

# BIG DATA ANALYTICS IN THE SRI LANKAN CONSTRUCTION INDUSTRY: AN ASSESSMENT OF THE CHALLENGES AND STRATEGIES

A.M.D.S. Atapattu<sup>1</sup>, R.M. Wattuhewa<sup>2</sup>, K.G.A.S. Waidyasekara<sup>3</sup> and R. Dilakshan<sup>4</sup>

## ABSTRACT

*The increasing complexity of construction projects and the expansion of the construction sector has complicated the data management process by highlighting the need for proper data management tools in arranging and organising construction data. Specifically, countries with developing economies such as Sri Lanka require more advanced data management tools, since the construction sector is the backbone of their economies. In this context, this study aims to identify the challenges to the implementation of Big Data Analytics (BDA) in the Sri Lankan construction sector and the potential strategies which can be adopted in overcoming the challenges for the implementation. Accordingly, a qualitative approach was followed in achieving the aim of the study. A comprehensive literature review was conducted to identify the existing body of knowledge related to the study area. Twelve semi-structured interviews were conducted for primary data collection with experts in the fields of construction and data analytics and the non-probability purposive sampling technique was used to select the experts for the data collection. Data were analysed using the content analysis method. Findings revealed that the requirement of large capital expenditure, resistance from industry professionals and lack of industry awareness are the major barriers to adopting BDA in the Sri Lankan construction sector. Eventually, it was revealed that conducting awareness sessions and educating the industry stakeholders will assist the strategic implementation of BDA in the Sri Lankan construction sector.*

**Keywords:** BDA; Data Management; Sri Lankan Construction Industry.

## 1. INTRODUCTION

The construction industry is the key contributor to developing economies and the construction sector is considered the reflection of a nation's development (Akinrata, 2016). Being a developing nation, Sri Lanka possesses a construction sector which is among the largest contributors to the country's GDP (Jayalath & Gunawardhana, 2017).

---

<sup>1</sup> Lecturer, Department of Building Economics, University of Moratuwa, Sri Lanka, [dilmia@uom.lk](mailto:dilmia@uom.lk)

<sup>2</sup> Graduate, Department of Building Economics, University of Moratuwa, Sri Lanka, [ravindumwattuhewa@gmail.com](mailto:ravindumwattuhewa@gmail.com)

<sup>3</sup> Senior Lecturer, Department of Building Economics, University of Moratuwa, Sri Lanka, [anuradha@uom.lk](mailto:anuradha@uom.lk)

<sup>4</sup> PhD Scholar, School of Engineering and Built Environment, Griffith University, Australia, [dilakshan.rajaratnam@griffithuni.edu.au](mailto:dilakshan.rajaratnam@griffithuni.edu.au)

However, the advancement of construction mechanisms is highly challenged in Sri Lanka due to its current economic conditions (Kulatilake et al., 2022). At the same time, the Sri Lankan construction industry is struggling to adapt to novel technologies in order to sustain the quality of the construction mechanisms (Cooray & Coomasaru, 2022). Specifically, data management in the Sri Lankan construction sector is also encountering considerable issues which manifest the need for proper procedures for construction data management in Sri Lanka (Kosala et al., 2021).

Meanwhile, BDA is globally accepted as an efficient data management tool which has the capacity to arrange and organise all types of data in the construction sector (Kostyunina, 2018). Further, BDA is identified as an effective measure in improving the performance of construction projects (Bilal et al., 2019). The vast amount of data generated in the construction sector can be efficaciously managed by utilising BDA and it directly assists in identifying the commercial values indicated by construction data (Wang et al., 2018). Besides, BDA has the potential in revealing the hidden value of data which manifests the importance of BDA towards construction data management (Chen & Lu, 2018). Therefore, this study is aimed at identifying the potential of utilising BDA for data management in the Sri Lankan construction context and this study intends to address the question of “how the Sri Lankan construction industry is challenged in utilising BDA and what are the strategies that could inspire the implementation of BDA in the Sri Lankan construction sector?”.

The paper is structured as follows. First, it provides a literature review on BDA in terms of applications in the construction sector. Next, the research method comprises data collection and analysis. This is followed by the findings and conclusions.

## **2. LITERATURE REVIEW**

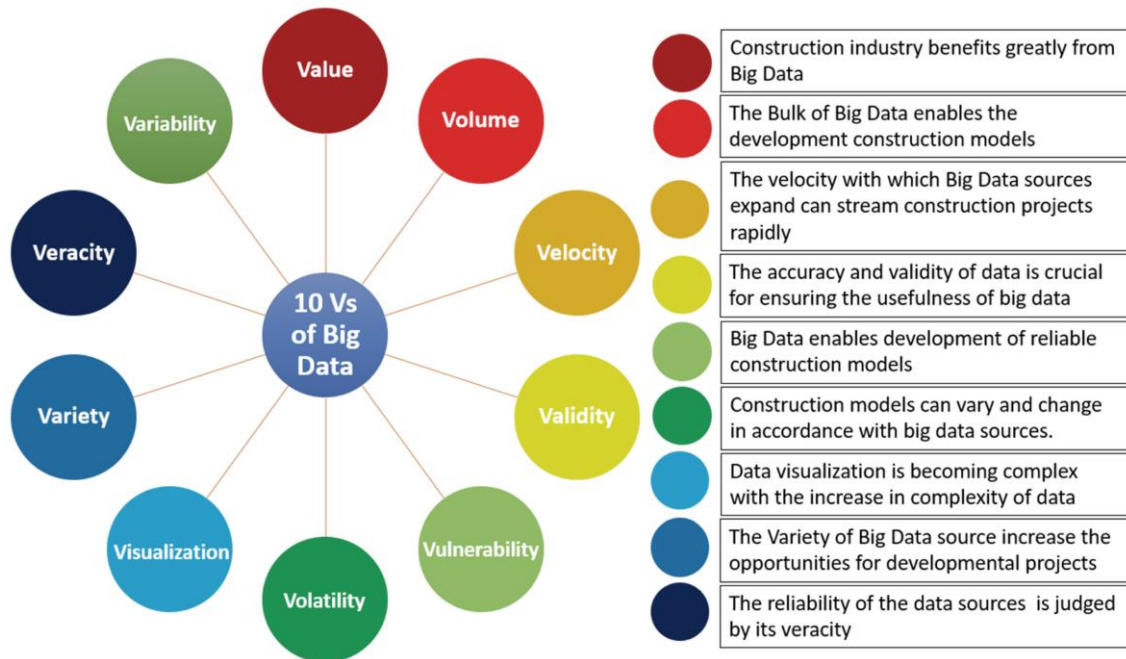
### **2.1 DATA MANAGEMENT IN THE CONSTRUCTION SECTOR**

Construction data management is a subset of information management which is focused on utilising the information for various purposes in construction mechanisms (Gaith et al., 2012). As Abu-Elkheir et al. (2013) elaborate, data management follows specific practices and data architectures in managing and extracting valuable insights from gathered or available data. Currently, it is a common focus of construction organisations to optimise the use of abundant data which have a massive capacity in improving project performance and other organisational tasks (George et al., 2014). In adhering to the rapid advancement of construction technologies, modern data management tools should also be considered since data management plays a vital role in a construction project (Wang et al., 2018). Accordingly, research has been conducted on the potential of utilising modern applications such as BDA in enhancing the productivity of construction data management (Barbosa et al., 2017; Kostyunina, 2018).

### **2.2 APPLICATION OF BDA AS A CONSTRUCTION DATA MANAGEMENT TOOL**

The main focuses of applying BDA in the construction sector are to predictively assess the data and to comprehend the link between different data available in the construction sector (Fan et al., 2014). Moreover, BDA is used by construction stakeholders in governing project progress and monitoring project performance (Ratajczak et al., 2019). Besides, BDA is used in tracking site operations, tracking material and equipment

records, productivity measuring and monitoring labour performance (Yang et al., 2015). Research suggests that BDA has the capacity of fulfilling various data management requirements with the ten (10) features specific to the concept, i.e., 10V's of Big Data (Sadiku et al., 2021). According to Munawar et al. (2022), applications, challenges and opportunities of BDA rely on these specific characteristics of Big Data i.e., value, volume, velocity, variety, veracity, volatility, validity, variability, vulnerability, and visualisation. Figure 1 detailly presents how these characteristics inspire effective data management in the construction sector.



*Figure 1: 10V's of Big Data*  
 Source: (Munawar et al., 2022)

As Figure 1 suggests, the characteristics of Big Data should be comprehended deliberately by being specific to the construction sector in order to acquire the maximum benefit of the concept. Eventually, BDA is an important tool because, in the proper application, BDA provides the right information to the right user at the right time within the key parameters of the right volume and right quality (Schermann et al., 2014).

### **2.3 WHY IT IS IMPORTANT TO IDENTIFY THE POTENTIAL OF UTILISING BDA FOR DATA MANAGEMENT IN THE SRI LANKAN CONSTRUCTION CONTEXT?**

The majority of Sri Lankan construction projects encounter time and cost overruns with a lower productivity rate which is mainly due to the poor planning and data management practices of construction projects (Jayalath & Gunawardhana, 2017). Further, most of the construction organisations in Sri Lanka follow traditional procedures for data management which are believed to reduce the effectiveness and efficiency of the overall construction project performance (Epasinghe et al., 2018). At the same time, BDA is well recognised by experts over the globe as a measure in enhancing the performance of the construction industry by optimising data management (Chen & Lu, 2018). Further, proper

use of BDA can allow process improvements while maximising the productivity levels of construction projects (Mexas & Quelhas, 2012; Wang et al., 2018).

More importantly, BDA has currently been utilised in other industries in Sri Lanka (Bolonne & Wijewardene, 2020; Samarajiva et al., 2015; Senavirathne, 2022; Surangi & Sellathurai, 2023) and the potentiality has been revealed in utilising BDA in the Sri Lankan context for few other industries even if there is a gap in utilising BDA for Sri Lankan construction context. Further, research has been conducted on using modern technologies such as Blockchain, Building Information Modelling (BIM), and Industry 4.0 for the construction sector in Sri Lanka (Cooray & Coomasaru, 2022; Epasinghe et al., 2018; Gunawardhana, 2018; Kosala et al., 2021), yet there is a gap in existing literature in utilising BDA for construction data management in Sri Lanka. Thus, it is important to address this gap by assessing the potentiality of utilising BDA for data management in the Sri Lankan construction sector as intended by the aim of this study. Specifically, Luthra and Mangla (2018) identify the importance of researching the challenges and strategies as the initial step in implementing new technology in a new context. Besides, when researching the challenges and strategies related to a specific concern, the key focus can be directed to the general challenges and strategies prior to focusing on challenges related to detailed stages (Ahmed et al., 2022). Accordingly, if the overall challenges of adopting BDA in a construction context are properly addressed, it will be conceivable in enhancing the performance of the construction industry through proper data management patterns (Ismail et al., 2018).

### 3. RESEARCH METHOD

In addressing the exploratory research question, this study adopts a qualitative approach since the qualitative method is considered the most effective approach for exploratory research (Aleixo et al., 2018). Accordingly, the survey method was followed by adopting semi-structured qualitative expert interviews since expert interviews allow researchers to identify the in-depth opinions and views of the survey participants (Priola, 2019). Further, the snowball and purposive sampling methods were followed in defining the research sample to increase the credibility of the collected data (Valerio et al., 2016). Accordingly, Table I presents the profile of the selected experts and the exposure of the experts to the research areas.

Table 1: Profile of the respondents

Respondent	Discipline	Years of Industry Experience	Exposure to the Research Areas	
			Construction Sector	BDA
R1	Ch. Quantity Surveyor	30	✓	✓
R2	Ch. Engineer	25	✓	✓
R3	Lecturer in Computer Science Engineering	20	Partially	✓
R4	IT Consultant	12	✓	✓
R5	Technical Manager in Engineering Software Development	07	✓	✓
R6	Data and Business Analyst	07	Partially	✓

Respondent	Discipline	Years of Industry Experience	Exposure to the Research Areas	
			Construction Sector	BDA
R7	Quantity Surveyor	07	✓	✓
R8	Lecturer in Architectural Software	06	✓	✓
R9	Civil Engineer	06	✓	Partially
R10	Machine Learning Engineer/ Machine Learning Researcher	02	Partially	✓
R11	Data Analyst	02	Partially	✓
R12	Cybersecurity Specialist	02	Partially	✓

The interviews were conducted until the saturation of data on the research question. The content analysis method was used to analyse the collected data for subjective data interpretations (Nayak & Singh, 2015).

## 4. RESULTS

### 4.1 CHALLENGES OF UTILISING BDA IN THE SRI LANKAN CONSTRUCTION INDUSTRY

The experts were questioned on the challenges in applying BDA to the Sri Lankan construction industry considering all the phases of a construction project and the results are presented in Table 2.

Table 2: Challenges for implementing BDA in the Sri Lankan construction industry

Challenges	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
Requirement of large capital expenditure	✓		✓		✓	✓		✓	✓		✓	✓
Resistance from professionals towards modern technologies		✓		✓	✓		✓			✓	✓	✓
Lack of awareness and knowledge by the professionals	✓		✓		✓	✓	✓	✓	✓		✓	✓
Dynamic nature of the construction industry	✓	✓		✓		✓	✓					
Fear of data loss and unauthorised access	✓	✓							✓		✓	✓
Absence of big data analytics culture within organisations		✓		✓		✓				✓		
Lack of technical advancements in the industry						✓			✓	✓		✓
Lack of government support			✓		✓			✓				

As Table 2 suggests Sri Lankan construction sector encounters considerable issues in initiating BDA applications in the construction industry and the findings of the expert survey can be comprehensively presented as follows.

- **Requirement of large capital expenditure**

Most of the respondents identified the requirement of large capital expenditure as one of the major challenges. According to R3, most construction companies are reluctant to adapt to complex data management measures since it requires high-performance computers and other expensive data management software. Further, R5 stated, *“Due to the current economic situation of Sri Lanka, many construction firms are struggling to maintain a positive cash flow”*. Therefore, the R5 mentioned that investing a considerable capital expenditure on data analytics methods will not be possible for many companies. This aspect was further highlighted by R8, who stated that most construction companies are relying on low or medium-performance computers and even the designers and other professionals have mediocre-level devices. R8 further stated that BDA requires high-performance computers and therefore, it can be considered a major challenge.

Moreover, R1 and R6 highlighted that investing in expensive data analytics software may not be possible for all construction companies, especially small-scale businesses. Accordingly, R1 stated that this capital expenditure will only be feasible for large companies and therefore, small, and medium-scale companies will fall back on the competition. As a result of this, R1 further stated that there is a possibility of small businesses being pushed out of the industry while only the large scales businesses remain as competitors. According to the respondent, this inequality is identified in most technological revolutions and R6 stated that this aspect can act as a barrier to any new companies entering the construction sector. However, both R1 and R6 stated that this barrier will disappear with time as the technology becomes less expensive and easily available over time. As an example of the above point, R1 pointed out,

*“Apple, Microsoft and Amazon are some of the companies that are quick to adopt new technology in other industries and as a result, they have been leading their respective industries. This factor can be applicable to the construction industry as well”*.

Hence, the respondents identified this as a social issue for small and medium-scale companies despite the numerous advantages BDA offers to the industry.

- **Resistance from professionals towards modern technologies**

Based on the interviews, resistance from professionals towards modern technologies was identified as a major challenge in utilising BDA in the construction industry. According to R2 and R4, many of the existing and leading construction professionals in the industry are accustomed to using traditional paper-based methods for data recording and therefore, they will show resistance to transferring to digitalised methods. In R4’s opinion, since getting used to new data management software tends to take up some time, most professionals prefer sticking to their familiar traditional methods. In addition, R5 stated, *“To adopt BDA in the construction industry, support from the industry professionals is essential”* and since there is a lack of support from many professionals, it has proven to be a challenge. Moreover, R7 highlighted that most of the established construction organisations have proven and good internal systems in place with traditional methods, and therefore, they may not see an immediate requirement to transition into digitalised data management methods.

- **Lack of awareness and knowledge by the professionals**

Lack of awareness and knowledge of construction professionals towards BDA and its usage in the industry is another main challenge identified by the respondents to the utilisation of BDA. According to R3, most construction professionals do not consider using BDA in the industry since they are not aware of the benefits it can offer to revolutionise the industry. R3 further stated that even if the users are aware of the benefits, they may not be educated on how to use these platforms and achieve the intended benefits. As supporting arguments, R5, R6, R7 and R8 stated that due to the highly technical nature of BDA, only a few professionals will be interested in learning the usage of BDA while only the professionals with advanced IT knowledge will realise the true potential of BDA to the construction industry.

- **Dynamic nature of the construction industry**

The rapidly changing and dynamic nature of the construction industry and its data is another challenge with the utilisation of BDA. As highlighted by R7, data related to construction projects tend to change with the project progression. Therefore, it may be difficult to predict and forecast future outputs with big data as the inputs to the BDA platforms change frequently. As stated by R1,

*“If we design a retaining wall, and the cost exceeds the budgetary limitations, we might consider changing the design or the materials. Even the structure itself can be changed for this purpose. Therefore, with this dynamic nature of the industry, BDA can have high costs compared to the benefits. If the analysis process takes a lot of resources, and time, it may not be worthwhile to carry out BDA for a project with a large number of changes”.*

- **Fear of data loss and unauthorised access**

According to R1, most construction professionals and companies are reluctant to share their databases with other professionals and as a result, there can be a lack of free flow of data which will be a bigger challenge in implementing BDA in construction. In addition, R2 highlighted that most of the companies may not be interested in BDA since, with the digitalisation of work, the number of cybercrimes has also increased. Therefore, the expert argued that the fear of data breaches is another factor that negatively assists the utilisation of BDA. Similar to this point, R2 further highlighted that some parties may have a fear of losing data due to technical problems and system breakdowns in adopting BDA applications.

- **Absence of big data analytics culture within organisations**

As identified by the experts, the absence of a BDA culture within organisations hinders the application of BDA in construction data management. R4 affirmed that organisational cultures mainly affect the resource allocation and the availability of infrastructure in a construction organisation. According to R2, Sri Lankan construction companies mostly follow an outdated culture in technological application which discourages the application of BDA to data management.

- **Lack of technical advancements in the industry**

According to the experts' opinion, there is an apparent lack of technical advancement in the construction industry which negatively affect the use of BDA for construction data management. R9 highlighted that the unavailability of technical advancements

significantly affects BDA applications since there are many technical requirements for the smooth implementation of this technology. As per R10 and R12's view, Sri Lanka lags a considerable level of technical advancements which are mandatory to implement BDA applications.

- **Lack of government support**

During the interview survey, it was noted that government support is not sufficiently provided for BDA implementations. R3, R5 and R8 suggest that government provides a minor consideration in stimulating novel technologies and BDA is also one of the technologies that are overlooked by the government.

Likewise, experts provided their opinion on the challenges in utilising BDA applications in the construction sector and followingly, shared their suggestions on the measures which can be followed in favouring a technological transition to BDA applications in the Sri Lankan construction sector.

#### 4.2 STRATEGIES TO OVERCOME THE CHALLENGES IN UTILISING BDA IN THE CONSTRUCTION INDUSTRY

The respondents were asked to suggest strategies related to all the phases of a construction project that can be used to overcome the challenges they identified. Accordingly, Table 3 illustrates the main strategies identified by the respondents in utilising BDA in the construction industry.

Table 3: Strategies to overcome the challenges in utilising BDA in the Sri Lankan construction industry

Strategies	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
Providing education and training to industry professionals	✓	✓	✓	✓	✓	✓		✓	✓			
Conducting awareness programs for industry professionals	✓	✓		✓					✓		✓	✓
Quantifying the benefits of BDA	✓		✓		✓		✓			✓		
Developing standards and guidelines for proper data management					✓				✓	✓		
Maintaining proper security for collected data						✓		✓				
Getting government support in promoting digitalisation							✓				✓	
Enhancing the technological applications within the industry											✓	✓

Based on Table 3, the key strategies highlighted by the respondents can be comprehensively discussed as follows.



- **Providing education and training to industry professionals**

Most respondents identified that providing education and training to industry professionals on how to use BDA platforms can help override the challenges identified in the previous chapter. In this regard, R3 and R4 stated that education and training can be provided to both fresh and established professionals by conducting workshops, seminars and even by introducing a module to the undergraduate programmes such as Civil Engineering, Architecture and Quantity Surveying. Similarly, R5 stated that by introducing basic software engineering, database management and programming knowledge to university students, they can start creating their own databases and properly manage all those data to enhance construction productivity through BDA. Further, R5 said that this step can be a good strategy for getting young professionals interested in bringing technology to the construction industry. Moreover, R6 highlighted that such education and training can help professionals with traditional mindsets towards new technologies by inspiring them to reconsider their approaches.

- **Conducting awareness programs for industry professionals**

As emphasised by R1, conducting awareness sessions is also important compared to the education and training programs. R11 and R12 mentioned that awareness programs should be conducted in general to all industries via effective platforms such as enterprise social media. R9 elaborated that *“awareness is the most important thing for the implementation of a new technology”* and R9 further emphasised the need for awareness sessions among construction professionals. Further, R2 and R4 affirmed that the awareness sessions should be conducted customising as per the construction organisational cultures and it will help the professionals to grab the essence of the concept.

- **Quantifying the benefits of BDA**

According to R1, the benefits of BDA in construction have not been quantified at present. R1 further stated, *“If we can come up with a strategy to measure the impact to the cost, speed of construction and quality of outputs due to BDA, it will become popular among clients as well as construction professionals”*. Therefore, quantifying the benefits and showing a numerical value in terms of cost or any other aspect can motivate the users to consider BDA adaptation in the construction industry. As a supporting argument, R5 stated that showing the return on investment of using BDA would drive the demand for such technologies. If the increase in the return on investment after utilising BDA can be properly calculated and communicated to the industry stakeholders, they will consider investing in BDA platforms. R5 further stated that example success stories of foreign countries can be shown to the local construction stakeholders.

- **Developing standards and guidelines for proper data management using BDA**

As R9 suggested, data management in the Sri Lankan industry is not standardised in the current context. R9 further argued that if proper BDA frameworks are proposed in utilising BDA in the construction context, it will stimulate the implementation of BDA in the Sri Lankan construction sector. Supportively, R10 suggested that construction professionals who have an in-depth knowledge of BDA can initiate the process of preparing frameworks in utilising BDA in the construction sector. Eventually, R5 commented on the potential of using standardised frameworks for effective construction

data management and R5 stated that BDA frameworks will ensure efficiency in construction data management.

- **Maintaining proper security for collected data**

As per experts' opinion, proper data security can ensure a smooth implementation of BDA applications in the construction sector. R8 suggested that construction organisations can outsource services related to data privacy and security, which is essential in accommodating a BDA culture in construction organisations. According to R6, organisations should not be reluctant to adhere to data security measures due to the initial costs since it has one of the major positive influences on the successful implementation of this concept.

- **Getting government support in promoting digitalisation and enhancing the technological applications within the industry**

The experts suggested that government should highly focus on promoting digitalisation. As R11 suggested, the government can allocate a specific budget and get the involvement of professionals in the relevant fields in promoting novel technologies in the construction industry. According to R7, the government can introduce policies and conduct sessions on promoting BDA applications since it will directly affect the advancement of the concept.

Furthermore, the experts suggested that the enhancement of technological applications within the construction industry has a direct impact on the successful implementation of the concept. R11 and R12 affirmed that BDA cannot be individually implemented and that overall technological improvements in the construction sector will strategically stimulate the application of BDA in the construction sector.

## **5. CONCLUSIONS AND RECOMMENDATIONS**

The increasing complexity of construction projects has affected the smooth flow of construction data management while highlighting the need for proper data management tools for complex construction projects. This study reveals that the Sri Lankan construction industry is in dire need of proper data management tools and BDA has the potential in making data management in construction projects more effective. The study suggests that the major challenge which hinders the implementation of BDA in the Sri Lankan construction sector is the large capital requirement which affects developing countries. Moreover, the unawareness and other myths on the security aspects challenge the transition to a BDA culture in the Sri Lankan construction sector. Nevertheless, these can be overcome by proper awareness sessions and education programmes on the use of BDA for construction data management.

Accordingly, this study contributes to the theory by revealing the challenges and strategies in establishing a BDA culture in the Sri Lankan construction sector. However, this study is limited to the general challenges and strategies of applying BDA to a construction project and further studies are directed to the detailed assessment of challenges and strategies related to the application of BDA to different stages of a construction project. Furthermore, it is important to research the feasibility of industry-specific BDA awareness sessions in Sri Lanka. Eventually, future studies are also directed at developing industry-specific BDA frameworks which can be utilised by construction professionals in standardising construction data management in Sri Lanka.

## 6. REFERENCES

- Abu-Elkheir, M., Hayajneh, M., & Ali, N. A. (2013). Data management for the internet of things: Design primitives and solution. *Sensors*, 13(11), pp.15582-15612.
- Ahmed, M., AlQadhi, S., Mallick, J., Kahla, N., Le, H., Singh, C., & Hang, H. (2022). Artificial neural networks for sustainable development of the construction industry. *Sustainability*, 14(22), 14738.
- Akinrata, E. (2016). Regional Economic Integration concept on South African construction industry: Lessons for other African construction industries. *World Scientific News*, 55, pp.77-88.
- Aleixo, A., Leal, S., & Azeiteiro, U. (2018). Conceptualization of sustainable higher education institutions, roles, barriers, and challenges for sustainability: An exploratory study in Portugal. *Journal of Cleaner Production*, 172, pp.1664-1673.
- Barbosa, F., Woetzel, J., Mischke, J., Ribeirinho, M. J., Sridhar, M., Parsons, M., . . . Brown, S. (2017). *Reinventing Construction through a Productivity Revolution*. Minneapolis: McKinsey Global Institute.
- Bilal, M., Oyedele, L. O., Kusimo, H. O., Owolabi, H. A., Akanbi, L. A., Ajayi, A. O., . . . Delgado, J. M. (2019). Investigating profitability performance of construction projects using big data: A project analytics approach. *Journal of Building Engineering*, 26.
- Bolonne, H., & Wijewardene, P. (2020). Critical factors affecting the intention to adopt big data analytics in apparel sector, Sri Lanka. *International journal of advanced computer science and applications*, 11(6), pp.149-162.
- Chen, X., & Lu, W. S. (2018). Scenarios for Applying Big Data in Boosting Construction: A Review. *Proceedings of the 21st International Symposium on Advancement of Construction Management and Real Estate* (pp. 1299-1306). Singapore: Springer.
- Cooray, N., & Coomasaru, P. (2022). Adoption of 3D printing technology in Sri Lanka's construction industry. *FARU Proceedings - 2022* (pp. 102-109). FARU, Research Unit, University of Moratuwa, Sri Lanka.
- Epassinghe, E., Jayasena, H., Kolugala, L., & Wijewickrama, M. (2018). Open BIM Adoption in Sri Lankan Construction Industry. *FOSS4G Asia 2018 Conference Proceedings*, (pp. 1-12).
- Fan, J., Han, F., & Liu, H. (2014). Challenges of big data analysis . *National Science Review* , pp.1-22.
- Gaith, F. H., Khalim, A. R., & Ismail, A. (2012). Application and efficacy of information technology in construction industry. *Scientific Research and Essays*, 7(38), pp.3223-3242.
- George, G., Haas, M., & Pentland, A. S. (2014). Big data and management. *Academy of Management Journal*, 57(2), pp.321-326.
- Gunawardhana, W. (2018). *Adaptability of digital technologies in construction practices in Sri Lanka*. Student Thesis, University of Moratuwa.
- Ismail, S. A., Bandi, S., & Maaz, Z. N. (2018). An appraisal into the potential application of big data in the construction industry. *International Journal of Built Environment and Sustainability*, 5(2), pp.145-154.
- Jayalath, A., & Gunawardhana, T. (2017). Towards Sustainable Constructions: Trends in Sri Lankan Construction Industry - A Review. *International Conference on Real Estate Management and Valuation* (pp. 137-143). ISSN: 2602-8565.
- Kosala, H., Francis, M., & Sirimewan, D. (2021). Applicability of blockchain technology to manage financial issues in the Sri Lankan construction industry. *Proceedings of the 9th World Construction Symposium*, (pp. 86-97).
- Kostyunina, T. (2018). Classification of operational risks in construction companies on the basis of big data. *Proceedings of MATEC Web of Conferences* (pp. 1-8). France: EDP Sciences.
- Kulatilake, N., Udawattha, C., & Ariyawansa, R. (2022). Sustainable facilities management framework for Sri Lankan construction industry. *19th International Conference on Business Management* (pp. 55-80). ICBM.
- Luthra, S., & Mangla, S. K. (2018). Evaluating challenges to Industry 4.0 initiatives for supply chain sustainability in emerging economies. *Process Safety and Environmental Protection*, 117, pp.168-179.
- Mexas, M. P., & Quelhas, O. L. (2012). Prioritization of enterprise resource planning systems criteria: Focusing on construction industry. *International Journal of Production Economics*, 139(1), pp.340-350.

- Munawar, H., Ullah, F., Qayyum, S., & Shahzad, D. (2022). Big Data in Construction: Current Applications and Future Opportunities. *Big Data and Cognitive Computing*, 6(1).
- Nayak, J. K., & Singh, P. (2015). *Fundamentals of Research Methodology: Problems and Prospects*. New Delhi: SSDN Publishers and Distributors.
- Priola, C. (2019). *Understanding Different Research Perspectives*. The Open University.
- Ratajczak, J., Riedl, M., & Matt, D. T. (2019). BIM-based and AR application combined with location-based management system for the improvement of the construction performance. *Buildings - MDPI*, 9(118), pp.1-17.
- Sadiku, M. N., Suman, G. K., & Musa, S. M. (2021). Big data in engineering: A primer. *International Journal of Advances in Scientific Research and Engineering (IJASRE)*, 7(10), pp.1-7.
- Samarajiva, R., Lokanathan, S., Madhawa, K., Kreindler, G., & Maldeniya, D. (2015). Big data to improve urban planning. *Economic and Political Weekly*, pp.42-48.
- Schermann, M., Hensen, H., Buchmuller, C., Bitter, T., Krcmar, H., Markl, V., & Hoeren, T. (2014). Big data: An interdisciplinary opportunity for information systems research. *Business & Information Systems Engineering*, 6(5), 2pp.61-266.
- Senavirathne, R. T. (2022). Application of big data analytics in telecommunication sector company in Sri Lanka: with reference to marketing perspective. *Sri Lanka Journal of Marketing*, 8(3), pp.114-140.
- Surangi, H., & Sellathurai, T. (2023). The role of big data analytics in personalised services - the case of Sri Lankan banking sector. *International Journal of Big Data Management*, 2(2), pp.133-151.
- Valerio, M., Rodriguez, N., Winkler, P., Lopez, J., Dennison, M., Liang, Y., & Turner, B. (2016). Comparing two sampling methods to engage hard-to-reach communities in research priority setting. *BMC Medical Research Methodology*, 16.
- Wang, D., Fan, J., Fu, H., & Zhang, B. (2018). *Research on optimization of big data construction engineering quality management based on RNN-LSTM*. China: Wiley.
- Yang, J., Park, M., Vela, P. A., & Golparvar-Fard, M. (2015). Construction performance monitoring via still images, time-lapse photos, and video streams: Now, tomorrow, and the future. *Advanced Engineering Informatics*, pp.1-14.