SCOPUS Q3 – Decision Science Letters

https://growingscience.com/dsl/dsl.html

Growing Science™
PUBLISHERS OF DISTINGUISHED ACADEMIC, SCIENTIFIC AND PROFESSIONAL JOURNALS

Home About Us Contact Us Search: All Fields

For Readers

- Volume 13 No 2 (2024)
- Volume 13 No 1 (2024)
- Volume 12 No 4 (2023)
- Volume 12 No 3 (2023)
- Volume 12 No 2 (2023)
- Volume 12 No 1 (2023)
- First Online Articles
- Previous Issues
- Indexing/Abstracting
- Editorial Board
- Journal Subscription

For Authors

- Author Guidelines
- Submit Manuscript
- Ethics
- Ethics
- Author Fee
- Reviewers
- Review Process

Recommend to LIBRARY

Decision Science Letters

ISSN 1929-5812 (Online) - ISSN 1929-5804 (Print)
Quarterly publication

Scopus WoS

Welcome to the online submission and editorial system for *Decision Science Letters*

Decision Science Letters is a quarterly publication dedicated to create a forum for scientists in all over the world who wish to share their experience and knowledge in the field of Decision Sciences. The journal's policy is to perform a peer review on all submitted articles and the papers will be appeared in a form of online on our website as soon as the review result becomes positive. The journal covers both empirical and theoretical aspects of management and gives the chance on sharing knowledge among practitioners. We do our best to contribute to recent advances on multiple criteria decision making problems including the following

- Multi Criteria Decision Making
- Grey Relational Analysis, COPRAS
- Best-worst Method
- MODM applications: NSGA-II, MOPSO
- Fuzzy techniques: Fuzzy TOPSIS
- Fuzzy DEMATEL, Fuzzy VIKOR
- Fuzzy DEMATEL, Fuzzy VIKOR
- Parameter Tunning by MCDM techniques
- Data mining and Data Clustering
- MCDM techniques and Robust optimization
- Engineering Optimization
- TOPSIS, VIKOR, AHP, ELECTERE, ...
- Simulation optimization
- Game theory
- Supplier Selection and Green management
- Reliability
- Artificial Neural Network (ANN)
- Artificial Neural Network (ANN)
- Non-traditional Machining Process
- MCDM techniques in SCM
- Data Envelopment Analysis
- Travelling salesman problem (TSP), VRP, etc.

Decision Science Letters is an open access journal, which provides instant access to the full text of research papers without any need for a subscription to the journal where the papers are published. Therefore, anyone has the opportunity to copy, use, redistribute, transmit/display the work publicly and to distribute derivative works, in any sort of digital form for any responsible purpose, subject to appropriate attribution of authorship. Authors who publish their articles may also maintain the copyright of their articles.

Growing Science publishes peer reviewed high quality open access papers in various fields of sciences. The primary aim of this publishing company is to perform fast and reliable process for contributors. Once a paper is accepted, our staffs work hard to provide online version of the papers as quickly as possible. All papers are assigned valid DOI number once they appear online just to make sure that the other people researchers cite them while no volume and numbers are still assigned to the papers. We believe this could help the existing knowledge grow faster; however, the actual publication of a paper with volume and number will not exceed more than 4 months.

Decision Science Letters applies the Creative Commons Attribution (CC BY) license to works we publish (read the human-readable summary or the full license legal code). Under this license, authors keep ownership of the copyright for their content, but permit anyone to download, reuse, reprint, modify, distribute and/or copy the content as long as the original authors and source are cited. No permission is needed from the authors or the publishers. Appropriate attribution can be provided by simply citing the original article (e.g., Rao, R. (2016). Review of applications of TLBO algorithm and a tutorial for beginners to solve the unconstrained and constrained optimization problems. *Decision Science Letters*, *5*(1), 1-30., 1-10. DOI: 10.5267/j.dsl.2015.9.003). For any reuse or redistribution of a work, users have to also make clear the license terms under which the work was
redistribution of a work, users have to also make clear the license terms under which the work was
published. This broad license was developed to facilitate free access to, and unrestricted reuse of, original works of all kinds. Applying this standard license to your own work will ensure that it is freely and openly available in perpetuity.

Most of the Growing Science published articles can be traced on Microsoft Academic search, Google Schoolar, Ulriches' web, Socolar, Genamics, Open J-Gate, Libraries of various well-known universities such as MIT, Washington State, GeorgeTown, Strathclyde, Tohoku, Indiana, North Dakota, York, Osaka, NovaNet, and Tamkang.

Decision Science Letters has been indexed by **Web of Science, Scopus, DOAJ and Scimago.**

Growing Science™

PUBLISHERS OF DISTINGUISHED ACADEMIC, SCIENTIFIC AND PROFESSIONAL JOURNALS

Home About Us

For Readers

- Editorial Board
- Journal Subscription

For Authors

- Author Guidelines
- Submit Manuscript
- Author Fee

Decision Science Letters

ISSN 1929-5812 (Online) - ISSN 1929-5804 (Print)
Quarterly Publication

Link daftar isi:
https://growingscience.com/dsl/Vol13/DslVol13Issue3.html

Link paper published:
https://www.growingscience.com/dsl/Vol13/dsl_2024_18.pdf

Growing Science™
PUBLISHERS OF DISTINGUISHED ACADEMIC, SCIENTIFIC AND PROFESSIONAL JOURNALS

Home About Us

Online Issues

Vol 13 Issue 3 Pages 525-766 (Summer 2024)

Open Access Original Article

1. **Stas crossover with K-mean clustering for vehicle routing problem with time window** *Pages:525-534*

Ratchadakorn Poohoi, Kanate Puntusavase and Shunichi Ohmori PDF (416 K)

Abstract: Vehicle Routing Problem (VRP) is important in the transportation and logistics industries. Vehicle Routing Problem with Time Window (VRPTW) is a kind of VRP with the additional time windows constraint in the model and is classified as an NP-hard problem. In this study, we proposed Stas crossover in Genetic Algorithm (GA) to solve VRPTW by developing the problem with K-mean clustering. The experiments use the standard Solomon's benchmark problem instances for VRPTW. The results with K-mean clustering are shown to perform better for minimum distance and average distance than without K-mean clustering. In the case of location and dispersion characteristics of the customer, the paths with K-mean clustering are arranged into groups and are orderly, but the paths without K-mean clustering are disordered. After that, this paper shows the comparison of the crossover operator performance on instances of Solomon benchmark, and appropriate crossover operators are recommended for each type of problem. The results of the proposed algorithm are better than the best-known solutions from the previous studies for some instances. Moreover, our proposed research will serve as a guideline for a real-world case study.

DOI: 10.5267/j.dsl.2024.5.008
Keywords: Vehicle Routing Problem with Time Window, Genetic Algorithm, K-mean Clustering, Crossover Operator

Open Access Original Article

18. **Towards sustainable polio vaccine distribution: Evaluating a green metrics framework in Indonesia's pharmaceutical industry**
Pages:741-750

Agus Purnomo and *Syafrianita* PDF (416 K)

Abstract: This study endeavors to evaluate the effectiveness of green distribution and green supply chain practices at PT Bio Farma (Persero) in relation to polio vaccine products. The ultimate objective is to establish and attain future green distribution targets. The research methodology utilizes the Green Supply Chain Operations Reference (Green SCOR) model and the Analytical Hierarchy Process (AHP) to analyze the production and distribution data of polio vaccine (OPV) and inactivated polio vaccine (IPV) products from January to December 2023. The performance values for each key component of Green Distribution and Green Supply Chain are as follows: Plan = 22.9, Source = 16.60, Make = 21.53, Deliver = 11.24, and Return = 7.08. The total performance value for Green Distribution and Green Supply Chain is 79.41. According to APICS standards, the performance of Green Distribution and Green Supply Chain is rated as "Good". Future performance improvements will focus on supply chain and collaborative planning, establishing long-term partnerships with suppliers and customers, optimizing environmentally friendly transportation, and developing the enterprise information system. Our study proposes that the distribution and logistics managers at PT Bio Farma should persistently monitor and assess their operations to enhance the efficiency of their green distribution and green supply chains. By doing so, they can ensure the successful attainment of performance objectives for disseminating the polio vaccine in Indonesia. This research presents a significant advancement by incorporating the Green SCOR framework into the specific domain of polio vaccines, emphasizing sustainability and environmental efficiency. This approach paves the way for new avenues of investigation in green supply chain research and offers a novel viewpoint on how the pharmaceutical industry, specifically vaccine distribution, can utilize sustainable practices to enhance their operations while mitigating environmental ramifications.

DOI: 10.5267/j.dsl.2024.3.005
Keywords: Analytical Hierarchy Process (AHP), Green SCOR, Green Distribution, Green Supply Chain, Polio Vaccine

Open Access Original Article

19. **Simple and efficient duelist algorithm variations for energy-aware virtual machine placement in cloud data centers** *Pages:751-766*

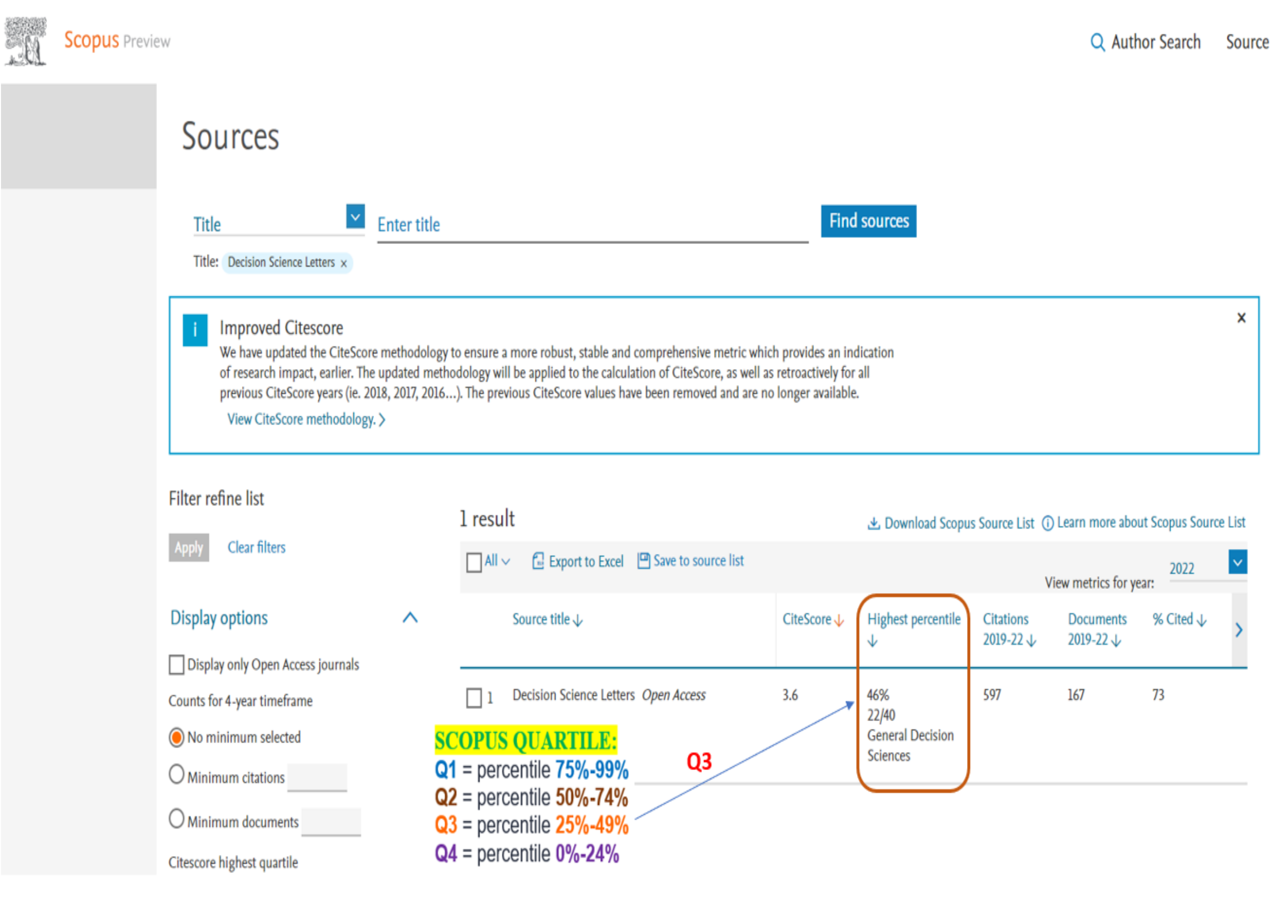
Amol Adamuthe and *Vrushabh D. Kupwade* PDF (416 K)

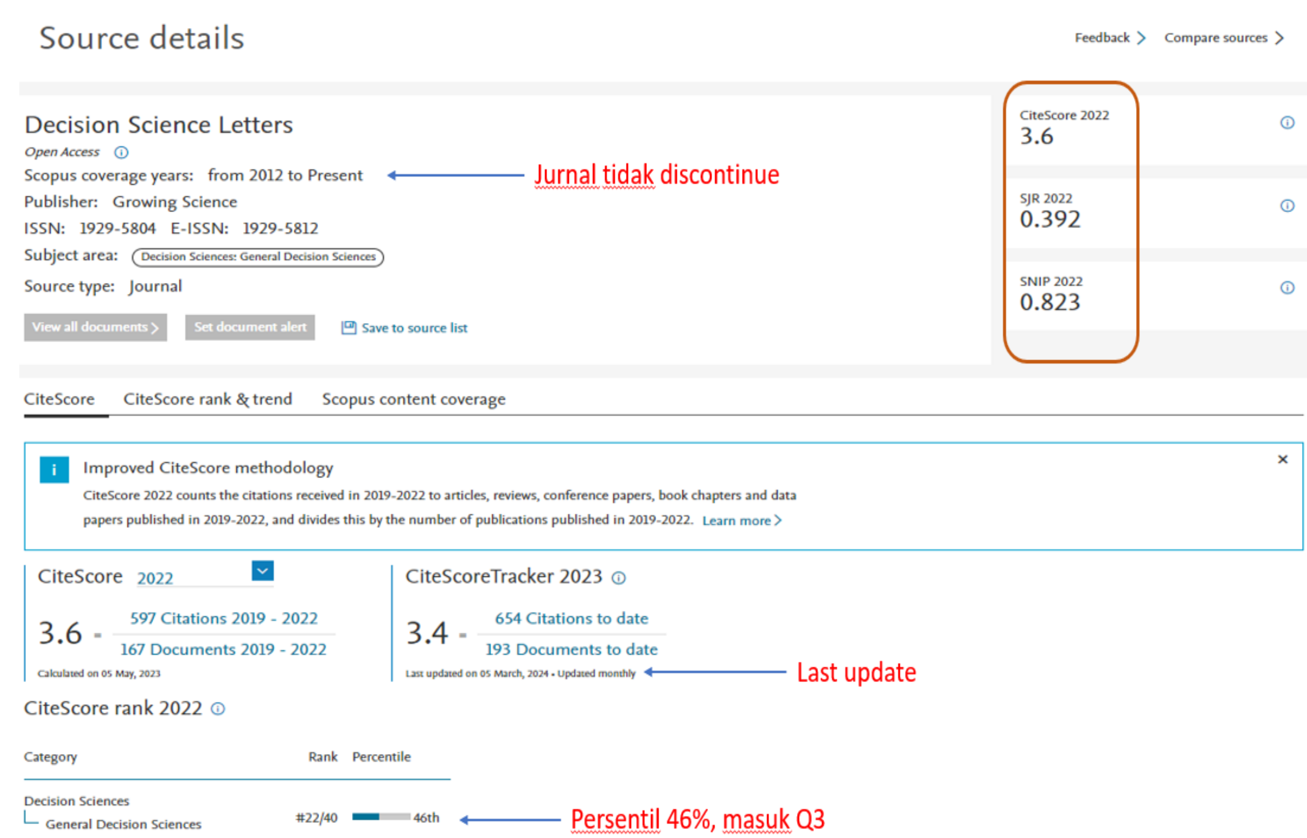
Abstract: This research presents a novel approach to address the Virtual Machine Placement Problem (VMPP) in cloud data centers with the aim of minimizing energy consumption. The main contributions of this study are threefold. Firstly, a Duelist Algorithm specifically designed for VMPP, which introduces a unique concept of duelists combined with optimization techniques. The algorithm aims to strike a balance between exploration and exploitation in the search space, leading to more effective resource allocation and energy-efficient cloud data center management. Secondly, enhance the performance of the Duelist Algorithm by reducing the number of algorithm-specific parameters. This simplifies the implementation process and increases the algorithm's adaptability to various real-world problems, making it more user-friendly and robust. Lastly, conduct a comprehensive comparison of the Duelist Algorithm with the widely used Hybrid Harmony Search Algorithm (HS+SA+LS) in terms of energy consumption and overall efficiency. The experimental results demonstrate that the Duelist Algorithm consistently outperforms the Hybrid Harmony Search Algorithm, achieving remarkable improvements in both best and mean fitness values. Additionally, the Duelist Algorithm exhibits lower standard deviation values, indicating more stable and consistent performance. The findings of this research validate the effectiveness of the proposed Duelist Algorithm in minimizing energy consumption and optimizing cloud resource allocation. The reduction of algorithm-specific parameters further contributes to its versatility and simplicity.

DOI: 10.5267/j.dsl.2024.3.004
Keywords: Energy efficiency in cloud, Virtual machine placement, Duelist algorithm

Pada SCOPUS Source, Percentile = 46% sehingga masuk Q3

Dapat dilihat pada: https://www.scopus.com/sourceid/21100314709





Decision Science Letters 13 (2024) 741–750

Contents lists available at GrowingScience

Decision Science Letters

homepage: www.GrowingScience.com/dsl

Towards sustainable polio vaccine distribution: Evaluating a green metrics framework in Indonesia's pharmaceutical industry

Agus Purnomo[a*] and Syafrianita[b]

[a]*Department of Master of Logistics Management, Faculty of Logistics, Technology and Business, Universitas Logistik Dan Bisnis Internasional, Indonesia*
[b]*Department of Transportation Management, Faculty of Logistics, Technology, and Business, Universitas Logistik Dan Bisnis Internasional, Indonesia*

C H R O N I C L E

Article history:
Received: January 17, 2024
Received in revised format: February 20, 2024
Accepted: March 29, 2024
Available online: March 29, 2024

Keywords:
Analytical Hierarchy Process (AHP)
Green SCOR
Green Distribution
Green Supply Chain
Polio Vaccine

A B S T R A C T

This study endeavors to evaluate the effectiveness of green distribution and green supply chain practices at PT Bio Farma (Persero) in relation to polio vaccine products. The ultimate objective is to establish and attain future green distribution targets. The research methodology utilizes the Green Supply Chain Operations Reference (Green SCOR) model and the Analytical Hierarchy Process (AHP) to analyze the production and distribution data of polio vaccine (OPV) and inactivated polio vaccine (IPV) products from January to December 2023. The performance values for each key component of Green Distribution and Green Supply Chain are as follows: Plan = 22.9, Source = 16.60, Make = 21.53, Deliver = 11.24, and Return = 7.08. The total performance value for Green Distribution and Green Supply Chain is 79.41. According to APICS standards, the performance of Green Distribution and Green Supply Chain is rated as "Good". Future performance improvements will focus on supply chain and collaborative planning, establishing long-term partnerships with suppliers and customers, optimizing environmentally friendly transportation, and developing the enterprise information system. Our study proposes that the distribution and logistics managers at PT Bio Farma should persistently monitor and assess their operations to enhance the efficiency of their green distribution and green supply chains. By doing so, they can ensure the successful attainment of performance objectives for disseminating the polio vaccine in Indonesia. This research presents a significant advancement by incorporating the Green SCOR framework into the specific domain of polio vaccines, emphasizing sustainability and environmental efficiency. This approach paves the way for new avenues of investigation in green supply chain research and offers a novel viewpoint on how the pharmaceutical industry, specifically vaccine distribution, can utilize sustainable practices to enhance their operations while mitigating environmental ramifications.

1. Introduction

Polio remains an ongoing and severe epidemic that has resulted in the paralysis of millions of children in recent years (Jin et al., 2022). This disease, which primarily affects children, induces paralysis and nerve damage and can even lead to death. According to Zomahoun et al. (2021), approximately 5-10% of reported polio cases end in fatality, with one child being left permanently paralyzed. Since its establishment in 1988, the Global Polio Eradication Initiative (GPEI) has made noteworthy progress in curbing polio cases worldwide. This initiative has successfully reduced polio-endemic countries from 125 to just 3, significantly diminishing the overall number of polio cases by 99% (Fahmy et al., 2017). In the case of Indonesia, a polio transmission risk assessment was conducted by the World Health Organization (WHO) in 2018 at both the national and provincial levels. The findings revealed that 23 provinces in Indonesia, accounting for 76.5% of the total, were classified as being at high risk, while the remaining nine provinces, or 23.5%, were categorized as medium risk.

* Corresponding author.
E-mail address: aguspurnomo@ulbi.ac.id (A. Purnomo)

doi: 10.5267/dsl.2024.3.005

Yogyakarta and Bali were the only two provinces deemed to have a low risk of polio transmission (Kementerian Kesehatan Republik Indonesia, 2020). To mitigate the risk of polio transmission, the Indonesian government includes the polio vaccine (OPV) and a dose of inactivated polio vaccine (IPV) as part of its routine immunization program for young children (Holmes et al., 2017). The responsibility for producing and distributing polio vaccines in Indonesia has been entrusted to PT Bio Farma (Persero), a state-owned company. Since the development of the polio vaccine in 1993, PT Bio Farma's production capacity has reached 1.7 billion doses annually, enabling the fulfillment of national requirements and capturing up to 60% of the global market share (Prayogi & Wandebori, 2020).

The distribution performance of PT Bio Farma's (Persero) polio vaccine in Indonesia has only achieved 90% for OPV4 and less than 80% for IPV. Thus, there is a need to enhance the distribution performance to ensure the success of the national polio eradication program (Kementerian Kesehatan Republik Indonesia, 2020). The vaccine industry should consider adopting environmentally friendly, green distribution practices to mitigate carbon emissions, energy consumption, and waste generation. Green distribution encompasses several strategies, including efficient delivery from manufacturers to end consumers, improved cold chain management, and reduced packaging waste (Yadav & Kumar, 2023; Mahmud et al., 2023). Moreover, the concept of a green supply chain can promote sustainable practices in industries and minimize adverse environmental impacts (M. Khan et al., 2023; Sharma et al., 2021; Tseng et al., 2019; Yildiz Çankaya & Sezen, 2019). It is crucial for PT Bio Farma (Persero) not only to meet the national distribution targets but also to produce and distribute polio vaccines under eco-friendly regulations. Additionally, the implementation of green distribution practices can also support optimization of transportation and inventory management (Muduli et al., 2020; M. Khan et al., 2023; Cvirik & Daneshjo, 2022). The notion of the green supply chain pertains to the integration of ecologically responsible managerial practices at each phase, encompassing green procurement and green distribution (Passetti et al., 2018; Srivastava, 2007). Green distribution, which constitutes a facet of the green supply chain, specifically emphasizes the adoption of green transportation and warehousing to enhance the organization's environmental performance (Nie & Zhang, 2023; Yang et al., 2022;Dzikriansyah et al., 2023).

As of early January 2023, PT Bio Farma (Persero) has implemented green distribution as part of its comprehensive green supply chain program. Thus far, no research has been conducted on the measurement of green supply chain performance and green distribution of polio vaccines in Indonesia, rendering an assessment of the level of success impossible. The absence of measurement and evaluation of distribution performance will impede the effectiveness of the distribution process and exacerbate negative environmental impacts. The analysis of available literature indicates a significant research gap regarding the application of the Green Supply Chain Operating Model (Green SCOR) in polio vaccine distribution. While there are studies examining specific aspects of green supply chains in the pharmaceutical industry, the specific utilization of the Green SCOR model as a framework to enhance the green distribution performance of polio vaccines has not been adequately explored. This gap presents an opportunity to bridge the knowledge deficiency and gain profound insights into the potential application of the Green SCOR model to optimize the vaccine supply chain with a focus on environmental sustainability and efficiency.

Hence, the objective of this study is to comprehensively assess the performance of green distribution and the green supply chain at PT Bio Farma (Persero) in the context of polio vaccine products. This will be achieved through the application of the Green SCOR framework, which will facilitate the establishment of future green distribution objectives. The specific aim of this study is to pinpoint areas for improvement and formulate strategic recommendations aimed at enhancing operational efficacy and mitigating the environmental impact of distribution activities.
The novelty of this research lies in its pioneering exploration of the application of the Green SCOR framework in the relatively unexplored realm of green polio vaccine distribution. By integrating the Green SCOR framework, traditionally employed in diverse industries, into the specialized domain of polio vaccines, with emphasis on environmental sustainability and efficiency, this research offers a significant breakthrough.

2. Theoretical Framework

2.1 Supply Chain Operations Reference (SCOR) and Green Supply Chain Operations Reference (Green SCOR)

SCOR is a process-based reference model for supply chain operations that can be used to map the supply chain (Zhou, 2022). The SCOR model integrates three key management elements into a cross-functional supply chain framework: business process reengineering, benchmarking, and process measurement (Chopra et al., 2022). Furthermore, according to Saen & Izadikhah (2022) and (Chopra et al., 2022; Bulsara et al., 2016), processes consist of three levels in SCOR. The top level includes five main processes - Plan, Source, Make, Deliver, and Return. This level describes performance from two perspectives: one from the customer's perspective and the other from an internal perspective. At this level, there is a definition of primary competition and instructions on how to achieve it. The explanations of the five processes at level 1 are as follows:

1) Planning: arranging supply and demand to fulfill production, delivery, and procurement requirements.

2) Sourcing: acquiring products or services to meet market demand. This process includes choosing suppliers, assessing their performance, scheduling supplier deliveries, receiving items, and verifying and authorizing payment for goods provided by suppliers.
3) Make: the process of converting raw materials/components into products that meet customer needs.
4) Deliver: the processes involved in meeting consumer demand for products and services, often involving distribution, transportation, and border control.
5) Return: the process of returning or receiving products for various reasons.

Furthermore, to assess supply chain performance, five categories are utilized: reliability, responsiveness, agility, cost, and asset management. The subsequent step involves the selection of the Key Performance Indicator (KPI) criteria matrix. Given the difficulty for a company to excel in all metrics, it is advisable to prioritize only a select few areas (Huang & Keskar, 2007). The Green SCOR concept has been developed by modifying the SCOR model to incorporate environmental considerations into the SCOR principles. The objective is to enhance the performance of the green supply chain by employing analytical metrics that reflect the relationship between supply chain activities and green concepts (Rosyidah et al., 2022). Furthermore, Rosyidah et al. (2022) and Pulansari & Putri (2020) explicate the four fundamental stages in the development of Green SCOR as follows:

1) Ascertain foundational practices and metrics for a green supply chain.
2) Assess existing SCOR process models in terms of their environmental implications.
3) Tailor the SCOR model by benchmarking exemplary practices and integrating environmental metrics.
4) Elucidate the modifications implemented and analyze their ramifications on supply chain operations.

2.2 Green Supply Chain Management (GSCM) Performance Measurement.

A fundamental aspect of supply chain management is performance management and continuous improvement. Effective performance management requires a measurement system that can assess the performance of the supply chain as a whole. GSCM is the integration of environmentally friendly concepts into supply chain practices from the product idea, design, sourcing, production process, and distribution to the end of the product life cycle so that it can be recycled, reused, repaired, remanufactured or destroyed so that supply chains and living things can be sustainable (Cazeri et al., 2017). The green supply chain starts from the awareness of the impact of supply chain activities on the surrounding environment. In practice, a green supply chain encompasses the role of the environment in all value-added activities in the supply chain (Kumar et al., 2012).

According to APICS (2017), the Green SCOR metrics used to measure GSCM performance based on the objectives expected by each stakeholder include:

1) % of suppliers with ISO 14001 certification.
2) % of suppliers meeting environmental requirements.
3) % of hazardous materials in inventory.
4) % of vehicle fuel from alternative fuels.
5) Energy consumption.

Measuring the performance of a green supply chain is crucial for enhancing environmental sustainability in business operations. The benefits of measuring green supply chain performance include the identification of environmental impacts, cost savings, ensuring regulatory compliance, and enhancing supply chain resilience. This measurement impacts sustainable performance in areas such as supplier selection and development, mode and operator selection, vehicle routing, location decisions, packaging options, and more APICS (2017). Tools for measuring GSCM performance from various literatures and practices include analytical hierarchy process, activity-based costing, environmental analysis design, balanced scorecards, and life cycle analysis type tools (Panpatil, Lahane, et al., 2023).

2.3 Analytic Hierarchy Process (AHP)

AHP considers the opinions of experts with questionnaires to support decision-making by comparing criteria, sub-criteria, and alternatives. The pairwise comparison matrix assessed by experts shows the importance level between criteria, sub-criteria, and alternatives so that weights are obtained, forming the basis for decision-making (Li et al., 2023). The steps of AHP are as follows (Panpatil, Prajapati, et al., 2023) :

1) Constructing a decision hierarchy centered on problem-solving objectives is a fundamental step. It entails the identification of the objectives that must be accomplished, followed by the listing of the relevant criteria and sub-criteria, along with the alternatives to be taken into account.
2) Analyze the objectives, criteria, sub-criteria, and alternatives. Create an expert-rated pairwise comparison matrix (using a scale of 1 to 9) to evaluate the criteria against the objectives, the sub-criteria against the criteria, and the alternatives against the sub-criteria.

3) Prioritisation. The relative comparative value is then processed to determine the ranking of alternatives.
4) Logical consistency. Knowing how good consistency is important because we want to make decisions based on something other than considerations with low consistency.

3. Methods

This research was approved by the Logistics Department of PT Bio Farma (Persero) for the Polio Vaccine (OPV) and Inactivated Polio Vaccine (IPV) products. Data on Green Distribution and Green Supply Chain performance were collected from January to December 2023. The Supply Chain Operations Reference (SCOR) is a three-level diagnostic and benchmarking methodology designed to significantly improve a company's supply chain processes. The top level, Level 1, consists of five key processes: planning, sourcing, manufacturing, delivery, and returns. Planning involves coordinating supply and demand to meet production, delivery, and procurement requirements. Sourcing is the activity of obtaining products or services to fulfill market demand. Manufacturing involves transforming raw materials/components into products that satisfy customer needs. Delivery meets consumer demand for products and services, often involving distribution, transportation, and border control. Returns refer to the process of returning or receiving products for various reasons. Level 2 is the configuration level, closely linked to the categorization of each process at Level 1. Level 3 is the implementation element level, further divided into advanced tasks and activities (APICS Supply Chain Council, 2017). Green SCOR is an extension of the SCOR methodology that incorporates environmental concepts into the SCOR process (Zhang & Liu, 2011) by embracing the work attributes of reliability, responsiveness, flexibility, cost, and assets (Qianhan et al., 2010). The next crucial step involves the development of metrics for measuring the performance of green distribution and supply chains, based on the Green Supply Chain Operations Reference (SCOR) model (Huang & Keskar, 2007). The Green SCOR concept expands upon the SCOR model by incorporating environmental principles. The objective is to improve the performance of distribution and green supply chains through analytical metrics that capture the relationship between supply chain activities and green concepts (Rosyidah et al., 2022). Subsequently, the weights of the evaluation metrics at level 1 and level 2 are determined using the Analytical Hierarchy Process (AHP), with input from 5 experts in the logistics department of PT Bio Farma (Persero). AHP utilizes expert opinions to facilitate decision-making by comparing criteria, sub-criteria, and alternatives in a pairwise comparison matrix (Li et al., 2023). The AHP process involves the following steps (Panpatil, Prajapati, et al., 2023):

1) Establish hierarchical objectives, criteria, sub-criteria, and alternative structures.
2) Evaluate criteria and alternatives through pairwise comparisons, utilizing a scale of 1 to 9 to reflect expert opinions.
3) Assess the logical consistency of the experts' judgments.
4) Prioritize alternatives based on the highest weighted value for each one.

4. Results and Discussion

4.1 Calculation of Actual Value of Green Distribution and Green Supply Chain Performance

In the initial stage, green distribution and green supply chain performance measurement metrics were designed according to the operational characteristics of PT Bio Farma (Persero) based on Green SCOR. Based on the data obtained from the logistics department of PT Bio Farma (Persero), the actual value is calculated for each top-level, consisting of five key processes: plan, source, make, deliver, and return. The calculation results using the designed metrics for measurement are presented in Table 1.

Table 1
Actual Value of Green Distribution and Green Supply Chain Performance for each Green SCOR top-level

No	Metrics Measurement	Formula & Actual value
		Plan: Reliability
1	Inventory level for packaging	$\frac{\text{The average number of products stored in the warehouse}}{\text{Average product demand}} \times 100\%$ (1.85 mio doses / 16.8 mio doses)×100% = 11,01 %/month
2	Internal meeting	Number of meetings between departments = 2 month
		Plan: Responsiveness
3	Planning schedule	Time to prepare a monthly production schedule = 2 days/month
		Plan: Green Supply Chain & Green Distribution
4	% employee trained on environmental requirements	$\frac{\text{No. of employees trained on gr. supply chain \& gr. distribution}}{\text{Total employees}} \times 100\%$ (921 emploees /921 employees) × 100% = 100 % per year
5	% waste disposition	$\frac{\text{The weight of waste discharged into the environment}}{\text{Total weight of waste produced}} \times 100\%$ (0.982 tons/127.60 tons) × 100% = 0,77 % per year
		Source: Reliability

No	Metrics Measurement	Formula & Actual value
1	Defect rate	$\frac{\text{Number of defective units}}{\text{Number of units shipped}} \times 100\%$ (115 vials/840,000 vials) × 100% = 0,01 % per month
2	Source fill rate	The percentage of requests that can be fulfilled by the distribution department = 68 %/ month
3	Number of meetings with project clients	Number of Purchasing meetings with main suppliers = 4 per year
		Source: Responsiveness
4	Purchase order cycle time	The time required to issue a purchase order = 60 days
5	Source Responsiveness	The time needed to find a replacement supplier if the first supplier cannot meet demand = 5 days
6	Source Flexibility	The number of suppliers who can be used as replacement suppliers if the first supplier cannot meet demand = 1 supplier
		Source: Green Supply Chain & Green Distribution
7	% of suppliers with an EMS or ISO 14001 certification	$\frac{\text{No. of suppliers who meet the criteria Gr. Supply Chain}}{\text{Total suppliers registered by the company}} \times 100\%$ (15 suppliers/17 suppliers) × 100% = 88,23 %
		Make: Reliability
1	% failure in process	$\frac{\text{Number of defective units}}{\text{Number of units produced}} \times 100\%$ (1,400 vials /70,000 vials) × 100% = 2 % per production batch
2	Machine material efficiency	$\frac{\text{No. of products processed x standard production cycle time}}{\text{Machine operating time}} \times 100\%$ ((68,600 vials x 0,4 seconds)/28,800 seconds) × 100% = 95,27 % per production batch
		Make: Green Supply Chain
3	% hazardous material	$\frac{\text{The amount of hazardous materials used in the production process}}{\text{Total materials used}} \times 100\%$ (200 kg/1,700 kg) × 100% = 11,7 % per year
4	% Material that is biodegradable	$\frac{\text{No. of biodegradable material used in the production process}}{\text{Total materials used}} \times 100\%$ (20 tons / 24 tons) × 100% = 83,33 % per year
5	Waste produced as % of product produced	$\frac{\text{Weight of waste produced (liquid, solid)}}{\text{Weight of finished product produced}} \times 100\%$ (127.60 tons/200 tons) × 100% = 63,8 % per year
6	% of recyclable/ reusable materials	$\frac{\text{The amount of material that can be recycled}}{\text{Total materials used}} \times 100\%$ (20 tons/23 tons) × 100% = 86,9 % per year
		Deliver: Reliability
1	Fill Rate	$\frac{\text{Number of products released}}{\text{Total product}} \times 100\%$ (11.08 mio doses/16.80 mio doses) × 100% = 65,9 % per month
2	Number of visit to customer	Number of visits to customers for sales promotion of polio vaccine = 2 per month
		Deliver: Responsiveness
3	Delivery to domestic customers	Lead time for distribution of polio vaccine to dometic customers = 14 days per order
4	Delivery to overseas customers	Lead time for distribution of polio vaccine to overseas customers = 14 days per order
		Deliver: Green Distribution
5	% of vehicle fuel derived from alternative fuels (%/year)	$\frac{\text{The amount of gas emissions reduced}}{\text{Total emissions produced before using environmentally friendly fuel}} \times 100\%$ (470.32 metric tons CO_2 per year/4,703,244 metric tons CO_2 per year) × 100% = 10 %
Return: Reliability		
1	Customer complaints	1 time per year
2	Return rate from PT. Bio Farma to supplier	$\frac{\text{Number of units returned}}{\text{Number of units received}} \times 100\%$ (0 unit/5490 units) × 100% = 0 %
Return: Responsiveness		
3	Project Client Repaired Time	60 days

No	Metrics Measurement	Formula & Actual value
4	Product replacement time	60 days
	Return: Green Distribution	
5	% of complaint regarding missing environmental requirements from product	$\frac{\text{Number of customer complaints related to environmental issues}}{\text{Total customer complaints}} \times 100\%$ (0/15) × 100% = 0% per year

4.2 Normalized Calculation of the Actual Value of Green Distribution and Green Supply Chain Performance

The next step is to normalize the value for green distribution and supply chain performance. Normalization is needed to equalize the value unit of each metric to a scale of 100. The formula used to normalize the actual value (Snorm) is:

$$S_{norm} = \frac{S_i - S_{min}}{(S_{max} - S_{min})} \times 100 \quad (1)$$

An example of normalization calculation for *Source fill rate* is as follows:

$$\text{Snorm} = \frac{85\text{-}65}{(95\text{-}65)} \times 100 = 66{,}6$$

Table 2 shows the results of normalizing the actual values associated with the worst and best scores for each dimension and metric for the Plan key process.

Table 2

Normalized Value of Plan Performance Metrics

Dimension	No	Metrics	Actual Value (Si)	Worst Score (Smin)	Best Score (Smax)	Score (Snorm)
Reliability	1.	Defect rate	0.01	5	0	99.8
	2.	Source fill rate	85	65	95	66.6
	3.	Number of meetings with Project Client	4	2	4	100
Responsiveness	4.	Purchase order cycle time	60	65	60	100
	5.	Source Responsiveness	5	10	2	62.5
Flexibility	6.	Source Flexibility	1	0	3	33.3
Environmental aspects	7.	% of Suppliers with an EMS or ISO 14001 certification	88.23	76.4	88.23	100

Table 3 shows the results of normalizing the actual values associated with each dimension's worst and best scores and metrics for the Make key process.

Table 3

Normalized Value of Make Performance Metrics

Dimension	No	Metrics	Actual Value (Si)	Worst Score (Smin)	Best Score (Smax)	Score (Snorm)
Reliability	1.	% Failure in Process	2	10	1	88.8
	2.	Machine Material Efficiency	95.27	0	97.2	98.01
Environmental aspects	3.	% of hazardous material	11.7	17.6	11.7	100
	4.	% Materials that are Biodegradable	83.33	0	83.33	100
	5.	Energy use	4,871,888	7,862,631	4,871,888	100
	6.	Water usage	5,000	7,300	5,000	100
	7.	Waste produced as % of product produced	63.8	100	63.8	100
	8.	% of recyclable/ reusable materials	86.9	0	86.9	100

Table 4 shows the results of normalizing the actual values associated with the worst and best scores for each dimension and metric for the Deliver key process.

Table 4

Normalized Value of Deliver Performance Metrics

Dimension	No	Metrics	Actual Value (Si)	Worst Score (Smin)	Best Score (Smax)	Score (Snorm)
Reliability	1	Fill rate	83	79	90	36.36
	2	Number of visits to customer	2	1	2	100
Responsiveness	3	Delivery to domestic customers	14	21	5	43.75
	4	Delivery to overseas customers	14	21	5	43.75
Environmental aspects	5	% of vehicle fuel emission derived from alternative fuels	10	0	10	100

Table 5 shows the results of normalizing the actual values associated with the worst and best scores for each dimension and the metrics for the return key process.

Table 5
Normalized Value of Return Performance Metrics

Dimension	No	Metrics	Actual Value (Si)	Worst Score (Smin)	Best Score (Smax)	Score (Snorm)
Reliability	1	Customer complain	1	2	0	50
	2	Return rate from PT Bio Farma to supplier	0	2	0	100
Responsiveness	3	Project Client Repaired Time	60	90	30	50
	4	Product replacement time	30	90	30	100
Environmental aspects	5	% of complaint regarding missing environmental requirenments from product	0	1	0	100

4.3 Weighting of importance levels 1 and 2 with Analytical Hierarchy Process (AHP)

The experts selected to consider the level of importance are the polio vaccine manager, the production manager, the marketing manager, and the distribution manager. These four respondents will complete a set of questionnaires from the pairwise comparison matrix for each level. The level of importance weighting for level one is done by pairwise comparing the key elements of plan, source, make, deliver, and return. The results of the level-one pairwise comparison are shown in Fig. 1.

	Plan	Source	Make	Delivery	Return
Plan		1.41421	1.86121	1.18921	3.13017
Source			1.0	1.10668	3.30975
Make				2.21336	2.05977
Delivery					2.0
Return	Inconsistency = 0.03 with 0 missing judgements.				

Fig. 1. Compare the relative importance with respect to: Goal; Distribution and Supply Chain Performance for Polio Vaccine at PT Bio Farma

Based on Fig. 1, the results of pairwise comparisons at level one are consistent because the inconsistency ratio (0.03) value is less than 0.1. Meanwhile, the results of weighting each key element are shown in Fig. 2.

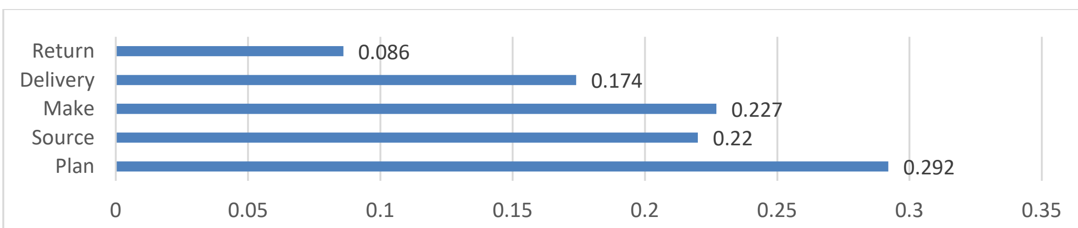


Fig. 2. Weighting value for each key element of the Green SCOR matrix level one

In the same way, the calculation of the level two weights can be done, and the results of the weights are used to calculate the final value of the performance of each dimension of Green Distribution and Green Supply Chain, which is presented in Table 6.

Table 6
Calculation of the final value for each measurement dimension

Supply Chain key elements (level 1)	No	Measurement dimensions (level 2)	Score (S)	Level 2 weight (LW)	Total Score (SxLW)	Total Score for each supply chain key element
Plan	1.	Reliability	51.62	0.367	18.94	
	2.	Responsiveness	100	0.389	38.9	
	3.	Environmental aspects	84.95	0.245	20.81	78.65
Source	4.	Reliability	88.56	0.189	16.73	
	5.	Responsiveness	81.25	0.375	30.46	
	6.	Flexibility	33.30	0.231	7.69	75.48
	7.	Environmental aspects	100	0.206	20.60	
Make	8.	Reliability	93.01	0.689	64,08	
	9.	Environmental aspects	99.06	0.311	30,8	94.88
Deliver	10.	Reliability	68.18	0.259	17.65	
	11.	Responsiveness	43.74	0.482	21.07	64.62
	12.	Environmental aspects	100	0.259	25.90	
Return	13.	Reliability	75	0.340	25.50	
	14.	Responsiveness	75	0.364	27.30	82.40
	15.	Environmental aspects	100	0.296	29.60	

In the final step, the total performance value for Green Distribution and Green Supply Chain is calculated and presented in Table 7.

Table 7

Total Performance Value for Green Distribution and Green Supply chain

No	Supply Chain key elements (level 1)	Total Score for each supply chain key (TS)	Level 1 weight (LW)	Performance (TSxLW)
1.	Plan	78.65	0.292	22.96
2.	Source	75.48	0.220	16.60
3.	Make	94.88	0.227	21.53
4.	Deliver	64.62	0.174	11.24
5.	Return	82.40	0.086	7.08
Total Performance Value				**79.41**

Based on Table 7, the total performance score for Green Distribution and Green Supply Chain for polio vaccine products is 79.41. According to the APICS standard (APICS, 2017), this overall performance is categorized as "Good." However, this performance can be improved to "Excellent" by improving the key elements and dimensions of the supply chain. The performance improvement can be known by comparing the results of the weighted values of the Green SCOR level one metric element for Plan, Source, Make, Delivery, and Return (Panpatil, Lahane, et al., 2023).

Level 1 metrics are aggregated assessments of Level 2 metrics, and Level 2 metrics are aggregated assessments of Level 3 metrics. Thus, the process of measuring green distribution and green supply chain performance begins with the measurement of processes at the lowest level (Level 3). From the analysis results, the constraints and inefficiencies of the process in the supply chain of polio vaccine products at PT Bio Farma were described, which impact the overall performance assessment. By resolving the constraints and inefficiencies that occur, performance can be improved. The problem was solved using the best practices approach in SCOR version 10.0. Best practices were selected based on the location of Green SCOR Level 2 metric inefficiencies and constraints in the material flow of the polio vaccine supply chain. The proposed best practice is then adapted to the polio vaccine distribution and supply chain conditions at PT Bio Farma as follows:

1. Collaborative planning best practices emphasize the importance of collaborative planning among strategic operations teams. This form of planning can improve the performance of the reliability and flexibility matrices of distribution and supply chains.
2. Best Practice Partnership, which emphasizes the importance of building long-term, trust-based relationships with suppliers and customers. This relationship can increase information transparency, support collaborative planning activities, and avoid PT Bio Farma's insider intervention in passing suppliers who still need to meet the requirements and commitments specified by PT Bio Farma.
3. Best practice transportation management, emphasizing distribution planning so that it can take place optimally and effectively. Transportation management consists of several stages: route planning, route optimization, optimized shipment, and carrier selection.
4. Best practice development of enterprise information system facilitates the implementation of production planning and can integrate existing information in the company. This information is useful for accelerating the order management process, which could have been more effective. At the time of the research process at PT Bio Farma, the development of the Enterprise Information System had just begun and would be applied through the ERP application.

Table 8 details the improvements in Green Distribution and Green Supply Chain performance in key areas.

Table 8

Best Practice Green SCOR to improve the performance of Green Distribution and Green Supply Chain of Polio Vaccine at PT. Bio Farma

Proses Green SCOR	Best Practice
Plan	1. Minimize the use of energy and hazardous materials 2. Maintain an environmentally friendly product policy 3. Properly handle and store hazardous materials to avoid environmental impact.
Source	1. Gain access to supplier environmental management reports and compliance data. 2. Collaborate with suppliers on environmental issues to help implement environmental requirements and sustainable business processes. 3. Improve the energy efficiency of lighting and production support systems by efficiently designing warehouse buildings and production areas.
Make	1. Routine measurement of air emissions at the end of each production process. 2. Obtain material data sheet system information for raw material handling from suppliers. 3. Conduct routine daily inspections of hazardous waste storage areas. 4. Conduct benchmarking against similar companies with better environmental management quality. 5. Production planning to minimize energy consumption.
Deliver	1. Reduce the use of packaging. 2. Perform distribution optimization so that it is optimal and effective, consisting of route planning, route optimization, optimized shipment, and carrier selection to increase the efficiency of vehicle fuel use. 3. Selecting a distribution company with no history of environmental violations. 4. Use environmentally friendly alternative fuels in vehicles.
Return	Maximize backhaul capacity to reduce excess fuel consumption.

Our study recommends that the distribution and logistics managers of PT Bio Farma should make improvements according to Table 8 to achieve the future green distribution goal. In addition, by making improvements according to the researcher's recommendations, competitive advantage, cost savings, sustainable use of resources, reduced carbon footprint, compliance with government regulations, and improved corporate image will be achieved (Chopra et al., 2022; S. A. Khan et al., 2020). We also recommend that managers continuously measure and evaluate the performance improvement of green distribution and supply chain to ensure achieving performance goals for polio vaccine distribution in Indonesia.

5. Conclusion

The researchers have devised the SCOR metrics, which have proven to be effective in evaluating the performance of green distribution and the green supply chain, resulting in a "Good" rating. To enhance future green distribution performance, it is recommended that collaborative planning be undertaken by strategic operations teams to ensure flexibility. Additionally, the company should place importance on establishing strong partnerships based on trust with suppliers and customers, optimizing green transportation to determine the most efficient distribution routes, and integrating systems with supply chain partners. Further investigations could be carried out to encompass the financial aspects of the company, thereby providing a more comprehensive understanding of its green distribution and green supply chain performance.

References

APICS. (2017). Supply Chain Operations Reference Model - SCOR Version 12.0. *Supply Chain Operations Management*.

APICS Supply Chain Council. (2017). APICS Supply Chain Operations Reference Model (SCOR). In *Supply Chain Operations Management*.

Bulsara, H. P., Qureshi, M. N., & Patel, H. (2016). Green supply chain performance measurement: An exploratory study. *International Journal of Logistics Systems and Management*, *23*(4). https://doi.org/10.1504/IJLSM.2016.075210

Cazeri, G. T., Anholon, R., Ordoñez, R. E. C., & Novaski, O. (2017). Performance measurement of green supply chain management: a literature review and gaps for further research. *Brazilian Journal of Operations & Production Management*, *14*(1). https://doi.org/10.14488/bjopm.2017.v14.n1.a7

Chopra, A., Golwala, D., & Chopra, A. R. (2022). SCOR (Supply Chain Operations Reference) model in textile industry. *Journal of Southwest Jiaotong University*, *57*(1). https://doi.org/10.35741/issn.0258-2724.57.1.33

Cvirik, M., & Daneshjo, N. (2022). The Construction of the Green Distribution Model and its Application on Consumers Perception. *Management and Production Engineering Review*, *13*(2). https://doi.org/10.24425/mper.2022.142056

Dzikriansyah, M. A., Masudin, I., Zulfikarijah, F., Jihadi, M., & Jatmiko, R. D. (2023). The role of green supply chain management practices on environmental performance: A case of Indonesian small and medium enterprises. *Cleaner Logistics and Supply Chain*, *6*. https://doi.org/10.1016/j.clscn.2023.100100

Fahmy, K., Hampton, L. M., Langar, H., Patel, M., Mir, T., Soloman, C., Hasman, A., Yusuf, N., & Teleb, N. (2017). Introduction of Inactivated Polio Vaccine, Withdrawal of Type 2 Oral Polio Vaccine, and Routine Immunization Strengthening in the Eastern Mediterranean Region. *Journal of Infectious Diseases*, *216*. https://doi.org/10.1093/infdis/jix133

Holmes, M., Abimbola, T., Lusiana, M., Pallas, S., Hampton, L. M., Widyastuti, R., Muas, I., Karlina, K., & Kosen, S. (2017). Resource Needs for the Trivalent Oral Polio to Bivalent Oral Polio Vaccine Switch in Indonesia. *Journal of Infectious Diseases*, *216*. https://doi.org/10.1093/infdis/jix073

Huang, S. H., & Keskar, H. (2007). Comprehensive and configurable metrics for supplier selection. *International Journal of Production Economics*, *105*(2). https://doi.org/10.1016/j.ijpe.2006.04.020

Jin, Q., Raza, S. H., Yousaf, M., Munawar, R., Shah, A. A., Hassan, S., Shaikh, R. S., & Ogadimma, E. C. (2022). Ingraining Polio Vaccine Acceptance through Public Service Advertisements in the Digital Era: The Moderating Role of Misinformation, Disinformation, Fake News, and Religious Fatalism. *Vaccines*, *10*(10). https://doi.org/10.3390/vaccines10101733

Kementerian Kesehatan Republik Indonesia. (2020). Buletin Surveilans PD3I dan Imunisasi. *Dirjen P2P Kementrian Kesehatan RI*, *3*.

Khan, M., Ajmal, M. M., Jabeen, F., Talwar, S., & Dhir, A. (2023). Green supply chain management in manufacturing firms: A resource-based viewpoint. *Business Strategy and the Environment*, *32*(4). https://doi.org/10.1002/bse.3207

Khan, S. A., Chaabane, A., & Dweiri, F. (2020). Supply chain performance measurement systems: A qualitative review and proposed conceptual framework. In *International Journal of Industrial and Systems Engineering* (Vol. 34, Issue 1). https://doi.org/10.1504/IJISE.2020.104315

Kumar, S., Chattopadhyaya, S., & Sharma, V. (2012). Green Supply Chain Management : A Case Study from Indian Electrical and Electronics Industry. *International Journal of Soft Computing and Engineering*, *1*(6).

Li, G., Guo, Y., Jiang, H., Kong, L., Zhou, Y., & Wang, W. (2023). Green ship evaluation based on improved AHP-FCE-ODM model from the perspective of shipbuilding supply chain. *International Journal of Logistics Research and Applications*. https://doi.org/10.1080/13675567.2023.2213659

Mahmud, P., Ahmed, M., Janan, F., Xames, M. D., & Chowdhury, N. R. (2023). Strategies to develop a sustainable and resilient vaccine supply chain in the context of a developing economy. *Socio-Economic Planning Sciences*, *87*. https://doi.org/10.1016/j.seps.2023.101616

Muduli, K. kanta, Luthra, S., Kumar Mangla, S., Jabbour, C. J. C., Aich, S., & de Guimarães, J. C. F. (2020). Environmental management and the "soft side" of organisations: Discovering the most relevant behavioural factors in green supply chains. *Business Strategy and the Environment*, *29*(4). https://doi.org/10.1002/bse.2459

Nie, X., & Zhang, K. (2023). Design of Fast Green Distribution Route Based on Greedy Algorithm. *Journal of Advanced Computational Intelligence and Intelligent Informatics*, *27*(2). https://doi.org/10.20965/jaciii.2023.p0143

Panpatil, S. S., Lahane, S., & Kant, R. (2023). Performance measurement framework of green supply chain implementation in the context of Indian manufacturing organizations. *Journal of Advances in Management Research*, *20*(4). https://doi.org/10.1108/JAMR-08-2022-0174

Panpatil, S. S., Prajapati, H., & Kant, R. (2023). Analysing a GSCM Enabler–Based Model for Implementation of Its Practices: a Pythagorean Fuzzy AHP and CoCoSo Approach. *Process Integration and Optimization for Sustainability*, *7*(3). https://doi.org/10.1007/s41660-022-00289-5

Passetti, E., Cinquini, L., & Tenucci, A. (2018). Implementing internal environmental management and voluntary environmental disclosure: Does organisational change happen. *Accounting, Auditing and Accountability Journal*, *31*(4). https://doi.org/10.1108/AAAJ-02-2016-2406

Prayogi, R., & Wandebori, H. (2020). Proposed Strategy for Pharmaceutical Industry (Case Study: PT Bio Farma Persero). *European Journal of Business and Management Research*, *5*(5). https://doi.org/10.24018/ejbmr.2020.5.5.457

Pulansari, F., & Putri, A. (2020). Green Supply Chain Operation Reference (Green SCOR) Performance Evaluation (Case Study: Steel Company). *Journal of Physics: Conference Series*, *1569*(3). https://doi.org/10.1088/1742-6596/1569/3/032006

Qianhan, X., Jing, W., & Rongyan, Z. (2010). Notice of Retraction: Research on green supply chain management for manufacturing enterprises based on green SCOR model. In *CCTAE 2010 - 2010 International Conference on Computer and Communication Technologies in Agriculture Engineering* (Vol. 2). https://doi.org/10.1109/CCTAE.2010.5544189

Rosyidah, M., Khoirunnisa, N., Rofiatin, U., Asnah, A., Andiyan, A., & Sari, D. (2022). Measurement of key performance indicator Green Supply Chain Management (GSCM) in palm industry with green SCOR model. *Materials Today: Proceedings*, *63*. https://doi.org/10.1016/j.matpr.2022.03.158

Saen, R. F., & Izadikhah, M. (2022). A novel SCOR approach to assess the sustainability of supply chains. *Operations Management Research*. https://doi.org/10.1007/s12063-022-00331-2

Sharma, V., Raut, R. D., Mangla, S. K., Narkhede, B. E., Luthra, S., & Gokhale, R. (2021). A systematic literature review to integrate lean, agile, resilient, green and sustainable paradigms in the supply chain management. *Business Strategy and the Environment*, *30*(2). https://doi.org/10.1002/bse.2679

Srivastava, S. K. (2007). Green supply-chain management: A state-of-the-art literature review. In *International Journal of Management Reviews* (Vol. 9, Issue 1). https://doi.org/10.1111/j.1468-2370.2007.00202.x

Tseng, M. L., Islam, M. S., Karia, N., Fauzi, F. A., & Afrin, S. (2019). A literature review on green supply chain management: Trends and future challenges. In *Resources, Conservation and Recycling* (Vol. 141). https://doi.org/10.1016/j.resconrec.2018.10.009

Yadav, A. K., & Kumar, D. (2023). A LAG-based framework to overcome the challenges of the sustainable vaccine supply chain: an integrated BWM–MARCOS approach. *Journal of Humanitarian Logistics and Supply Chain Management*, *13*(2). https://doi.org/10.1108/JHLSCM-09-2021-0091

Yang, Z., Shang, W. L., Zhang, H., Garg, H., & Han, C. (2022). Assessing the green distribution transformer manufacturing process using a cloud-based q-rung orthopair fuzzy multi-criteria framework. *Applied Energy*, *311*. https://doi.org/10.1016/j.apenergy.2022.118687

Yildiz Çankaya, S., & Sezen, B. (2019). Effects of green supply chain management practices on sustainability performance. *Journal of Manufacturing Technology Management*, *30*(1). https://doi.org/10.1108/JMTM-03-2018-0099

Zhang, Y., & Liu, M. (2011). Research on Green supply chain design for automotive industry Based on Green SCOR Model. *Proceedings - 2011 4th International Conference on Information Management, Innovation Management and Industrial Engineering, ICIII 2011*, *2*. https://doi.org/10.1109/ICIII.2011.277

Zhou, Z. (2022). Green Supply Chain Management Model of e-Commerce Enterprises Based on SCOR Model. *Mobile Information Systems*, *2022*. https://doi.org/10.1155/2022/3191317

Zomahoun, D. J., Burman, A. L., Snider, C. J., Chauvin, C., Gardner, T., Lickness, J. S., Ahmed, J. A., Diop, O., Gerber, S., & Anand, A. (2021). Impact of COVID-19 Pandemic on Global Poliovirus Surveillance. *MMWR. Morbidity and Mortality Weekly Report*, *69*(5152). https://doi.org/10.15585/mmwr.mm695152a4