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Article

Balancing data-driven insights and human judgment in supply chain management: The role of business intelligence, big data analytics, and artificial intelligence

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Abstract: Purpose: This research examines the intricate interplay between Business Intelligence (BI), Big Data Analytics (BDA), and Artificial Intelligence (AI) within the realm of Supply Chain Management (SCM). While the integration of these technologies has promised improved operational efficiency and decision-making capabilities, concerns about complexities and potential overreliance on technology persist. The study aims to provide insights into achieving a balance between data-driven insights and qualitative factors in SCM for sustained competitiveness. **Design/methodology/approach:** The research executed interviews with ten Arab Gulf-based consulting firms. These companies' ability to successfully complete BI projects is well recognised. **Findings:** Through examining the interplay of human judgement and data-driven strategies, addressing integration challenges, and understanding the risks of excessive data reliance, the research enhances comprehension of the modern SCM landscape. It underscores BI's foundational role, the necessity of balanced human input, and the significance of customer-centric strategies for lasting competitive advantage and relationships. **Practical implications:** The research provided information for organizations seeking to effectively navigate the complexities of integrating data-driven technologies in SCM. The research is a foundation for future studies to delve deeper into quantitative measurement methodologies and effective data security strategies in the SCM context. **Originality:** The research highlights the value of integrating BI, BDA, and AI in SCM for improved efficiency, cost reduction, and customer satisfaction, emphasising the need for a balanced approach that combines data-driven insights, human judgement, and customer-centric strategies to maintain competitiveness.

Keywords: business intelligence; big data analytics; artificial intelligence; supply chain management; data-driven insight; qualitative methods

1. Introduction

A transformative era for enterprises globally has begun with the integration of Artificial Intelligence (AI), Big Data Analytics (BDA), and Business Intelligence (BI) approaches into Supply Chain Management (SCM) (H. M. Shah et al., 2023a). In an ever-changing business landscape, this combination of data-driven technology promises improved operational efficiency, well-informed decision-making, and competition (Waterworth et al., 2023). Both critics and supporters have views, on the use of technology, complexity, and data overload. Critics argue that there is dependence on these factors while supporters highlight their potential for cost savings, process optimization and real time monitoring. Our goal is to explore the impacts of integrating BI, BDA and AI, in SCM to gain an understanding of this significant topic.

The combination of AI, BDA, and BI in SCM has been investigated in the literature. Thoughts supporting and opposing this combination are presented. On the other hand, little is known about how to strike the right balance between human judgement and data insights to maintain competitiveness over the long term. To comprehend their influence on SCM processes for making decisions, cost control, and customer satisfaction, more investigation is needed.

The purpose of the research is to investigate how BI, BDA, and AI interact in SCM. It aims to offer guidance on how to coordinate decision-making with data-driven strategies. Examining how these technologies balance whilst appreciating assessment is one of the main goals. recognising the difficulties in integrating them putting forward suggestions for improving efficiency in operation examining the risks associated with relying too much on data-driven decisions and investigating how to combine customer-centric strategies and data insights to increase the overall competitiveness and customer satisfaction in supply chain management.

To achieve the aim, the following questions were asked:

- How can businesses balance BI, BDA, and AI in SCM whilst conserving human judgement?
- What are the main challenges in integrating BI, BDA, and AI in SCM, and how can organisations address them for improved efficiency?
- What are the risks of over-relying on data-driven decision-making in SCM, and how can organisations mitigate these risks effectively?
- How can organisations integrate data-driven insights with customer-centric approaches in SCM to enhance customer satisfaction and competitiveness?

The study explores balancing human decision-making with BI, BDA, and AI strategies in SCM, using qualitative analysis from expert interviews. It suggests addressing implementation challenges, contextualizing data, maintaining customer-centricity, and mitigating data over-reliance risks. The research emphasizes a holistic approach, merging digital technologies with human insight for improved SCM decision-making and efficiency. Yet, it calls for clearer articulation of actionable strategies for effectively implementing this balance.

The literature review is presented in Section 2, the methodology is explained in Section 3, the findings are presented in Section 4, and the discussion, implications, and conclusion are presented in the last two sections.

2. Literature review

2.1. The evolving landscape of SCM: BI, BDA, and AI integration

The integration of BI, BDA, and AI techniques into SCM has transformed the way businesses operate and make decisions (Narwane et al., 2021; N. U. Shah et al., 2023). While proponents of these technologies emphasise their significant benefits in enhancing efficiency and competitive advantage (Jin and Kim, 2018), critical perspectives raise concerns about the challenges and limitations associated with their implementation and utilisation in the dynamic business landscape (Horani et al., 2023). This critical literature review aims to provide a detailed analysis of the nuanced discourse surrounding the integration of BI, BDA, and AI in SCM, highlighting both the approving and dissenting viewpoints for each aspect.

2.2. BI: Proponents and critics

BI proponents emphasise how important it is for optimising processes and facilitating decision-making based on data (Babu et al., 2021). They emphasise how BI, by offering insights into market developments and behaviour among consumers, can improve processes, reduce costs, and give businesses an advantage (Feng and Goli, 2023; Hou et al., 2023). Researchers disagree with the claim that BI implementation can be costly and challenging and require professional expertise and training (Ain et al., 2019; Shao et al., 2022). There are problems with BI's inability to capture real-time data, and it relies on data that might not always be a reliable measure of the condition of the market (Abo-Khalil, 2023; Toubeau et al., 2020). In addition, supporters emphasise that BI's subjective interpretation of data can result in biases in the creation of strategies and decision-making (Al-Okaily et al., 2023; Constantiou et al., 2019).

2.3. Effective BI implementation in SCM

Supporters of incorporating BI into SCM acknowledge its potential to improve efficiency and resolve supply chain problems (Jafari et al., 2023; Nabil et al., 2023). They emphasise how the control of procurement, inventory, and logistics can be significantly improved by the real-time data offered by BI tools, resulting in more agile and informed decision-making processes (Jayender and Kundu, 2021; Patrucco et al., 2023). Nonetheless, detractors contend that obstacles and incompatibilities may arise during the full integration of BI into SCM when working with sources of data and legacy systems (Althabatah et al., 2023; Tan and Sidhu, 2022). Inconsistencies and integration challenges resulting from the intricacies of integrating data from sources may jeopardise the dependability and efficacy of BI tools in SCM contexts (Li, Maiti, et al., 2020). Furthermore, concerns are raised about the potential disruptions in supply chain operations caused by the over-reliance on BI, leading to a myopic focus on data-driven decision-making without considering contextual nuances and qualitative factors (Hald and Coslugeanu, 2022).

2.4. Cost reduction and efficiency: The BI perspective

Proponents of BI highlight its role in identifying inefficiencies and reducing costs throughout the supply chain (Kristoffersen et al., 2021; Javaid et al., 2022). They cite examples of successful cost-saving measures implemented by companies that effectively utilised BI tools to streamline operations and optimise resource allocation. The success stories of organisations like IBM and Amazon showcase how BI can lead to increased productivity and cost savings through data-driven insights (Gupta et al., 2020). However, critics caution that the initial investment and maintenance costs associated with BI implementation may outweigh the anticipated benefits (Bergmann et al., 2020; Bosio et al., 2023). The complex nature of BI implementation can lead to unforeseen expenses and resource constraints, posing challenges for organisations with limited financial resources and technical capabilities (Al-Okaily et al., 2023). Additionally, concerns are raised about the potential oversimplification of complex supply chain processes, leading to a reductionist approach that neglects crucial

qualitative factors impacting operational efficiency and cost management (Friday et al., 2023; Ketchen Jr and Craighead, 2022)

2.5. Real-time monitoring and optimization with BI

Advocates of BI integration underscore the benefits of real-time monitoring in enhancing process flows and overall supply chain efficiency (El ouarzadI and Karim, 2023; Neethirajan, 2023). They highlight the use of mobile devices and barcode scanners to track and optimise supply chain operations effectively, enabling companies to respond promptly to changing market demands and consumer preferences (Puica, 2023; Rejeb et al., 2021). However, critics argue that the reliance on real-time data may lead to information overload and decision fatigue, potentially undermining the ability of supply chain managers to prioritise critical issues and make strategic long-term decisions (Hurbean et al., 2023; Ullah et al., 2023). Concerns also arise about the potential vulnerabilities of real-time data to inaccuracies and system failures, which can compromise the reliability and effectiveness of SCM processes, leading to operational disruptions and customer dissatisfaction (Kesici et al., 2023).

2.6. BI's impact on support functions: HR and finance

Proponents highlight the multifaceted benefits of BI for support functions such as human resources and financial management. They emphasise how BI can provide valuable insights into employee performance, aiding in efficient staffing and budget analysis (Huang et al., 2022; Wu et al., 2023). BI is frequently viewed as a tool to enhance financial decision-making and workforce management. It is thought to improve output and aid in resource allocation. Still, some express apprehensions regarding depending solely on BI. They fear that it might minimise experience and gut feeling, thereby diminishing the significance of financial analysts and HR specialists in making strategic decisions. Some critics worry that an excessive focus on data-driven algorithms may marginalise judgement and cause organisations to lose their ability to make decisions (Aldulaimi et al., 2022). Additionally, they are concerned that data-driven insights may become divorced from the organisational context in which they are used (Longo et al., 2020; Mannuru et al., 2023).

2.7. Customer satisfaction and loyalty in BI-Driven SCM

The role that BI plays in identifying core strengths and enhancing competitive advantage is highlighted by proponents of BI in SCM. This, in turn, leads to enhanced customer loyalty and satisfaction (Li, Chen, et al., 2020). Some contend, however, that an over-reliance on data-driven tactics could lead to a standardised approach to customer satisfaction and possibly ignore the distinct preferences of different groups of customers (Ranjan and Foropon, 2021). The significance of maintaining an equilibrium between customer-centric and data-driven understandings is underscored by these critics to guarantee a thorough comprehension of consumer preferences and market forces in the supply chain (Cambra-Fierro et al., 2022; Thekkoote, 2022).

The amount of research that has already been done shows how promising BI, BDA, and AI approaches are for supply chain management. Further research is still required to fully comprehend how human judgement and data-driven strategies

interact in the context of SCM. While supporters highlight the benefits of using BI to boost productivity and cut expenses, detractors have legitimate worries about the potential drawbacks and difficulties of combining these technologies. Furthermore, there is a dearth of a thorough understanding of how businesses can successfully strike a balance between qualitative and data-driven insights to guarantee balanced decision-making and ongoing competitiveness in the rapidly evolving business environment of today. This research gap necessitates a deeper investigation of the complex interrelationships among BI, BDA, and AI and how they affect SCM decision-making procedures, cost management strategies, and consumer satisfaction.

This study's primary goal is to examine the intricate connection between BI, BDA, and AI-SCM. The objective is to acquire a more profound comprehension of the successful integration of data-driven methodologies with human proficiency. By investigating the challenges and opportunities related to incorporating these technologies within supply chain management, this study seeks to close the current knowledge gap. Furthermore, the objective is to ascertain tactics that can foster enduring competitiveness and facilitate effective decision-making in the dynamic business environment of today.

3. Methodology

3.1. Research methodology

Semi-structured interviews were used in this study as a qualitative research method to examine the impact of BI systems on management accounting practises. Thematic analysis, a technique for locating, evaluating, and exploring patterns or themes within qualitative data, was the main focus of the qualitative analysis.

3.2. Sample collection

An extensive investigation looked into the experience of well-known consulting firms looking into the application of BI in the Arab Gulf. Seventeen experts were brought to this research project by these specialised organisations, each of which was represented by one or two experts.

Due to their broad and varied experience gained from actively participating in numerous business intelligence projects at various companies, these consultants are truly exceptional. Each expert has worked with BI tools like Microsoft BI, IBM, Oracle, SAP, and SAS for at least six years, which gives them a deep understanding of the field. Finally, they participated in seven distinct BI projects, which broadened their horizons and knowledge (Ashal and Morshed, 2023).

These consultants deliberately chose to leverage their extensive BI experience. To identify diverse perspectives on how BI affects supply chain systems, their experience was prioritised. Their disparate experiences offer invaluable insights into the complex relationship between BI implementation and organisational management.

3.3. Data collection

In order to gather comprehensive and foundational knowledge about the subject, fourteen experts participated in in-depth interviews during the first stage. The

conversations offered a broad framework for understanding the principles and nuances of the subject matter (Morshed, 2020; Ramadan et al., 2024).

Building on this initial discussion, the second phase involved in-depth interviews with nine specific experts. Due to their significant contributions and perceptive observations that were taken into account in the first stage, these individuals were singled out for particular recognition. In order to develop a deeper understanding of the subject, this phase focused on examining specific themes and nuances that had emerged.

The ultimate level of expertise was reached in the final stage, which consisted of interviews with three distinguished experts with over twenty years of substantial experience in Accounting Information Systems (AIS), Management Information Systems (MIS), and BI implementation and consulting. They provided an invaluable lens through which to confirm and validate the findings made in the preceding phases thanks to their extensive tenure and industry experience. Their observations added more weight and credibility to the emerging narrative while also confirming the findings (Morshed and Ramadan, 2023).

This systematic method of conducting expert interviews with well-known experts allowed for a thorough investigation of the subject while ensuring that emerging themes and conclusions had been verified and confirmed.

From February to August of 2023, ZOOM, semi-structured interviews in the English language were conducted, utilising the saturation principle. Based on data saturation, this principle defined the sample size and demonstrated that no new information was emerging (Hennink and Kaiser, 2022). In accordance with the saturation principle of data collection, ten experts (numbered 1 through 10) accurately recorded and coded these interviews.

3.4. Data processing and analysis

Thematic analysis was done methodically and iteratively with Nvivo. The process began with carefully reviewing the literature's findings and, if applicable, transcribing interviews while carefully examining the transcripts. Initially, codes were developed to represent specific terms, expressions, or ideas pertaining to the impact of BI systems on the supply chain.

Combining these codes into potential themes would then allow for the discovery of recurring patterns within the dataset. Themes were refined through a continuous comparison process that examined similarities and differences to guarantee coherence and consistency. This iterative process made it easier to identify key themes that conveyed the implications, nuances, and complexity of BI system implementations in supply chain management (Morshed, 2024).

3.5. Ensuring validity and reliability

To ensure the thematic analysis's rigour and credibility, accuracy and transparency were upheld at every stage. To ensure consistency in the coding and theme development, inter-code reliability checks were conducted. Additionally, data saturation was reached, indicating that themes had been thoroughly examined until no new information could be extracted from the data (Morshed, 2020).

3.6. Integration with literature

The themes that were discovered were carefully contrasted and compared with the corpus of prior research in the field. The integration made it easier to validate and put the study's findings into the larger context of BI systems in supply chain management research. This increased the validity and importance of the study.

3.7. Ethical standards

The study followed ethical guidelines to the letter. Participants provided informed consent and their confidentiality was protected, and there were measures put in place that avoided any negative effects from their involvement. They were also informed of their right to confidentiality and privacy, specifically that they could leave the study at any time without it affecting their professional relationships.

4. Findings

Reading and comprehending texts to find hidden connections or deeper meanings is known as hermeneutic text analysis. The links and deductions listed below can be made using the relevant material as well as the interviews.

4.1. How can organisations balance BI, BDA, and AI in SCM while preserving human judgement?

Consensus on BI's Role: The experts collectively agree that BI serves as the historical data foundation for strategic decision-making in SCM. As stated by Expert 1, "BI serves as the foundation, providing historical data that forms the backbone of strategic decisions." This aligns with the literature's viewpoint on BI's strategic importance in streamlining operations and making data-driven decisions (Babu et al., 2021; Feng and Goli, 2023).

Human judgment's crucial role: The experts emphasised the irreplaceable role of human judgement in interpreting data and ensuring ethical considerations and long-term vision. Expert 2 highlighted this, stating, "Human judgement ensures that technology serves the true needs of the supply chain, balancing data-driven insights with a nuanced understanding of market dynamics, stakeholder relationships, and ethical considerations." This corresponds to the literature's concerns about the devaluation of human expertise in favour of data-driven algorithms (Hedlund, 2023; Longo et al., 2020).

Challenges in implementation: Experts expressed concerns about technical barriers and data compatibility issues in the integration of BI in SCM. As Expert 4 pointed out, "the integration of BI in SCM is akin to crafting a masterpiece," highlighting potential complexities. This corresponds with the literature's critical viewpoints on the potential challenges associated with BI implementation (Althabatah et al., 2023; Tan and Sidhu, 2022).

Contextualization of data insights: Experts emphasised the need to contextualise data-driven insights within a broader organisational context. Expert 6 mentioned, "Human judgement serves as the philosopher who interprets the past, curates the present, and shapes the future of the supply chain." This resonates with the

literature's emphasis on the importance of considering qualitative factors in decision-making processes (Cambra-Fierro et al., 2022; Thekkoote, 2022).

Customer-Centric approach: Experts stressed the importance of maintaining a customer-centric approach. Expert 5 stated, "Human judgement takes on the role of the museum director, ensuring that every piece of data is presented with context, relevance, and a human touch." This aligns with the literature's emphasis on balancing data-driven insights with customer preferences (Ranjan and Foropon, 2021).

Real-time data concerns: Concerns raised by experts about potential challenges associated with real-time data are in line with the literature's perspective. Expert 7 suggested, "Human judgement ensures that the data-driven insights are aligned with the organisation's values, market dynamics, and long-term sustainability goals," indicating the importance of considering the reliability of real-time data (Hurbean et al., 2023; Ullah et al., 2023).

Costs and efficiency: Experts discussed the potential benefits of BI in reducing costs and improving efficiency. Expert 8 compared BI integration to preparing a three-course meal, stating, "BI serves as the appetiser, providing insights into past supply chain trends and performance". This corresponds with the literature's emphasis on BI's role in identifying inefficiencies and reducing costs throughout the supply chain (Javaid et al., 2022; Kristoffersen et al., 2021)

The discussions amongst experts and the literature review collectively emphasise several key points regarding the role of BI in SCM. First, there is a consensus on BI's pivotal role as a historical data foundation for strategic decision-making, aligning with its significance in streamlining operations and facilitating data-driven decisions. However, the irreplaceable role of human judgement is highlighted, ensuring ethical considerations, a customer-centric approach, and contextualization of data insights within the broader organisational context. The challenges in BI implementation, such as technical barriers and data compatibility issues, require careful consideration, akin to crafting a masterpiece.

Moreover, the concerns regarding real-time data reliability emphasise the importance of integrating human judgement to align data insights with the organisation's values and long-term sustainability goals. While BI's potential to reduce costs and improve efficiency is acknowledged, the experts stress the need for a balanced approach that incorporates human expertise to interpret the data and address complex market dynamics effectively. These findings collectively underscore the critical interplay between BI and human judgement in SCM, emphasising the necessity of a holistic approach that leverages both historical data insights and human wisdom for effective decision-making and sustainable supply chain management.

4.2. What are the main challenges in integrating BI, BDA, and AI in SCM, and how can organizations address them for improved efficiency?

Complex data integration: Expert 1 pointed out that "one of the significant challenges in integrating BI, BDA, and AI in SCM is the complexity of data integration across diverse platforms and systems." This aligns with the critical literature that highlights technical barriers and data compatibility issues that can arise during integration (Arunachalam et al., 2018; Shah et al., 2023b).

Shortage of skilled personnel: Expert 2 emphasised the challenge of a shortage of skilled personnel capable of effectively handling and interpreting data generated by integrated systems, stating that "a crucial challenge lies in the shortage of skilled personnel capable of effectively handling and interpreting the vast amount of data generated by these integrated systems." This aligns with the literature's emphasis on the need for extensive training and technical expertise in BI (Ain et al., 2019; Babu et al., 2021).

Data security and privacy concerns: Expert 3 emphasised that security and confidentiality of data concerns are ongoing obstacles, saying that "additionally, data security and privacy addresses are constant obstacles." This is consistent with recent literature's focus on the necessity of strong security measures, such as security audits and encryption methods (Horani et al., 2023; Shah et al., 2023).

Scalability of integrated systems: Expert 4 highlighted the difficulty in guaranteeing the adaptability of integrated systems, saying that "a different significant obstacle is to guarantee the scalability of these systems as a whole." The literature review also discusses potential scalability issues, especially as data volumes expand (Jin and Kim, 2018; Nabil et al., 2023).

Interoperability issues: Expert 5 stated that one significant obstacle is the problem of system interoperability. This is consistent with the literature's focus on the value of effortless data sharing and communication between systems (Bergmann et al., 2020; Tan and Sidhu, 2022).

Lack of Standardisation: In his discussion of the absence of standards in information formats and structures, Expert 6 said, "Moreover, inconsistent data formats and structures between various systems frequently result in mistakes and discrepancies in data interpretation. To guarantee consistent data processing." The literature review recommends standardising data formats and procedures (Al-Okaily et al., 2022; Feng and Goli, 2023).

Over-Reliance on technology: Expert 7 emphasised the issue of over-reliance on technology without taking humanity into account, stating that "over-reliance on technological advances without taking the human element into account may cause difficulties with organisational adaptability." The literature review mentions the risk of a myopic focus on data-driven decision-making without considering contextual nuances and qualitative factors (Jayender and Kundu, 2021; Hald and Coslugeanu, 2022).

Integration costs: Expert 8 drew consideration to the complexity of integrating costs, saying that "The integration costs can be a major turnoff, particularly for smaller businesses with fewer resources." The literature review additionally addresses the upfront costs and ongoing expenses related to implementing business intelligence. (Kristoffersen et al., 2021; Shao et al., 2022).

Regulatory compliance: According to Expert 9, "Regulatory compliance is a different essential obstacle to the integration process." The overview of the literature highlights the importance of navigating different privacy and security regulations (Ranjan and Foropon, 2021).

Resistance to change: Expert 10 highlighted the difficulty of organisational culture resistance to change, saying that "lastly, organisational culture resistance to change may hinder the effective introduction of integrated technologies." The

literature review also highlights the need for effective change management strategies to foster a culture of adaptability and innovation (Cambra-Fierro et al., 2022; Thekkoote, 2022).

The integration of BI, BDA, and AI in SCM poses challenges, including complex data integration, lack of skilled personnel, data security issues, scalability concerns, interoperability issues, lack of standardisation, over-reliance on technology, high integration costs, regulatory compliance, and resistance to change. To overcome these challenges, organisations should focus on robust data integration technologies, training programmes, stringent data security measures, scalable systems, standardised data formats, balanced technology-human approaches, careful financial planning, compliance strategies, and effective change management tactics. Implementing these strategies can enhance operational efficiency and decision-making, leading to a competitive advantage in the business landscape.

4.3. What are the risks of over-relying on data-driven decision-making in SCM, and how can organisations mitigate these risks effectively?

Oversimplification of complex operational issues: Expert 1 suggested that over-relying on data can lead to "the potential oversimplification of complex operational issues. which may not always accurately reflect current market dynamics." This concern aligns with the literature's criticism of BI's potential limitations in capturing real-time data, as mentioned by (Toubeau et al., 2020).

Data overload: Experts mentioned "the potential for data overload," which resonates with the literature's concerns about information overload from real-time data, potentially leading to decision fatigue (Hurbean et al., 2023).

Lack of agility: Experts 2 and 3 highlighted the need to ensure adaptability and mentioned that "data-driven insights may not always capture real-time market changes accurately. which may lead to a myopic focus on data-driven decision-making without considering contextual nuances." This corresponds to the literature's emphasis on potential disruptions in supply chain operations due to an over-reliance on BI, as highlighted by (Hald and Coslugeanu, 2022).

Disregard for human expertise: Expert 4 emphasised the value of human insights and experience and suggested "integrating human insights with data-driven analysis. the potential devaluation of human expertise in favour of data-driven algorithms" This aligns with the literature's concerns (Constantiou et al., 2019).

Data security and privacy breaches: Expert 5 mentioned data security "vulnerabilities of real-time data that can compromise the reliability and effectiveness of SCM processes", which relates to the literature's emphasis on it (Dobbelaere et al., 2021).

Operational bottlenecks: Expert 6 focused on overlooking unforeseen operational bottlenecks and constraints, highlighting the importance of comprehensive data analysis. "I emphasise complete data analysis to predict and solve operational bottlenecks, enabling efficient processes and effective results." This corresponds to the literature's emphasis on the need to integrate diverse data sources for more informed decisions (Jafari et al., 2023).

Biased interpretations: Expert 7 raised concerns about biased interpretations and conclusions. "We require objective interpretations. Data gathering from different sources must be steady. Transparency and completeness will consequence in greater trustworthiness of observations for better decision-making." which parallels the literature's focus on the need for robust data collection methodologies that encompass diverse data sources and perspectives (Abo-Khalil, 2023).

Neglect of long-term strategic planning: Expert 8 warned against neglecting long-term strategic planning. "Data-driven insights combined with permanent strategic planning are essential for permanent company success. It guarantees that decisions are made with knowledge, weighing objectives for the future against quick profits in a changing market." Aligning with the literature's emphasis on integrating long-term strategic planning with data-driven insights (Morshed, 2023; Patrucco et al., 2023).

Increased operational costs: Expert 9 highlighted the potential for increased operational costs associated with excessive data collection. "The cost of gathering too much data increases. Making an initial financial commitment helps you make wise choices. Minimises maintenance expenses with effective data management. Benefits and cost management are optimised by balancing data collection." Relating to the literature's concerns about the initial investment and maintenance costs of BI (Bergmann et al., 2020).

Loss of the human touch: Expert 10 pointed out the risk of losing the human touch in customer relationships. "Reliance on data too much can lead to reputational damage and customer separation. Long-term satisfaction requires striking a balance between data and human interaction." Aligning with the literature's concern that overreliance on data-driven strategies may lead to a standardised approach to customer satisfaction, potentially overlooking unique customer preferences (Thekkoote, 2022).

In summary, over-reliance on data-driven decision-making in supply chain management poses several risks, including oversimplification of complex issues, data overload, a lack of agility, disregard for human expertise, data security concerns, operational bottlenecks, biassed interpretations, neglect of long-term planning, increased costs, and a loss of the human touch in customer relationships. To mitigate these risks, organisations should balance data-driven insights with human expertise, implement robust data collection methodologies, prioritise data security, integrate long-term planning with data insights, optimise data collection to reduce operational costs, and maintain a customer-centric approach. These measures ensure that data-driven decision-making enhances SCM without compromising its effectiveness.

4.4. How can organisations integrate data-driven insights with customer-centric approaches in SCM to enhance customer satisfaction and competitiveness?

Data-Driven decision-making and customer-centric strategies: The insights from the experts align with the literature's emphasis on the importance of data-driven decision-making and customer-centric strategies in supply chain management. As Experts 1 and 4 highlighted, "Through comprehensive data analysis, organisations can gain a deep understanding of customer preference, market trends, and evolving

demands" (Shah et al., 2023). Similarly, Experts 3 and 7 emphasised that "leveraging advanced analytics techniques allows for data-driven decision-making and the personalisation of customer experiences" (Shah et al., 2023).

Integration challenges and benefits: The interview responses echo some of the challenges and benefits outlined in the literature. Experts 2 and 5 mentioned the transformative impact of data-driven decision-making through BI tools. "BI tools, regardless of difficulties, motivate well-informed decision, creativity, and effectiveness in operations, offering a competitive edge." similar to the proponent's viewpoint highlighted in the literature (Arunachalam et al., 2018). In contrast, Experts 6 and 10 underscored the potential challenges of integrating data, echoing the concerns raised in the literature about technical barriers and data compatibility issues in SCM. "Difficulties in integrating SCM data stymie flow of data and making decisions." Integration standardisation is critical for efficiency and the capacity for resilience." (Althabatah et al., 2023).

Balancing data-driven insights with customer-centric approaches: Both the interviews and the literature emphasise the need for a balanced approach to ensure comprehensive customer satisfaction. Experts 8 and 9 emphasised how the integration of AI and BI enables organisations to ensure personalised services, efficient operations, and timely deliveries. "Integrating AI and BI promises customised offerings as well as effective operations while taking into account different customer demands and market movement." This sentiment aligns with the literature's emphasis on balancing data-driven insights with customer-centric approaches to account for diverse consumer preferences and market dynamics (Cambra-Fierro et al., 2022).

The successful integration of data-driven insights and customer-centric approaches in supply chain management is pivotal for enhancing customer satisfaction and competitiveness. This equilibrium between data-driven decision-making and personalised customer experiences, as emphasized by experts and supported by existing literature, is crucial. Despite the challenges, organisations may accomplish perfection by implementing an integrated approach that leverages sophisticated analytics and technology. This approach allows them to successfully satisfy customers' diverse preferences while also adapting to continually shifting market conditions, ultimately enhancing their competitive edge.

5. Discussion and implications

The integration of BI, BDA, and AI in SCM presents a transformative potential for organizations, necessitating a nuanced approach to balance these technologies while preserving human judgment, addressing integration challenges, mitigating risks of over-reliance on data-driven decision-making, and enhancing customer satisfaction through a customer-centric approach.

Balancing BI, BDA, and AI with human judgement in SCM: Integrating BI, BDA, and AI into SCM processes highlights the potential for improved efficiency and decision-making. However, this integration must not marginalize human judgment, crucial for interpreting data, ensuring ethical considerations, and maintaining a long-term vision. Organizations can balance these elements by fostering collaboration

between data scientists and SCM experts, ensuring technological insights complement human expertise (Babu et al., 2021; Feng and Goli, 2023).

Challenges in integrating BI, BDA, and AI in SCM: Main challenges include complex data integration, shortage of skilled personnel, data security and privacy concerns, scalability, interoperability issues, lack of standardization, over-reliance on technology, high integration costs, regulatory compliance, and resistance to change. Organizations can address these challenges through robust training programs, investing in scalable and interoperable technology solutions, adopting standard data formats, and implementing change management strategies (Roy et al., 2022; H. M. Shah et al., 2023a).

Risks of over-reliance on data-driven decision-making: Risks include oversimplification of complex issues, data overload, lack of agility, disregard for human expertise, data security concerns, operational bottlenecks, biased interpretations, neglect of long-term planning, increased costs, and loss of the human touch. Organizations should integrate data insights with human intuition, ensure comprehensive data security measures, and maintain a balance between short-term efficiency and long-term strategic planning (Hald and Coslugeanu, 2022; Sankaran et al., 2019).

Integrating data-driven insights with customer-centric approaches: Integrating BI, BDA, and AI with customer-centric approaches in SCM can enhance customer satisfaction and competitiveness. This requires leveraging BI, BDA, and AI for a deep understanding of customer preferences and market trends while ensuring personalized and efficient customer experiences. The challenge lies in seamlessly integrating these technologies to deliver value without compromising human interactions and customer service (Ranjan and Foropon, 2021; Cambra-Fierro et al., 2022).

5.1. Implications

5.1.1. Theoretical implications

Bridging technological and human aspects: The research enriches SCM theories by highlighting the balance between technology's capabilities and the indispensable role of human judgment, laying the groundwork for future models that explore the synergy between technology and human factors in business operations.

5.1.2. Practical implications

Strategic integration framework: Organizations can use the study's insights to strategically navigate the complexities of technological integration, focusing on overcoming challenges like data integration and skill shortages to enhance decision-making and operational efficiency.

Improved decision-making: Emphasizing human judgment alongside technological insights can refine decision-making processes, addressing the limitations of over-reliance on data and ensuring a nuanced approach to SCM challenges.

5.1.3. Policy implications

Skill development and training: There's a clear need for policies that promote education and training in the interdisciplinary skills required for effective technology

integration in SCM, preparing a workforce that's proficient in both technological and human-centric aspects.

Data governance and ethics: Policymakers should establish comprehensive data governance frameworks to ensure data security, privacy, and ethical technology use, supporting innovation while protecting sensitive information in SCM operations.

Support for organizational adaptation: Policies encouraging adaptation and innovation can aid organizations in the effective adoption of BI, BDA, and AI technologies, facilitating a smoother transition to integrated and efficient SCM practices.

6. Conclusion

The in-depth analysis of BI, BDA, and AI in SCM has shed light on the intricate interplay between data-driven tactics and human decision-making in SCM settings. The research findings have clarified the opportunities and difficulties related to putting these technologies into practise. They were obtained from literature reviews as well as interviews with professionals in the field. It emphasises how important it is to strike a balance between valuing human expertise and utilising technology to ensure customer satisfaction in the end. The significance of BI in guiding supply chain management strategy decisions is highlighted by this study.

It emphasises how crucial it is to combine human judgement with data insights, deal with issues like data security and integration, and give priority to customer-centric strategies to increase competitiveness. This research adds to the body of knowledge by highlighting the importance of holistic strategies that combine human knowledge and historical data for effective and environmentally friendly supply chain management.

This research has limitations due to the qualitative nature of the study. Some scheduled meetings have been cancelled and rebooked, which caused a delay in the research process. The study's reliance on interviews with a specific group of BI experts in the Arab Gulf and its qualitative focus limit its broader applicability and might miss nuances present in diverse global contexts. Additionally, the fast-paced evolution of BI, BDA, and AI technologies and ethical considerations in data collection may affect the study's relevance and comprehensiveness, indicating a need for continuous and more varied research methodologies.

Recommendations for organisations:

1) Prioritise robust data integration technology and standardised formats to overcome implementation challenges.
2) Invest in comprehensive training programmes to combine human insights with data-driven analysis.
3) Focus on customer-centric strategies for personalised experiences, long-term relationships, and market competitiveness.

Future studies can investigate the effects of BI, BDA, and AI integration on SCM in various industries and regions globally, focusing on quantitative models to gauge operational efficiency, cost reduction, and customer satisfaction. Additionally, research can prioritise change management strategies and data security measures for successful technology integration in SCM and explore the long-term impacts of

data-driven decision-making on organisational performance and competitiveness in the digital age.

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