



THE IMPACT OF ENVIRONMENT IN SUPPLY CHAIN MANAGEMENT USING BUSINESS INTELLIGENCE

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Abstract

In an era where sustainability is paramount, businesses are increasingly turning to innovative technologies to enhance their supply chain practices. This paper explores the transformative potential of Business Intelligence (BI) in sustainable supply chain management, highlighting how it can unlock efficiencies and drive greener practices. We discuss the vital integration of BI with green supply chain collaboration, emphasizing strategies that facilitate stakeholder engagement and foster transparency. The convergence of Artificial Intelligence (AI), big data, and sustainability is examined, showcasing how intelligent supply chains can utilize data-driven insights to minimize their environmental impact while optimizing performance. Furthermore, we provide a roadmap for mastering the agile, intelligent supply chain, demonstrating how BI can offer a competitive advantage through enhanced responsiveness and adaptability to market changes. Finally, this paper envisions a greener future, arguing that leveraging BI is essential for the sustainable transformation of supply chains, ultimately contributing to a more resilient and eco-conscious global economy. Through a combination of case studies and best practices, we outline a comprehensive approach for organizations aiming to integrate sustainability into their core operational strategies effectively.

Introduction

In today's rapidly evolving business landscape, the pursuit of sustainability has become a critical imperative for organizations striving to remain competitive. The global landscape of business is undergoing significant transformation as organizations increasingly recognize the importance of sustainability. Enterprises are challenged to meet the dual goals of profitability and environmental responsibility, particularly in their supply chain operations, which constitute a significant portion of their overall carbon footprint. The advent of Business Intelligence (BI) provides a powerful approach to convert vast amounts of data into actionable insights, allowing companies to optimize their supply chains sustainably. Stakeholders are increasingly holding companies responsible for damage in the environment created by their SDGs (Payán-Sánchez et al., 2019) and putting pressure on firms to extend their environmental responsibilities with the adoption of Green Supply Chain Management (GSCM) practices (Gölgeci & Kuivalainen, 2020; Al-Sheyad et al., 2019; L. Pinto, 2020; Silva et al., 2021). These pressures also reach to include the incorporation of environmental requirements along the supply chain in supplier selection activities, the manufacturing of products, and delivery processes to the final customer (Srivastava, 2007). Researchers have paid attention to the relationship between supply chain management and the natural environment since the late nineties (Mardani et al., 2019; Agi and Nishant, 2017; Badi and Murtagh, 2019; Tseng et al., 2019) when environmental issues began to impact supply chain management (Reche et al., 2020; de Oliveira et al., 2018; Micheli et al., 2020) and influence its results, positively or negatively (Zhu et al., 2012a; Cousins et al., 2019; Cankaya and Sezen, 2019; Green et al., 2012). As supply chains are often at the forefront of environmental impact, the effective application of Business Intelligence (BI) emerges as a transformative tool in promoting sustainable practices across the supply chain. Modern companies have to be more efficient to match customers' needs while reducing the time and cost of the production process. Thus, a company can't be viewed as a single entity, but as a part of the supply chain if they want to gain a competitive advantage. One of the most used practices is business intelligence (BI) which integrates and analyses various software. BI provides a set of technologies and products for supplying users with the information they need to

answer business questions, and make tactical and strategic business decisions (Stefanovic et al., 2006) concept of business intelligence, supply chain and characteristics implement such as OLAP, data warehouse or data mining. Audrey Langloisa and Benjamin Chauvela (2017) By unlocking the power of BI, companies can harness data-driven insights to optimize resource use, reduce waste, and improve overall efficiency. However, effectively bridging the gap between traditional supply chain management and green practices necessitates collaborative efforts among stakeholders, where integrated BI systems play a vital role in fostering transparency and synergies. Moreover, the intersection of Artificial Intelligence (AI), big data, and sustainability presents profound opportunities for organizations to develop intelligent supply chains that are responsive to market demands while adhering to ecological considerations. As we explore the roadmap to mastering agile supply chains, it becomes evident that leveraging BI is essential not only for competitive advantage but also for driving meaningful transformation towards a greener future. This introduction sets the stage for examining how organizations can strategically align their supply chains with sustainability goals through the innovative application of BI technologies and methodologies.

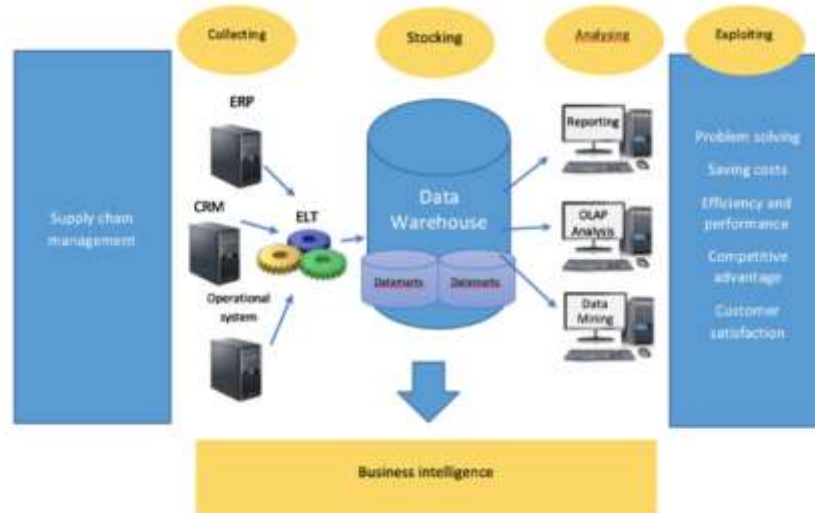


1. Unlocking the power of BI in sustainable SCM

The power of (BI) **Business Intelligence** provides organizations with a comprehensive view of their supply chain operations by collecting, analyzing, and visualizing data. refers to the use of data analysis tools and techniques to gain insights into the various processes and activities within a supply chain. Business Intelligence (BI) plays a pivotal role in modern supply chain management, offering a robust set of functionalities that empower organisations to harness data for informed decision-making. These functionalities, essential for thriving in today's dynamic business landscape, encompass a range of critical factors:

- (i) **Data Collection and Integration:** BI tools gather data from multiple sources such as inventory systems, transportation management systems, and customer relationship management systems. This data is then integrated and transformed into a unified format for analysis.
- (ii) **Data Analysis and Visualization:** BI tools utilise advanced analytics techniques to analyze the integrated data and generate meaningful visualisations, such as dashboards and scorecards. These visualisations provide a comprehensive view of key performance indicators (KPIs) and help stakeholders identify trends and patterns. Also monitor KPIs such as lead time, delivery accuracy, and inventory levels, ensuring smoother operations.
- (iii) **Real-time Monitoring and Alerts:** BI tools enable real-time monitoring of supply chain operations by continuously collecting and analysing data. This allows organisations to identify and address issues promptly, such as inventory shortages or delivery delays. Alerts can be set up to notify stakeholders of critical events or deviations from predefined benchmarks. BI tools analyze routes, fuel costs, and delivery schedules, helping organizations streamline logistics and cut expenses. Evaluating supplier reliability and performance is easier with BI. By tracking metrics like order accuracy and on-time delivery.
- (iv) **Predictive Analytics:** BI tools leverage predictive analytics models to forecast future demand, optimise inventory levels, and anticipate supply chain disruptions. Accurate demand forecasting is crucial for minimizing stockouts or overstock situations. By analysing historical data and external factors, organisations can make proactive decisions to mitigate risks and optimise resource allocation.

- (v) **Collaboration and Communication:** BI tools facilitate collaboration and communication among supply chain stakeholders by providing a centralised platform for data sharing, reporting, and decision-making. This improves visibility and transparency across the supply chain, businesses can foster better supplier relationships and negotiate more favorable contracts, enabling better coordination and faster response to changing market conditions.



Business Intelligent in Supply Chain Management

2. The Role of Collaboration in Green Supply Chains Management

Green supply chain management (GSCM) focuses on reducing the ecological impact of supply chain processes. Collaboration among supply chain partners, including suppliers, manufacturers, and retailers, is essential for achieving these sustainability objectives. Business Intelligence (BI) tools can enhance collaboration by transforming data into actionable insights, fostering transparency and communication across the supply chain. The theory of ecological modernization that underlies environmental discourse and policies throughout the industrialized world. The new environmental policy field of environmental supply chain management is used to explore how ecological modernization informs strategies towards environmental policy making. EMT (Ecological modernization theory) has been applied to various levels of analysis. EMT plays an essential role in the FEW context since many initiatives at the most basic transdisciplinary levels focus on the sciences and engineering technology. EMT does not only focus on technology that is just scientific, but also ‘softer’ technologies such as management processes and product technology that may be important in the FEW (food-energy-water) context. Supply chains and their management and activities represent a large fraction of the environmental burden caused by industry and commerce. Management of each supply chain flow provides avenues for practice, research, and development within FEW systems. Environmental, social, technology and economic issues are each part of the design, planning, and managerial complexities of sustainable supply chains. Thus, EMT is also instrumental in understanding and managing sustainable supply chains.

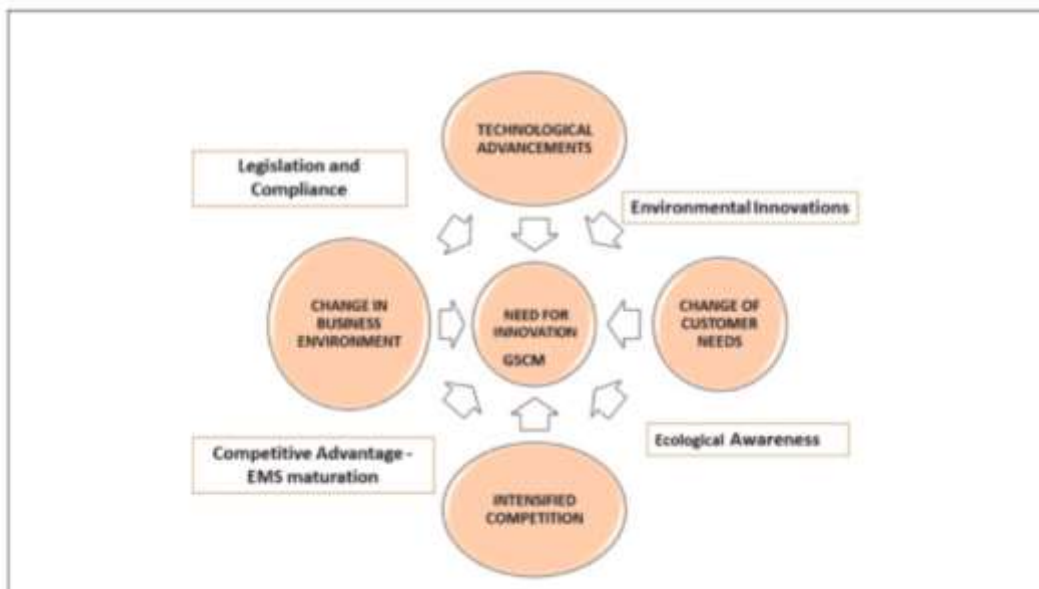


Fig. shows the drivers that connect the necessity to enhance innovation to implement GSCM

Set of GSCM practices and the main characteristics.

PRACTICE CATEGORY	DESCRIPTION	PRACTICES INCLUDED	MAIN REFERENCES
Customer Cooperation (CC)	Downstream Cooperative Network and stakeholder relationship	Adoption of ecological packaging, ecological and cleaner production projects and customer-oriented ecological projects.	Holt and Ghobadian (2009); Azevedo et al. (2011); Zhu et al. (2015); Zhu et al. (2016); Zhu and Wang (2018)
Ecodesign (ECD)	Product Lifecycle and Disposal Projects	Projects that assess their life cycle, reduction or elimination of materials hazardous to the environment, remanufacturing, reuse, recycling, recovery of materials and components, development of clean technologies and environmentally friendly packaging.	Srivastava (2007); Zhu et al. (2008); Awasthi and Govindan (2016); Hsu and Hu (2010); Rha (2010); Zsidisin and Siferd (2011); Green et al. (2012); Tseng and Chiu (2013); Govindan et al. (2014); Zaid et al. (2018); Badi and Murtagh (2019); Micheli et al. (2020); Stekelorum et al. (2021)
Green Compliance (GC)	Risks and associated requirements and senior management commitment	Environmental compliance and audit programs; environmental audit for internal supplier management, effectively responding to public opinion and society's expectations and top management's commitment to environmental improvement.	Vachon and Klassen (2008); Awasthi et al. (2010); Zhu et al. (2011); Rha (2010)
Green Marketing (GM)	Environmentally oriented marketing and awareness mix	Green-image management practices, innovation to improve R&D functions to provide low-cost green products, modify dirty technologies for cleaner technologies and cross-functional cooperation for environmental improvements, and training for green practices.	Zhu et al. (2011); Tseng and Chiu (2013); Govindan et al. (2014); Cankaya and Sezen (2019)
Green Purchasing (GP)	Upstream cooperative network	Purchasing policies, which include environmental concerns related to raw materials (extraction and purchase), supplier selection, supplier evaluation and development, supplier operations, packaging, recycling, reuse, resource reduction, management systems, and final destination of company products.	Zhu et al. (2008); Thun and Muller (2010); Green et al. (2012); Azevedo et al. (2011); Zaid et al. (2018); Badi and Murtagh (2019); Cankaya and Sezen (2019); Micheli et al. (2020)
Internal Environmental Management (IEM)	GSCM practice-driven operation	Implement and manage environmental management systems and certification, managing pollution control initiatives and reducing the consumption of hazardous and toxic materials and integrating the quality and environmental management system into the planning and operation processes.	Zhu et al. (2008); Vachon and Klassen (2008); Awasthi et al. (2010); Wan Mahmood (2013); Zhu et al. (2016); Cankaya and Sezen (2019); Micheli et al. (2020); Stekelorum et al. (2021)
Investment Recovery (IR)	Life cycle of products, equipment, and raw materials as a source of resources	Selling materials and supplies that are leftover from the production process, selling unused raw stock, selling used/obsolete equipment.	Zhu et al. (2008); Zsidisin and Siferd (2011); Tseng and Chiu (2013); Wan Mahmood (2018); Govindan et al. (2014); Rha (2010); Green et al. (2012); Zhu et al. (2015); Zhu et al. (2008); Zhu et al. (2016); Cankaya and Sezen (2019); Micheli et al. (2020); Stekelorum et al. (2021)
Reverse Logistics (RL)	Product and flow-packaging	Management of return flows induced by various forms of reusing products and materials in	Hsu and Hu (2010); Srivastava (2007); Zaid et al. (2018); Oliveira et

	induced return for asset recovery	industrial production processes related to the product and packaging, such as activities to resell, redeem, renew, remanufacture, recover, and recycle.	al. (2019); Stekelorum et al. (2021)
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These are eight categories of GSCM practices and conceptualize their impact on innovation. Collaboration is critical in GSCM as it enables stakeholders to work together to minimize risks and optimize resources. Effective collaboration requires a clear understanding of each partner's capabilities, goals, and sustainability practices. BI tools can facilitate this process by offering real-time visibility into supply chain operations, fostering trust and transparency. With shared access to data, organizations can better align their sustainability initiatives, streamline processes, and reduce waste across the supply chain.

Integrating Business Intelligence (BI) and Green Supply Chain Management (GSCM) through data sharing is a strategic approach to enhance sustainability, efficiency, and decision-making in supply chains.

1. Understanding Business Intelligence (BI)

BI involves the technologies, processes, and practices that convert raw data into meaningful insights to support business decisions. It includes data collection, analysis, reporting, and visualization tools to help organizations track performance, identify trends, and predict future outcomes.

2. Green Supply Chain Management (GSCM)

Green Supply Chain Management (GSCM) focuses on integrating environmentally friendly practices across every stage of the supply chain to promote sustainability and reduce ecological impact. This includes eco-friendly product design, where products are developed with minimal environmental footprint, and sustainable sourcing and purchasing, ensuring that raw materials and suppliers adhere to green standards. GSCM also emphasizes efficient production processes that minimize waste and pollution, creating cleaner and more responsible manufacturing systems. Additionally, reverse logistics plays a vital role by managing the return, recycling, reuse, and remanufacturing of products and materials, extending their lifecycle and reducing landfill waste. Investment recovery and resource efficiency further enhance sustainability by selling unused or obsolete equipment and leftover materials, maximizing the value of resources while reducing waste. Through these practices, GSCM fosters a more responsible, cost-effective, and environmentally conscious supply chain.

3. Role of Data Sharing in GSCM Collaboration

Data sharing is crucial for aligning various stakeholders, including suppliers, manufacturers, logistics partners, and customers, around common sustainability goals. By enabling real-time, accurate data exchange, it fosters collaboration and transparency across the supply chain. This seamless flow of information helps track the environmental impact at different stages, providing clear insights into areas like carbon footprint, energy consumption, and waste generation. Through consistent data sharing, companies can ensure compliance with environmental regulations, avoiding legal risks and promoting responsible practices. Moreover, the availability of precise data makes it easier to identify opportunities for improvement and innovation, driving the development of greener, more efficient processes. Ultimately, effective data sharing strengthens the collective effort to create a sustainable and environmentally conscious supply chain.

4. How BI Enhances Green Supply Chain Collaboration

Business Intelligence (BI) tools play a critical role in enabling data-driven decisions for Green Supply Chain Management (GSCM) by providing powerful capabilities that enhance environmental performance and sustainability. One of the key functions of BI tools is data integration, where data from multiple sources such as ERP systems, IoT sensors, and supplier reports are combined to provide a holistic view of the entire supply chain's environmental impact. This integrated approach helps identify inefficiencies and track sustainability metrics across different operations. Advanced analytics further strengthens this capability by using techniques like machine learning and predictive analytics to forecast demand, optimize inventory, and reduce waste. These predictive insights allow companies to plan more efficiently and minimize their environmental footprint.

BI tools also facilitate real-time monitoring, tracking emissions, energy consumption, and resource usage as they occur. This real-time visibility enables quick identification of inefficiencies and immediate corrective actions, ensuring that environmental goals are consistently met. Through performance dashboards, BI tools present key sustainability metrics in a clear and accessible format, keeping all stakeholders—suppliers, manufacturers, logistics partners, and customers—informed and aligned on green objectives. Additionally, supplier evaluation becomes more effective with BI tools, as they assess supplier performance in terms of environmental compliance and sustainability practices, promoting accountability and collaboration across the supply chain.

5. Benefits of Integrating BI and GSCM through Data Sharing

The integration of BI and GSCM through effective data sharing offers numerous benefits. Enhanced transparency is one of the most important, as it provides clear visibility across the supply chain, fostering trust and accountability among all partners. This transparency supports informed decision-making, enabling businesses to respond quickly and effectively to environmental issues with real-time data insights. Moreover, identifying opportunities for cost savings through energy efficiency and waste reduction helps lower operational costs while contributing to sustainability goals. Ensuring regulatory compliance is another critical advantage, as accurate

data tracking helps companies adhere to environmental standards and avoid potential penalties. Finally, the use of data-driven insights fuels innovation and competitive advantage, empowering companies to develop greener products, adopt more sustainable processes, and position themselves as industry leaders in environmental responsibility. Through the integration of BI and GSCM, businesses not only achieve their sustainability objectives but also enhance efficiency, reduce costs, and strengthen their market position.

6. Challenges and Solutions

Implementing Business Intelligence (BI) and Green Supply Chain Management (GSCM) through data sharing comes with its own set of challenges, and addressing these is crucial for the success of a sustainable supply chain. One of the primary challenges is data quality, which involves ensuring that the data collected from all partners—suppliers, manufacturers, logistics providers, and customers—is accurate, consistent, and reliable. Poor data quality can lead to incorrect analyses and misguided decisions, ultimately impacting environmental performance and efficiency. This challenge can be effectively addressed by establishing standardized data protocols, which define clear rules and formats for data collection, entry, and sharing across the supply chain. Standardization minimizes discrepancies and ensures that every stakeholder provides information in a uniform, comparable format.

Another significant concern is data security, as the supply chain often involves the exchange of sensitive information, including production data, supplier details, and environmental performance metrics. Protecting this data from unauthorized access, breaches, or cyberattacks is essential to maintaining confidentiality and trust among partners. This issue can be mitigated through encryption, which secures data by converting it into a code that can only be deciphered by authorized parties, and access controls, which restrict data usage based on user roles and responsibilities. These security measures ensure that only verified and relevant stakeholders have access to critical supply chain information.

Technology integration is also a key challenge when aligning different IT systems across a diverse supply chain network. Each partner may use different software, databases, and tools, leading to compatibility issues and data silos. Overcoming this requires the implementation of cloud-based platforms and APIs (Application Programming Interfaces), which enable seamless communication and data exchange between various systems. Cloud platforms offer centralized, scalable storage and access, while APIs facilitate the integration of different applications by enabling them to share data and functions efficiently. Together, these solutions help create a connected, transparent, and efficient supply chain, allowing BI tools to generate valuable insights and drive sustainability initiatives forward.

Conclusion:

Unlocking the power of Business Intelligence in sustainable supply chain management presents a unique opportunity for organizations to achieve their environmental and operational goals. By harnessing data-driven insights, companies can enhance decision-making processes, optimize resource use, and build resilient supply chains. As global demand for sustainability continues to grow, businesses that effectively integrate BI into their supply chain strategies will not only comply with regulatory requirements but also gain a competitive edge in the marketplace.

Bridging the gap between Business Intelligence and green supply chain collaboration is essential for organizations seeking to enhance their sustainability efforts. By leveraging BI tools, firms can cultivate collaborative relationships, achieve greater transparency, and drive significant environmental improvements. As sustainability becomes increasingly important, the integration of BI into green supply chain practices will not only support compliance with regulations but will also provide a competitive edge in the marketplace.

References:

1. Waller, M. A., & Fawcett, S. E. (2013). Data Science, Predictive Analytics, and Big Data: A Revolution that Will Transform Supply Chain Design and Management. **Journal of Business Logistics**, 34(2), 77-84.
2. Govindan, K., Soleimani, H., & Kannan, D. (2016). A bibliometric review of green supply chain management: A decade of progress and future directions. **International Journal of Production Economics**, 194, 146-158.
3. Gunasekaran, A., & Spalanzani, A. (2012). A framework for sustainable supply chain management. **International Journal of Production Economics**, 140(1), 57-65.
4. Porter, M. E., & Kramer, M. R. (2011). Creating Shared Value. **Harvard Business Review**, 89(1/2), 62-77.
5. B. Payán-Sánchez, et.al., 2019 Supply chain management in a degrowth context: the potential contribution of stakeholders Sustainable Development Goals and Sustainable Supply Chains in the Post-global Economy, Springer, Cham (2019), pp. 31-45

6. Gölgeci, Kuivalainen, 2020. Does social capital matter for supply chain resilience? The role of absorptive capacity and marketing-supply chain management alignment
Ind. Market. Manag., 84 (2020), pp. 63-74
7. Al-Sheyad et. al. 2019(A.A. Al-Sheyad, L. Muyldermans, K. Kauppi). The complementarity of green supply chain management practices and the impact on environmental performance. J. Environ. Manag., 242 (2019), pp. 186-198
8. L.Pinto, 2020. Green supply chain practices and company performance in Portuguese manufacturing sector. Bus. Strat. Environ., 29 (5) (2020), pp. 1832-1849
9. G.M. Silva, P.J. Gomes, J. Sarkis
The role of innovation in the implementation of green supply chain management practices Bus. Strat. Environ., 28 (5) (2019), pp. 819-832.
10. Stefanovic, N., Majstorovic, V., & Stefanovic, D. (2006). Supply Chain Business Intelligence Model. In Proceedings 13th International Conference on Life Cycle Engineering (pp. 613- 618).
11. Audrey Langloisa and Benjamin Chauvela (2017) The impact of supply chain management on business intelligence. Journal of Intelligence Studies in Business Vol. 7, No. 2 (2017) pp. 51-61.

