Big Data Analytics Adoption and Implementation in Public Transportation: The Gap in Practise

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Abstract

Big data is rapidly becoming a major driver for firms seeking to gain a competitive advantage. With an abundance of data, organizations are trying to leverage big data analytics to integrate data as part of the decision making. Nonetheless, despite the potential, the conditions under which big data investment can potentially create business value remains largely unexplored. Only a small percentage of companies have been able to capture the full potential of their big data investments. Research has shown that 85% of the big data project failed and abandoned mid-way of their implementation. Prasarana, the largest public transport operator in Malaysia is seemingly following the same trend, having generated a lot of data and yet has not been able to maximize the use of those data. This paper reports this gap and proposes factors that are critical for the success of development and implementation of big data. Application of big data in public transportation will be explored in order to identify the state of big data adoption as well and the challenges faced by organization during their big data development and implementation.

Keywords: *Big data; Analytics; Public transportation; Action research*

1. Introduction

The government of Malaysia has made urban public transportation (PT) improvement as one of the national aspirations [1]. There has been an extensive transformation of PT around the country, with projects such as LRT3, MRT, ECRL and a few others with the objective is to provide better mobility and connectivity to the public. Blueprint such as Greater KL/Klang Valley PT Masterplan and Urban Rail Development Plan outlined how these developments are being planned, therefore integrated approach can maximize the level of services that will be rendered to the public eventually. The fact that PT serves the society by providing cheap and fast mobility services that people are relying more and more on the services.

As the demand increases, PT operators see the need to continue innovating in order to meet the demand of their customers [2]. Planning of resources allocation and route, transforming the way how customers interact with the PT operators and making it easier for the customers to plan their journey are some of the innovations that PT operators have undertaken to further increase their

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competitive advantage as well as improve the customer satisfaction. One common denominator that makes all of these innovations to be successful is data.

The history of previous trends in IT investment and innovation and its impact on competitiveness and productivity strongly suggest that Big Data can have similar power, namely the ability to transform our lives [3]. Gupta & George (2016)[4] opined that BDA is heralded as the next big thing for organizations to gain a competitive edge, in the same manner, that IT was touted as a competitive weapon in the 1980s. Therefore, it is not surprising that the organization are trying to leverage big data analytics (BDA) to drive their competitive advantage further.

Despite the potential that BDA can bring to the organization, the conditions under which big data investment can potentially create business value remains largely unexplored. Only a small percentage of companies have been able to capture the full potential of their BDA investments. This is a stark contrast to the number of articles that flaunt the transformative power that BDA has on the organization's performance [3]. Gupta & George [4] have suggested that a lot of these articles on BDA were written by industry practitioner or consultants, where the emphasis was given more towards the application of the big data, rather than empirically identify the factors that made up the reason why organizations were adopting the technology as well as the challenges with the process along the way. This is seemingly consistent with the finding by Gartner, whereby they are reporting that 85% of the big data project failed and abandoned mid-way of their implementation [5]. Sanchez-Martinez & Munizaga [6] are seemingly agreed to the finding and further iterated that there is still a lot that needs to be done in the PT space before BDA adoption can produce a tangible result. Despite having an abundance of data, the development and implementation of BDA in Prasarana remain lukewarm.

Based on that context, the objective of this research is to first understand how the largest PT operator in Malaysia undertake their BDA adoption, second is to identify the factors that influence the adoption, the third is to understand the challenges faced in the process of adoption and lastly is to understand the impact and implication of the BDA adoption.

The rest of the paper is organized as follows. Section 2 to 5 are the reviews from previous literature on big data, big data in public transportation, some key success factor during implementation and challenges while implementing big data projects. Section 6 will explain the site setting for the research. Section 7 will explain the use of Action Research (AR) during the adoption and implementation of big data analytics within PT. Finally, Section 8 concludes the conceptual paper.

2. Big Data

For the past few decades, companies have been known to utilize Information Technology (IT) to enable their business operations. There are various examples within literature research that are showing how IT is transforming companies in the area such as customer service, operation, engineering and to name but a few. It has also been shown that the implementation of IT has improved the performance of organizations irrespective of industries [7],[8]. One of the direct results of the IT implementation is the data generated by the system.

The term big data to a certain extent is still vague. As different stakeholders look at big data from a different perspective, it is not easy to write down the exact definition of big data. However, information technology professionals agree that big data comprises of large data sets that require supercomputers to collate, process and analyze to draw meaningful conclusions [9]. Constantiou, Kallinikos, & Kallinikos [10] meanwhile refers to big data as large data volumes generated and made available on the Internet and existing digital media ecosystem.

IBM in its report has defined big data using the 4Vs dimension, which is volume, velocity, variety, and veracity [11]. Volume refers to the enormous volume of data. Velocity refers to the pace at which data flows from its sources. Variety refers to the many sources and types of data. Meanwhile, veracity refers to the biases, noises and abnormalities in the data.

Standing on its own, big data is just data that the organization or individual has been generating all this while. It is therefore not a new concept. In fact, organizations have been generating data, regardless of whether it is in digital format or not since the late 1970s [12]. Organizations have been known to incorporate these data as part of their decision-making process, in which information about financial, customer, operation and human resources shaped some of the decisions that organization is deciding [13],[14],[15]., These data would normally be captured in a structured manner and extracted for analysis when required. Examples of these data are customer records, credit scores, financial information and so on.

The advent of the Internet of Things (IoT) has also contributed to the rise of data [16]. IoT is referring to sensors that are embedded in any physical things or assets that generated data such as body-related metrics (step-taken, heartbeat), locations, movement, temperature and sounds [17]. The availability of ubiquitous wireless networks such as Wi-Fi, LoraWAN and the proliferation of 4G and upcoming 5G networks have opened up the use of IoT in our daily lives. It is estimated that by 2015, there are 6 billion objects in the world that will be connected to the Internet through of Internet of Things [18].

Social networks are another source where big data is being generated. There are numerous social networks that are currently being thronged, with the most prominent are Facebook, YouTube, Twitter, LinkedIn, Google, Instagram and to name but a few. These social networks allow their users to upload or create content such as text, sounds, photos, videos. With the number of active social media users hover around 2billion [19], we can imagine the amount of data that is being generated by these users.

3. Big Data Analytics in Public Transportation

Historically, the transportation domain in general and public transportation, in particular, generated a vast amount of data. The volume of these data is likely to increase significantly due to the drive by the operator to improve its service delivery by adopting the digitalization of some of its services for the purpose of making the journey experience more pleasant as well as using embracing it for the purpose of improving their internal process [17].

There have been many bodies of literature that have documented the use of big data in public transportation. One of the most prominent is the use of big data to

look into asset maintenance [20]. Public transportation maintains a massive amount of assets in the form of the fleet (bus and train) as well as facilities like depots, and stations. These assets have a certain lifespan that requires some level of maintenance. In the case of train rolling stocks, components and systems within the train need to have some level of maintenance in order to be certified for operation. After the assets have clocked certain miles, it would need to be taken out of the service for maintenance purposes. However, taking these assets out from operation would means other assets need to take over the operation else there is a gap where customers may not be able to enjoy the service at full capacity. This where the Internet of Things (IoT) comes into the picture, where these assets have sensors embedded into them. The sensors allow monitoring of assets metric, such as fuel consumption, braking, tire pressure, air-conditioning temperature. Data is constantly being pumped into the central server, thus allowing analytics to be performed [21]. With enough data captured, predictive analytics can be performed. Instead of relying on the normal preventive maintenance, condition-based or predictive maintenance can be performed. Future wear and tear of assets components can be monitored and forecasted into the future. All of these are based on data streams being aggregated onboard and transmitted to the back-office system. A number of Original Equipment Manufacturer (OEM) such as Volvo and Benz have incorporated these features inside their offering [22].

In term of smart facilities like stations or depots, IoT has been identified to be critical in allowing the asset owner to predict the disruption of facilities such as air-conditioners, elevators as well as escalators. The study conducted by Das, Ladin, Ismail, & Rahmat [23] has found that escalator to be one of the factors affecting customer satisfaction among the monorail users in Kuala Lumpur. This is due to a number of unplanned disruptions that affected the escalator in the station. In the study conducted by the City of Melbourne, it was identified that IoT can be used to perform building management monitoring function that encompasses the monitoring of temperature, humidity control and energy usage [21].

The proliferation of social media applications or websites such as Facebook, Twitter, YouTube, and Instagram provide another avenue where public transport operators can engage its customers. The engagement would allow the operator to understand the perceptions, attitudes and the behaviour of the passengers. Traditionally, the understanding of these behaviours is via the use of traditional survey or interview methods. However, it can only be done once or twice a year, as the process can be time-consuming and costly. Chicago Transit Authority (CTA) has been using the Twitter feed of its passengers to monitor their sentiment while using CTA services (Luong & Houston, 2015)[24]. At the same time, they have been running similar Twitter analysis towards the passengers that were using Los Angeles County's transit system. The MetroTrains Melbourne has been shifting to Twitter to replace their text messages system due to the growing cost and reliability issues [25].

What makes these platforms to be attractive for the transit operator is due to the lower cost it takes to connect with the passenger. At the same time, with a higher number of people remains connected, dissemination of time-sensitive information can be done quite fast. Targeted messages to where people are communicating can be done through geospatial information provided by these social media applications. Social media applications also appealed to a certain category of

groups such as young people, thus the public transport operator will look as if they are in touch with those generations [25].

4. Key Success Factors in Big Data Implementation

Research has shown that companies that embarking on Big Data journey can outperform their competitors. Everybody seems to be wanting to jump into the bandwagon. But was it a good enough justification to jump into the pool, to swim and to expect we get something tangible out of big data implementation? The fact that, based on the Gartner, 85% of mobile data implementation failed or abandoned mid-way [5], makes us wonder why it is difficult to get it right. It is therefore imperative for organizations to understand why it takes more than just a technology. It is not only a one-night-stand affair but a journey that needs to address the process, people and technology requirement.

The process part will need to touch on the need for how we govern the use of data within the group [16]. If we look at how technology companies such as Facebook and Google, they started with their business with data in mind. Having accumulated data since the beginning, the transition toward data-driven is seamless. Traditional businesses may have the difficulty to move toward data-driven, as their data was scattered all around. The consolidation of these data can become a taxing task. Having no governance of how these data are being managed will make it more stressful to manage. There is a high need to come out with the data governance process within the group that can simplify our journey into a data-driven organization.

It goes without saying that technology plays a big role in big data implementation. After all, there is no data if the technology is not there to generate it. And true enough, there is a lot of technology currently that is capable to help with the implementation. The question is which is the best one? And does the most expensive translate to better technology. When we go back to the actual objectives of implementing big data, most of the users seem clueless about what big data is all about. Even if we deploy the best of the breed in technology, we run a chance into turning them as the white elephant. Do we want to risk our reputation and money into that, or should we conduct our journey as and when we see it fit our requirement?

However, the most important aspect of the journey is how people adapt to the transformation that we are embarking [26]. As the mantra goes, people are the most valuable asset in any organization. There is no denying that for any transformation to be successful, we need to ensure our people will understand and embrace the change to their hearts. Being data-driven means that we will embrace data and use it for our day-to-day decision making. This would entail the need for us to be able to story tell our data in the most meaningful way, thus making sure it can back up any of our claims. It is no longer about gut feeling. Now it is the time that gut feeling is substantiated with quantified data.

5. Challenges of Big Data Implementation

There are many challenges that companies need to weather when adopting big data. In fact, one of the major challenges of big data is to ensure that individual privacy is not breached. We leave behind digital footprints whenever we conducted our lives online. These data, when combined with other data sources,

could denote unique aspects about us that would otherwise go unnoticed. This is akin to the concept of digital DNA [27].

The availability of a bigger pool of data also does not necessarily mean we are a way of better when it comes to getting an answer to our question. The notion of ‘‘garbage in, garbage out’’ still holds when it comes to big data [28]. The data is only as good as its value. That is why the value in big data definition plays a big role before any organization can benefit anything out of it. Big datasets can generate dirty, gamed or biased data, or data with poor fidelity. Any analysis conducted on it surely will produce an answer that has a weakened validity and deliver fewer benefits. It might even lead to a wrong conclusion that can prove to be fatal sometime.

The increasing demand for big data analysts who can crunch and communicate the numbers and the lack of managers and business leaders who can interpret the data means there is a growing talent shortage that organizations may face. A survey conducted by New Vantage Partners indicated that companies are facing difficulty in finding and hiring big data professionals [29]. Having a large volume of data is meaningless if the organization does not have any clue of what question to ask.

Wamba, Akter, Edwards, Chopin, & Gnanzou [16] in their study has identified data policy can be a barrier for any organization to embark on big data analytics. Traditionally, most of the enterprise's systems were being deployed in-silo. There was no integration between one system to another. Due to this design nature, there is a possibility that more than one system can carry the same kind of data. Apart from wasting the storage resource, having multiple sets of data across the organization may present another set of the challenge when it comes to reporting. Multiple versions of the truth can create asymmetry when it comes to using data as part of decision making.

Big data technology is also having a higher cost of implementation in comparison to the existing analytical technology [30]. The 5Vs characteristic of big data is a contributor to this increase in cost. The organization would need to invest in better technology that can cope with the increasing speed and volume of data that are being produced. Large organizations may have additional resources to invest in this initiative and gain the advantage of big data. Small organizations may not have the same capacity to invest in technology. This is what has been echoed Boyd & Crawford [31], in which they have suggested that big data can create the digital divide, in which only the organization with financial muscles can competitively edge its competitor.

6. Research Setting

The action research for this study is being conducted within the context of Prasarana Malaysia Berhad (Prasarana), a wholly-owned Malaysian Ministry of Finance (MoF) company that has been entrusted to transform Malaysia’s public transportation services by incorporating the previous concessionaire lines in the city and embarking on a long-term programme of physical, brand and increasingly fares and ticketing integration [32].

Established in 1998, Prasarana has been operating since 2002. Prasarana owns and operates the country’s urban rail services that include three LRT networks and

the KL Monorail, in addition to operating the MRT line. Prasarana also owns and operates the stage bus services in Kuala Lumpur, Selangor, Penang, Perak, and Pahang. Operating the largest fleet of buses in Klang Valley, Penang, and Kuantan, as well as the four rail lines within Klang Valley, Prasarana is relying heavily on the use of technology to automate some of these operations.

Generally, the system can be divided into three main categories; which is a corporate services system, rail system, and bus system. The corporate services system is being deployed to cater to the requirement across the whole group. For example, in order to ensure the rail and bus assets are being maintained accordingly, the use of Enterprise Resource Planning (ERP) software is being used to track the maintenance of the asset. This asset management software is being integrated together with the Financial system as well as the Human Resource system, thus ensuring the integrated view of the company performance. Knowledge Management System is being made available to the employee of the company. This system is being used to capture any tacit and explicit knowledge within the group. Physical documents that are circulating in the group will be converted into digital form. These digital documents and other such as email, video, and audio will be fed into the Knowledge Management System, thus making it a powerful data warehouse for the company.

The use of the token, as well as touch card for the Fare Collection System (FCS) or Automated Fare Collection (AFC), is becoming a norm. As society is moving towards cashless, the introduction of other ticketing media such as Near Field Communication (NFC), e-Wallet and other mediums are being explored by the regulator for future consideration. At the same time, fleets are being tracked at the Operation Control Center (OCC) and Bus Control Center (BCC). The availability of Automatic Vehicle Locator (AVL) for buses allows real-time information about the bus whereabouts. This information will be shared with the passenger, thus making their journey planning much more efficient. Prasarana is also utilizing the use of social media to engage with its customers. They are now able to use Twitter or Facebook to reach out and communicate with the contact centre user to enquire about any services rendered by the company.

However, as most of these systems are built in-silo, extensive use of these data under a single data warehouse is non-existence. In the study conducted by Capgemini Consulting, 46% of the organization believe data lying in-silo has hampered their effort to implement a big data project [33]. Valuable insights would normally available by integrating and analysing data from all these silos. Thus, having data silo within the environment caused wasted resources as well as inhibited productivity. As data sits on multiple systems, the company is having difficulties to have a single view of the dashboard, as the effort to consolidate all the information can be time-consuming. Reporting would have to be done from multiple data-points.

7. Research Methodology

There is a growing interest in the subject of big data. It is not surprising that researchers started to look deeper into the subject. Numerous previous works of literature have shown where researchers have empirically look into why organizations from various industries adopted big data in their environment. Verma & Sekhar [34] were using a qualitative approach to understand factors on

why Indian adopt BDA. A similar approach was adopted by Ramanathan, Philpott, Duan, & Cao [35] when they performed a study to understand the issues faced by the retails sector in the UK. Mikalef et al. [3] meanwhile employed mix-method when they conducted the study to understand the link between the use of BDA and firm performance, where they highlighted the inter-relationship between BDA and firm performance as well as the challenges faced by those organizations. There were many kinds of research that performed a quantitative method to study the determinants that affect the adoption of big data. Coupled with frameworks such as Technology Adoption Model (TAM), TOE (Technology-Organization-Environment), Diffusion of Innovation (DOI) and UTAUT, there are many identified determinants that affect why organizations adopt BDA. Some of the examples are study conducted by Soon, Lee, & Boursier (2016)[36] that try to understand the determinant of adoption of BDA for private companies in Malaysia, Almoqren & Altayar [37] whom research setting were in Saudi banks, and Al-Rahmi et al. [38] where they explore the adoption of BDA and knowledge sharing within educational environment.

There has also been much systematic literature review (SLR) that were conducted to review current studies of BDA within the various industry. Kamilaris, Kartakoullis, & Prenafeta-Boldu [39] have performed an extensive review of BDA usage among the agricultural ecosystem and found that the use of BDA is still at the early development stage. Akoka, Comyn-wattiau, Laoufi, & Laou [40] meanwhile, performed a systematic mapping study to review how researchers grasp the concept of big data. Their finding seems to reflect the continuing trend of big data popularity, whereby significant contributions have been made by the research community. A number of the SLR touch on the taxonomy of BDA as well as the applications of BDA within the industry setting. Among the examples are research in [16],[41],[42],[43].

There is however a lack of research on big data that is using the Action Research (AR) methodology. Baskerville & Wood-Harper [44], has suggested that action research was ideal as a systems development methodology for information systems (IS) research. Rather than looking at the research from outside of the research setting, the researcher in AR is involved directly in the research setting and intervenes with the outcome of the research. In this way, the action researcher can intervene in the organizational change and simultaneously studies the impact of this change [45]. Nonetheless, Baskerville & Wood-Harper [44] suggested that action researchers in IS can run into risk that their finding will be questioned on philosophical grounds. Issues such as lack of discipline, lack of impartiality, confusion with consulting can always derail the objective of conducting the research. These can be overcome by observing strict rules when conducting the AR. The need to establish ethical client-system infrastructure and research environment is a must. Data collection must also be planned properly. Every iterative phase that involved the formulation of the strategy, plan action, takes action and evaluation of action must be observed as well.

Within the setting of the largest PT operator in Malaysia, the development and implementation of BDA were given a high priority by the top management. While the availability of the data was very much apparent, the use of BDA to complement the analytics of these data wasn't as extensive as the management would like to be. As a result, there was a strong push for the development and implementation of the technology. The researcher has been entrusted to drive the

development and implementation of the BDA, starting from January 2019. This study will make use of the five-phase, cyclical process to execute the development and implementation of BDA.

8. Conclusion

It is not going to be an easy journey toward the adoption of big data. Challenges abound that may derail the good intention that big data can provide. Issues such as data privacy, technology complexity, talent availability and more can hamper the journey toward data-driven economic decisions. While waiting for the technology to become mature, it is important for the organization to be aware of the benefit of big data and taking the first step to leap into the technology. As such, when the technology has become mature, and all those challenges have at least been ironed out, the organization would not be a laggard and lost in the race to have that competitive advantage.

The use of action research in the study can be a rewarding experience yet challenging at the same time. In Prasarana's setting, the development and implementation of big data are timely and long outstanding. It is, however, a complex implementation that requires effort to ensure the people, process and technology components are being addressed simultaneously. What makes AR attractive in assisting the development and implementation of BDA are the flexibility it allows the researcher to research on their own professional activities while at the same time helping the researcher to implement the change effectively. AR can also develop a holistic understanding of the entire cycle of the change. In the end, the knowledge gain throughout the AR cycle can become a bridge between theory and practice, allowing Prasarana to solve real-world problems while contributing to the generation of new knowledge.

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