applications.

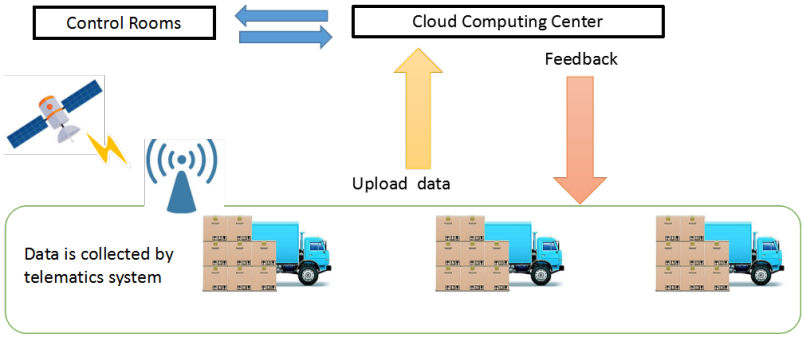

Figure 1. Agent Vehicle Tracking solution from DHL (Hopkins & Hawking, 2018)

Application Case: Take the Agent Vehicle Tracking solution from DHL as an example (shown in figure 1). In 2011, DHL has adopted cloud computing throughout their organization and believe that Big Data would improve their logistics operational performance, such as efficiency and service quality (Hopkins & Hawking, 2018). To achieve the goals of 'Plan Zero' (Zero Vehicle Accidents, Zero Environmental Impacts and so on), DHL implemented a range of truck telematics and established cloud computing platforms to collect and process sensor data from trucks, including speed, distance travelled, location, engine data and so on, with control rooms which monitor and change driver behaviors. According to the annual report from DHL, by 2016, DHL had reduced their GHG emissions by 42 percent. Specially, 32 percent of this reduction was due to Agent Vehicle Tracking (Hopkins & Hawking, 2018).

Analysis: Cloud-based service has four key strong supports to big data: Scalability, Flexibility, collaborated and Security (Tiwari, et al., 2018). Firstly, from the view of scalability and flexibility, Cloud-based services are ideal for businesses with growing or fluctuating demands. Logistics companies always meet seasonal demand fluctuations on delivery, especially affected by the commercial promotions, for example, 'Black Friday' in the UK or 'Double Eleven Day' in China. In the case of DHL, the fluctuation of logistics demands may lead to the data change on its type and amount, which requires the big data platform in the capability of scalable and flexible. And, Cloud Computing can allow this growth or fluctuation, and the steadily process a huge amount of unstructured data.

Besides, the cloud computing can increase the collaboration of a business team. The members of Agent Vehicle Tracking team in DHL can access, edit and share documents anytime from anywhere, which enables them to do more together and better.

At last, cloud-based services improve the security of data storage. Cloud-based services can enable the data storage, computing and memory resources in an elastic and ''transparent'' way, which can avoid the data loss as far as possible (Hopkins & Hawking, 2018).

B. Big Data Analytics

Data Analytics includes descriptive analytics, diagnostic analytics, predictive analytics, prescriptive analytics and so on (Nguyen, et al., 2017). In transport & logistics operations, the Big Data analytics can support the dynamic routes design by processing real-time information from sensor data or external customer information.

Application Case: As an example, Routific is a commercial route optimisation software developed

for most delivery businesses to improve the performance of last-mile delivery.

In figure 2, it exposes the user interface of 'Routific' for on-demand logistics management, where the freight fleet can be tracked for last-mile delivery optimisation.

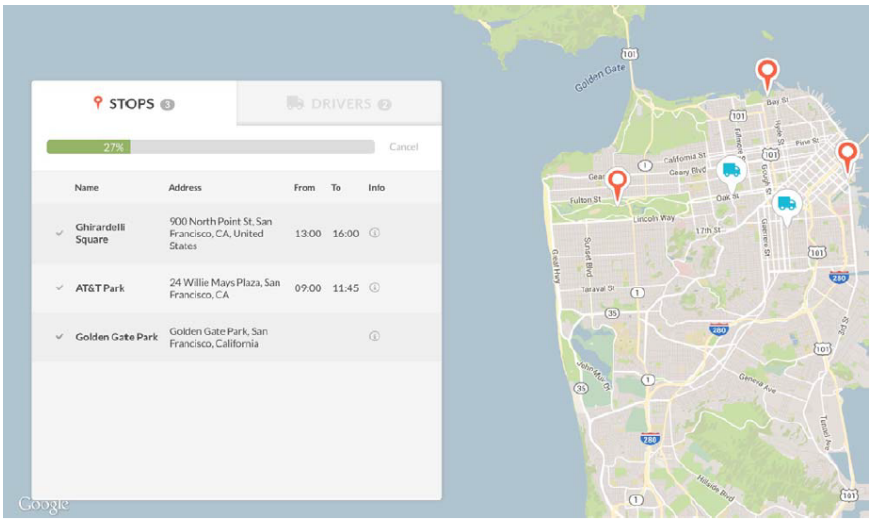

Figure 2. The user interface of last-mile optimization tool (Tiwari, et al., 2018)

Analysis: In the case of last-mile optimization tool, the software – 'Routific' provides a flexible solution to the Vehicle Routing Problem, based on the factors in terms of time windows, delivery types, vehicle capacities, driver speeds, priority stops, driver shift times, driver breaks, traffic, and more (Tiwari, et al., 2018). According to the statistics on its website, the software – 'Routific' can help its customers save time and fuel with 40% shorter routes (Routific, 2018).

As for the operational level, Big Data analytics applied in the 'Routific' can dynamically analyse and optimise the distribution network in consider of the coordination between transport routes and transit points, by processing real-time senor data from vehicles (Govindan, et al., 2018). However, in previous, the route plan was based the past inefficient resources such as historical averages or even personal experience, which was hard to reflect the reality.

3.2 Weakness Analysis

A. Big Data Technology

Firstly, Cloud computing platforms need lots of investment for its development and maintains. Most of the Small & Medium-sized Enterprises (SMES) relies on the Third-Party service, such as Amazon, Microsoft and iCloud, which may meet more risks on information leakages, especially for the information related to market strategy. In addition, since cloud computing needs a constant internet connection, if the Third-Party services has any failure, the daily operations of SMES will also be significantly impacted.

B. Big Data Analytics

At first, it is not all companies can afford the cost on the building of analytical capabilities.

Generally, the Big Data analytics are always developed by high-level professionals who are named as 'Data Analytics' in many cases. Recently, some large firms are beginning to create "Chief Analytics Officer" roles to oversee the building of analytical capabilities, such as UPS. But, both the cost of human resources and technologies development are very expensive. Only few large logistics companies could afford its costs. Thus, if some SMEs want to improve their transport or logistics performance by the Big Data analytics, they must rely on the Third-Party services.

Besides, while cost is often a limiting factor in many technology decisions, ease of use appears to be a more pressing issue than cost (Gasova, et al., 2017). Because, the implementation of a complex big data system throughout the organisation always needs staff training and professionals to support, which would cost a lot of time on it.

3.3 Opportunities Analysis

A. Big Data Technologies

The application of Big Data technologies is still a new trend in transport & logistics field, which promotes to a fast growth of new technologies, such as Artificial Intelligence (AI) and Data Science. Meanwhile, the investigation of new technologies is also leading to the development of fully auto-decision processes, known as Smart Logistics in the transport & logistics industry (Gasova, et al., 2017). Under this context, transport & logistics industry and Big Data are in together development.

In Smart Logistics, the research and development of new intelligent self-driving vehicles in a Big Data and IoT-based traffic infrastructure has been popular in recent years (Wang, et al., 2016). The new intelligent self-driving vehicles would be a key trend in transport & logistics area during the following years and bring more flexible and automated logistics solutions as well. Because, the shared sensor data provides more great deal of information on weather and traffic for the optimisation of efficiency and self-management on the flow of logistics and goods. For example, Mercedes is leading to the design of "future Truck 2025" that presents a self-driving truck would change the future of shipping methods (Borgi, et al., 2017).

B. Big Data Analytics

Based on Big Data predictive analytics, the Predictive Analytics allows logistics providers to improve their process efficiency and service quality by forecasting demands before any request or order will be placed, to short its delivery time (Tiwari, et al., 2018). Take the concept of Internet of Trains as an example. The Internet of Trains is a new trend of maintenance services proposed by Siemens in past few years, which could reduce the train failures by analysing the sensor data, to achieve a data-driven predictive maintenance of trains fleet (Teradata, 2015).

3.4 Threats Analysis

A. Big Data Technologies

Firstly, the development of Big Data technologies may meet a threat on the data monopoly. Even though transport & logistics industry can create huge amounts of data due to the adoption of new technologies, such as IoT, all these data may meet a forbidden challenge on share from

several large firms in the transport & logistics industry, which may affect the development of Big Data technologies in logistics domains (Hopkins & Hawking, 2018).

In addition, the privacy and security issues are still a serious challenge for the storage and transmission of enormous quantity of sensor data (Tiwari, et al., 2018). For example, in 2016, over 50 million of Facebook users suffered their data exploited by a political consultancy. There're no detail regulations for professionals or businesses on the development of the crowd-sourced data and application platforms. However, those multi-platforms, such as Google, adopted big data technologies are becoming more and more easy to locate or track objects, including vehicles and people. which may lead to new threats in terms of privacy and security. If misunderstood and misconfigured, it may pose risk to our data, privacy, and safety.

B. Big Data Analytics

One of the important challenges maybe from the predictive analytics limitations. On one hand, predictive models cannot offer a reliable answer for future during the self-learning and self-regulating processes. Because, history data cannot always predict the future, which means the data fitting is unable to resolve all the issues. On the other hand, data that are inaccurate, incomplete, or inconsistent can also noise the results of prescriptive analytics and create serious operational problems for businesses. For example, the self-driven car may meet traffic accidents, due to inaccurate decisions under the inaccuracies in transport data and road conditions information. Besides, the inaccurate decisions caused by predicative analytics limitations may lead to a threat on legal insight. For example, the self-driven car from Uber caused a casualty accident in America at the beginning of 2018. How to determine its legal responsibility was a difficult.

4. Conclusion & Limitation

This paper explored a literature overview of Big Data, and analysed the main strength, weakness, opportunities and threats in the transport & logistics industry. The application of Big Data technology and analytics in transport and logistics fields is still in development. Firstly, this paper proposed that the Big Data technology and new knowledge explored from the vast of sensor data along the logistics chains are in together development, which could offer vuluable opportunities. Besides, the technical limitations and risks of Big Data in transport & logistics industry also needs to concerned by scientists and researchers, such as the raising challenges of privacy and safety. In addition, since the analysis of this literature review is based on materials just collected from academic journals, in future researches, it shall collect more information from practice. At last, this review just reflects the recent views of scholars who research on Big Data in the field of transport & logistics. Therefore, the analysis proposed in this review needs to be further enhanced based on much more academic journals and practical cases.

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