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Supply Chain Bottleneck Analysis Dashboard Using Power BI

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Abstract: Contemporary supply chains produce massive amounts of operational data in the areas of procurement, storage, logistics, and order fulfillment. Unfortunately, many organizations face the challenge of transforming operational data into valuable insights that can help detect inefficiencies and bottlenecks within the supply chain. This paper proposes a data-driven analytical approach for supply chain bottleneck analysis through the use of Microsoft Power BI. The proposed methodology combines structured supply chain data and leverages systematic data preprocessing, feature development, and key performance indicator modeling to assess performance from a multi-stage operational perspective. Interactive dashboards are designed to display key performance indicators such as order cycle time, on-time delivery rate, supplier delay percentage, and warehouse processing efficiency. Through the assessment of these KPIs within an integrated platform, the methodology facilitates the detection of suppliers with high delay risks, capacity-limited warehouses, and inefficient transportation. The findings of the paper illustrate the potential of business intelligence tools to improve operational visibility and facilitate data-driven evaluation. The findings illustrate the potential of dashboard analytics to improve supply chain visibility and performance analysis. This paper makes a significant contribution to the increasing use of business intelligence and data visualization tools in supply chain management and operational optimization. The system successfully identifies bottlenecks across suppliers, transportation, and locations using interactive KPI-based visualization.

Keywords: *Supply Chain Analytics, Business Intelligence, Power BI, Bottleneck Analysis, KPI Modeling, Data Visualization, Decision Support.*

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I. INTRODUCTION

Supply chain management has increasingly become complex in the current global and analytics-driven economy. Businesses involve multiple suppliers, warehouses, distribution centers, and logistics, creating massive amounts of operational data on a daily basis. Although the data is rich in information, many organizations find it challenging to turn the data into meaningful information to enable informed decision-making. This has led to operational bottlenecks and inefficiencies remaining undetected until they cause a substantial impact on cost, service, or customer satisfaction.

Operational bottlenecks in supply chain management can occur at various points, such as procurement, warehouse processing, logistics, or demand. To detect these bottlenecks, there is a need to systematically analyze performance data across interrelated processes. Conventional methods of reporting, such as static spreadsheets and summary reports, do not offer much insight and often lack the ability to dynamically relate various operational factors. This has created a pressing need for analytical solutions that can monitor performance, calculate key metrics, and provide insights in an interactive and intuitive way.

Business intelligence tools, especially Microsoft Power BI, provide sophisticated functionalities for data integration, processing, modeling, and visualization. By utilizing the structured data and computing key performance indicators like order cycle time, on-time delivery rate, and supplier delay percentage, it is feasible to assess supply chain performance from diverse viewpoints. The interactive dashboard also improves analytical efficacy by enabling users to investigate trends, compare entities, and identify patterns that reveal operational limitations.

This research paper presents a data-intensive approach for analyzing supply chain bottlenecks using Microsoft Power BI.

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The paper primarily concentrates on data processing, KPI modeling, and dashboard visualization for facilitating a systematic approach towards identifying inefficiencies in supply chain operations. This research also examines the efficacy of dashboard analytics in enhancing operational clarity and evaluation. By integrating performance analysis with interactive visualization, this research can be seen as an extension of business intelligence applications in supply chain optimization and performance analysis.

- *Problem Statement and Objectives:*

Contemporary supply chains are characterized by highly dynamic settings where procurement, storage, transportation, and distribution functions result in large amounts of structured operational data. However, despite the existence of such data, organizations face challenges in deriving valuable insights that can help in the identification of inefficiencies and bottlenecks in operations. Conventional reporting methods are often manual, time-consuming, and departmental, resulting in delayed decision-making and a lack of visibility into performance bottlenecks. Consequently, inefficiencies and disruptions in supply chains can remain unidentified, resulting in decreased productivity and increased operational costs.

The biggest problem with the approach is the need to analyze various performance metrics together to identify delay-prone areas in the supply chain. Analyzing each performance metric individually may not help in identifying bottlenecks. Moreover, the lack of interactive visualization capabilities makes it difficult for managers to analyze trends, compare entities, and analyze inter-relationships among various performance metrics. Thus, there is a need for an integrated analytical solution that incorporates data preprocessing, key performance indicator modeling, and interactive visualization to enable effective bottleneck identification.

The first objective of this research paper is to create a data-driven model that can analyze and detect supply chain bottlenecks through the use of structured data and Microsoft Power BI. The second objective is to create and calculate the key performance indicators, which are order cycle time, on-time delivery rate, supplier delay percentage, and warehouse processing efficiency. The third objective is to assess the usefulness of the dashboard approach in visualizing data for better performance monitoring and transparency. The last objective of this research is to investigate how business intelligence analytics can improve decision support.

II. LITERATURE REVIEW

A comprehensive foundation in supply chain management is given in the work of Chopra and Meindl [1], which emphasizes the importance of integrating strategy, planning, and operations in supply chain management. The work is based on the importance of integrating suppliers, warehouses, and distribution systems to achieve supply chain efficiency and effectiveness. The present study is based on the theoretical foundation of understanding the occurrence of inefficiencies and bottlenecks in the supply chain management system. Gunasekaran et al. [2] discussed the importance of big data and predictive analytics in improving supply chain and organizational performance. The work emphasizes the importance of using data-driven approaches in forecasting, performance evaluation, and decision-making in supply chain management. Waller and Fawcett [3] discussed the importance of data science and predictive analytics in transforming supply chain management and design. The work emphasizes the importance of using data-driven approaches in evaluation and understanding organizational performance in supply chain management. Ivanov [4] analyzed the importance of supply chain resilience and adaptability, particularly in the context of disruptions such as the COVID-19 pandemic. The work emphasizes the importance of using strategies in making supply chain management more viable in uncertain situations. A performance evaluation framework for supply chain optimization, based on KPI, is proposed by Gupta et al. in their research paper [5]. The paper highlights the significance of key performance indicators in evaluating the efficiency of supply chains. The paper offers a systematic approach for evaluating supply chain performance, including supplier performance, inventory management, and logistics. Chen et al. in their paper [6] have explored the applicability of business intelligence dashboards for supply chain performance evaluation. The paper highlights the significance of interactive visualization tools for efficient decision-making. The paper offers a detailed analysis of the applicability of business intelligence for supply chain performance evaluation. Kumar and Sharma have proposed a data-driven approach for identifying bottlenecks in supply chains, utilizing business intelligence tools for logistics optimization. The paper highlights the applicability of performance metrics and tools for identifying bottlenecks in supply chains, making it highly relevant to the objectives of this research. Stadtler et al. in their paper [8] have discussed the applicability of advanced planning concepts and models for supply chain management. The paper highlights the applicability of optimization techniques and decision support tools for supply chains. Singhal and Agarwal [9] in their paper "Supply Chain Analytics: A Comprehensive Review" discuss the evolution, techniques, and applications of supply chain analytics. This paper highlights the increasing significance of data analytics in the efficiency of supply chain operations and decision-making.

A. Research Gaps and Challenges

Despite the fact that considerable progress has been achieved in terms of supply chain analytics and business intelligence, there are still some major issues that need to be addressed in order to effectively manage bottlenecks in the supply chain. These issues include:

- *Fragmented Data Sources*

Supply chain data is scattered and stored in different sources, including ERP systems, warehouse management systems, and transportation systems. This is one of the major issues that make it difficult to perform end-to-end analysis and detect bottlenecks in the supply chain.

- *Limited Use of Integrated KPI Frameworks*

Most studies in this area have concentrated on analyzing individual performance metrics instead of combining different KPIs in order to perform comprehensive bottleneck detection

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in the supply chain. This is also an issue that limits the ability to perform bottleneck detection in the supply chain.

- *Lack of Interactive Visualization*

Most reporting tools only provide static reports in the form of dashboards and spreadsheets. This limits the ability to perform interactive and comprehensive bottleneck detection in the supply chain.

- *Scalability and Real-Time Analysis Issues*

Most studies in this area have concentrated on analyzing historical data instead of focusing on real-time data integration and scalable analytics.

Table 1 Comparison Analysis of Existing Approaches

Author	Focus Area	Method/Technology	Advantages	Challenges
Chopra & Meindl [1]	Supply Chain Fundamentals	Strategic Planning Models	Strong Theoretical Foundation	Limited Real-Time Analytics
Gunasekaran et al. [2]	Big Data in SCM	predictive Analytics	Improves Forecasting and Decision-Making	Requires Large Datasets
Waller & Fawcett [3]	Data-Driven SCM	Various Data Science Techniques	Improves Operational Insights	Complexity in Implementation
Ivanov [4]	Supply Chain Resilience	Adaptive Strategies	Handles Disruptions Effectively	Limited Focus on KPI Dashboards
Gupta et al. [5]	KPI-Based Evaluation	Performance Metrics Framework	Structured Approach for Performance Measurement	Limited Availability of Visualization Tools
Chen et al. [6]	BI Dashboards	Visualization Systems	Improves Decision-Making	Depends on Data Quality
Kumar & Sharma [7]	Bottleneck Detection	BI-Based Analytics	Identifies Inefficiencies Effectively	Limited Scalability
Stadtler et al. [8]	Supply Chain Planning	Optimization Models	Improves Coordination	Complexity in Implementation
Singhal & Agarwal [9]	SCM Analytics Review	Analytical Frameworks	Comprehensive Overview of SCM Analytics	Limited practical dashboard integration

III. METHODOLOGY

The proposed system utilizes a data-driven analytical approach to detect the bottlenecks in the supply chain operations using various business intelligence tools. The proposed methodology is expected to transform the raw data into useful information using various structured data preprocessing, KPI development, and data visualization techniques. The proposed system starts with the collection of various supply chain data, including orders, supplier data, warehouse operations, and transportation records. These data are generally stored in a structured format, such as CSV or Excel format.

The proposed system starts with the data preprocessing stage, which includes various operations to improve the quality of the data. The proposed system utilizes Power Query to clean the data, making it suitable for analysis. It also generates useful features such as order cycle time, delivery time, and order processing time, which are essential for performance analysis.

The second stage involves defining key performance indicators (KPIs) and calculating them using data analysis expressions (DAX) in Power BI. Key KPIs include order cycle time, on-time delivery rate, supplier delay percentage, inventory turnover, and warehouse processing time. These KPIs offer measurable measures of efficiency in various areas of the supply chain process. Comparative analysis is conducted by examining the KPIs of various suppliers, warehouses, and routes to detect differences in their performance.

The final stage in developing the system involves creating an interactive dashboard using Power BI. The dashboard combines various visual components such as bar charts, line graphs, and filters to allow for dynamic analysis of the data. It enables users to analyze the data, compare the performance of various entities, and detect areas of inefficiency by examining the visual patterns of the data. The system allows for multi-dimensional analysis, enabling users to focus on specific areas of operations to detect inefficiency.

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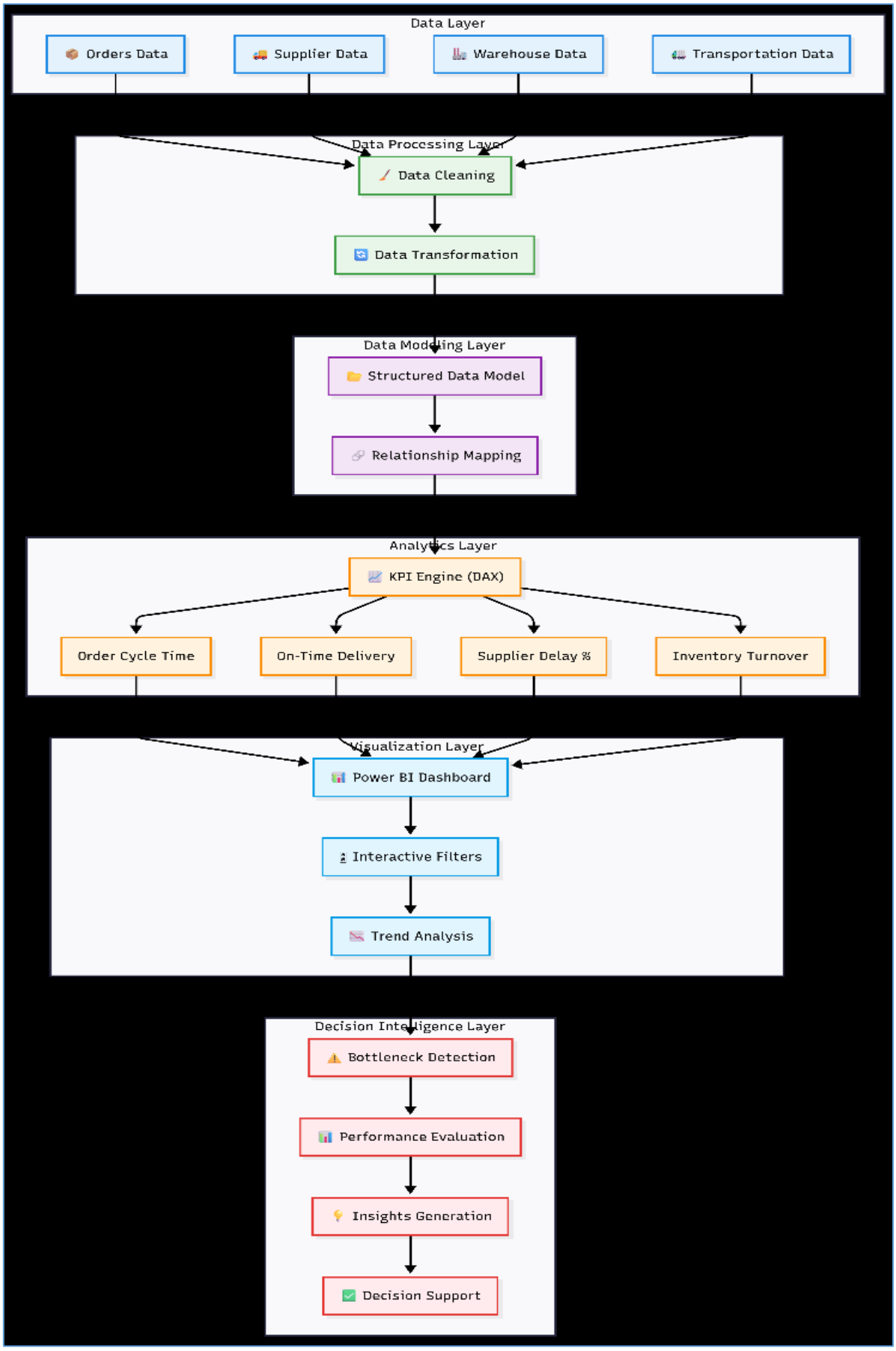

Fig. 1. Proposed Supply Chain Bottleneck Analysis Framework

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Fig.1 below is an illustration of the proposed Supply Chain Bottleneck Analysis Framework. As shown in the architecture above, the Supply Chain Bottleneck Analysis Framework is divided into multiple layers that represent the entire data processing and analysis chain. The process begins with the data layer, where structured supply chain data such as orders, suppliers, warehouse operations, and transport operations are collected from various sources. The data is then processed in the data processing layer, where data cleaning and transformation are performed using tools such as Power Query. In the data modeling layer, the processed data is structured according to a unified data model, where relationships between different entities are also established. In the analytics layer, the Supply Chain Bottleneck Analysis Framework computes various key performance indicators (KPIs) using DAX, such as order cycle time, on-time delivery rate, supplier delay percentage, and inventory turnover. Next, the visualization layer is used to visualize the computed KPIs through an interactive Power BI dashboard. Finally, in the decision layer, the system detects bottlenecks through KPI deviation analysis. This information can then be used for operational decisions by pointing out inefficiencies in the supply chain. The dataset used in this study includes attributes such as supplier, location, transportation mode, lead time, defect rate, and stock levels. Data preprocessing was performed to ensure consistency before visualization in Power BI

IV. RESULTS AND DISCUSSION

The result of the proposed system can be seen from the interactive Power BI dashboard, as depicted in Fig. 2 and Fig. 3. From the figures, it is possible to see the visual representation of key performance indicators (KPI) at different stages of the supply chain. It is also possible to compare different suppliers, locations, and transportation modes using the proposed system. As a result, it is possible to identify inefficiencies within the supply chain.

As depicted in Fig. 2, it is possible to see the overview of major KPIs such as delay percentage, total cost, average lead time, bottleneck count, defect rate, and average shipping time. The overview of these major KPIs is important since it is possible to get a general understanding of the performance of the entire supply chain.

As depicted in Fig. 3, it is possible to identify bottlenecks for suppliers, transportation, and location. The use of slicers is important since it is possible to identify bottlenecks based on location, transportation mode, product type, and supplier. The interactivity of the proposed system is important since it is possible to get a better understanding of the performance of different components within the supply chain.

Fig. 2. Supply Chain Performance Dashboard (KPI Overview).

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Fig. 3. Supply Chain Bottleneck Analysis Dashboard.

As per the results, it is observed that some suppliers have higher percentage delays, which can cause reliability problems for them in future operations. In addition, different transportation modes have shown that inefficiencies are caused by some transportation modes more than others. Moreover, performance issues in different locations have shown that inefficiencies are not caused at a single stage, i.e., inefficiencies are caused at multiple stages.

It is observed that performance issues are caused at multiple stages in the supply chain, i.e., performance issues are caused in the procurement stage, transportation stage, and distribution stage in the supply chain. By using multiple KPIs, entities with higher lead times, higher percentage delays, and lower performance efficiency are identified as critical bottlenecks in the supply chain. From this, it is observed that performance issues are caused at multiple stages, i.e., inefficiencies are not caused at a single stage.

As per the results, it is observed that inefficiencies are not identified using a single KPI. However, inefficiencies can clearly be seen using all the KPIs. For example, a supplier with higher percentage delays and lower delivery efficiency is identified as a critical bottleneck in the supply chain. In addition, higher shipping times for different transportation modes have shown performance issues in logistics operations.

The dashboard-based approach enhances the quality of decision-making. The system allows for the dynamic exploration of the data based on particular criteria. This enhances the accuracy of the results.

The results show that the business intelligence tools, like Power BI, can be effectively used for the transformation of the raw data into valuable insights for the supply chain management system. The system not only indicates the areas where the supply chain is facing bottlenecks but also provides a deeper understanding of the causes for the inefficiencies.

However, the system is associated with a few limitations. The accuracy of the results depends on the quality of the data. Inconsistent data may result in the incorrect calculation of KPIs. Moreover, the system is only capable of conducting historical data analysis. It does not have the ability to predict the future.

The system can be improved in the future by using the power of machine learning for predictive analysis. Such enhancements can be made to the system for the prediction of potential areas where the supply chain may face bottlenecks.

V. CONCLUSION

The results obtained through the use of the developed system clearly indicate the efficiency achieved through the use of business intelligence techniques for analysis and optimization in supply chain operations. The use of the system in implementing the Power BI dashboard is efficient in the visualization of key performance indicators such as delay percentage, lead time, defect rate, and transportation efficiency in supply chain operations. The use of the system is efficient in identifying inefficiencies in different stages of supply chain operations, including suppliers, different modes of transport, and different locations.

The use of the system in implementing different interactive tools is efficient in enhancing the efficiency of the system in supply chain operations. The use of the system in implementing different key performance indicators is efficient in enhancing the visualization of supply chain operations. Inefficiencies in supply chain operations can be clearly observed through the use of this system in supply chain

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operations. The study indicates that performance issues in supply chain operations are observed in different stages of supply chain operations. Suppliers who contribute to a higher percentage in delay, different modes of transport with longer shipping time, and different locations with a higher percentage in delay contribute to inefficiencies in supply chain operations. The use of the system is efficient in enhancing decision-making through the use of the dashboard approach in supply chain operations.

Also, the results verify the fact that it is possible to make use of tools such as Power BI for transforming the raw data available in the supply chain into information. Not only is it possible to identify the bottleneck in the supply chain, but it is also possible to identify the cause of the bottleneck. Thus, the results verify the fact that business intelligence tools can be used for supply chain management.

- *The Limitations Faced by the System are as Follows:*

The accuracy of the analysis depends upon the accuracy of the data. If there is any inconsistency in the data, then incorrect KPIs would be generated. The existing system is capable only of descriptive analysis. It is not capable of performing predictive analysis.

- *Future Scope*

Further enhancements of this system can also be made by focusing on the integration of advanced analytics and machine learning-based techniques for predictive and prescriptive analysis. With the integration of forecasting techniques, this system can also be enabled with the predictive analysis of possible bottlenecks and delays. Further, the integration of real-time data integration techniques can also help to further enhance this system's response time and accuracy.

Further, advanced techniques can also help to increase the efficiency of the supply chain by employing techniques such as anomaly detection, optimization, and AI-based recommendations. Further, the integration of external data sources such as market demands and environmental factors can also help to develop a more comprehensive analytical framework for this system. Further development of this system towards more scalable solutions can also help to increase this system's applicability towards real-world supply chain operations.

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