

GLOBAL SUPPLY CHAIN COORDINATION – THE BUSINESS ANALYTICS USAGE IN INDUSTRY 4.0 CONDITIONS

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Purpose: The purpose of this publication is to present the applications of usage of business analytics in global supply chain coordination.

Design/methodology/approach: Critical literature analysis. Analysis of international literature from main databases and polish literature and legal acts connecting with researched topic.

Findings: The integration of business analytics in global supply chain coordination within the framework of Industry 4.0 is a transformative strategy that propels organizations toward enhanced efficiency, adaptability, and competitiveness. This approach is particularly crucial as industries undergo significant technological transformations. Business analytics strategically deployed in the modern supply chain serves as a vital tool, addressing the complexities inherent in Industry 4.0. The diverse applications of business analytics, including demand forecasting, supply chain visibility, predictive maintenance, collaboration, and risk management, highlight its multifaceted benefits. These applications empower organizations to anticipate market demands, optimize inventory, ensure reliable production flows, foster collaboration, and proactively address risks, thereby bolstering overall supply chain resilience and responsiveness. The use of sophisticated software tools like SAP Integrated Business Planning, Oracle SCM Cloud, and IBM Watson Supply Chain underscores the pivotal role of technology in overcoming the intricate challenges of managing global supply chain processes. Despite the numerous advantages, challenges such as data quality, integration issues, implementation costs, and skill shortages necessitate careful consideration and strategic planning. Organizations must address these challenges, along with security and privacy concerns, resistance to change, and the complexity of analytics tools, through investments in training and change management strategies to fully unlock the potential of business analytics. The presented tables further illustrate the advantages and challenges, emphasizing the positive impact of business analytics on efficiency, risk management, and strategic alignment with organizational goals. In conclusion, the judicious use of business analytics offers substantial opportunities for optimizing global supply chain coordination in Industry 4.0, requiring organizations to navigate both advantages and challenges proactively to position themselves at the forefront of innovation and competitiveness in the dynamic landscape of modern industry.

Originality/Value: Detailed analysis of all subjects related to the problems connected with the usage of business analytics in the case of global supply chain coordination.

Keywords: business analytics, Industry 4.0, digitalization, artificial intelligence, real-time monitoring; supply chain.

Category of the paper: literature review.

1. Introduction

In the ever-evolving landscape of Industry 4.0, the integration of business analytics has emerged as a cornerstone for global supply chain coordination, ushering in a new era of efficiency, adaptability, and competitiveness. As industries undergo profound transformations driven by technological advancements, the strategic deployment of business analytics has become instrumental in navigating the complexities of the modern supply chain.

In the context of Industry 4.0, characterized by the convergence of digital technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and automation, businesses are presented with unprecedented opportunities to enhance their supply chain operations. Business analytics, leveraging the vast amounts of data generated throughout the supply chain, plays a pivotal role in extracting actionable insights to optimize decision-making processes (Ghibakholl et al., 2022).

The purpose of this publication is to present the applications of usage of business analytics in global supply chain coordination.

2. The selected aspects of business analytics usage in global supply chain coordination

One of the key aspects of business analytics in global supply chain coordination is demand forecasting. The amalgamation of historical data, market trends, and predictive analytics enables organizations to anticipate consumer demands with a higher degree of accuracy. This proactive approach facilitates more efficient inventory management, reducing the risk of stockouts or excess inventory, and ultimately contributing to cost savings (Zeng et al., 2022; Pech, Vrchota, 2022).

Moreover, analytics-driven supply chain visibility is paramount in Industry 4.0. Real-time monitoring and analysis of various supply chain components provide stakeholders with a comprehensive understanding of the entire process, from raw material sourcing to end-product delivery. This heightened visibility enables swift identification and resolution of potential disruptions, thereby enhancing the overall resilience of the supply chain (Bakir, Dahlan, 2022).

Furthermore, predictive analytics in maintenance management has become indispensable for Industry 4.0 supply chains. By leveraging machine learning algorithms and IoT data, organizations can forecast equipment failures and schedule preventive maintenance, minimizing downtime and optimizing operational efficiency. This predictive maintenance approach not only extends the lifespan of machinery but also ensures a continuous and reliable production flow (Cillo et al., 2022).

In the realm of global supply chain coordination, business analytics fosters collaboration among diverse stakeholders (Scappini, 2016). Data-driven insights facilitate better

communication and coordination between suppliers, manufacturers, distributors, and retailers. This collaborative approach not only streamlines the flow of goods but also enables the rapid adaptation to market changes, reducing lead times and enhancing overall supply chain responsiveness.

The implementation of business analytics in Industry 4.0 also revolutionizes risk management strategies. By analyzing historical data and market trends, organizations can identify potential risks and develop mitigation strategies. Whether it be geopolitical uncertainties, natural disasters, or disruptions in the transportation network, analytics empowers businesses to proactively address challenges and ensure the continuity of supply chain operations (Gajdzik, Wolniak, 2022; Gajdzik et al., 2023).

The incorporation of business analytics in global supply chain coordination within the framework of Industry 4.0 represents a paradigm shift in how businesses approach and manage their operations (Jonek-Kowalska, Wolniak, 2021). The ability to harness the power of data for informed decision-making not only optimizes efficiency and reduces costs but also positions organizations at the forefront of innovation and competitiveness in the dynamic landscape of modern industry. As Industry 4.0 continues to unfold, business analytics will undoubtedly remain a cornerstone for driving the success of global supply chain coordination (Akundi et al., 2022).

Table 1 contains descriptions of how business analytics is used in the case of global supply chain coordination.

Table 1.

The usage of business analytics in global supply chain coordination

Application	Description
Demand Forecasting	Utilizing historical data and predictive analytics to estimate future demand, aiding in inventory planning and production scheduling.
Inventory Optimization	Analyzing supply and demand patterns to determine optimal inventory levels, reducing carrying costs while ensuring product availability.
Supplier Performance	Assessing and monitoring supplier performance through key performance indicators (KPIs) and analytics, ensuring reliability and quality in the supply chain.
Route Optimization	Optimizing transportation routes and logistics networks to minimize costs, reduce lead times, and enhance overall supply chain efficiency.
Risk Management	Identifying and mitigating potential risks in the supply chain, such as disruptions, geopolitical factors, and market fluctuations through data analysis.
Real-Time Visibility	Utilizing analytics to gain real-time visibility into the entire supply chain, enabling quick response to disruptions, and improving overall decision-making.
Cost Analysis	Analyzing cost structures across the supply chain to identify areas for cost reduction and efficiency improvement, contributing to overall cost-effectiveness.
Sustainability Tracking	Using analytics to monitor and report on sustainability metrics, ensuring compliance with environmental standards and meeting corporate social responsibility goals.
Order Fulfillment Analytics	Improving order fulfillment processes through analytics, reducing lead times, optimizing order processing, and enhancing customer satisfaction.
Performance Benchmarking	Comparing supply chain performance metrics against industry benchmarks to identify areas for improvement and maintain a competitive edge.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

3. Software used in global supply chain coordination in Industry 4.0 conditions

Business analytics software plays a pivotal role in enhancing the efficiency and effectiveness of global supply chain coordination. These sophisticated tools are designed to address the intricate challenges associated with managing and optimizing supply chain processes on a global scale. One such notable example is SAP Integrated Business Planning (IBP), an advanced solution that facilitates real-time collaboration and decision-making across the entire supply chain network. Business analytics software in the context of global supply chain coordination serves as a comprehensive platform for organizations to gain insights into various aspects of their supply chain operations. These tools are instrumental in demand planning and forecasting, enabling organizations to anticipate market trends and align their production and distribution strategies accordingly. Furthermore, they facilitate inventory optimization, ensuring that organizations maintain optimal stock levels to meet customer demand while minimizing carrying costs (Nourani, 2021).

Collaboration with suppliers is a critical aspect of global supply chain management, and business analytics software provides the necessary infrastructure for effective supplier collaboration. This includes features such as data sharing, communication channels, and joint planning mechanisms to synchronize activities and improve overall supply chain performance.

Scenario-based planning is another key functionality offered by business analytics software. Organizations can simulate different scenarios, considering factors like market fluctuations, geopolitical events, and disruptions, allowing them to develop robust contingency plans and enhance their resilience in the face of unforeseen challenges (Adel., 2022).

Oracle SCM Cloud is another example of business analytics software that contributes to the seamless coordination of global supply chains. This solution offers a comprehensive suite of applications embedded with analytics capabilities. It covers various aspects, including order management, procurement, transportation management, and predictive analytics, providing organizations with end-to-end visibility and control over their supply chain processes (Du et al., 2023; Fjellström, Osarenkhoe, 2023; Castro et al., 2014; Wang et al., 2023).

Table 2 highlighting examples of software and applications used in global supply chain coordination, along with descriptions of their usage.

Table 2.

The usage of business analytics software in global supply chain coordination

Software/Application	Description	Key Features
SAP Integrated Business Planning (IBP)	Advanced planning and analytics tool for optimizing global supply chain processes. Enables real-time collaboration and decision-making.	<ul style="list-style-type: none"> - Demand planning and forecasting - Inventory optimization - Supplier collaboration - Scenario-based planning

Cont. table 2.

Oracle SCM Cloud	Comprehensive suite of supply chain management applications with embedded analytics. Streamlines supply chain operations.	<ul style="list-style-type: none"> - Order management - Procurement - Transportation management - Predictive analytics
IBM Watson Supply Chain	Uses AI and ML to enhance supply chain visibility and predict disruptions. Enables data-driven decision-making.	<ul style="list-style-type: none"> - Supply chain visibility - Predictive analytics
Microsoft Dynamics 365 Supply Chain Management	Integrated supply chain management solution within the Dynamics 365 suite. Enhances visibility and collaboration.	<ul style="list-style-type: none"> - Inventory management - Order fulfillment\ - Warehouse management - Analytics
JDA Software (now Blue Yonder)	Provides end-to-end supply chain solutions, including planning, execution, and optimization.	<ul style="list-style-type: none"> - Demand and supply planning - Inventory optimization - Order fulfillment
Kinaxis RapidResponse	Cloud-based solution for concurrent planning in supply chain management. Enables real-time decision-making.	<ul style="list-style-type: none"> - Rapid scenario analysis - Demand and supply planning - Supply chain visibility
Manhattan Associates SCM	Offers supply chain solutions, including warehouse management and transportation optimization.	<ul style="list-style-type: none"> - Warehouse management\ - Order fulfillment - Transportation optimization
Tableau	Data visualization and business intelligence software. Used for analyzing and presenting supply chain data.	<ul style="list-style-type: none"> - Visual analytics - Dashboard creation - Data connectivity
Qlik Sense	Business intelligence and data visualization platform. Provides insights into supply chain performance.	<ul style="list-style-type: none"> - Associative data modeling - Data visualization - Dashboard development
Anaplan	Cloud-based planning platform that includes supply chain planning capabilities.	<ul style="list-style-type: none"> - Integrated business planning - Scenario modeling - Performance analytics

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

4. Advantages and problems of business analytics usage in global supply chain coordination

Business analytics plays a pivotal role in enhancing global supply chain coordination, offering a multitude of advantages that contribute to efficiency, resilience, and improved decision-making. One key benefit lies in improved forecasting capabilities. By analyzing historical data, market trends, and external factors, organizations gain a more accurate understanding of demand, facilitating precise inventory planning. Furthermore, the real-time insights provided by business analytics empower stakeholders to make informed decisions promptly. This heightened decision-making ability is crucial for adapting to dynamic market

conditions and ensuring seamless coordination throughout the supply chain. The result is a more agile and responsive operational framework.

Cost reduction and increased efficiency are inherent advantages of leveraging business analytics in supply chain management. By scrutinizing supply chain data, organizations can identify inefficiencies, optimize resource allocation, and ultimately reduce operational costs. This optimization process leads to a more streamlined and cost-effective supply chain (Charles et al., 2023).

Effective risk management and mitigation are also facilitated by business analytics. The ability to identify and assess potential risks allows organizations to implement proactive measures, ensuring the resilience of the supply chain against disruptions. This strategic approach minimizes the impact of unforeseen events and enhances overall risk management strategies. Supplier performance evaluation is another area where business analytics proves invaluable. Organizations can utilize analytics to assess supplier performance based on various metrics, fostering better relationships and ensuring a reliable and high-quality supply network (Nourani, 2021).

Inventory optimization is a critical aspect addressed by business analytics. Insights into demand patterns, lead times, and order quantities enable organizations to maintain optimal inventory levels, preventing both overstocking and stockouts. This, in turn, improves cash flow and operational efficiency.

Real-time visibility is a cornerstone advantage provided by business analytics. Stakeholders gain immediate access to comprehensive information about the entire supply chain, allowing for the monitoring of operations, tracking of shipments, and identification of bottlenecks. This real-time visibility facilitates prompt corrective actions and enhances overall supply chain performance.

Enhanced customer satisfaction is a natural outcome of optimized supply chain operations. By leveraging analytics to improve order fulfillment, reduce lead times, and meet delivery expectations, organizations can elevate customer satisfaction levels and strengthen their market position. Strategic planning and alignment with organizational goals are facilitated by the insights derived from business analytics. Long-term planning becomes more informed, enabling companies to adapt to market changes and maintain competitiveness.

Lastly, compliance and regulatory adherence are ensured through the use of analytics. Organizations can leverage data analytics to monitor and enforce compliance with various regulations and industry standards, reducing the risk of legal issues and maintaining a reliable and ethical supply chain. Overall, the adoption of business analytics in global supply chain coordination offers a comprehensive framework for optimizing operations, mitigating risks, and driving strategic growth (Greasley, 2019).

Table 3 contains the advantages of using business analytics in global supply chain coordination within Industry 4.0 conditions, along with descriptions for each advantage. These advantages demonstrate how the implementation of business analytics in global supply

chain coordination can contribute to efficiency, resilience, and overall improvement in business operations.

Table 3.

The advantages of using business analytics in global supply chain coordination

Advantage	Description
Improved Forecasting	Utilizing business analytics allows organizations to analyze historical data, market trends, and external factors, leading to more accurate demand forecasting and inventory planning.
Enhanced Decision-Making	Business analytics provides real-time insights into the supply chain, enabling stakeholders to make informed decisions promptly. This leads to better overall coordination and responsiveness.
Cost Reduction and Efficiency	Analyzing supply chain data helps identify areas of inefficiency, optimize resource allocation, and reduce operational costs, ultimately improving the overall efficiency of the supply chain.
Risk Management and Mitigation	Business analytics enables the identification and assessment of potential risks in the supply chain, allowing for proactive measures to mitigate disruptions and enhance risk management strategies.
Supplier Performance Evaluation	Organizations can use analytics to assess the performance of suppliers based on various metrics, fostering better relationships and ensuring a reliable and high-quality supply network.
Inventory Optimization	Analytics helps in maintaining optimal inventory levels by providing insights into demand patterns, lead times, and order quantities, preventing overstocking or stockouts and improving cash flow.
Real-Time Visibility	Business analytics provides real-time visibility into the entire supply chain, enabling stakeholders to monitor operations, track shipments, and identify bottlenecks for prompt corrective actions.
Enhanced Customer Satisfaction	By optimizing the supply chain through analytics, organizations can improve order fulfillment, reduce lead times, and enhance overall customer satisfaction by meeting delivery expectations.
Strategic Planning and Alignment	Analytics aids in aligning the supply chain with broader organizational goals and strategies. It provides insights for long-term planning, helping companies adapt to market changes and stay competitive.
Compliance and Regulatory Adherence	Businesses can use analytics to ensure compliance with various regulations and industry standards, reducing the risk of legal issues and maintaining a reliable and ethical supply chain.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

Table 4 contains the problems of using business analytics in global supply chain coordination within Industry 4.0 conditions, along with descriptions for each advantage. These problems underscore the importance of addressing data quality, integration, skill development, and change management to successfully harness the benefits of business analytics in global supply chain coordination.

Table 4.*The problems of using business analytics in global supply chain coordination*

Problem	Description
Data Quality Issues	Poor data quality, inaccuracies, and inconsistencies can undermine the effectiveness of business analytics, leading to flawed insights and misguided decision-making within the supply chain.
Integration Challenges	Difficulty in integrating diverse data sources and systems across the global supply chain can impede the seamless flow of information, hindering the ability to gain a comprehensive and real-time view.
High Implementation Costs	The initial investment required for implementing robust business analytics solutions can be substantial, posing a challenge for some organizations, especially smaller ones with limited financial resources.
Lack of Skilled Personnel	An insufficient number of personnel with the necessary skills to interpret and leverage analytics results may hinder the successful implementation and utilization of business analytics in supply chain management.
Security and Privacy Concerns	With the increasing reliance on data for decision-making, concerns regarding the security and privacy of sensitive information within the supply chain become more pronounced, potentially leading to breaches or unauthorized access.
Overemphasis on Historical Data	Relying too heavily on historical data without considering evolving market dynamics may result in suboptimal decision-making. The supply chain needs to adapt to current conditions rather than relying solely on past trends.
Resistance to Change	Employees and stakeholders may resist adopting new analytics-driven processes, causing friction and delaying the integration of business analytics into the existing supply chain coordination framework.
Complexity of Analytics Tools	The complexity of some analytics tools may pose a challenge for users, particularly those without a strong technical background. This complexity can limit the accessibility and effectiveness of analytics within the organization.
Incomplete or Insufficient Data	Gaps in the data collected or the absence of critical information may limit the accuracy and completeness of analytics insights, potentially leading to suboptimal decision-making within the supply chain.
Limited Predictive Accuracy	Despite advancements, predictive analytics may not always accurately forecast future events, and reliance on inaccurate predictions can result in inefficient resource allocation and disruptions in the supply chain.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

5. Conclusion

The integration of business analytics in global supply chain coordination within the framework of Industry 4.0 represents a transformative approach that propels organizations towards efficiency, adaptability, and competitiveness. As industries undergo significant transformations fueled by technological advancements, the strategic deployment of business analytics emerges as a vital tool for navigating the complexities of the modern supply chain.

The selected aspects of business analytics usage in global supply chain coordination, such as demand forecasting, supply chain visibility, predictive maintenance, collaboration, and risk management, highlight the diverse applications and benefits it brings to Industry 4.0. These applications enable organizations to anticipate market demands, optimize inventory,

ensure reliable production flows, foster collaboration, and proactively address risks, thereby enhancing overall supply chain resilience and responsiveness.

The software used in global supply chain coordination under Industry 4.0 conditions, such as SAP Integrated Business Planning, Oracle SCM Cloud, IBM Watson Supply Chain, and others, underscores the role of sophisticated tools in addressing the intricate challenges of managing and optimizing supply chain processes on a global scale. These tools contribute to demand planning, inventory optimization, supplier collaboration, and scenario-based planning, fostering real-time decision-making and enhancing organizational resilience.

Despite the numerous advantages, it is crucial to acknowledge the challenges associated with business analytics usage in global supply chain coordination. Issues such as data quality, integration challenges, high implementation costs, and a shortage of skilled personnel underscore the need for careful consideration and strategic planning during implementation. Additionally, security and privacy concerns, resistance to change, and the complexity of analytics tools require organizations to invest in training and change management strategies to maximize the effectiveness of business analytics. Table 3 illustrates the advantages of using business analytics in global supply chain coordination, emphasizing how it improves forecasting, enhances decision-making, reduces costs, and fosters collaboration, among other benefits. These advantages showcase the positive impact of business analytics on efficiency, risk management, and strategic alignment with organizational goals.

Conversely, Table 4 outlines the challenges and problems associated with business analytics usage in global supply chain coordination. These problems highlight the importance of addressing data quality, integration challenges, and the need for skilled personnel and change management strategies to unlock the full potential of business analytics.

While business analytics presents tremendous opportunities for optimizing global supply chain coordination in Industry 4.0, organizations must navigate both the advantages and challenges carefully. By addressing these challenges proactively, businesses can leverage the power of data-driven insights to position themselves at the forefront of innovation and competitiveness in the dynamic landscape of modern industry.

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