INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 10, Issue 1 - V10I1-1200)
Available online at: https://www.ijariit.com

How Open Data is Reshaping Supply Chains for Social Equity

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ABSTRACT

The supply chain is vital in achieving a conducive working environment for business stakeholders. Current developments in big data analytics technology create insights that help supply chain members achieve their objectives (Mol, 2015). The bottle neck of unsustainability in industries can be achieved when firms take corrective actions on challenges that members encounter while analyzing open data (Saeed & Kersten, 2019). A literature review is the method of investigation in the study. During the inquiry, 50 research articles were analyzed by researchers to get comprehensive results on the topic (Scott, 2020). The paper applies the Toulmin model of argumentation to elaborate on the link between big data analytics and supply chain management. Some components of big data analytics are integration, security, economics, reporting, analytics, and data processing. (Gardner et al., 2019). Researchers in the study have used different examples of supply chains to analyze and understand the relationship between transparency and sustainability in various supply chain categories (McDermott, 2014). Supply chain information enhances improvement in sustainability governance. In this paper, the researchers gathered information from the literature to get a comprehensive concept of sustainable supply chain management (Egels-Zandén & Hansson, 2016). A direct correlation between sustainability and supply chain through an open data management approach exists. Applying big data analytics by firms can lead to cost savings by reducing expenses that the company could have otherwise incurred in the health and safety of the workforce and members of society. The data should comply with quality for effective decision-making across the supply chain network (Brandenburg et al., 2019).

Keywords: *Data Transparency, Open Data, Supply Chain Management, Decision-Making, Stakeholder Feedback, Risk Management, Data Collection Devices, Big Data Analytics, Economic Improvement, Disruption, Growth Trends*

Summary

Organizations should prioritize the critical issues for their efficient operations while maintaining risk management, corporate strategy, material assessment, and stakeholder feedback (Egels-Zandén & Hansson, 2016). Data transparency is one of the critical elements in ensuring accountability across the various levels of the supply chain. Open data helps clarify some complex issues of the supply chain as traders from different sectors in society can use the information to reduce risks and enhance the working conditions in their respective lines of specialization (Gardner et al., 2019). There are different types of transparency in the supply chain that stakeholders can harness to ensure an open data system. The types of transparency include regulatory, management, consumer, and public transparency (Mol, 2015).

The data software and intelligent devices should be able to gather data from various points across the supply chain; these data collection devices should also be able to process information and report it to the various authorities in the supply chain (Scott, 2020). A properly managed supply chain by business people is essential as it helps them to convert data information to decisions, which is critical for the growth of an organization. Data visibility is vital to supply chain managers as it provides them with crucial information they require in decision-making in the event of any disruption in the supply chain network (Gardner et al., 2019). A literature review is the research method the study team applied. The literature that the researchers used for the study included journals, Elsevier, and scholarly books (Egels-Zandén & Hansson, 2016). Findings from the study show a positive growth in interest

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in the subject of supply chain in the last couple of years, from 2011 onwards (Egels-Zandén & Hansson, 2016). The application of big data analytics can potentially improve an organization's economic status (Egels-Zandén & Hansson, 2016).

I. INTRODUCTION

The supply chain is key in achieving the global goals of environmental, social, and governance in businesses and ensuring that an organization aligns with the enterprise risk management process. In many situations, companies usually set their goals in a silo without determining the data, process, or mechanisms of achieving those objectives. The environmental, social, and governance aspects are very broad aspects of supply chain management and make the business pillars essential for the stakeholders. Therefore, organizations should prioritize the key issues to their efficient operations while maintaining risk management, corporate strategy, material assessment, and stakeholder feedback (Egels-Zandén & Hansson, 2016). This paper will elaborate on the importance of open data for the sustainable development of global supply chain management in organizations.

Data Transparency and Sustainability of the Global Supply Chains

There has been notable growth in the process of collecting, disclosing, monitoring, and disseminating data in the supply chain sector over the last couple of years. The advances in the supply chain segment have contributed to the development of virtually new categories of sustainability governance for worldwide community supply chains. Evaluations done by the members of society on the contributions of various transparency agencies towards the influence of new governance have not given enough feedback on the effect of data transparency in reshaping the global supply chain. Traders have made different transparency initiatives to underpin their influence in the new governance arrangement. The initiatives seek to address the question of the relevance of open data in supply chain sustainability governance (Gardner et al., 2019).

Enhancement of open data information by stakeholders is essential in transforming the sustainability of the production systems of both goods and services. Open data helps clarify some complex issues of the supply chain as traders from different sectors in society can use the information to reduce risks and enhance the working conditions in their respective lines of specialization. The deep-rooted compressibility of the supply chain systems in the world has played a vital role in obscuring some production practices that are unsustainable and questionable (Zyglidopoulos & Flemming, 2011).

The lack of an open data system has also distracted the efforts to investigate the effectiveness of efforts made by global actors on the sustainability of supply chain systems. The open data systems will, therefore, undoubtedly help the members of society to strive for a balance in the discordance that has existed in the access of information and their impacts on business materials; this helps to strengthen the assailable industries in both the production and consumption chain of the economy (Gardner et al., 2019). However, many things could be improved in the use of open data in supply chain transparency; these range from the collection and circulation of information to the potential stakeholders of a sustainable supply chain system. Some of the assumptions that researchers have come up with are that a high level of transparency can favor a governance system that is more democratic and liberal. However, supply chain stakeholders have observed that a high degree of open data can magnify the inequities in governance and strengthen the already powerful systems in society (Egels-Zandén & Hansson, 2016).

In order to enhance transparency in the diverse supply chain system, organizations recommend businesses to standardize, simplify, reduce, and dis-embed from the local environmental and social context of data transparency; this will ensure that some aspects of open data management systems are more visible than others. Power dynamics directly influence the type of data to be included or excluded in a supply chain organization (Scott, 2020). The use of open data also varies according to various scales of references; for instance, vulnerable actors are empowered through transparency if their interests are in agreement with those of invulnerable players. Open data that is reproducible, transparent, and accessible to a multi-national organization or the governing State may differ from those that are accessible to local members of the society and communities at large. Some examples of the data are detailed reports, scientific studies, databases, and registries (McDermott, 2014).

Process of Improving Open Data System for Sustainability in Supply Chain

There are different types of transparency in the supply chain that stakeholders can harness to ensure an open data system. The types of transparency include regulatory, management, consumer, and public transparency. Management transparency deals with exchanging data and ideas within organizations or between one company and the other. Regulatory transparency, on the other hand, concerns the disclosure of information to the members of the public or public authorities. Consumer transparency is limited to information related to claims of sustainable production practices in an organization or government agencies, and public transparency is directly concerned with the availability of commodity characteristics and sustainability of the production process to the members of the public society (Mol, 2015). All types of transparencies drive an organization or a government body to a sustainable level; however, different levels of influence have different disruptive and transformative potentials. For instance, public transparency has the greatest potential for change as more is needed to place information in the public domain. Systems should be put in place by stakeholders to ensure that data is available, readily interpretable, and scrutinized by third parties. Big data analytics is an essential tool for providing solutions to the challenges in sustainable supply chain management by verifying the potential results of several projects on the environment and society (Mageto, 2021).

II. LITERATURE REVIEW

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Management of Sustainable Supply Chain

As a result of people worldwide becoming more knowledgeable about climate change and social and environmental matters in the current society, there is an increased focus on the sustainable supply chain management system by members of the public. For the sustainability of the supply chain system to be realized by people in society, enterprises in the supply chain need to report on environmental and social performance besides the profits they are making in the business (Scott, 2020). For firms to achieve sustainable supply chain management objectives, there should be set goals on transparency reporting, developing a culture of sustainability, and appropriately managing the risks that usually relate to the supply chain. The supply chain in the manufacturing sector of the economy has become even more complex as a result of globalization, and hence, there is difficulty in observing the act of sustainability in every individual country that does not have a background in regulations. Investigations by researchers have shown that regular monitoring of sustainability practices aids in reducing the overutilization of natural ecological setup and exploitation of vulnerable society members in developing countries. Some organizations can take advantage of the complexity of the manufacturing supply chain to thrive in unethical behaviours such as child labour and poor working environments.

Therefore, for firms to achieve sustainable goals in the supply chain and operate reputable businesses with minimal disruptions and other operational risks, enterprises need to apply advanced technology in collaboration, analyzing and sharing relevant data from all firms in the supply chain. Open data information will aid firms in monitoring the activities of related organizations in the industry and taking corrective action whenever there is a deviation from the norm (Egels-Zandén & Hansson, 2016). The current advancements in industrial technology like robotics, the internet, artificial intelligence, value addition in manufacturing and information technology have enabled organizations to gather enough amount of data that relates to sustainability in the supply chain; these data that experts commonly refer to as the big data has assisted the stakeholders in breaking down the complexity of observing sustainable practices in the manufacturing supply chain. Big data analytics technology is essential in supply chain management as it provides a continuous report on data analysis and shares the results within a short time frame; this helps organizations make decisions and acquire new knowledge for solving complex problems in the supply chain. According to researchers in the supply chain sector, the advantages acquired by organizations that have fully implemented sustainable supply chain management systems are that they can operate at low cost, pursue sustainability goals and improve the business's reputation in society (Scott, 2020).

Supply Chain in the Manufacturing Sector

In the manufacturing sector of the economy, supply chain means the process of organizing, planning and administering all events that relate to the movement of raw materials from the suppliers to the processing firms, directing public relations with all partners in the supply chain and transferring of finished commodities to the consumers. Manufacturers, therefore, play an important role in the supply chain as they are at the centre of the process that involves both upstream and downstream connections (Egels-Zandén & Hansson, 2016). The upstream connections involve the movement of the raw materials from the point of manufacture to the customer. The main activities related to upstream linkage are product development, production and engineering. On the other hand, downstream linkages deal with activities that pertain to distribution, product disposal and the use of products or services (Gardner et al., 2019).

The dynamic nature of customers' requirements poses many challenges to managing a sustainable supply chain in the social, environmental, and economic aspects. Big data analytics is essential as it enables the management supply chain to meet its environmental, economic and social goals. Other benefits of big data analytics include providing an opportunity for the processing supply chains to apply the concepts of smart factories and smart logistics; through the concepts, manufacturers can collect smart data by using smart devices in the supply chain. For instance, there can be movement of information from the stage of getting the raw materials to the final product (Egels-Zandén & Hansson, 2016).

In research to reveal the impact of data analytics on an intelligent and sustainable supply chain in the current era, investigators collected data simultaneously from different supply chain members. After data collection, the researchers stored the information in a cloud before performing a critical analysis of the data. The results of the data analysis were then immediately shared with the stakeholders in the supply chain for an instant decision-making process. The research implies that the data researchers will aid the companies in planning for production depending on the demand data from retail stores, smart homes, and customers. Information on the requirement of the raw materials can also be automatically made available through the data to the supplier's side; therefore, supply chain members can chain can therefore quickly know any disruption in the supply chain and plan for corrective actions to minimize the risks of damages in their businesses (Gardner et al., 2019).

Dimensional View of the Big Data Analytics

In the recent era of technological advancements, there is a growing need for big data chains by organizations in order to develop both internal and external demand-sensing networks. Research on big data analytics is currently broadening to cover the linked database for government and privately owned enterprises. Current research studies on extensive databases focus on their economic and technical viabilities on the supply chains and engagements with the members of the society. An organization should create an ecosystem with advanced data processing capacity for a proper data processing strategy. The data software and intelligent devices should be able to gather data from various points across the supply chain; these data collection devices should also be able to process information and report it to the various authorities in the supply chain (Scott, 2020).

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Big data analytics makes the data processing rate faster and provides a proper perspective that ensures sustainability across various supply chain categories. There is a need to synchronize the transparency in the supply chain and data processing to motivate the partners in the supply chain to share relevant information concerning the commodities they are dealing in and the possible consequences of their business to society and the ecosystem. When various businesses across the supply chain embrace transparency, there is advancement in achieving the goal of sustainable supply chain management by the relevant stakeholders in society. Investigations have shown that the legitimate use of big data analytics enables transparent and ethical business operations across the supply chain and depends on mutual collaborations among member states or organizations. The specific stages of the supply chain that require collaboration include producing, sourcing and distributing goods and services to the consumers (Gardner et al., 2019).

Environmental and Social Impacts of Supply Chain Data Transparency

The transformations in the modes of accessing information and transparency initiatives are the influences that shape the supply chain's governance. Access to data and relevant information is directly linked to sustainability conditions and overcoming challenges that usually relate to supply chain governance; these help organizations make sound decisions regarding sustainable sourcing strategies. The concept of data transparency has, therefore, aided organizations in minimizing risks in the supply chain and improving the working conditions in instances where production practices are unsustainable and unfair. (Egels-Zandén & Hansson, 2016).

Data that relates to supply chain and risks are important to the stakeholders such as the third parties and the governing bodies as the information helps them to comply with the regulatory requirements such as taxes embargos, fines and moratoria. Supply chain information is also essential to the verification bodies as a measure of enforcement of incentives such as credit lines and subsidies. In order for third-parties to show the authenticity of standard systems and acquire more investments, they need the information of data transparency across the supply chain network. Partnership sustainability also emanates from information or data transparency in the supply chain (McDermott, 2014).

Transparency can lead to trade-offs between varying normative objectives and goals as different actors use can access and use new data to increase investments (Mol, 2015). For instance, the systems that observes the public satellites are transparent can be used by the state, organizations and prominent non-governmental organizations. The national satellites are however not reachable by regional manufacturers because they does not have the resource rights and ability to protect their interests from external invasion (McDermott, 2014). Transparency can be of little value when there is an increase in demand for more standardization and synchronization of main components of information that assures stakeholders of accessibility and transparency. Another major area of concern about data transparency is that there can be strong trade-off in the use of transparency initiative to expose private organizations for non-compliance to the requirements through unethical behaviours. When participants across the supply chain increase their attention on transparency, then there can be a likelihood of the term transparency being bleak of whether it is a means to an end or an end in itself (Mol, 2015).

Connections between Supply Chain and Visibility

Reports from investigations by researchers show that the supply chain ecosystem can be improved adversely by visibility. A group of researchers who performed their study on a single private sector supply chain found out that the supply chain manager uses the available data to make decisions and achieve the objectives of the business. The main business objectives are making a profit and being sustainable, resilient, and agile. Therefore, a properly managed supply chain by business people is essential as it helps them to convert data information to decisions, which is critical for the growth of an organization. Producers can apply statements such as "if-then" to guide them in the process of decision-making. For instance, if the stock status is less than one thousand pieces, restock the warehouse to raise the level back to one thousand pieces of materials. Additionally, the business owner should not add more items if the stock level is equal to or greater than one thousand pieces (Gardner et al., 2019).

Data visibility is vital to supply chain managers as it provides them with crucial information they require in decision-making in the event of any disruption in the supply chain network. Visibility also helps the stakeholders in the supply chain to tackle the dynamic challenges effectively in the supply chain from the initial stages of product development or movement of commodities to the final point of consumption of goods by the consumers. In the transport industries, business people apply the supply chain to transfer freight at terminals and ports; private businesses own the freight transfer points and provide services to all stakeholders across the supply chain. Collaboration between the private and public sectors is essential for greater supply chain visibility (Gardner et al., 2019).

Methodology

The researchers applied a secondary method to investigate the effect of open data on reshaping the supply chain's impacts on social equity. The study team applied specifically used a literature review as a specific method of analysis. The method used databases to evaluate data's social and environmental effects in the supply chain network. The literature that the researchers used for the study included journals, Elsevier, and scholarly books. The time for the study was six months, which was enough for the researchers to understand the aim of the study entirely. The investigators limited their work to research and review of articles and books (Egels-Zandén & Hansson, 2016).

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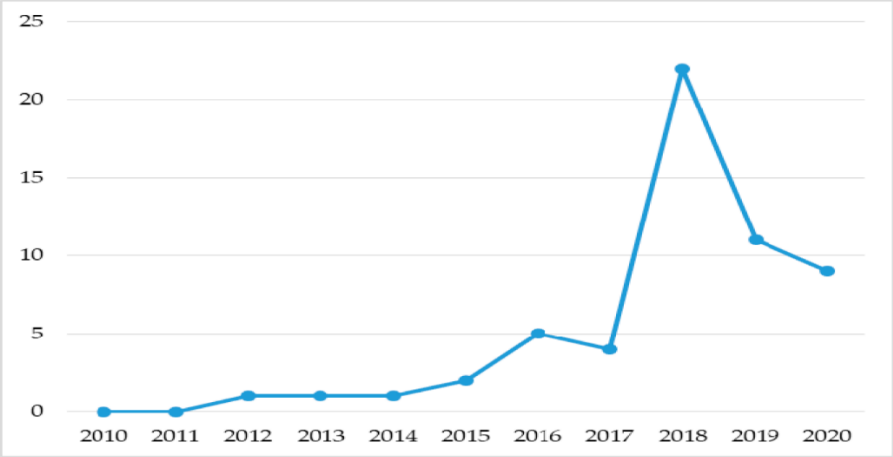
For the accessible location of relevant topics by the study team, the researchers looked for supply chain and data management in society. The team located 50 relevant articles for the study and recorded the results (Mageto, 2021). The researchers analyzed and categorized relevant articles depending on their contents and relevance. The contents that the researchers considered for investigation included the dimensions of sustainability and the impacts of open data in reshaping the supply chain industry. The study team used the Toulmin model of argumentation; in the model, the research consisted of several models with components of grounds, warrants, backing, qualifiers and claims (Mol, 2015)

Researchers grouped the contents of the articles according to relevance regarding the topic of study. For instance, some of the relevant issues the researchers selected for the study included supply chain sustainability management, big data analytics and manufacturing supply chains. A summary of the criteria for reviewing the literature in the study is in Figure 2 of the appendices (Mol, 2015).

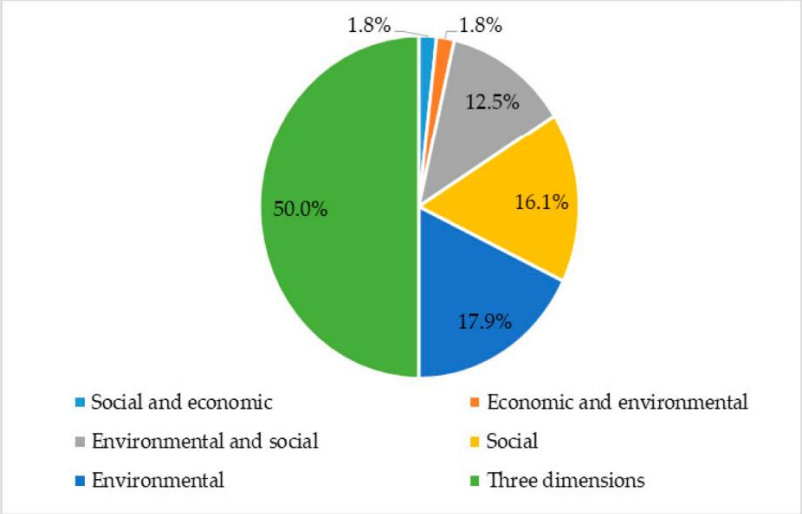
III. RESULTS

The researchers used content and descriptive analysis to provide an insight analysis of the investigation for the 50 articles. From the articles that researchers investigated, there is an increasing trend in the publications that people are making that relate to the effects of open data on the supply chain in society; this is enough evidence to show rising interest in the topic. The findings show a positive growth in interest in the subject in the last couple of years, from 2011 onwards. The observers witnessed an exponential increase in publications from 2015 to 2018(Egels-Zandén & Hansson, 2016).

A graph showing the Number of Articles that relates to open data in Supply Chain (Sánchez-Flores et al., 2020)



A chart Showing the Major Topics of Supply Chain Sustainability that the Researchers Investigated **(Sánchez-Flores et al., 20**



IV. DISCUSSIONS

Empirical information from the literature has indicated a direct relationship between leadership and the sustainability of supply chains through open data systems. For instance, Akhtar et al. used data from top management of worldwide agricultural product

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industries in the current economy. The investigators used the structural equation model. Through the model, the researchers obtained the results, providing them insight into data-driven supply management through sustainable initiatives. (Akhtar et al., 2016).

In another literature, researchers administered structured to a group of companies in Pakistan. The investigators analyzed the data from their findings using the structural equation model; the report from their findings indicates that state agencies support organizations in their endeavour to provide green and sustainable supply chain networks. Top management is also influential in managing green supply chains and achieving organizations' development objectives (Ilyas & Wiwattanakornwong, 2020).

In Malaysia, Hong et al. also applied the structural equation model to understand the impact of environmental and social factors on a nation's economy; they investigated results from survey research from various manufacturing industries. The research survey results helped them understand the relationship between big data analytics and supply chain management. Indications from the literature study showed that the management of data plays a significant role in achieving positive outcomes in sustainable supply chain management. For proper product development, there is a need for a mutual working relationship between organizations and other participants in the supply chain (Hong et al., 2018).

Data is an essential means of integrating the supply chain, and there are five characteristics of big data: velocity, volume, variety, value and integrity. Some data processing elements are the continuous collection of various data using intelligent appliances and analysis, integral dimensions of data analytics. Information from data analytics helps traders and other business people make decisions that are sustainable enough to impact the supply chain industry positively (Egels-Zandén & Hansson, 2016).

From the literature gathered by the researchers, the study team elaborated that stakeholders in the supply chain can collect transparent big data across the supply chain, and top managers can process the data to give insight for decision-making. Supply chain partners should uphold high ethical values and accountability and be open to the quality of data they share with the public; this contributes to transparency in private organizations, non-governmental organizations and public entities. For members across the supply chain to collaboratively make sound decisions, they require openness and accountability while evaluating data analytics. Data analysts should have the proper infrastructures and technologies to process data, store the information effectively, and get enough insights to make the right decision. Stakeholders across the network should maintain an appropriate chain of supply framework and strategy for the firms to meet their objectives. The advantage of the technical perspective of data analysis is that it gives direction on the threshold of data infrastructure and technology that an organization should apply to reap the benefits fully from its ability to process data (Egels-Zandén & Hansson, 2016).

Literature that elaborates on Toulmin's argumentation model has proved that there is a close link between big data analytics and sustainable supply chain management. According to Toulmin, an argument should comprise three components: warrant and ground. Other elements of arguments, according to Toulmin, include rebuttal and backing. The research report shows that data is a means through which the various links of the supply chain are combined, collected and distributed across the supply chain by the stakeholders. For effective decision-making across the supply chain network, the data should be of complying quality (Brandenburg et al., 2019). Collaboration and cooperation between supply chain members are essential for quality data and reasonable accountability. When organizations apply big data analytics, they can enhance visibility across the supply chain, which is vital for promoting transparency to the stakeholders. Organizations that embrace transparency in their data management of data have shown a remarkable improvement in their ethical conduct and reduced the setbacks that usually affect the smooth running of the business. Data transparency, therefore, enhances the proper utilization of the available resources by business people and promotes sustainability by sharing data and activities across the supply chain (Egels-Zandén & Hansson, 2016).

There is compatibility in the implementation of sustainable supply chain management practices by different firms due to the diverse interests of different groups in the industry that are interacting with each other. Members need to have a broader perspective on the cost benefits that relate to some social and environmental activities in the supply chain. Therefore, data analytics is essential in explaining the effect of individual activities in the supply chain, categorizing projects that support sustainability, and eliminating the activities that are against sustainability. Predictive data analytics is essential in the supply chain for properly making decisions that pertain to competitiveness and cost savings by all stakeholders (Ilyas & Wiwattanakornwong, 2020).

There should be proper balance and analysis of data analytics's social, economic and environmental impacts by all interested parties in the supply chain. For instance, investigations carried out by researchers have shown that there can be adverse effects on some environmental and social projects established by organizations if there is no elaborate balance between the two factors of the economy (Saeed & Kersten, 2019). Researchers using the simulation method have shown that big data analytics is an essential tool for providing solutions to the challenges in sustainable supply chain management by verifying the potential results of several projects on the environment and society. Experts are basing their evaluation on the latest data that business people are using to project the future by preventing the establishment of projects that can negatively affect a firm's sustainability agendaEgels-Zandén & Hansson, 2016).

Application of big data analytics by firms can, therefore, lead to cost savings by reduction of expenses that the company could have otherwise incurred in the health and safety of the workforce and members of the society; this enables the firms to accomplish their work within a shorter time cycle makes the organization have a positive reputation from the perspective of the members of the

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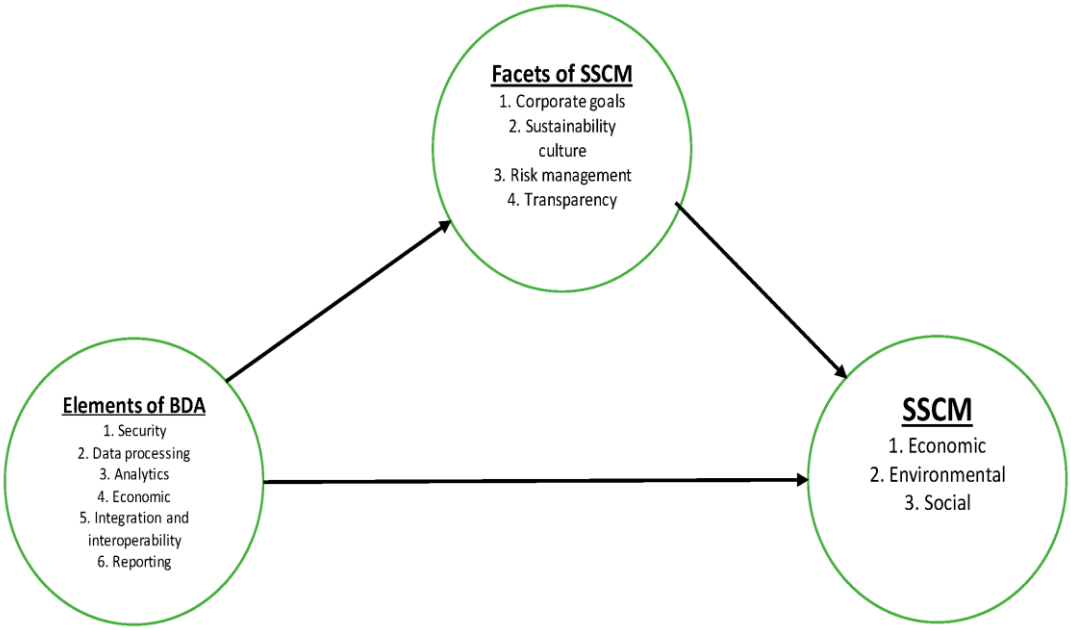
society. The application of big data analytics has the potential to improve the economic status of an organization as the experts can guide firms on the mechanisms of reducing the cost of operation and giving the business a competitive advantage over other enterprises (Egels-Zandén & Hansson, 2016).

Information that organizations obtain from big data analytics is also essential for firms to apply while implementing sustainable initiatives for the growth and development of the organization (Engert et al., 2016). Integration and interoperable software provide quicker data analysis from internal and external sources across the supply chain and help get insight information from specific supply chain units. Real-time data analytics helps top managers identify disruptions and damages early enough and take corrective actions to reduce related risks to the organization (Mageto, 2021).

A Model Showing the Relationship between Big Data Analytics (BDA) and Sustainable Supply Chain Management (SSCM) (Mageto, 2021).



V. CONCLUSION

From the research findings, open data is essential for the sustainable development of the global supply chain across different sectors of the economy. Organizations use the technique of big data analytics to assist in the process of data making and calculations. Big data analytics comprises a technology for processing data that incorporates computer-aided devices and other software for collecting information from different categories. Data analysis promotes accountability and transparency in the activities of all partners in the supply chain. Open data system enables organizations to get reports within the shortest time possible hence quicker decision making. Big data analytics supports engagement and cooperation among stakeholders in the supply chain. Open data systems provide security to the business system across all categories of supply chain management; some of the security features include privacy and data protection from internal and external attacks.

Data integration is needed to enhance compatibility between various units in the supply chain industry. Open data systems give organizations economic value as they help reduce costs and embrace sustainability. Therefore, the literature data shows that well-managed big data analytics can promote sustainable supply chain management. Open data system is a concept that can help organizations acquire insights due to the big data they gather across the firms or in the supply chain network, which enhances an organization's performance. Managers can, therefore, overcome the supply chain challenges by implementing of an extensive data analytics system.

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Appendices

Figure1: Data Collection in a Processing Supply Chain (Mageto, 2021).

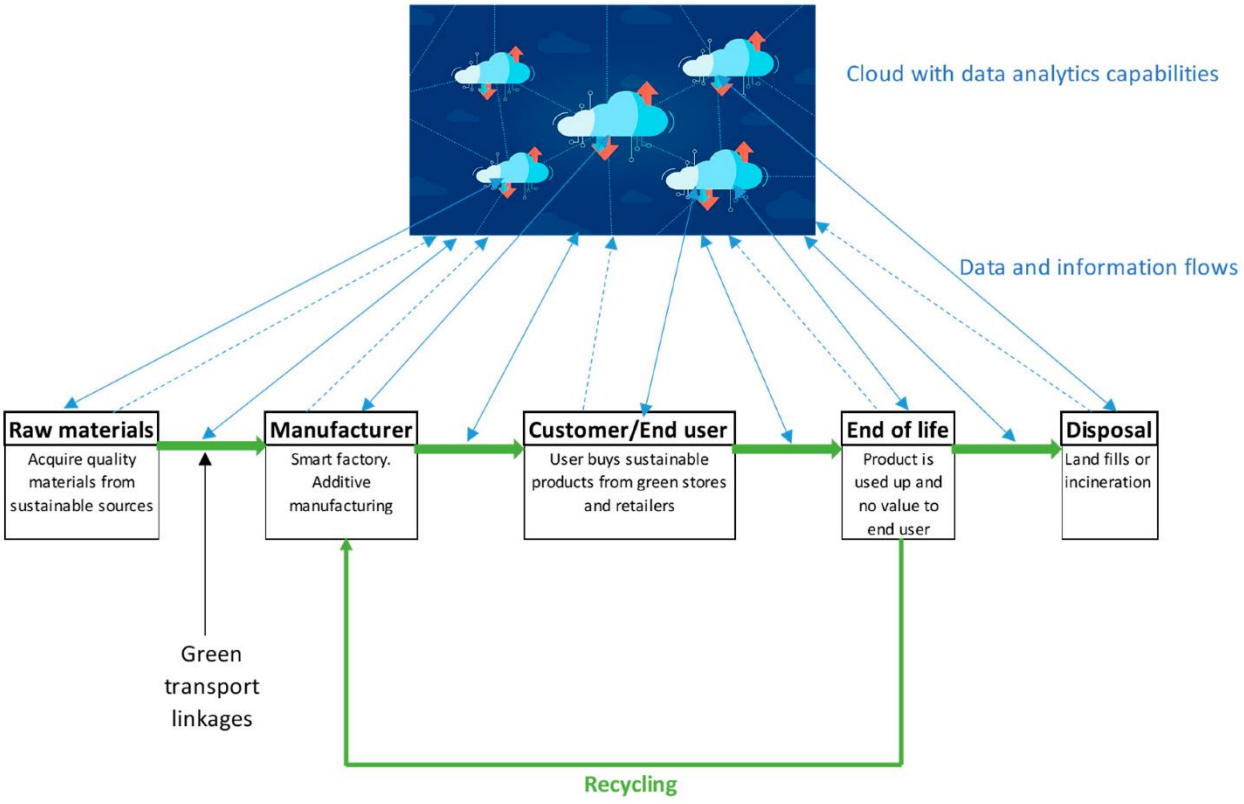
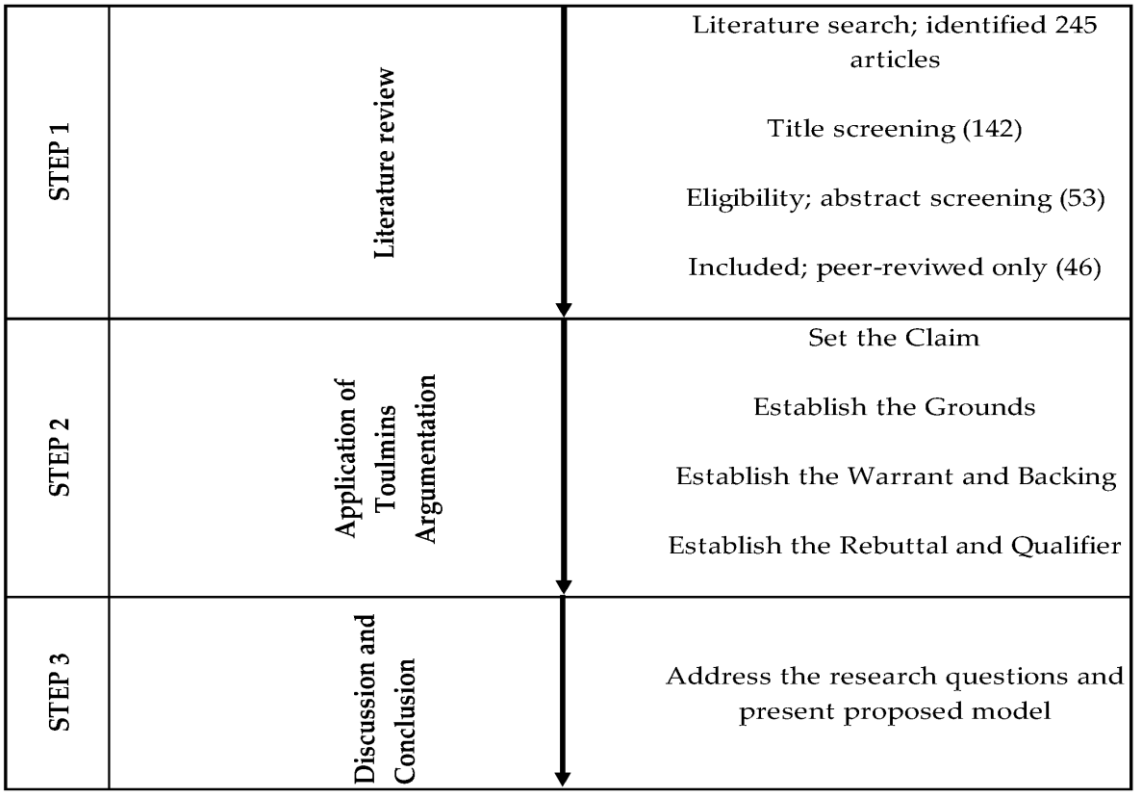


Figure 2 Research Methodology. (Mageto, 2021)



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