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Conceptual Framework for Efficient Inbound Supply Chain Analytics

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Abstract— **Industry 4.0 is a terminology that denotes the era of industrial digitization with the emergence of new technologies in which data is the main focus of increasing company competitiveness in all aspects, including supply chain management systems. It has become one of the main focuses of companies to build resilience when dealing with the risk of uncertainties while still meeting the critical goal of improving the efficiency and responsiveness of customer needs. Therefore, supply chain analytics become essential for facilitating data-driven decision-making in planning, sourcing, making, and delivering functions. However, implementing supply chain analytics in developing countries limits only the traditional application silos and ignores disruptive emerging technologies such as cloud computing. This paper explores cases from the manufacturing and retail domains in Indonesia and discusses in detail the conceptual framework for efficient inbound supply chain analytics, which embodies the three characteristics of adequate supply chain visibility such as automation (implementation of automation technology), information (good data management), transformational (analytic application to display information) to meet the organization's need for consolidated reports in all branches/subsidiaries. The aspect of inbound supply chain analytics is specified in the plan and source functions, consisting of eight supplier and inventory key performance indicators through the analytical descriptive data visualization aspect in the Analytics Dashboard.**

Keywords- analytics dashboards; performance measurement; supply chain visibility; inbound supply chain; cloud computing

I. INTRODUCTION

Industry 4.0 is the era of industrial digitization, which includes the emergence of new technologies, where data is the main focus to increase company competitiveness. Data from various sources is collected and processed into information to support the proper strategic decision-making process for the company (data-driven decision making). However, industry 4.0 transformation is more implemented in developed countries and is still lagging in developing countries. It is due to several key challenges, such as the lack of a digital strategy, support from top management, uncertainty about the benefits of investing in technology, and the unpreparedness of the organization to store and process data [1].

The application of technology is one of the main focuses of companies in dealing with the risk of uncertainty (especially during the COVID-19 pandemic). It marks the fourth revolution in supply chain management systems. Technology application can increase company resilience through improved efficiency, responsiveness, flexibility, reliability, transparency, visibility, and traceability of the company [2–4] and still considers the following items: interoperability between technologies, special attention to managerial issues, and the level of technology implementation capability [3, 5–7]. In addition, the means of technology increase the amount of data which could be leveraged for future decision making.

Supply chain analytics refers to a process in the business organization to extract valuable information from a large amount of data associated with supply chain aspects such as procurement, processing, and distribution of goods. Supply chain analytics has evolved from model-driven analysis to data-driven analysis that leverages various approaches such as statistical techniques, business intelligence, and machine learning. The most crucial goal of supply chain analytics is to improve the efficiency and responsiveness of customer needs. However, the abundance of data and various data supplies hinder the effectiveness of supply chain analytics. In addition, traditional application silos (such as enterprise resource planning (ERP), warehouse management, and logistics) are susceptible to developing relevant and interdependency supply chain analytics. Therefore, achieving end-to-end supply chain analytics, which brings information across the supply chain aspects, requires tremendous efforts and scalable technology.

This study aims to propose a conceptual supply chain analytical framework for efficient supply chain analytics. This study emphasizes the inbound supply chain visibility, which embodies the three characteristics; automation (implementation of automation technology), informational (good data management), and transformational (analytic application to display information) [8]. The proposed analytical framework leverages the cloud-based solutions with four sequential layers; data, data ingestion, data aggregation, and presentation. These four layers are expected to ease the information system management, data integration, and data governance which, in the end, increase the effectiveness of supply chain visibility.

II. LITERATURE REVIEW

A. *Supply Chain Analytics*

Decision making, in general, can be divided into two types, namely: analytical/data-driven decision making and intuitive decision making. Analytical/data-driven decision making is rational decision making based on information analysis to reach a decision. In contrast, intuitive decision making is making decisions that are fast, unconscious, and holistically associated with past and present experience or knowledge. Optimal strategic decision-making combines rationality and intuitiveness [9].

Business analytics is the application of models, methods, and data analysis tools to produce information that helps managers make corporate strategic decisions (data-driven decision making) [10]. The implementation of business data analytics in the supply chain context is referred to as supply chain analytics. There are several types and pillars of analytics currently available, as shown in Table I.

TABLE I. BUSINESS ANALYTICS TYPES AND PILLARS [10]

Analytics Type	Definition	Analytics Pillar	Definition
Descriptive Analytics	Analytics aims to discover the main source of the issue, when, where, how often, and how to visualize the data and notify if an issue is emerging. Examples of this type of analytics are drill-down queries or reports, ad hoc or routine reports, dashboards, and visualizations.	Visualization	Visualization is the most suitable for descriptive analytics due to involving visualizing data from several variables, dimensions, correlations, and information. Tools such as business intelligence help with visualization.
Predictive Analytics	Analytics aims to predict when events will occur, what trends can be seen, alternatives, and what scenarios emerge. Examples of this type of analytics are forecasting and simulation.	Statistical Modeling	Statistical modeling is more suitable for predictive analytics due to its relation with mathematical modeling and data representation using assumptions and methods such as linear regression.
Prescriptive Analytics	Analytics aims to see how to get the best results, how to make decisions in uncertainty, what actions are better to take, and with what impact. Examples of this type of analytics are optimization, decision making under uncertainty, and impact analysis.	Machine Learning	Machine learning is suited for prescriptive analytics due to its relation to mathematical modeling of data and identifying patterns in data to solve a problem. However, unstructured data such as text, audio, and video are better suited to this pillar type.
Discovery/ wisdom analytics	Analytics aims to find a new product or service and how to apply knowledge about knowledge (meta- knowledge).		

Information visualization enhances human cognition of abstract data through visual graphical representations, making it easier to understand. Visualization in analytics can improve decision-making abilities by providing clear, contextual, and interactive visualizations [9]. This study focuses on the data visualization aspect of analytical description with the features of historical data graphics (variables, dimensions, and measurements).

Analytics capabilities in the context of a supply chain can be distinguished according to the plan, source, make, and deliver functions. Analytics in the planning function relates to analysis data prediction of market demand for products and services to determine capacity and align supply chain operations following market demand and existing resources, thereby providing benefits. Analytics of the sourcing function relates to the consolidation of inbound supply. It focuses on identifying and responding to disruptions related to the procurement process (supplier and market procurement) and providing supplier performance information for the supplier selection and management process. Analytics on the make function includes 1) cost and capacity analysis, 2) production adjustments, 3) identification of material waste, 4) machine failures, and 5) anomalies in the production process. Finally, the analytics function on the delivery function focuses on increasing the efficiency and effectiveness of material flow outbound through delivery to market and customer with the correct time, total, location, and quality. It is said that organizations with limited budgets should implement supply chain analytics with the order of priority from the plan, source, make, and deliver [11]. However, small and Medium Enterprises have limited IT infrastructure and budget. Therefore, it can be concluded that the scope appropriate when implementing supply chain analytics is the plan and source functions (inbound supply chain).

B. *Supply Chain Performance Measurement System*

Based on the available literature, the industry subjects that are often discussed are the retail and manufacturing industries. Aligning with the list of retail and manufacturing industry indicators in the scope of inbound supply chain processes related to the procurement to delivery of goods through suppliers and inbound logistics results. The list of eight key performance indicators (KPIs) consists of four suppliers and four inventory KPIs. A total of eight KPIs were selected based on the research of Brint et al. [12], which states that the number of appropriate KPIs should not be too much or too little as it can confuse (if it is too much) or cause loss of information (if it is too little). Furthermore, the KPIs can be categorized as a leading (a proactive measurement which can predict or influence future performance) or lagging (the result of measurement focuses on historical performance and explains what is currently happening) indicator [13]. Therefore, the list of supplier KPIs for the inbound supply chain is as follows.

- A percentage supplier on time deliveries (leading) is a percentage of orders to supplier fulfilled on the original date and time committed [14–20].
- A supplier lead time (lagging) is the time needed for the supplier to fulfill an order [14–19].
- A percentage of supplier delivery item accuracy (leading) is a percentage of orders to the supplier. All items ordered are the items provided, and no extra items are delivered [15–17, 20].
- A percentage of supplier shipments delivered in good condition (leading) is a percentage of orders to the supplier. Therefore, all items ordered are the items that were delivered in good condition [15, 16, 19].

The list of inventory KPIs for inbound supply chain is as follows.

- A stockout rate (leading) is when items are not available upon the requested need date [14, 16].
- A gross inventory value (lagging) is an average inventory value [14, 15].
- An inventory turnover (leading) is the rate of how many times a company can replace the inventories it has sold in a given period [14].
- An inventory day of supply (leading) is how many days it will take for the stock to run out if sales continue at the same rate as recent sales [15].

C. Cloud Computing for Supply Chain Analytics

Cloud computing delivers on-demand IT infrastructure and applications to individuals and organizations via an internet platform. In general, there are three service models in cloud computing technology, namely: 1) Software-as-a-Service (SaaS), where the application is located in the service provider's cloud infrastructure and delivered to the user via a web interface or application, 2) Platform-as-a-Service (PaaS), which provides a platform for creating applications through a programming interface and is supported by cloud service providers, and 3) Infrastructure-as-a-Service (IaaS), which provides virtual hardware (storage, server, memory, CPU) that can be leased and run by the user. In service delivery, cloud computing has four types of models, namely: 1) public cloud (IT third parties and cloud services physically own infrastructure resources are provided to customers, individuals, or organizations via the internet), 2) private cloud (cloud services). They are only intended for a specific organization so that data is under its control, security protocols and organizational system performance. It can be deployed by the organization or used by a third party to help deploy services, 3) community cloud (cloud services for an organization) associations of organizations that have a mission, security needs, and regulatory conditions (e.g., in a company holding group), and 4) hybrid cloud (there are several enterprise applications in public, private, or community clouds) [21]. In this study, the system developed supports the SaaS model, so companies can use the system in public, private, or community clouds as needed.

III. Methodology And The Analytical Framework

This section aims to discuss the methodology for developing the analytical framework. The study starts with organization needs finding by interviewing stakeholders. The interview results would be the basis for exploring the proper ERP modules for supply chain analytics. Next, this study limits the inbound supply chain by selecting 8 of 150 KPIs from six literatures. Since the supply chain analytics include several pillars, this study attempts to leverage the descriptive analytics instead of doing all the aspects. Subsequently, data is extracted from the database to look for the fundamental descriptive analysis. The extracted data would be the basis for the proposed analytics framework. The flow of the methodology is described in Fig. 1.

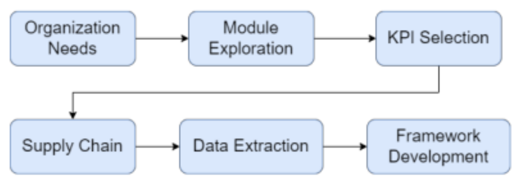

Figure 1. Research Methodology Flow.

After interviewing the stakeholders, it was found that there is an organizational need for consolidation reports based on subsidiary branches or companies. The current reporting in the ERP system could not create consolidation reports with the capability to drill up or down based on the hierarchy of data, warehouses, product categories, suppliers, and subsidiary branches or companies. To manually export the reports based on each branch or subsidiary, stakeholders would need to combine them. Up to this point, there has not yet been any data analytics module developed to visualize each business function's KPIs. There is an increased need for KPI information to help measure their business performance. It helps them evaluate, plan, and make decisions regarding their business in this era of uncertainty. Each of these obstacles is explained in detail in the following sections.

The focus of this study is to complete the current inbound supply chain subsystem with the drill up, drill down, and KPI information. The flow of processes related to the inbound supply chain ERP system consists of purchasing and fulfilling production plans. Thus, the flow of process observed in the existing system is the purchasing process. The interview and discussion concluded that two companies meet the criteria to observe inbound supply chain processes, namely a wafer biscuit manufacturing company (Company X) and a medical device retail company (Company Y). Therefore, these companies are the basis of the framework development.

A. *A Use Case in Manufacturing Industry*

Company X is a wafer-biscuit manufacturer consisting of the main factory, several warehouses near the main factory, and several distribution centers spread across the nation. In general, there are five types of items in the purchasing process, which are: raw materials and packing, machine or transportation spare parts, office and household stationery, maintenance services, non-stock costs (such as shuttle fees and employee meals) and finished good expedition services for distribution across the seas. The purchasing process is illustrated in Fig. 2.

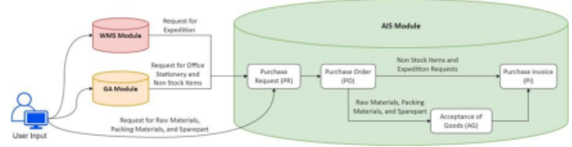

Figure 2. General Purchasing Process in Assessed Manufacturing Company.

The purchasing process, in general, consists of four major processes, which are: user's purchase request (PR), creation of purchase order (PO), creation of acceptance of goods (AG), and the creation of purchase invoice (PI). For non-stock items, there are two purchasing process flows, which are: through the creation of PR, PO, and PI or through PI only. Based on the data inputted into the system, there are several reports related to the purchasing process used frequently in the company, which are described in Table II.

TABLE II. REPORTS FREQUENTLY USED IN THE COMPANY

Report Name	Description	Stakeholder
List of suppliers	Consists of how many new suppliers in a month	PPIC staff whose tasks are related to production planning and supplier selection
Supplier performance rating	Based on each supplier's capability in completing POs, lead time, item outstanding, product received in good condition, price competitiveness	PPIC staff helps to evaluate the quality of each supplier
Outstanding PR, PO, AG, and PI report	Shows the number of PRs. POs, AGs, and PIs which are unfinished	Top management (as approver) and staff admin (who inputs the data)
Vendor Performance for each PO	Percentage of orders to the supplier in which all items ordered are the items arrived in good condition	PPIC staff
PO Approval Information	Shows PO approval lead time	PPIC and top management (as approver)

B. *A Use Case in Retail Industry*

Company Y is a medical device retail company with one main supplier and several small secondary suppliers. Company Y has a total of 13 branches which provide online (e-commerce) and offline sales. The goods distribution process from the main supplier to each branch is illustrated in Fig. 3.

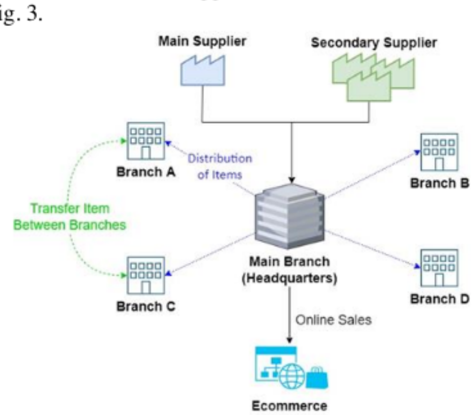

Figure 3. General Distribution Process from Suppliers to Each Branches in Assessed Retail Company.

The main and secondary suppliers distribute the goods to the main branch, which then will be redistributed to each branch. Goods obtained from secondary suppliers are for products which need to be assembled first in the main branch. An example of these types of products is first aid kits which consist of bandages, antiseptics, and plaster stock that are repackaged and sold together. After the assembly process in the main branch is finished, the company will distribute the goods to the other branches.

Item transfer requests are also available to transfer goods from one branch to another. For example, this feature is used when Branch A has items out of stock, and it can request item transfers from Branch B. As the company has two sales platforms, online and offline, the company acquires a third party omnichannel application solution to help consolidate the stock level information between the online and offline stock.

As the goods are distributed from the main branch, the procurement process begins with accepting goods from each branch, as illustrated in Fig. 4. The main branch manages the distribution process based on the stock levels reports on each branch. First, the main branch will distribute the goods to each branch. Each branch will then check and input the acceptance of goods (AG) based on the delivery note. The stock level information will then be updated. After the goods are accepted, and the invoice has been released, the purchase invoice is made based on the delivery note, acceptance of goods, and supplier invoice.

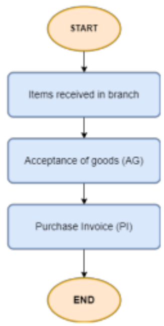

Figure 4. General Purchasing Process in in Assessed Retail Company.

When the main branch checks the stock level status, the staff admin or company owner needs to access the stock report for each branch and consolidate each branch's report into one report consolidation. The consolidation report will then help staff admins and owners to determine the level of product requests in each branch which is crucial for the procurement process. Based on the study case, it can be concluded that there are two main issues which these two companies encounter:

- Difficulties in obtaining a consolidation report across all branches or subsidiaries companies. The state of the COVID-19 pandemic has resulted in fluctuating demand and stock levels of each branch or subsidiary due to very high uncertainty.
- Reports are displayed in the form of tables and lists, thus making it difficult for users to retrieve helpful information which accommodates the company's strategic and operational needs. Users put in extra effort to process the reports manually and produce the needed information. In other words, the visibility of the inbound supply chain is less efficient.

IV. Conceptual Framework For Inbound Supply Chain Analytics

The system development process begins with the creation of a conceptual framework. In this section, a solution is analyzed academically, and its implementation based on the use case of the manufacturer and retail industry to produce the proposed conceptual framework [22, 23].

The proposed architecture of the conceptual framework in general consists of four layers such as data layer, data ingestion layer, data aggregation layer, and presentation layer, which is illustrated in Fig. 5. These four layers support data integration, data governance, and system management.

A. Data Layer

The first layer is a data layer which consists of large databases from various daily operational business process functions. This data is the source for information processing to support managers' data-driven decision-making. Database components needed to transform operational data into analytical data are Data Definition Language (DDL or metadata) and data. Inbound supply chain processes are related to production planning and sourcing processes, of which the three modules related to these processes are Accounting Information System (AIS), General Affair Management System (GAMS), and Warehouse Management System (WMS). Three of these sub-systems provide data related to procurement planning and inventory management. Data from the AIS module is heavily associated with raw or finished goods stock data, affecting the company's procurement planning and production processes. Data from the GAMS module is needed for non-stock procurements, such as services or office equipment. Data from the WMS module is required for expedition service procurement to distribute finished goods to the company's distribution centers or branches. Last but not least, data from GAMS and WMS is also used in the AIS module to provide data related to the procurement or acceptance of raw or packing materials from warehouses.

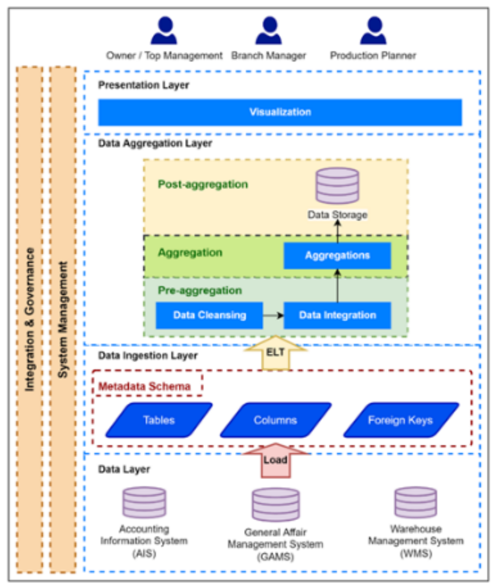

Figure 5. The Conceptual Framework for Inbound Supply Chain Analytics.

B. Data Ingestion Layer

The second layer is the Data Ingestion Layer. This layer consists of a database schema or metadata extraction process to select the needed tables and columns extracted for the data aggregation process. Metadata schema extracted includes the list of tables, columns, and foreign keys in the database. After the metadata schema has been successfully extracted and used to select the tables and columns to be extracted, the process proceeds to the Extract, Load, and Transform (ELT) to be propagated onto the next layer. The system automatically does the ELT process as the configured interval schedule.

C. *Data Aggregation Layer*

The third layer is the Data Aggregation Layer, which consists of pre-aggregation, aggregation, and post-aggregation stages. The pre-aggregation stage consists of two processes: data cleansing and data integration. The data cleansing process identifies and cleanses the invalid and irrelevant raw data. The data integration process standardizes the formats and structures of raw data, which was sourced from multiple systems, and has been through the data cleansing process and stored in the staging area.

The next step is the aggregation stage which aggregates the data using an aggregate function or calculation against raw data to generate the KPI information listed in the previous section. After all KPI calculations have finished, the next step is post-aggregation. In this step, the KPI calculation results are stored in the data storage, which is a data warehouse.

D. *Presentation Layer*

The last layer is the presentation layer which consists of visualization tools to visualize KPI information for analysis. The visualization tool used is in the form of a web-based dashboard directly accessible by users, which shows the combination of various KPIs from multiple systems in the data layer. For example, in the inbound supply chain scope, the target user who uses the KPI information for decision-making includes the owner, top management, branch manager, and production planner. An owner or top management can view the (drill-up) consolidated branches/subsidiaries or (drill-down) certain branches/subsidiaries' inbound supply chain KPI to help in determining the company's strategy. The inbound KPI supply chain can also be drilled up and down based on the date by a user, warehouse, supplier, and product category.

V. CONCLUSION

This study proposed a conceptual framework design for efficient inbound supply chain analytics. The result of this study focused on the organization's need for a consolidation report across subsidiaries and branches/companies through supply chain analytics. There are four layers in the conceptual framework: data layer, data ingestion layer, data aggregation layer, and presentation layer. These four layers work together to support data integration, data governance, and system management. For example, the data aggregation layer consists of three sublayers: pre-aggregation, aggregation, and post-aggregation. Although the preliminary feedback from the stakeholders confirms the suitability of the proposed conceptual framework, the future work should involve the activities related to the assessment of the system design, the system prototype development, and the evaluation of the system as a whole by conducting field studies.

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REFERENCES

[1] J. Nagy, J. Oláh, E. Erdei, D. Máté, and J. Popp, "The role and impact of industry 4.0 and the internet of things on the business strategy of the value chain-the case of hungary," Sustain., vol. 10, no. 10, 2018, doi: 10.3390/su10103491.

[2] G. F. Frederico, J. A. Garza-Reyes, A. Anosike, and V. Kumar, "Supply Chain 4.0: concepts, maturity and research agenda," Supply Chain Manag. An Int. J., vol. 25, no. 2, pp. 262–282, Jan. 2020, doi: 10.1108/SCM-09-2018-0339.

[3] G. F. Frederico, "Towards a Supply Chain 4.0 on the post-COVID-19 pandemic: a conceptual and strategic discussion for more resilient supply chains," Rajagiri Manag. J., vol. 15, no. 2, pp. 94–104, Jan. 2021, doi: 10.1108/RAMJ-08-2020-0047.

[4] T. Sobb, B. Turnbull, and N. Moustafa, "Supply chain 4.0: A survey of cyber security challenges, solutions and future directions," Electron., vol. 9, no. 11, pp. 1–31, 2020, doi: 10.3390/electronics9111864.

[5] G. F. Frederico, J. A. Garza-Reyes, A. Kumar, and V. Kumar, "Performance measurement for supply chains in the Industry 4.0 era: a balanced scorecard approach," Int. J. Product. Perform. Manag., vol. 70, no. 4, pp. 789–807, 2021, doi: 10.1108/IJPPM-08-2019-0400.

[6] J. Hallikas, M. Immonen, and S. Brax, "Digitalizing procurement: the impact of data analytics on supply chain performance," Supply Chain Manag. An Int. J., vol. 26, no. 5, pp. 629–646, Jan. 2021, doi: 10.1108/SCM-05-2020-0201.

[7] N. P. Singh and S. Singh, "Building supply chain risk resilience: Role of big data analytics in supply chain disruption mitigation," Benchmarking, vol. 26, no. 7, pp. 2318–2342, 2019, doi: 10.1108/BIJ-10-2018-0346.

[8] S. Somapa, M. Cools, and W. Dullaert, "Characterizing supply chain visibility – a literature review," Int. J. Logist. Manag., vol. 29, no. 1, pp. 308–339, Feb. 2018, doi: 10.1108/IJLM-06-2016-0150.

[9] L. Rabelo, E. Gutierrez-Franco, A. Sarmiento, and C. Mejía-Argueta, Engineering Analytics: Advances in Research and Applications, 1st ed. New York: CRC Press, 2021.

[10] W. Raghupathi and V. Raghupathi, "Contemporary Business Analytics: An Overview," Data, vol. 6, no. 8, pp. 1–11, Aug. 2021, doi: 10.3390/data6080086.

[11] S. Zhu, J. Song, B. T. Hazen, K. Lee, and C. Cegielski, "How supply chain analytics enables operational supply chain transparency: An organizational information processing theory perspective," Int. J. Phys. Distrib. Logist. Manag., vol. 48, no. 1, pp. 47–68, 2018, doi: 10.1108/IJPDLM-11-2017-0341.

[12] A. Brint, A. Genovese, C. Piccolo, and G. J. Taboada-Perez, "Reducing data requirements when selecting key performance indicators for supply chain management: The case of a multinational automotive component manufacturer," Int. J. Prod. Econ., vol. 233, no. January 2020, p. 107967, 2021, doi: 10.1016/j.ijpe.2020.107967.

[13] S. Biazzo and P. Garengo, Performance Measurement with the Balanced Scorecard, no. 1. Berlin, Heidelberg: Springer Berlin Heidelberg, 2012.

[14] N. Anand and N. Grover, "Measuring retail supply chain performance: Theoretical model using key performance indicators (KPIs)," Benchmarking An Int. J., vol. 22, no. 1, pp. 135–166, Jan. 2015, doi: 10.1108/BIJ-05-2012-0034.

[15] APICS, "Supply Chain Operations Reference Model: SCOR Version 12.0," 2017.

[16] G. Bressolles and G. Lang, "KPIs for performance measurement of e-fulfillment systems in multi-channel retailing: An exploratory study," Int. J. Retail Distrib. Manag., vol. 48, no. 1, pp. 35–52, 2020, doi: 10.1108/IJRDM-10-2017-0259.

[17] F. T. S. Chan and H. J. Qi, "An innovative performance measurement method for supply chain management," Supply Chain Manag. An Int. J., vol. 8, no. 3, pp. 209–223, Aug. 2003, doi: 10.1108/13598540310484618.

[18] A. Gunasekaran, C. Patel, and R. E. McGaughey, "A framework for supply chain performance measurement," Int. J. Prod. Econ., vol. 87, no. 3, pp. 333–347, 2004, doi: 10.1016/j.ijpe.2003.08.003.

[19] Q. Lu, M. Goh, and R. De Souza, "A SCOR framework to measure logistics performance of humanitarian organizations," J. Humanit. Logist. Supply Chain Manag., vol. 6, no. 2, pp. 222–239, 2016, doi: 10.1108/JHLSCM-09-2015-0038.

[20] N. R. Sangwa and K. S. Sangwan, "Development of an integrated performance measurement framework for lean organizations," J. Manuf. Technol. Manag., vol. 29, no. 1, pp. 41–84, 2018, doi: 10.1108/JMTM-06-2017-0098.

[21] P. K. Senyo, E. Addae, and R. Boateng, "Cloud computing research: A review of research themes, frameworks, methods and future research directions," Int. J. Inf. Manage., vol. 38, no. 1, pp. 128–139, 2018, doi: 10.1016/j.ijinfomgt.2017.07.007.

[22] A. Dresch, D. P. Lacerda, and J. A. V. Antunes Jr, Design Science Research. Cham: Springer International Publishing, 2015.

[23] L. Mayer, N. Mehdiyev, and P. Fettke, "Manufacturing execution systems driven process analytics: A case study from individual manufacturing," Procedia CIRP, vol. 97, pp. 284–289, 2020, doi: 10.1016/j.procir.2020.05.239.

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