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The Prospect of Internet of Things and Big Data Analytics in Transportation System

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Abstract. Internet of Things (IoT); the new dawn technology that describes how data, people and interconnected physical objects act based on communicated information, and big data analytics have been adopted by diverse domains for varying purposes. Manufacturing, agriculture, banks, oil and gas, healthcare, retail, hospitality, and food services are few of the sectors that have adopted and massively utilized IoT and big data analytics. The transportation industry is also an early adopter, with significant attendant effects on its processes of tracking shipment, freight monitoring, and transparent warehousing. This is recorded in countries like England, Singapore, Portugal, and Germany, while Malaysia is currently assessing the potentials and researching a purpose-driven adoption and implementation. This paper, based on review of related literature, presents a summary of the inherent prospects in adopting IoT and big data analytics in the Malaysia transportation system. Efficient and safe port environment, predictive maintenance and remote management, boundary-less software platform and connected ecosystem, among others, are the inherent benefits in the IoT and big data analytics for the Malaysia transportation system.

Keywords: Internet of Things; Big Data Analytics; Malaysia transportation systems

1. Introduction

The Malaysia transportation system has potential benefits from harnessing the strengths and functionalities of Internet of Things (IoT), and applying the analytics of its big data. IoT is defined as the process and technological framework that explains the interaction, interconnection and interdependence among data, people, and associated electronic objects over the internet [1-3]. IoT is also aided by the sensory and communication abilities of the connected physical electronic objects. Through these objects, the environment is monitored and reported, and communicating electronic objects are programmed to act according to the information received [1, 4, 5]. Different varieties, large volume, and high velocity data (big data) are generated due to the intercommunication among the



physical electronic objects. Therefore, exploring the analytics of the generated big data, for prescription, description, prediction, and actionable insights become necessary.

IoT and big data analytics have become the dawning technological revolution, and due to its enormous benefits, they have been adopted in diverse domains for varying purposes. IoT and big data analytics have been utilized in manufacturing, agriculture, banks, oil and gas, healthcare, retail, hospitality, food services, among others [6-8]. Automated and robotic manufacturing [9, 10] automated teller machine's fraud detection [11, 12], and human profile security alert [13, 14] are applications of IoT and big data analytics recorded in manufacturing, banking, and security, respectively, to mention a few. The transportation industry is also one of the early adopters of IoT and big data analytics [6, 7]. Its applications in tracking shipment, freight monitoring, and transparent warehousing, signify the benefits of IoT and big data analytics in the transportation industry as recorded in the transportation sector of countries like England, Germany, Portugal, Singapore [7], among others. However, Malaysia can be said to still be at the teething stage.

This paper presents a summary of the inherent prospects in adopting IoT and big data analytics in the Malaysian transportation system. In doing this, the next section of this paper describes the general overview of the applications of IoT and big data analytics in transportation system. Countries that have adopted IoT and big data analytics in their transportation systems are presented, and the impact of its adoption are highlighted. In the third section, the present situation of Malaysia transportation system is described, and the prospects of adopting IoT and big data analytics are enumerated. The fourth section is the last and concluding part of this paper.

2. Applications of Internet of Things and Big Data Analytics in Transportation System

The transportation sector is in the forefront of IoT technologies implementation and it is rapidly adopting its innovations to remain competitive, increase productivity and bottom-line, and to enhance customer loyalty and satisfaction. This is much necessary because of the evidently low-margin fragmentation that is typical of the transportation industry. IoT has been responsible for the timely need of the supply chain transparency, and its support to data-driven decision making in a connected and distributed network [6].

The track-and-trace global positioning system (GPS) technology is an IoT technology that was firstly used in tracking shipment before the emergence of radio-frequency identification (RFID) technology. Now, virtually the entire logistics chain warehousing, freight transportation, and last mile delivery have adopted IoT technology, with an estimated €16.8 trillion investment stake [15]. As shown from literature, Portugal [16], Germany [6], England [17], and Singapore [18] are some of the leading countries that have massively adopted IoT and the associated big data analytics for revolutionizing their transport systems.

In Lisbon, Portugal, according to Baptista, Azevedo [16], there was a problem of non-compliance with speed limits by majority of the drivers, resulting in recurring cases of fatal car accidents. This portends negative image for the national transportation agency and the expected safety policy. It is against this backdrop that IoT and big data analytics were employed. A study of the potential environmental and economic impacts of implementing information communication technological (ICT) measures in transportation was conducted. The implementation of IoT, big data analytics, and other associated ICT applications achieved a behavioral change in the drivers' eco-driving and public decorum attitudes. Subsequently, a drastic reduction in the cases of fatal car accidents in Lisbon was achieved. Also, there was considerable impact in eco-friendly environment in terms of reduced energy consumption and CO₂ emission.

In the same vein, the Port of Hamburg in Germany being one of the busiest ports in Europe was facing traffic rise which was compounded by its space limitation. There are other factors, such as road safety

concern, traffic congestion, and pollution, which must be addressed in view of creating safe and low-cost port environment. The port is also a point for the tourism industry because of the large number of cruise passengers that use it [19]. To these ends, IoT technologies were employed and strategically implemented. Smart port infrastructure, intelligent trade flow, and intelligent traffic flow are the main sub-components of the IoT technological framework adopted. As a result, Port of Hamburg became a major economic driver for the country and the region by creating more than 260 thousand jobs and generating over €750 million as yearly tax revenue. With the capacity of the IoT technologies, the port now handles container and bulk cargo which are expected from 2010's 8 million to 25 million in 2025 [20].

There was also the need for operational waste reduction, timely execution of project and worker/passenger safety in the England's transportation sector. Tezel [17] explored both the quantitative and qualitative benefits of a practical visual system developed with IoT technologies. The implementation of the system contributed to increased self-management, better team coordination, and more efficient delivery of cargo. It also helped in easier control of the workforce and their activities in the transportation sector.

In Singapore, also, there was a dire need for consumers' choice to evaluate different bus option in view of making wise purchase decision. IoT and big data analytics infrastructure were therefore employed for better passengers' experience in bus transportation. The industry experts were also interviewed in order to understand the necessities in the domain and how IoT can be explored for better and more efficient transportation service delivery in Singapore [18]. The study produced an IoT-based technical architecture for an application that predicts arrival times for the buses, makes comparative analysis of passengers' options, and gives estimate of the number of passengers in the arriving buses. This ultimately guides the passengers in choosing their preferred bus and route.

The benefits in the implementation of IoT and big data analytics in the transportation system cannot be overemphasized. Portugal, Germany, England and Singapore have been able to overcome the problems of fatal car accidents, traffic rise, operational waste, and passengers' decision making using IoT and big data analytics applications. These prospects are also achievable in Malaysian transportation system with careful study of the sector and strategic implementation of the applicable IoT technologies and big data analytics. Table 1 presents the problems observed and solved in these countries with IoT and big data analytics.

Table 1: The Summary of IoT and Big Data Analytics Implementation in Transportation Sector

Countries	Problems (before the implementation of IoT and Big data analytics)	Results (after the implementation of IoT and Big data analytics)
Portugal	Recurring cases of fatal accidents due to non-compliance with speed limits	Behavioral change in the drivers' eco-driving, then drastic reduction in the cases of fatal car accidents
Germany	Road safety concern, traffic congestion, and pollution.	Eco-friendliness, and hitch-free traffic flow
England	Operational waste and workers' safety	Operational waste reduction and safe working environment
Singapore	Unpleasant passenger's booking experience	Better passenger's booking experience

3. Malaysia Transportation System and the Prospects of Internet of Things (IoT) and Big Data Analytics Implementation

The prospects of IoT implementation and big data analytics applications in Malaysian transportation system lie in their strengths in solving the myriads of problems in the sector. This will also address the externally-influenced issues in the industry, and finally support the modernization of the entire system.

Similar to what were experienced in Portugal, Germany, England, and Singapore, Malaysia can also move into a top-notch service delivery country in its airport, train, seaport, and city bus transportation.

According to *Transport Statistics Malaysia, 2015*, Malaysian international and domestic airport facilities operate 24 hours, with total passengers excluding transit passengers of 85, 948, 179 within the year 2006 and 2015. The airport facilities also handled cargoes of 959, 042 metric tonnes, and 857, 232 mails within the same year span. There is also remarkable freight traffic of 1, 474, 35 as the number of registered vehicles on Malaysia roads within the year 2006 and 2015. The Malaysia transport capacity for the year 2006 – 2015 is depicted in Figure 1. This figure indicate that Malaysia transportation sector is thriving with massive international and local demands to meet. This, undoubtedly, comes with its problems and challenges. The leading among these problems, as indicated by *Transport Statistics Malaysia, 2015*, is road accidents, which are 489,606 cases in 2015 [21]. Though, the causes are not documented. Also of important attention are the operational bottlenecks, environmental hazard, such as noise pollution, traffic congestions, passengers' choice conflict, among others associated issues of growing modern transportation sector.

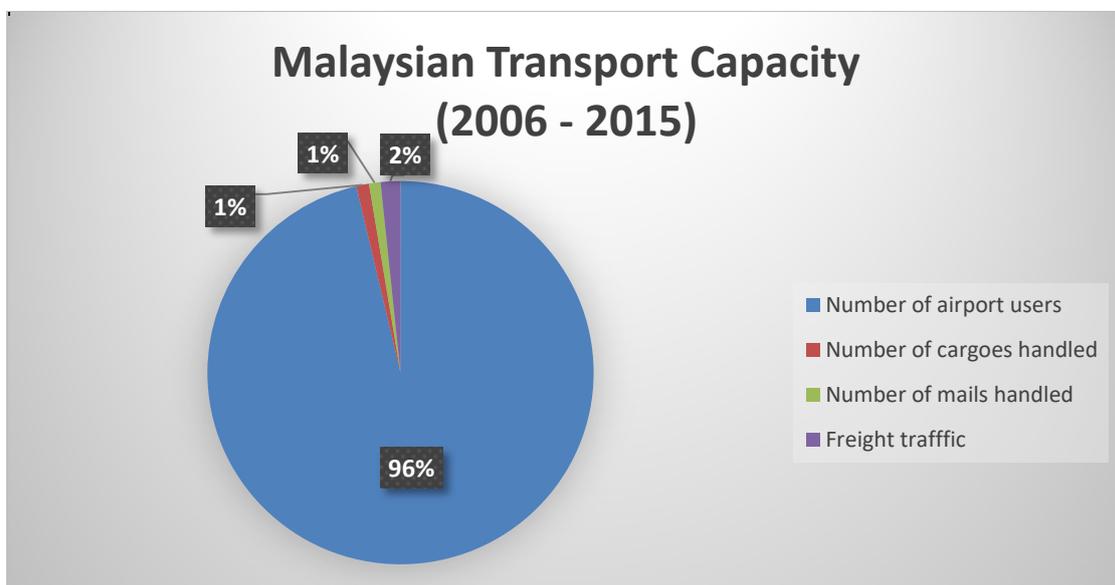


Figure 1. Malaysian Transport Capacity (2006 – 2015)

The lessons in the application of IoT technologies and big data analytics to reduce high rate of fatal car accidents in Lisbon, Portugal, can equally be applied in Malaysia. Most importantly is a generic overview of the applications of IoT and big data analytics in Portugal, Germany, England and Singapore. From this, Malaysia tends to achieve (a) reduction in cases of road accidents, (b) eco-friendly and user-friendly transportation environment, (c) revenue generation, (d) job creation, and (e) enhanced productivity and efficient service delivery, by applying IoT and big data analytics in its transportation system.

4. Conclusion

There are massive benefits in the adoption and implementation of IoT technologies and big data analytics. This is evident in its diverse adoption across domains, such as hospitality, oil and gas, security, healthcare, among others, and transportation, as focused in this paper. Countries like Portugal, Germany, England and Singapore have taken the front row in the application of IoT and big data analytics to solve varying problems in their transportation sectors. These problems range from incessant fatal car accidents, ports' traffic rise and congestion, operational waste, and bus passengers' choice.

This paper presents the prospects of applying big data analytics and implementing IoT technologies in the Malaysia transportation sector. Besides the generic benefits of port safety, supply chain transparency, and its support to data-driven decision making in a connected and distributed network, there are Malaysian peculiarities which will be ultimately addressed. These are closely related with what are obtained in the transportation sectors of the countries reviewed, while the Malaysia sector also need tailored study.

Notably, IoT and big data analytics are offshoots of the broader Industrial Internet which must be paid adequate attention. These technologies are disrupting business model and modes of service delivery. Technology providers, technology adopters, public policy makers, and all stakeholders in the Malaysia transportation sector must be ready to work in synergy. There is need to raise market awareness on successful use cases, identify partners in the sector's technological ecosystem, revisit industries' regulations and policies, and implement new training model for the sector's workforce. These will cumulatively actualize the prospects of IoT and big data analytics for the transportation sector.

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