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CHAPTER 7

SOCIAL MEDIA FOR IMPROVING METRO RAIL PROJECT OPERATIONS

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7.1 INTRODUCTION

Countries across the world are investing heavily in infrastructure projects to achieve their socio-economic objectives. These projects are created with enormous budgets and are often called as infrastructure megaprojects, i.e., projects costing more than one billion USD (Flyvbjerg, 2014). Wang et al. (2020) suggested that the boom in megaprojects is having 'a significant impact on social and economic developments (e.g., immigrant settlement, poverty eradication, and public health) as well as the natural environment (e.g., ecological processes and biodiversity)' (p. 831). Majority of these expenses are incurred in the planning and construction phase, due to which the front-end of these projects draw attention from policy makers, construction companies, designers, and researchers (Osei-Kyei and Chan, 2015). However, the value to the society or impact on the society is realized only in the later periods of these projects, particularly the operation phase and projects are remembered for how they serve the community more than the efficiency of construction phase. For example, the Sydney Opera house was a project management failure resulting in cost overrun and time overrun but is now an iconic symbol for Sydney and even Australia.

Most infrastructure projects have a lifecycle of 60-80 years, with the initial 4-5 years earmarked for planning and the next 4-5 years for construction. The remaining period of the infrastructure project is its operation phase, which takes up the largest portion of the project's lifecycle (Liu et al., 2014). An infrastructure project with a poorly managed operational phase undermines the project objectives and erodes its value for money (Osei-Kyei et al., 2017). In contrast, a high performing infrastructure project is generally associated with high operational efficiency and addressing the needs of the society (Partnerships UK, 2006). The consistent ignoring of the operations phase by the designers, contractors, policy makers and researchers has led to recurrent occurrence of problems and thereby increased lifecycle costs of these projects (Karim & Magnusson, 2008). Projects require an integration of its life-cycle dynamism, stakeholder heterogeneity, and social responsibility interactivity (Lin et al., 2017), most of which are only evident during the operation phase.

The research reported in this chapter discusses how the operation phase of infrastructure projects can be managed effectively. Frequent monitoring of the operations of a project can help the decision makers to accurately evaluate the performance objectives and take corrective actions to increase value for the society (Osei-Kyei et al., 2017). Considering project management in the twenty first century, inferences to operation management can be drawn from the digital big data. Big data sets are increasingly used to help public managers derive real-time insights into behavioural changes, public opinion, or daily life (Mergel et al., 2016). Particularly, we look at the big data available on social media regarding the project. Megaprojects, due to their large scale, complex and controversial nature (Frick et al., 2008) attract a lot of attention on these digital platforms, with users taking it to social media to express their sentiments regarding the project. The large social media data can be mined to address concerns of the community and improve services during the operation phase of infrastructure projects. Social media is one of the significant channels for constructing voice of customer which is increasingly being used to provide qualitative feedback on benefits tracking and data-driven decisioning. Data Science Initiatives (DSI) which include investments in data analytics, business intelligence and data science including machine learning and artificial intelligence (Mathur, Sankaran, MacAulay, & Tsang, 2021) provide us with a mechanism to harness the bigdata including that on social media generated during delivery and in operation phase. Mathur et al. (2021) proposed a DSI Delivery Framework synthesizing program management, change management, scaled agile, data management and data science domains for program managers to realise value from such investments. Hence, our research objective is to develop a framework for engaging with the users of an infrastructure project during the operation phase using social media big data.

This chapter is organized as follows. In the next section, the literature on challenges in operation phase, the use of big data, and the role of social media in projects are discussed. Following this, the case study of two metro rail projects in Sydney, Australia and Chennai, India are introduced along with the data collection and analysis methods employed. The findings section discusses how social media can be an effective way to manage the operation phase of infrastructure projects. Subsequently, the challenges of using social media platform and the proposed data science initiative delivery framework are discussed. The final section highlights the contributions, limitations, and scope for future research in the area.

7.2 LITERATURE REVIEW

7.2.1 Importance of operational phase for projects

The operations phase of an infrastructure asset covers the running, repair and maintenance of the project (Liu et al., 2014). There can be multiple concerns during the operation phase of an infrastructure asset that can affect the long-term demand of the facility (Osei-Kyei et al., 2017). Research has highlighted that the most reported problems in infrastructure projects are evident during the operational stages, and some are exclusively confined to this phase (Edwards et al., 2004). The application of improper operations and maintenance methods can reduce the productivity of the asset and value for the users (Ghalenoeei et al., 2021). It is also important to have effective safety and environmental health management systems in place for successful operations of an infrastructure asset (Liu et al., 2014).

Despite the importance of the operations phase, maintainability of an infrastructure project is seldom considered a priority for designers and policymakers (Barbarosoglu & Arditi, 2019). Many scholars (Brochner, 2003; Meng, 2013; Wang & Xie, 2002) argue that the problems in the operations phase of an infrastructure asset result from wrong processes and decisions from the early phases of projects. In short, the decisions made in the initial stages of the project can affect the fate of the asset during its lifecycle (Dunston & Williamson, 1999). Others claim the problems arise due to lack of constructive feedbacks from the operations and maintenance staff to the design team during the planning phase (Jensen, 2009). It is appropriate and cost effective to consider various aspects of operations in the early stages of projects and revise the project parameters, considering that the ability to change is high and the cost to change is low during the early stages

(Gardiner & Simmons, 1992). Thus, frameworks have been created to bring the operators and maintenance professionals together with designers during the planning phase to address the future operational issues (Rivera-Vazquez et al., 2009). Even the use of personnel knowledge and experience throughout the lifecycle are considered by designers for creating a project well suited to operation phase (Liu & Issa, 2016).

7.2.2 Foreseeing operational issues

It is rarely possible for projects to foresee all the operational issues in the front-end itself, especially considering the long life of these projects. In some cases, knowledge of operations in different societies are contradictory making its translation to design stages complex (Cheng, 2004). Even within the same context, it is not possible for planners to foresee all the challenges that the project would experience during its lifetime. As Mok et al. (2015) highlights, project managers are unable to comprehend the full project lifecycle because of their limited cognition. Unforeseen events can occur in projects during its lifecycle as it is not possible for even experts to forecast anything over a year (Flyvbjerg, 2021). Ma et al. (2017) argued that 'the prolonged lifecycle and heterogeneous stakeholders of megaprojects have posed great challenges for the governance of the economic, social, and environmental issues involved' (p. 1365). Even though the ability to make changes in a project decreases with time, some adjustments can still be made to improve the experience of the users. So, it is important to listen to the users of the infrastructure asset and take necessary actions for improving operations.

Reliable and effective service delivery is important as any public project aims to achieve service as the end result (Robinson and Scott, 2009; Meng et al. 2011). The service delivery framework of project needs to be periodically evaluated and updated based on the changing needs of the society (Partnerships UK, 2006; Mladenovic et al., 2013). Scholars have also suggested that user fee adjustments have to be made routinely and stakeholders including public users and trade unions have to be consulted prior to these adjustments (Kumaraswamy and Morris, 2002; Edwards et al., 2004). Additionally, there should be a focus on timely rectification of operational problems encountered by the users (Partnerships UK, 2006). For all these, there should be proper stakeholder engagement not just during the front end of a project, but also during the operation phase. As noted by Tang et al., (2012), transparency and frequent communication with external stakeholders during the operation phase is a critical factor for the success of infrastructure projects. There is a need to create an efficient system for bringing in feedbacks from the users to improve the infrastructure service and manage the dynamic operation phases of infrastructure assets.

7.2.3 Stakeholder engagement in the backend of projects

Stakeholder engagement has traditionally been restricted to the front end of infrastructure projects. For example, stakeholder engagement in co-creation sessions helped in cocreation of public values in front end of infrastructure development programs (Liu et al., 2019; Oldenhof et al., 2014; Steenhuisen and van Eeten 2008). However, there is a growing argument that stakeholder engagement should not be restricted to just the planning stages of a megaproject, but also extent to the construction and operations phase (Ninan et al., 2020). Stakeholders have to be engaged during the operation phase to considerably inform practitioners of the key operational management issues which need critical attention (Osei-Kyei et al., 2017). Traditionally these are done through surveys, interviews, questionnaires and feedback forms.

In the modern era, data from different online sources can be compiled to manage projects better (Ninan, 2020). Big data is the large, diverse, complex, longitudinal, and/or distributed data sets generated from instruments, sensors, Internet transactions, email, video, click streams, and/or all other digital sources available today and in the future (Favaretto et al. 2020; p.3). Big data sets are increasingly used to help public managers derive real-time insights into behavioural changes, public opinion, or daily life (Mergel et al. 2016). Big data has been used to evaluate customer agility and responsiveness for public value creation. It is predicted that new smart technologies and strategies will shape and will be shaped by the future of public organizations and management and could lead to transformative practices in the public sector. There are already some examples from around the world that big data has been useful in providing more transparent information to the public and citizens such as healthcare (Raghupathi and Raghupathi 2014; Ziora 2015); public sector performance (Bovaird and Loeffler 2015) and smart cities (Al Nuaimi et al. 2015).

Big data can be generated from a wide range of sources to create value in infrastructure megaprojects. Sensors can record the people movement in stations (Alawad and Kaewunruen 2018) and can help decision-makers increase or decrease the frequency of trains for certain periods of the day. The way people move within the stations can also help decision-makers allocate commercial space in the stations effectively. Another source of big data generated by infrastructure users is the data available on social media. Social media data can enable us to understand megaprojects better as many conversations relating to projects are only evident online and they are not currently captured or analysed (Ninan, 2020). Even though there are large amounts of data generated in the social media regarding infrastructure projects daily, researchers have not explored the scope of using this big data for decision-making in infrastructure projects. Social media has been used in projects for studying branding practices (Ninan et al., 2019), requirements management (Daemi et al., 2020), consultation process (Lobo & Abid, 2020), stakeholder engagement process (Ninan et al., 2020; Lehtinen, 2021), knowledge sharing (Ma et al., 2021). It is in this context that we situate our research to understand how social media can be used to manage the operation phase in infrastructure megaprojects. In one of our earlier research projects, we found that there were more tweets with complaints about the infrastructure service than compliments about it (Mathur et al., 2021). People generally log into social media to criticize rather than to praise (Park, 2015). As noted by Dwivedi et al. (2021) negative information flows faster than positive information in social media platforms. Project operators can mine this data source for a good understanding of the concerns of the community during the operation phase and then address these to improve services.

7.3 RESEARCH SETTING AND METHOD

To understand how the big data from social media can be used to manage the megaproject operations, we chose a qualitative research methodology. Scholars have suggested that such a method is apt for exploratory research when the aim is to gain familiarity with a problem or to generate new insights for future research (Eisenhardt 1989; Scott 1965). Within the qualitative research methodologies, we chose to use multiple case study method as it provides excellent opportunities to enhance contextual understanding and simultaneously enable the generalization of findings (Flyvbjerg 2006; Saunders et al., 2009). Multiple-case design brings benefits of robustness, versatility and replication (Yin, 2017).

We chose the case study of a metro rail project in Australia and India to understand the scope of using social media for managing the operations phase. We selected the Sydney metro rail project from Australia and the Chennai metro rail project from India because of their similarities. Both the projects started operation around the same time and had similar track length, 36 kms and 45.1 kms respectively. Twitter posts of the Sydney metro rail project and Chennai metro rail project was captured through a Twitter search API. The keywords are the titles of two projects, i.e., "Chennai Metro" and "Sydney Metro". It is acknowledged that some tweets would not be retrieved if those tweets discussed the two projects without using the keywords. No duplicates were observed on checking the unique ID of each tweet, and the collected data were stored as a comma-separated values (CSV) file. We collected the tweets for a 90-day period from 1 July 2019 to 30 September 2019, during which both the metro rail projects were operational. There were 5960 tweets relating to the Sydney metro rail project and 1064 tweets relating to the Chennai metro rail project. All the tweets were in English.

Table 7.1: Summary of cases considered

	Sydney metro rail	**Chennai metro rail**
Operation start date	26 May 2019	10 February 2019
Operational network length	36 kms	45.1 kms
Keyword used for search	"Sydney Metro"	"Chennai Metro"
Period of data collected	1 July 2019 to 30 September 2019	1 July 2019 to 30 September 2019
Tweets collected	5960	1064

For analysis, we used content analysis and open coding of the tweets collected to understand what each tweet conveyed. The process was very iterative, and we took multiple readings of the tweets as some categories are often not obvious until the second or third reading (Steger, 2007), due to the focus on content and meaning. We employed manual coding as automatic methods could create a barrier to understanding in this exploratory study (Kozinets et al., 2014).

7.4 FINDINGS

From the analysis of the social media tweets collected from the Sydney metro rail and Chennai metro rail, we found that social media can be used for collating feedbacks from the users and charting the future direction of the infrastructure project. Social media can inform project operators on the day-to-day technical operational issues, collating the suggestions to improve, and capturing the live sentiments associated with the project.

7.4.1 Social media for addressing day-to-day technical operational issues

Issues relating to operation of the infrastructure service have to be addressed as soon as possible for smooth service. The users widely shared operational issues relating to the project on Twitter across both projects. In Chennai metro rail, one user complained in Twitter that the doors were not opening in one of the stations as below,

> "Crazy. @chennaimetro rail's doors didn't open when it stopped @Pachaiyappas metro station, at around 11am today, putting the passengers to hardships. What's happening?" (2 Sept 2019)

Similarly, in the case of Sydney metro rail, a user complained about lifts being out of service in one of the stations.

> "The lift between the concourse and the platforms at North Ryde is out of service" (29 Sept 2019)

In the case of the Sydney metro rail project, besides complaints about specific facilities such as USB points, air conditioning, thermometers and escalators, the most common complaints were about train delays. Social media provides an excellent platform where users of the infrastructure service post day to day operational issues surrounding the projects. We can create more value in infrastructure projects if we can systematically collect this big data, analyse them through algorithms, and efficiently communicate it to the service team to mitigate the current issue through timely action.

7.4.2 Social media for collating suggestions to improve

Many users are active stakeholders offering multiple suggestions to improve the services. In contrast to operational issues, suggestions to improve are more than addressing an operational defect on a particular day. For example, in the case of the Sydney metro, a user offered a suggestion to fix the 15 second door opening duration before people get hurt, as below.

> "@SydneyMetro Your 15 second door opening is stupid and dangerous. People cannot get off the train in the fifteen seconds. Fix it before people get hurt" (16 Sept 2019).

Similarly, in the case of Chennai metro, a user suggested to bring down the ticket costs and this will lead to more traffic and hence revenue, as below.

> "Volumes shud b the mantra & increased patronage vl automatically bring in more revenue & help in bridging gap btw cost & income." (30 Sept 2019).

In the case of the Chennai metro rail project, the community complained about different aspects of the project such as its unaffordability and poor design. Collating such suggestions to improve can help the project create more value for the society as decision makers would know the main issues raised by the community.

7.4.3 Social media for capturing the live sentiments associated with the project

The users also communicated their feelings regarding the project on social media. They posted selfies and took pride in the megaproject being in their city. In one instance, a user in the Sydney metro rail claimed they are having fun and feel like they are on a holiday, as below.

> "Tbh going on the Sydney metro makes me feel like I'm on holidays … So fun" (30 Sept 2019)

In the case of Chennai metro rail, a user claimed that the project is a step towards public transport as many are leaving their cars and choosing to travel by metro. The user also claims that the metro rail is a safe, convenient and clean means of transport, as highlighted below.

> "Yes, of course. It's getting there. It's visible in office as there are many of us who leave our cars at the station and take the Metro. So many people exercising this option that safe and convenient and clean" (20 Aug 2019)

Capturing live sentiments can give guidance to investors to make long term strategic decisions such as which route has to be expanded. It can also help the project take suitable steps to improve the sentiment associated with the project such as offering complimentary rides for school children or celebrating a regional festival (Ninan et al., 2019). By using big data from social media to analyse sentiments, decision-makers can take proper strategic decisions to create more value to the public.

7.5 DISCUSSION

As discussed above social media can help manage the operation phase of infrastructure projects, however there are certain challenges in analysing the data. After discussing these challenges, we will highlight the steps to create a data science initiative delivery framework for using social media for operations management of infrastructure megaprojects.

7.5.1 Challenges of using the social media platform

The major challenge to deriving inferences from big data is the bias in data. The presence of interest groups and predominance of younger group can bias the findings from social media.

1. Presence of interest groups: One of the pressing issues of public infrastructure projects is a change for the most vocal instead of most affected. The most vocal opposition tend to challenge infrastructure development and often get what they want from the project (Bornstein, 2010). In the case of the Chennai metro rail project there was an interest group campaigning against land acquisition often posting the same message daily on social media. Similarly, some tweets were often re-tweeted, and this can also create a challenge in analysing the big data and making decisions relating to suggestions to improve the service.
2. Predominance of younger groups: One of the most highlighted limitations of social media data is its inability to represent the entire population. Younger population have substantial technical knowledge, digital familiarity, and willingness to engage online and, hence, are more represented on social media (Kaplan and Haenlein, 2010), which can bias the data. Critical insights for the infrastructure operation such as elderly care and access ramps may not be represented in social media discourses. Therefore, the insights gained from the analysis on social media on the way people behave may not be representative of all age groups and needs to be coupled with traditional feedback mechanisms, such as feedback forms or suggestions from customer service counters.

To address these challenges, a data science initiative framework, which can reduce bias due to presence of interest groups and predominance of younger groups needs to be implemented.

7.5.2 Data Science Initiative (DSI) delivery framework

Data science initiative is “a set of fundamental principles that support and guide the principled extraction of information and knowledge from data” (Provost & Fawcett, 2013). DSIs have unique characteristics and pose challenges delivering the envisaged value when using traditional processes for managing ICT-enabled programs (Mathur, Sankaran, MacAulay, & Tsang, 2021). Infrastructure assets such as metro rails, bridges, dykes, and roads are by nature data intensive and data science initiatives are required for the digital transformation and management of these assets (Brous et al., 2020; Berman, 2012). Organizations without data science capability may find it difficult to compete in a technology intensive environment. Sensing this many infrastructure asset managers are introducing data science initiatives to support predictive maintenance modelling and anomaly detection (Chen et al., 2012; van der Aalst, 2016). Our proposed framework seeks to use social media data for predictive analysis and would help in the operations management of infrastructure assets.

Data science initiatives are complex and encompasses a broad range of knowledge and capabilities such as data mining and machine learning, which are designed to extract knowledge from data (Brous et al., 2020). The quality of the data being used determines the decision-outcomes of data science models and thereby the success of the initiative (Lee & Pan, 2017). A data governance framework defined as the exercise of authority and control over the management of data assets (DAMA International, 2017) can mitigate some of the challenges associated with the initiative and provide benefits. A ‘one size fits all’ approach may not work for these initiatives as all of them come with their unique set of challenges and the initiative can change depending on the domains and organizational types (Abraham et al., 2019). For the data science initiative to manage the operations phase of metro rail projects, the following steps are proposed.

1. Raw data: As discussed above, the data from Twitter can be used to manage the operations phase of metro rail projects by informing the day-to-day technical challenges, collating suggestions to improve, and capturing the live sentiments

associated with the project. Multiple data retrieval programs are available which can help retrieve the raw data from these platforms. Suitable keywords can be identified to retrieve social media messages for a particular project.

2. Process data: The raw data has to be pre-processed to make it suitable for analysis. This includes removing identifiers to anonymize the data. Automatic data collection may cause privacy infringements, both in the physical space and digital space. For example, cameras in the physical space used to track traffic movements need to remove personally identifiable data such as number plates or faces of persons in the vehicles (Cecere et al., 2015). Similarly, social media exchanges in the digital space used to manage operations phase of infrastructure projects needs to remove personally identifiable data such as names and organizations (Ninan, 2020). In addition to pre-processing to remove identifiers, noise such as use of symbols and stopwords such as 'a' and 'the' needs to be removed. Lemmatization needs be carried out to convert multiple words in tweets meaning the same thing such as drive, drove, driven into a common word. Tokenization is a final step of pre-processing where a particular text is converted to a number to enable analysis and interpretation.
3. Evaluate data: There are multiple Natural Language Processing (NLP) and Machine Learning (ML) models that can analyse the tweets to derive insights. Choosing a particular model is often an iterative process as all models may not apply to a particular context. Analysis of big data can be descriptive, predictive or prescriptive and thereby can inform different decisions during the operation phase.
4. Interpret data: Data can be interpreted through artificial intelligence to prescribe what could be done to address operational issues. A distinction can be made between the changes undertaken. Quick fixes can be proposed for addressing day-to-day technical issues. A strategic long-term implementation would be required for addressing the suggestions to improve or steps that could be taken to maintain the sentiments.

The interpreted data has to be integrated into the business process. The four processes described above operate in an iterative process for validation and refining, as shown in Figure 7.1.

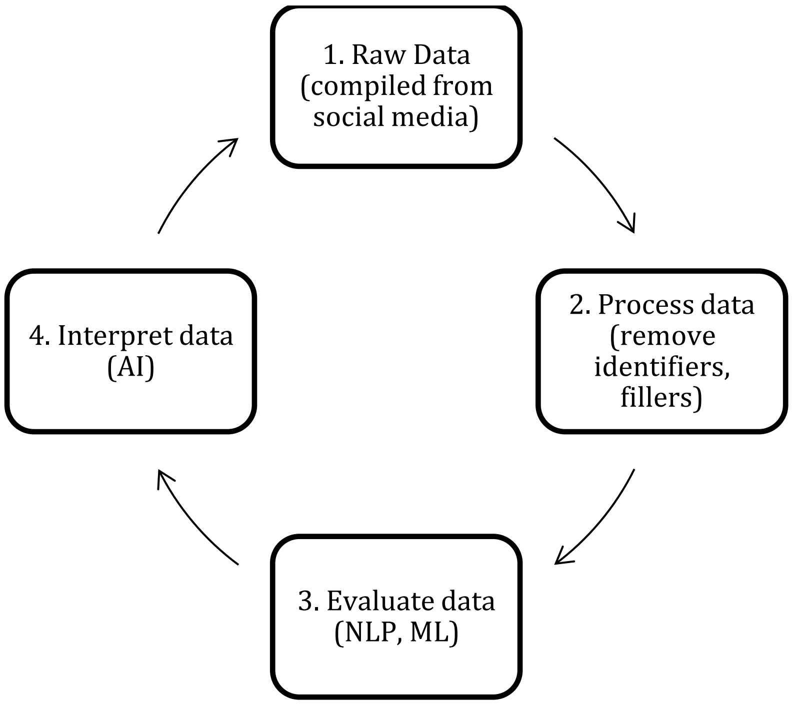

Figure 7.1: DSI process for using social media to improve metro rail operations

(Alt Text: A cyclic DSI process framework comprising of four steps – raw data, process data, evaluate data and interpret data)

Data science initiatives are delivered through a program management and involves a continuous improvement through a Plan-Do-Check-Act (PDCA) cycle. During the initial program management phase, only the owner and director of operations may be involved. Change management has to be carried out such that all stakeholders are able to adopt the initiative. Awareness and training programs can be carried out for the users on how to use social media to reach the project and for the operators on how to implement the insights generated from social media. A change manager may be required for this phase along with business analyst. Initially, only a small scope is taken up through the DSI initiative. Subsequent scaling of the DSI framework is taken up based on the feedback from earlier iterations. Agile frameworks can be implemented for scaling the DSI implementation. Support can be taken from agile coaches, developers, project managers and testers during this phase. Data management is an important step in the DSI framework. The collected data needs to be stored safely after removing the identifiers from the data. For the data science stage, data scientists, analysts, project manager and even the director of operations may be involved. The DSI framework for social media use during operations phase is summarized in Table 7.2.

Table 7.2: DSI delivery framework

Domains	Key actions	People
Program Management	PDCA cyclic process	Owner, Director (Operations)
Change management	Awareness creation; training programs; working concept	Change manager, Business Analyst, Employees and customers
Scaled agile	Start small and scale (one or two action points initially)	Agile coach, Developers, Project Managers, Testers
Data management	Data storage and retrieval; Data security; Automated pre-processing	Data manager, Data scientist, Data analyst
Data science	Prescriptive and predictive analysis; model validation and implementation	Data scientist, Data analyst, Project Manager, Director (Operations)

7.5.3 Social media for active transport at Transport for NSW, Australia

While our original study focussed on Sydney Metro and Chennai Metro, further use case emerged in Active Transport mode at Transport for NSW, Australia. Active Transport focusses on increasing Walking and Cycling usage in NSW and provides a healthy and safe option to commute especially in the post Covid-19 world. Transport for NSW has allocated $950 million to deliver this infrastructure in the state covering both Greater Sydney and Regional & Outer Metropolitan areas. The key challenge is how to track the benefits of infrastructure which has been delivered and secondly, how to plan connected cycleways and walkways. Trials are underway using cameras to track the pedestrian and cyclist volumes as well as to get additional data on near misses and incidents. This quantitative view on walking & cycling is being complemented with a qualitative view of voice of customer using social media and surveys. A Stakeholder and Commuter Sentiment Score is being constructed to assess impact of Active Transport infrastructure on a near-real time basis. The advances in big-data technology are allowing Transport for NSW network insights to provide better service to the customers.

7.6 Conclusions

This research calls on a focus on the operations phase of the project and the use of big data to generate understanding of projects. This exploratory research is aimed at understanding how social media can be used for managing operations in infrastructure projects. Compiling insights from social media can create a comprehensive view of the interests of all stakeholders throughout an infrastructure project's lifecycle, as both external and internal stakeholders use social media and are part of the broader project community (Ninan et al., 2021).

The different data on the performance of an infrastructure asset available from social media such as day-to-day technical issues, suggestions to improve, and live sentiments are discussed from the case study of the Sydney metro rail and the Chennai metro rail project. Some of the challenges of using the social media platform for operations phase are discussed along with a framework for adoption of the data science initiative in projects. The use of social media for analysing feedbacks and engaging with the user comments affords multiple benefits such as offering real time data, identifying the major concern of the users, and presenting an intuitive tool for engaging with the community. Such a DSI initiative can pave the way for managers and stakeholders involved in projects to reduce problems, duplications, costs and to increase success of infrastructure projects in their operations. In the future, action research or autoethnography (Datta et al., 2020) methodologies can be used to understand how projects implement the proposed framework, the challenges associated with implementation, and lessons learnt.

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