Vol. XV & Issue No. 09 September - 2022
INDUSTRIAL ENGINEERING JOURNAL

# A ROAD MAP FOR IMPLEMENTATION OF BIG DATA ANALYTICS IN SUSTAINABLE SUPPLY CHAIN MANAGEMENT

**Prashant Jain**
**Dr. Dhanraj P. Tambuskar**

**Abstract**

*The objective of this research is to suggest a roadmap for implementation of Big Data Analytics (BDA) in sustainable supply chain management (SSCM) in Indian manufacturing sector. Through an extensive literature survey the factors that are crucial to the application of BDA technologies to SSCM are identified. A comprehensive PESTEL framework is used for classification and analysis of these factors. The acronym PESTEL covers a variety of factors namely political, economic, social, technological, environmental and legal. This paper provides managers with an implementation framework comprising of four stages viz. identification of PESTEL factors, ascertainment of the critical success factors, selection of appropriate BDA technologies, and application of BDA technologies for SSCM. The implications of the study have been discussed at length. Theoretical implications highlight the importance of data generation, BDA infrastructure, data rationalization, BDA expertise and the BDA management capabilities. The managerial implications underline the competence and the dynamic capabilities that are required on the part of managers for organization of resources and effective selection and integration of BDA technologies. The factors identified, as a future work, may be evaluated and validated through suitable techniques. Also, the research may be extended to small and medium scale industries, which is currently its limitation.*

***Keywords: Big data analytics (BDA); Sustainable supply chain management (SSCM); Sustainable manufacturing; PESTEL analysis***

## 1. INTRODUCTION

This is the age of data generation at unprecedented speed due to advent of advances in the ICT technologies and widespread use of mobile devices, sensors, and IoT etc. [1]. This has caused a sea change in the operations and management of the manufacturing supply chains by making the integration and coordination of the various links of the supply chain much more effective than the conventional systems. Currently almost all the industry sectors have adopted these latest ICT technologies [2]. These massive data sets are called Big Data and they have a high potential to influence the growth and competitive edge of business organizations by empowering them with innovations and enhanced productivity [3]. This has become possible due to the sophisticated Big Data Analytics (BDA) technologies that have initiated a new era in the field of SSCM [4]. The BDA markets in India are predicted to grow up to $16 billion in 2025 which was just $1 billion in 2013 [5]. The BDA has transformed the SSCM decisions from raw material purchasing to the product delivery to the customer [6]. The BDA also plays a vital role in strengthening the performance of the SME's and their agility [7]. The BDA provoids an analytical know-how for business intelligence and efficient decision making [8] by identifying the trends and patterns that are hidden in the data sets. BDA, in other words may be said to be a means for the diffusion of knowledge [9]**.** Currently the BDA is being applied for the decision making in all the operations and at all the levels of the supply chain. The objective of this paper is the exploration of the possibilities of applying BDA for enhancement of quality of manufacturing decisions.

The current literature discusses the BDA as applied to the supply chain operations in the field of project performance [10], lean, agile, resilient and green practices [11], Sustainability and Financial Performance [12], operational excellence for sustainable supply chain [13], sustainable performance in agriculture supply chain [14], supply chain agility [15], supply chain modelling [16], FMCG industries [17] etc. For maintaining the competitive edge of the supply chain all the stakeholders have to constantly improve the performance of the supply chain. this being an intricate task, includes numerous management processes e.g. identifying performance indicators, setting targets, exhaustive planning, continuous monitoring, effective communication, regular reporting and comprehensive feedback etc. due to this reason, there is no standard measure for performance and the measuring tools for enhancing the supply chain decisions vary from company to company [18].

In spite of the potential possessed by BDA for enhancing the corporate and supply chain decisions, companies still face lack of clarity as to how should they build BDA capabilities, implement the BDA program and overcome the organizational barriers [19]. Fewer researchers have taken up an all-inclusive investigation on the major factors that affect an organization's willingness to implement big data [20]. Quite limited work has been done for underlining the enablers and barriers of successful adoption of BDA in SSCM [21]. To the best of author's knowledge, PESTEL-BDA in SSCM is not discussed in current literature. This study attempts to address this by identifying these PESTEL factors that cover a variety of factors namely political, economic, social, technological, environmental and legal. These are identified by an extensive literature survey. Also, a framework is suggested for the implementation of BDA

technologies for sustainable manufacturing. However, the study has certain limitations too which are discussed in section 5.

There are two research questions that have been attempted to be answered in this work. The first is whether the existing systems and practices prevailing in the Indian manufacturing industry are amenable for application of BDA technologies to SSCM. This also covers the exploration of the internal and external factors that are vital for implementation of these novel technologies in Indian industry. The second research question is regarding the probable process or the framework for effective implementation of BDA technologies to SSCM in Indian context. In order to answer these research questions a widespread literature review was undertaken with the keywords sustainable manufacturing, PESTEL analysis, big data analytics, and sustainable supply chain management etc. The peer reviewed papers from reputed journals were then selected and shortlisted on basis of title, abstract, and keywords. Based on the literature review, it was found that the PESTEL framework was the most effective for identifying and classifying the factors that affect the implementation of BDA in SSCM. It also provided important clues for development of the BDA implementation framework. On basis of the research questions cited above and the literature survey, the research objectives (ROs) of the study have been stated as follows:

RO1: To identify and classify the PESTEL factors which influence the adoption of BDA in SSCM

RO2: To propose a BDA implementation framework for SSCM

The paper is organised in five sections. Section 2 presents a detailed literature survey on PESTEL factors. Section 3 elucidates the proposed framework or the roadmap for implementation of BDA in SSCM. Section 4 discusses the theoretical and managerial implications of the study. Finally, section 5 concludes the article with a note on limitations of the study and the possible agenda for future work.

## 2. A LITERATURE SURVEY ON PESTEL FACTORS

There are three major factors that affect the task of systems innovation in a company. These factors are technology factors, organization factors, and the business environment. The various PESTEL factors more or less are the extension of these factors only. Through an extensive literature survey, the factors which affect the implementation of BDA in sustainable manufacturing are identified in this work. A total of ten factors are identified, one each from political and legal category and two each from economic, social, technological, and environmental categories. These factors are environmental policy and regulations, sustainable performance, competitive advantage, managerial and leadership commitment, stakeholders involvement and capabilities, technology resources and readiness, technology integration, lean and green practices, improvement in environmental performance, and compliance with state regulations. The eleventh factor BDA is the mediator between these ten factors and sustainable manufacturing. All these factors may be further divided in sub factors for the purpose of analysis. A brief discussion on the PESTEL factors is as follows.

**2.1. Political Factors:** The modern industrial society has witnessed rampant decline in natural resources accompanied with continuously increasing pollution. This has enacted the government to promote green initiatives at a greater scale. The organizations have to abide by the legislations, regulations and policies brought about by the government to address these issues [22]. There are emission caps imposed by the government and also provisions of carbon tax and emission trading are there [23]. The objective of the policymakers is to stimulate sustainable operations and BDA can be helpful in achieving this to a great extent [24].

**2.2. Economic Factors:** Application of BDA can improve the overall efficiency of operations of an organisation and its strategic position. It can suggest and create new ways to increase profits and advantage over competitors [25]. The BDA projects warrant a huge cost to be incurred. These include the cost incurred for capturing and storage of data, cost of analytics technologies and the cost of employing data scientists with adequate experience, expertise and knowledge to fetch the meaningful insights from big data. In all, it's a real challenge for small businesses to deploy huge funds for such a new technology [21]. The careful examination of practices prevailing in the organization and the challenges it is facing is key to a justified and fruitful decision regarding investment in BDA [26].

**2.3. Social Factors:** The commitment of top management is key to the success of a BDA project. The responsibility of allocation of resources, building of capabilities and ensuring competitive advantage for the firm lies with the top management [27]. The vision and the understanding on the part of top management about the development of sustainable supply chain, and their commitment for managing its social, economic and environmental impacts plays a big role in prompting them to invest liberally in BDA technologies [28]. Apart from this, managers have to build a BDA team comprising of the members with all the necessary skills to achieve the common goal. Moreover the managers need to be good at communication and building relationships with external and internal stakeholders that are part of the project [29]. It has been observed that in spite of the many successful examples of BDA initiatives, managers are hesitant to allocate adequate resources for this purpose [30]. Managers need to include big data initiatives in their strategic plan and support its implementation to ensure its success. The data driven mind-set or the big data culture amongst the employees is another significant aspect of the BDA implementation. The lack of big data culture may lead to failure of the big data initiatives, that otherwise may result in substantial benefits [31]. In order to develop requisite big data capabilities amongst employees and external stakeholders and to make them conversant with BDA technologies and systems, their training is very important. The change management also is very crucial to the success of a BDA project. To get a positive outcome from a BDA initiative the decision making people need to have complete insight in the problem and they should work with right data, right people and right techniques for solving problems [21].

**2.4. Technological Factors:** In the times of big data revolution, the companies need to deploy sufficient resources and develop technological capabilities to sustain the competitive advantage [32]. They should be equipped with advanced technologies, so as to be able to handle volume, velocity and variety of the data to extract useful and authentic information [33]. For the executives of many firms, adoption of this novel and valuable technological innovation has become a strategic issue [20]. A great deal of ingenuity is required in selection of appropriate and cost effective technologies for BDA implementation. It's imperative to match the organizational needs with suitable BDA technologies that are introduced in the organization [21]. As the big data are both good and bad, it's important that the good or useful data are segregated in order to ensure effective use of IoT capabilities and BDA for competitive advantage [34]. The privacy, security and ethics pertaining to collection of data is another important issue in adoption of BDA. Therefore it's important to address the privacy and security challenges so that the wide spread use of BDA is encouraged. Data privacy is important at all stages i.e. collection, storage and processing of data for ensuring the benefits of BDA technologies. Finally, the things that are probably the foremost in implementation of BDA technologies are the readiness of the firm and the resources at its disposal for creating the business value [20].

**2.5. Environmental Factors:** In the era of smart manufacturing it is imperative on the part of industry to observe the norms of environmental restrictions in order to attain the objective of sustainable supply chain [34]. Rising temperature, extreme weather, dearth of natural resources etc. warrant a novel strategy towards protection of environment. BDA plays a big role in ensuring the cooperation from customers in terms of information sharing that results in emission mitigation and pollution control [24]. Sustainability should be the biggest consideration in every part of the business, the supply chain and the managerial decision making [29]. This is especially true for energy intensive industries [35]. With the advent of technology huge amount of energy related data are available, its interface with BDA has given birth to a new tool for productivity improvement i.e. energy big data. The ongoing research and development in the field of Energy Analytics has brought about novel opportunities for energy efficiency, conservation and management in energy intensive industries.

**2.6. Legal Factors:** Every business has to comply with the law of the land related to various business functions and activities. These laws may be business laws and regulations, environmental regulations, laws related to privacy and data security [36]. There are well articulated legal provisions for the business and environmental regulations in India. But India doesn't have an explicit legal framework completely devoted to privacy and data protection. However in context of the digital data processing, some of the aspects of data protection are included in the 'Information Technology Act of 2000' and the 'Reasonable Security Practices and Procedures and Sensitive Personal Data or Information Rules of 2011' [37].

## 3. PROPOSED FRAMEWORK

The purpose of this work is to establish the high level of business value that can be gained by the adoption and application of BDA to SSCM. BDA is a novel technology and its implementation to the existing operations comes with its own burdens and challenges. The roadmap for implementation of BDA in SSCM suggested here consists of four stages viz. identification of PESTEL factors, ascertainment of the critical success factors, selection of appropriate BDA technologies, and application of BDA technologies for SSCM. These steps are depicted in Fig 1 below followed by a detailed explanation.

**Fig. 1 (a): Steps for Implementation of BDA Technologies for sustainable Supply Chain Management**

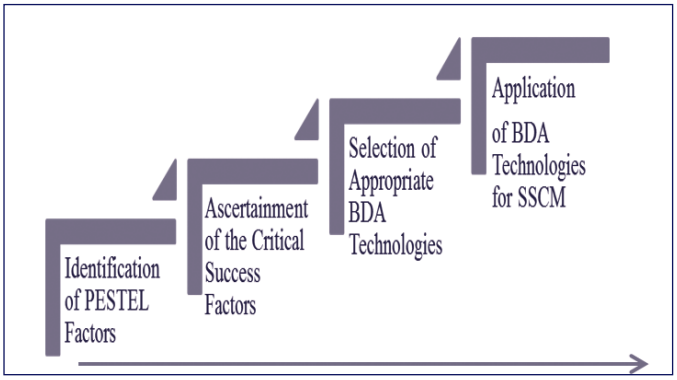
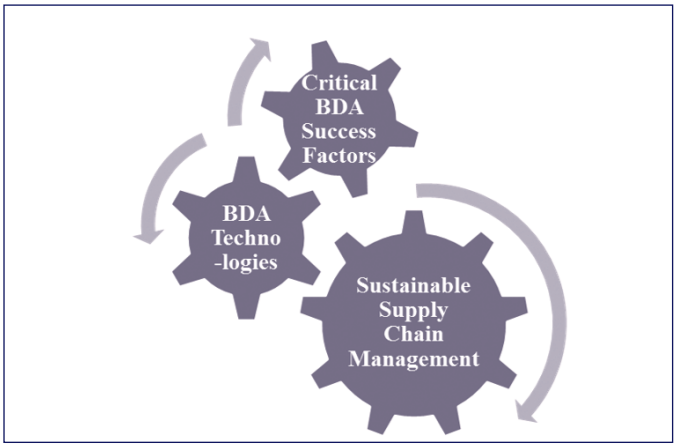



**Fig. 1 (b): BDA Technologies as mediator for the success of sustainable Supply Chain Management**




**3.1 Identification of PESTEL Factors:** The first step is identification of PESTEL factors that influence the implementation of BDA technologies for SSCM. There are a wide range of factors that play their role in this regard. These factors are identified through an extensive literature survey and also through an expert opinion if possible. A large number of factors are listed from different categories. These factors are then shortlisted through compression and merger into each other. Finally they are categorised according to the PESTEL framework that covers the categories of political, economic, social, technological, environmental and legal factors.

**3.2 Ascertainment of the Critical Success Factors:** The second step is ascertainment of the critical success factors. For this the PESTEL factors obtained above are analysed and evaluated using suitable multi-criteria decision making technique in order to obtain their relative importance and cross relationships. They are validated also through suitable

techniques. This analysis will result in the segregation of factors as cause and effect, and also as drivers and barriers for application of BDA technologies to SSCM. Based on their relative merit the critical BDA success factors in the form of drivers or barriers may be ascertained that the organisation would like to consider for application of BDA systems in line with the available resources.

**3.3 Selection of Appropriate BDA Technologies:** The third step is selection of appropriate big data analytics technologies. The flow of information is crucial to a BDA enabled SSCM. The data originated from different stakeholders need to follow common standards and their accessibility rights for different types of data must be clearly defined. Also, the other technologies should ensure the best utilization of data. There are basically two types of technologies that need to be judiciously integrated for reaping the benefits of the BDA system namely Internet of Things (IoT) and Cloud Computing. IoT is a network of objects with attached RFID devices with the application of proper middleware. The users of IoT have realised the massive capabilities of BDA and that the success of IoT rests on the effective integration and harmonization of industrial big data with the cloud computing systems. Recent developments in the field of IoT also facilitate the efficient handling of huge amount of real time data. Integration of cloud computing technologies for application of BDA to SSCM is crucial to conversion of the investment into maximum business value [38]. The cloud computing systems are aimed at using huge storage and computing resources for providing BDA applications with reliable computing capacity [39]. These technologies are capable of improving the efficiency of acquisition and processing of big data through the use of parallel computing for their analysis and management. The cloud enabled BDA systems improve knowledge and information sharing with stakeholders that results in enhanced logistics performance and customer satisfaction. The combination of IoT and Cloud Computing is termed as Cloud of Things (COT). Apart from this the organizations also face the issues related to privacy, security and integration of data. All these technologies call for a huge investment and their scrupulous selection is crucial to achieving the goal of a cost effective BDA system.

**3.4 Application of BDA Technologies for SSCM:** The forth step in the process is implementation of Big Data Analytics Systems. BDA is without any doubt capable of bringing about dramatic change to the performance of an organization but the strategies for its application are yet to be explored [40]. Similar to any novel technology or ICT tool the implementation of BDA systems also is a challenge. Big data is of course a buzz word today, but just a small percentage of organisations succeed in realizing the true potential of big data and the returns from the investments [41]. Many organisations fail to complete the BDA project within planned budget or schedule. Sometimes they fail to fulfil the intended objective. Due to similar problems a number of BDA ventures abort at the pilot or experimentation stage only. The lack of infrastructural resources is a common problem that emerges while venturing into BDA implementation [38]. But, gaining competitive advantage from big data is not all about the investment made in building the infrastructure with sophisticated technology, but the availability of personnel with technical expertise and managerial skills are also equally important. The BDA practitioners face a challenge of change management also, as the organisations have to undergo many organisational and structural changes and switch over to a data driven culture[42]. In the wake of these issues managers need to plan conscientiously before introducing BDA systems into their organisations.

## 4. DISCUSSION

The key findings of this study are the critical success factors that are set in PESTEL framework, for implementation of BDA in SSCM. The political factors include general government policies, regulations and standards regarding business and environment. There is a cap imposed by the government on emission and provision for emission trade also is there for facilitating the companies. Apart from this Carbon tax policy is there to dissuade companies from emission. The first sub group of economic factors i.e. sustainable performance comprises of reduction in material and energy cost, improvement in operational performance, reduction in environmental cost and long-term economic and financial viability. The economic performance of an organization also depends on its edge over competitors for which creation of competitive advantage, globalization and total quality management are important. The social factors include the skills, commitment, collaboration and relational practices of managers and also their capacity to overcome barriers and manage change. The involvement and capabilities of employees and other stakeholders in the upstream and downstream supply chain, their learning and training provisions and culture of data driven decision making also belong to social factors. BDA being a novel technology the technological resources and readiness, technical skills, innovative capabilities at the disposal of company are crucial to its implementation. For effective data driven decisions the information and data quality, security, privacy and overcoming the data related barriers also are equally important. For SSCM the environmental factors probably are of prime importance and these lay the foundation for implementation of BDA. The first component of environmental factors i.e. lean and green practices includes application of life cycle assessment, green processes and products and also the lean and green manufacturing. For improvement in environmental performance i.e. the second component, emission mitigation, reduction in air pollution, minimisation of waste water and solid waste and optimization of material and energy consumption are important. Finally, there are a number of state laws and regulations regarding any business. The legal factors cover this aspect which comprise of compliance with laws and regulations regarding business, environment, data security and privacy.

**4.1 Theoretical Implications:** The first and foremost thing on the part of an organization is the data generation capabilities. Many organizations do not have the required infrastructure for generation of enormous amount of data. On the contrary, the companies that are affluent with regards to data should have periodic audit of their data so as to ensure that they are not

burdened by irrelevant data. In this context the reduction of data at source is important. For this the variables that need to be measured in context of a business need to be ascertained and defined so as to develop appropriate data reduction strategies [43]. After data reduction, the next important thing is to rationalize the unstructured data for improving the data quality. The segregation of good data from the bad data will result in minimization of storage cost and logistics efforts. Further, for achieving effective data integration, standard principles and policies for information sharing amongst various stakeholders need to be designed. The cloud computing technologies are key to information sharing along with access control and maintenance of security [38]. Apart from data generation capabilities, the other BDA capabilities that are required to be developed by the organization are BDA infrastructure, BDA expertise capabilities and the BDA management capabilities [44]. The real-time information provided by BDA systems helps in monitoring and regulating upstream and downstream inventories as per changes in the manufacturing environment [45]. Sustainable energy is a key constituent of sustainable manufacturing. So it is important for the organization to strive for cleaner production through energy efficiency, conservation and management. Big data systems definitely can play a vital role in achieving this objective. But the whole hierarchy of personnel needs to be involved in this i.e. from top level to the operational level [46]. With a conscientious implementation of BDA technologies, all the critical success factors can be addressed effectively. In due course of time they may prove to be the key drivers for success of the organization. It's incumbent on the heads of the organizations to deploy necessary resources on this front as it may turn out to be a vehicle for the other peripheral factors also, to contribute to the performance improvement of the organization in a huge way.

**4.2 Managerial Implications:** This article establishes the importance of big data technologies as an instrument for quality enhancement of decisions regarding SSCM. It also highlights the challenges regarding the adoption of BDA and the importance of harmony amongst the organisational and technological resources. BDA technologies have an important role to play for the organizations to develop a competitive edge. Though it has been established by many researchers that BDA systems definitely pay off, it is incumbent on the managers to acquire requisite knowledge and skills to develop crucial dynamic capabilities. This is especially important in wake of the fact that acquisition and operation of BDA systems warrants a good deal of efforts and resources. So, in order to derive the maximum benefit out of the investment, proper understanding of the relevant issues is crucial on the part of managers [45]. The managers also have to ascertain the level of sophistication they would like to impart to their supply chain by means of the application of technology and tools for analysis of the available data and information [47]. For data driven culture in an organization the commitment of management is crucial. Management should be forthcoming to integrate the BDA with their business processes and accept BDA as a sought after decision making tool. For this the enrichment of analytics through experts' opinion and better communication of the BDA insights to the management is imperative [48]. In order to attain sustainable supply chain performance it's important for managers to have a high level of integration of organizational resources as a precursor to developing BDA capabilities [49]. In order to have a sound data driven culture in business, the understanding of statistics and ability of critical thinking on the part of decision makers have a significant role to play [50]. Further, the managers need to encourage collective learning in their organization to ensure better collaboration amongst the firms involved in the supply chain. This will lead to enhanced relational knowledge of BDA and will enable people to make use of technologies and implement real time decision making. This will also enhance transparency and encourage mutual goodwill amongst stakeholders [51]. There are three main problems with implementation of big data in the energy field viz. data collection in a short time, enormous amount of multidimensional data and the limitations of the existing applications to process this huge amount of data. To analyse and comprehend the energy consumption behaviour of an individual or utility, to improve energy efficiency of systems and to find the energy conservation opportunities are a real challenge for managers in the SSCM [52].

The cost of BDA technologies being high, managers have to strive for optimizing the technology deployment as well as enable themselves to tap the internal strength of the organization to the maximum extent. Apart from cost minimization and high service level, the goal of sustainability also is important for managers. For achieving this managers are faced with the challenge of keeping their supply chain adaptive to the dynamic requirements [47]. There are continual developments in the big data software and technology. Managers have to keep themselves updated and broaden the application of the big data systems to improve the capability of the organization towards sustainable manufacturing [46]. Raut et al. (2019) have studied the role of BDA systems in sustainable practices in the manufacturing firms of developing countries. They suggest that the managers can improve their understanding of the factors influencing the adoption of BDA in order to move ahead in the direction of sustainability [8].

## 5. CONCLUSION

The BDA enabled SSCM is different from conventional supply chain in the sense that it keeps an account of what is happening in real time. Along with this it has a futuristic outlook and is an important tool for predicting the performance of an organization. This work explores the possibilities of application of BDA in the field of SSCM in the Indian context. There are a wide range of factors that play a vital role in this endeavour. A comprehensive framework of PESTEL analysis has been used for identification and categorisation of these various factors. The acronym PESTEL is representative of political, economic, social, technological, environmental and legal factors. In the literature survey it is observed that out of the six PESTEL factors economic, social, technological and environmental are the most explored factors, while the political and legal factors are the least explored. In this regard, this work is an effort to address these lesser explored factors also. All the factors are

not important for all the organisations in the same way. The critical success factors vary from firm to firm based on the type of operations and the decision making environment etc. In uncertain environment the managerial or social factors are more important while in a moderately uncertain or relatively certain environment technological factors play a major role in reaping the benefits from BDA implementation. Further, the study presents a roadmap for implementation of BDA technologies for SSCM. This roadmap comprises of four steps viz. identification of PESTEL factors, ascertainment of the critical success factors, selection of appropriate BDA technologies and application of BDA technologies for SSCM.

**5.1 Limitations:** The study presented here has its own share of limitations that need to be taken care of while considering the applicability of the BDA implementation framework in a particular context. The first limitation is that the study focuses on large scale organizations that are having adequate financial resources at their disposal to invest in BDA implementation. It may be difficult for small and medium scale industries (SMEs) to create business value with the implementation of BDA systems, because it warrants huge cost to be incurred. Such firms may install the physical infrastructure necessary for BDA and outsource the analytics services as it requires a chunk of BDA implementation funds. The second limitation of the study is regarding the human factor that is crucial to the implementation of novel methods and technologies such as BDA. The proposed framework highlights the importance of selection and incorporation of appropriate technologies and it is presumed that the managers and the employees are competent enough to select and implement such technologies. But actually, especially in Indian context and any developing nation for that matter, this may not be the case. If any inadequacy is there in the organization in this regard, the capability building through personnel development will be an additional task to be incorporated in the framework. The third limitation is regarding the legal factors that are vital to the implementation of the BDA systems in Indian industry. In India, an explicit legal framework devoted to privacy and data protection is still not in place. The acts cited in this paper include only some of the aspects of data protection and data processing. The organizations can be able to undertake BDA implementation projects more effectively only if favourable and explicit legal provisions are there.

**5.2 Future Scope:** Future studies may focus on implementation of big data systems in SMEs, which would address their specific needs and challenges. Future studies may also take up sector wise studies for BDA implementation, such as automobile sector, FMCG sector or process industries. As has already been said, the implementation of BDA technologies entails huge amount of funds, so it's imperative on the part of organizations to evaluate their performance on BDA capabilities. Further, the measures of performance for BDA processes are different from conventional supply chain measures. They need to be tracked and monitored in real time requiring prompt actions from the managers. So, the development of a BDA performance measurement system based on the BDA processes and the performance measures can be a future work in line with this BDA implementation framework. Over the past many years experts have expanded the PESTEL framework by adding the factors such as Intercultural, Demographics, Ecological and Ethical etc. This has resulted in the variants such as SLEPIT, DESTEP and STEEPLED etc. However in this work, the PESTEL framework has been used, as it covers the most significant factors that play their role in manufacturing supply chain management. Inclusion of lesser important factors may necessitate expansion of the PESTEL framework as mentioned above and may be taken up as a future work.

## REFERENCES

[1] *Giannakis, M., Spanaki, K., & Dubey, R. (2019). A cloud-based supply chain management system: effects on supply chain responsiveness. Journal of Enterprise Information Management.*

*[2] Yan, J., Meng, Y., Lu, L., & Li, L. (2017). Industrial big data in an industry 4.0 environment: Challenges, schemes, and applications for predictive maintenance. IEEE Access, 5, 23484-23491.*

*[3] Mishra, D., Gunasekaran, A., Papadopoulos, T., & Childe, S. J. (2018). Big Data and supply chain management: a review and bibliometric analysis. Annals of Operations Research, 270(1), 313-336.*

*[4] Arunachalam, D., Kumar, N., & Kawalek, J. P. (2018). Understanding big data analytics capabilities in supply chain management: Unravelling the issues, challenges and implications for practice. Transportation Research Part E: Logistics and Transportation Review, 114, 416-436.*

*[5] NASSCOM (2017), "The IT-BPM sector in India—strategic review 2017", available at:www.nasscom.in/knowledge-center/publications/it-bpm-industry-india-2017-strategic-review.*

*[6] Wamba, S. F., Gunasekaran, A., Akter, S., Ren, S. J. F., Dubey, R., & Childe, S. J. (2017). Big data analytics and firm performance: Effects of dynamic capabilities. Journal of Business Research, 70, 356-365.*

*[7] Ashrafi, A., Ravasan, A.Z., Trkman, P. and Afshari, S. (2019), "The role of business analytics capabilities in bolstering firms' agility and performance", International Journal of Information Management, Vol. 47, pp. 1-15.*

*[8] Raut, R. D., Mangla, S. K., Narwane, V. S., Gardas, B. B., Priyadarshinee, P., & Narkhede, B. E. (2019). Linking big data analytics and operational sustainability practices for sustainable business management. Journal of cleaner production, 224, 10-24.*

*[9] De Camargo Fiorini, P., Seles, B. M. R. P., Jabbour, C. J. C., Mariano, E. B., & de Sousa Jabbour, A. B. L. (2018). Management theory and big data literature: From a review to a research agenda. International Journal of Information Management, 43, 112-129.*

*[10] Mangla, S. K., Raut, R., Narwane, V. S., & Zhang, Z. J.*

*(2020). Mediating effect of big data analytics on project performance of small and medium enterprises. Journal of Enterprise Information Management.*

*[11] Raut, R. D., Mangla, S. K., Narwane, V. S., Dora, M., & Liu, M. (2021). Big Data Analytics as a mediator in Lean, Agile, Resilient, and Green (LARG) practices effects on sustainable supply chains. Transportation Research Part E: Logistics and Transportation Review, 145, 102170.*

*[12] Shokouhyar, S., Seddigh, M. R., & Panahifar, F. (2020). Impact of big data analytics capabilities on supply chain sustainability: A case study of Iran. World Journal of Science, Technology and Sustainable Development.*

*[13] Bag, S., Wood, L. C., Xu, L., Dhamija, P., & Kayikci, Y. (2020). Big data analytics as an operational excellence approach to enhance sustainable supply chain performance. Resources, Conservation and Recycling, 153, 104559.*

*[14] Kamble, S. S., Gunasekaran, A., & Gawankar, S. A. (2020). Achieving sustainable performance in a data-driven agriculture supply chain: A review for research and applications. International Journal of Production Economics, 219, 179-194.*

*[15] Dubey, R., Gunasekaran, A., & Childe, S. J. (2019b). Big data analytics capability in supply chain agility: the moderating effect of organizational flexibility. Management Decision.*

*[16] Lamba, K., & Singh, S. P. (2018). Modeling big data enablers for operations and supply chain management. The International Journal of Logistics Management.*

*[17] Nozari, H., Fallah, M., Kazemipoor, H., & Najafi, S. E. (2021). Big data analysis of IoT-based supply chain management considering FMCG industries.* Бизнес-информатика*, 15(1 (eng)).*

*[18] J. Cai, X. Liu, Z. Xiao, and J. Liu, "Improving supply chain performance management: A systematic approach to analysing iterative KPI accomplishment", Decision support systems, Volume 46,issue 2, pp. 512-521, 2009.*

*[19] Sena V., Bhaumik S., Sengupta A., Demirbag M.: 'Big data and performance: what can management research tell us?', Br. J. Manag., 2019, 30, pp. 219–228*

*[20] Sun, S., Cegielski, C. G., Jia, L., et al.: 'Understanding the factors affecting the organizational adoption of big data', Journal of Computer Information Systems, 2018, 58, (3), pp. 193-203*

*[21] Lamba, K., and Singh, S. P.: 'Modelling big data enablers for operations and supply chain management', The International Journal of Logistics Management, 2018, 29, (2)*

*[22] Ciftci, I., Tatoglu, E., Wood, G., et al.: 'Corporate governance and firm performance in emerging markets: Evidence from Turkey', International Business Review, 2019, 28, (1), pp. 90-103*

*[23] Lamba, K., Singh, S. P., and Mishra, N.: 'Integrated decisions for supplier selection and lot-sizing considering different carbon emission regulations in Big Data environment', Computers & Industrial Engineering, 2019, 128, 1052-1062*

*[24] Raut, R. D., Mangla, S. K., Narwane, V. S., et al.: 'Linking big data analytics and operational sustainability practices for sustainable business management', Journal of cleaner production, 2019a, 224, pp. 10-24*

*[25] Papadopoulos, T., Gunasekaran, A., Dubey, R., et al.: 'Big data and analytics in operations and supply chain management: managerial aspects and practical challenges', Production Planning & Control, 2017, 28, (11-12), pp. 873-876*

*[26] El-Kassar, A. N., and Singh, S. K.: 'Green innovation and organizational performance: the influence of big data and the moderating role of management commitment and HR practices', Technological Forecasting and Social Change, 2019, 144, pp. 483-498*

*[27] Chadwick, C., Super, J. F., and Kwon, K.: 'Resource orchestration in practice: CEO emphasis on SHRM, commitment-based HR systems, and firm performance', Strategic Management Journal, 2015, 36, (3), pp. 360-376*

*[28] Shokouhyar, S., Seddigh, M. R., and Panahifar, F.: 'Impact of big data analytics capabilities on supply chain sustainability', World Journal of Science, Technology and Sustainable Development, 2020, 17, (1)*

*[29] Jeble, S., Dubey, R., Childe, S. J., et al.: 'Impact of big data and predictive analytics capability on supply chain sustainability', The International Journal of Logistics Management, 2018*

*[30] Braganza, A., Brooks, L., Nepelski, D., et al.: 'Resource management in big data initiatives: Processes and dynamic capabilities', Journal of Business Research, 2017, 70, pp. 328-337*

*[31] LaValle, S., Lesser, E., Shockley, R., et al.: 'Big data, analytics and the path from insights to value', MIT sloan management review, 2011, 52, (2), pp. 21-32*

*[32] Vidgen, R., Shaw, S., and Grant, D. B.: 'Management challenges in creating value from business analytics', European Journal of Operational Research, 2017, 261, (2), pp. 626-639*

*[33] Gupta, M., and George, J. F.: 'Toward the development of a big data analytics capability', Information & Management, 2016, 53, (8), pp. 1049-1064*

*[34] Côrte-Real, N., Oliveira, T., and Ruivo, P.: 'Assessing business value of Big Data Analytics in European firms', Journal of Business Research, 2017, 70, pp. 379-390*

*[35] Liu, W., and Wang, Z.: 'The effects of climate policy on corporate technological upgrading in energy intensive industries: Evidence from China', Journal of Cleaner Production, 2017, 142, pp. 3748-3758*

[36] *Mani, V., Delgado, C., Hazen, B., et al.: 'Mitigating supply chain risk via sustainability using big data analytics: evidence from the manufacturing supply chain', Sustainability, 2017, 9, (4), pp. 608*

[37] *'India Law Journal', 2020 (http://indialawjournal.org/big_ data_a_ challenge_ to_data_protection.php), accessed 14 January 2020*

[38] *Arunachalam, D., Kumar, N., and Kawalek, J. P.: 'Understanding big data analytics capabilities in supply chain management: Unravelling the issues, challenges and implications for practice', Transportation Research Part E: Logistics and Transportation Review, 2018, 114, pp. 416-436*

[39] *Addo-Tenkorang, R., and Helo, P. T.: 'Big data applications in operations/supply-chain management: A literature review', Computers & Industrial Engineering, 2016, 101, (4), pp. 28-543*

[40] *Jhaa, A.K., Agi M.A.N., Ngaic E.W.T.: 'A note on big data analytics capability development in supply chain', Decision Support Systems, 2020, 138, 113382*

[41] *Ross, J. W., Beath, C. M., and Quaadgras, A.: 'You may not need big data after all', Harvard business review, 2013, 91, (12), pp. 90-+*

[42] *Hindle, G. A., and Vidgen, R.: 'Developing a business analytics methodology: A case study in the foodbank sector', European Journal of Operational Research, 2018, 268, 3, pp. 836-851*

[43] *Maheshwari, S., Gautam, P., and Jaggi, C. K.: 'Role of Big Data Analytics in supply chain management: current trends and future perspectives', International Journal of Production Research, 2020, 1-26*

[44] *Wamba, S. F., Gunasekaran, A., Akter, S., et al.: 'Big data analytics and firm performance: Effects of dynamic capabilities', Journal of Business Research, 2017, 70, pp. 356-365*

[45] *Dubey, R., Gunasekaran, A., and Childe, S. J.: 'Big data analytics capability in supply chain agility', Management Decision, 2019a*

[46] *Herman, J., Herman, H., Mathews, M. J., and Vosloo, J. C.: 'Using big data for insights into sustainable energy consumption in industrial and mining sectors', Journal of Cleaner Production, 2018, 197, pp. 1352-1364*

[47] *Gupta, S., Drave, V. A., Bag, S., et al.: 'Leveraging smart supply chain and information system agility for supply chain flexibility', Information Systems Frontiers, 2019, 21, (3), pp. 547-564*

[48] *Blackburn, R., Lurz, K., Priese, B., et al.: 'A predictive analytics approach for demand forecasting in the process industry", International Transactions in Operational Research, 2015, 22, (7), pp. 407-428*

[49] *Kamble, S. S., Gunasekaran, A., & Gawankar, S. A.: 'Achieving sustainable performance in a data-driven agriculture supply chain: A review for research and applications', International Journal of Production Economics, 2020, 219, pp. 179-194*

[50] *Radke, A. M., and Tseng, M. M.: 'Design considerations for building distributed supply chain management systems based on cloud computing', Journal of Manufacturing Science and Engineering, 2015, 137, (4)*

[51] *Mandal, S.: 'An examination of the importance of big data analytics in supply chain agility development', Management Research Review, 2018*

[52] *Chehbi-Gamoura, S., Derrouiche, R., Damand, D., et al.: 'Insights from big Data Analytics in supply chain management: an all-inclusive literature review using the SCOR model', Production Planning & Control, 2020, 31, (5), pp. 355-382*

## AUTHORS

**Prashant Jain**, Research Scholar, Department of Mechanical Engineering, Pillai College of Engineering, Dr. K. M. Vasudevan Pillai Campus, Plot No. 10, Sector 16, New Panvel (East), Navi Mumbai – 410 206, (MS), India
Email: pjain68@gmail.com

**Dr. Dhanraj P. Tambuskar**, Faculty, Department of Mechanical Engineering, Pillai College of Engineering, Dr. K. M. Vasudevan Pillai Campus, Plot No. 10, Sector 16, New Panvel (East), Navi Mumbai – 410 206, (MS), India
Email: dhanrajt@mes.ac.in