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Analysis of SCOR Model Implementation for Green Supply Chain Management Performance Measurement: Case Study of PT. Bali Towerindo Sentra Tbk in the Fiber-to-the-Home (FTTH) Internet Service Industry

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Abstract *- This research analyzes the implementation of the Supply Chain Operations Reference (SCOR) Model within the framework of Green Supply Chain Management (GSCM) at PT. Bali Towerindo Sentra Tbk, specifically for their Fiber to the Home (FTTH) services. The aim is to measure supply chain performance by considering environmental aspects, operational efficiency, and customer satisfaction. A quantitative approach is used, employing a survey method with internal and external respondents, supported by primary data through questionnaires and interviews, as well as secondary data from company reports. Performance measurement uses the five key dimensions of SCOR: reliability, responsiveness, agility, cost, and asset management, aligned with GSCM indicators such as waste reduction, energy efficiency, and the use of environmentally friendly technologies. The analysis shows that the implementation of GSCM through the SCOR Model improves process efficiency, accelerates response to market demand, and reduces environmental impact. The findings provide strategic implications for the telecommunications industry, particularly in building a sustainable and adaptive supply chain to meet digital challenges. The integrative application of SCOR-GSCM has proven relevant for enhancing competitiveness, complying with environmental regulations, and strengthening the company's image among customers and stakeholders.*

Keywords*: SCOR Model, Green Supply Chain Management, Supply Chain, Sustainability, Operational Efficiency, Environmental Sustainability.*

I. INTRODUCTION

In today's highly competitive global market, companies are continuously challenged to enhance their operational efficiency, product quality, and overall performance. Rapid technological advancements, evolving business environments, and increasingly complex consumer demands force organizations to adapt quickly and effectively. To remain competitive, companies must develop strategies and management systems that support both short-term and long-term objectives, while also addressing emerging issues such as environmental sustainability.

The telecommunications sector, with its pivotal role in supporting digital transformation and connectivity, faces distinct challenges related to supply chain management (SCM). PT. Bali Towerindo Sentra Tbk, a key player in Indonesia's telecommunications infrastructure, provides Fiber to the Home (FTTH) services that are central to the country's internet connectivity. However, the company faces significant challenges in streamlining its supply chain operations while integrating sustainable practices. This study aims to assess the application of the Supply Chain Operations Reference (SCOR) Model within the framework of Green Supply Chain Management (GSCM) to evaluate the performance of PT. Bali Towerindo Sentra Tbk's supply chain, particularly in the context of its FTTH services.

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Incorporating environmental sustainability into supply chain operations is no longer an optional consideration but a necessity, especially in industries such as telecommunications that have a large environmental footprint. The integration of green principles into SCM through GSCM can significantly reduce environmental impacts while optimizing cost efficiency, improving customer satisfaction, and enhancing operational performance. This study will focus on how the SCOR Model can be employed to measure and enhance PT. Bali Towerindo Sentra Tbk's SCM performance while ensuring alignment with environmental sustainability goals.

Supply Chain Management (SCM) is a critical aspect of modern business operations, as it involves the management of the flow of goods and services from the point of origin to the end customer. According to Chopra and Meindl (2016), SCM encompasses all activities involved in sourcing, procurement, conversion, and logistics management. Effective SCM ensures that goods are produced and distributed to the right locations in the right quantities, minimizing costs and maximizing customer satisfaction.

One of the key elements of SCM is its ability to adapt to changing market conditions and customer demands. In the context of telecommunications, this becomes particularly challenging due to the technological innovations and rapid market shifts that characterize the industry. Thus, telecom companies must continuously improve their SCM systems to maintain competitive advantage and operational efficiency.

Green Supply Chain Management (GSCM) integrates environmental concerns into SCM practices, aiming to reduce the environmental impact of supply chain activities. Srivastava (2007) defines GSCM as the inclusion of environmental thinking in supply chain management, from product design to end-of-life product management. The goal of GSCM is to ensure that operations not only meet customer needs but also minimize resource consumption and environmental damage.

The application of GSCM practices includes reducing waste, conserving energy, and using sustainable materials. These practices are increasingly important in industries like telecommunications, where energy consumption and waste production can be significant. Companies that adopt GSCM not only improve their environmental performance but also enhance their brand image, attract eco-conscious consumers, and achieve cost savings through better resource utilization.

The SCOR Model (Supply Chain Operations Reference Model) is a widely recognized framework used to assess and improve supply chain performance. According to the Supply Chain Council (2012), the SCOR Model provides a structured approach to measuring supply chain efficiency by evaluating five key performance attributes: Plan, Source, Make, Deliver, and Return. These attributes help companies assess the effectiveness of their supply chain activities and identify areas for improvement.

The SCOR Model offers a detailed set of metrics that allow companies to benchmark their performance against industry standards. In the case of PT. Bali Towerindo Sentra Tbk, the SCOR Model can help analyze the efficiency of its FTTH service delivery, identifying inefficiencies in areas like order fulfillment, cycle time, and cost management. Furthermore, by integrating GSCM into the SCOR Model, companies can measure their environmental performance alongside traditional supply chain metrics, offering a more comprehensive view of their operational sustainability.

Several studies have explored the integration of SCM, GSCM, and the SCOR Model in various industries, including telecommunications. For example, a study by Nair et al. (2013) in the telecom industry found that adopting GSCM practices improved not only environmental performance but also customer satisfaction and supply chain responsiveness. This study highlights the potential benefits of implementing both SCM and GSCM, which can lead to more efficient and sustainable supply chain operations.

In another study, Zhang et al. (2018) applied the SCOR Model to assess the performance of the telecommunications sector in China. The study found that while traditional SCM practices were widely implemented, there was significant room for improvement in terms of environmental sustainability. This reinforces the need for integrating GSCM into SCM practices to create more resilient and sustainable supply chains.

A more recent study by Lee et al. (2020) explored how the SCOR Model, combined with GSCM, can be used to measure and optimize the supply chain performance of telecom companies. The study emphasized the importance of adapting the SCOR Model to incorporate sustainability metrics, which can lead to improved operational efficiency and reduced environmental impact. This aligns with the goals of the current research, which seeks to assess PT. Bali Towerindo Sentra Tbk's supply chain through the lens of both the SCOR Model and GSCM.

The telecommunications industry has a significant environmental footprint due to the energy-intensive nature of its infrastructure and operations. According to Deloitte (2017), telecom companies are among the largest consumers of energy and are responsible for a considerable amount of electronic waste. Therefore,

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adopting GSCM practices is not only important for reducing environmental impact but also for complying with increasing regulatory pressures on sustainability.

Moreover, telecom companies that integrate GSCM into their SCM strategies can achieve cost savings through energy efficiency and waste reduction. For example, adopting energy-efficient technologies in network infrastructure and recycling electronic waste can lead to substantial long-term savings, while simultaneously improving the company's reputation as a socially responsible business.

The conceptual framework for this study combines elements from SCM, GSCM, and the SCOR Model. The study posits that integrating GSCM principles into SCM practices, through the use of the SCOR Model, will enhance the sustainability and efficiency of PT. Bali Towerindo Sentra Tbk's supply chain. The research framework includes the following key components:

1. **SCM Performance**: Measured using the SCOR Model's five key performance attributes Plan, Source, Make, Deliver, and Return.
2. **Environmental Sustainability**: Assessed through GSCM practices, including waste reduction, energy efficiency, and sustainable material sourcing.
3. **Integration of GSCM and SCOR Model**: Evaluating how GSCM principles can be incorporated into the SCOR Model to optimize both environmental performance and supply chain efficiency.

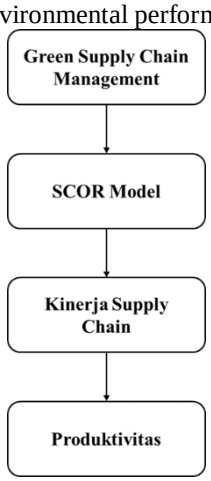

Figure 1. Conceptual Framework

II. METHOD

The data collection method combines primary and secondary data to ensure comprehensive and relevant information for the study. Primary data is collected from employee performance records, including stock opname and FOP data from PT. Bali Towerindo Sentra Tbk.'s Cable Installation Division (IKR), covering 71 employees for the period 2020-2023. Secondary data is gathered through documentary study, including internal documents like FTTH Sales Order data (2020-2023), supply chain performance reports, SOPs, and GSCM policies, as well as literature study from academic sources on Green Supply Chain Management and the SCOR Model. The data analysis utilizes the SCOR Model with five key metrics: Perfect Order Fulfillment (POF), Order Fulfillment Cycle Time (OFCT), Total Cost to Serve (TCTS), Cost of Goods Sold (COGS), and Cash-to-Cash Cycle Time (CTCCT), which evaluate the supply chain's reliability, responsiveness, cost efficiency, and agility. Benchmarking compares PT. Bali Towerindo Sentra's performance to SCOR standards, helping determine whether the performance is Superior, Advantage, Parity, or Lagging. Gap analysis identifies discrepancies between actual and expected performance, while employee productivity analysis evaluates job completion rates, returns, and efficiency in FTTH installation.

III. RESULT AND DISCUSSION

A. Result

Level 1 (Business Objective)

The data analysis using the SCOR Model reveals several key findings regarding the performance of PT. Bali Towerindo Sentra, Tbk's supply chain from 2020 to 2023.

Table 1. Achievement of POF at PT Bali Towerindo Sentra, Tbk from 2020 to 2023

Year	Uninstalled Units	POF (%)	Non-Achievement (%)	Analysis of Non-Achievement Causes
2020	4,368	85.3%	14.7%	- Limited field technicians - Coordination issues with customers - Logistical constraints of installation materials
2021	2,558	88.6%	11.4%	- Impact of mobility restrictions (PPKM) - Incorrect customer address data - Permit and installation site access issues
2022	3,362	86.4%	13.6%	- Insufficient stock of ONT devices - Shortage of technical personnel - Lack of training for new technicians
2023	5,107	84.0%	16.0%	- Sharp increase in demand - High rework rate due to initial mistakes - Disruptions in material distribution

Source: Processed Sales Order Data by Researcher. (2025)

The average POF over the period was 86.1%, with a target of 95%. The performance gap shows that the company is not meeting its target, largely due to issues such as technician limitations, logistical disruptions, and external factors like the pandemic.

Table 2 OFCT Values at PT Bali Towerindo Sentra, Tbk from 2020 to 2023

Year	Sales Order	Installed	OFCT Target (Days)	Average Realized Days	OFCT Performance (%)	Causes of Non-Achievement
2020	29,588	25,248	≤30 days	43	69.8%	- Limited technicians - Manual processes - External disruptions
2021	22,594	19,936	≤30 days	41	73.2%	- PPKM adjustments - Slow logistics - Limited capacity
2022	24,791	20,980	≤30 days	39	76.9%	- Increased demand - Scheduling system not optimal
2023	31,928	23,356	≤30 days	38	73.2%	- High rework rate - Installation queue - Field issues

Source: Processed Sales Order Data by Researcher. (2025)

The average OFCT over 2020-2023 was 65 days, which far exceeds the target of 7 days. Factors contributing to this discrepancy include technician shortages, scheduling issues, and rework during installations. This gap indicates that significant improvements are needed in the company's operational processes.

Table 3 COGS at PT Bali Towerindo Sentra, Tbk from 2020 to 2023

Year	COGS (%)	Ideal COGS Target (%)	Difference (%)	Causes of Non-Achievement
2020	66.50%	60%	6.50%	High costs in materials and initial installations
2021	65.40%	60%	5.40%	Increased operational costs post-pandemic
2022	67.80%	60%	7.80%	Vendor and raw material price increases
2023	65.00%	60%	5.00%	Efficiency not yet optimized in procurement and logistics

Source: Processed Sales Order Data by Researcher. (2025)

The average COGS was 66.2%, which is higher than the target of 60%. The reasons for this overrun include increased material and installation costs, as well as rising vendor prices.

There is a need for optimization in procurement and operational efficiency to meet the cost targets.

Table 4 Total Cost to Service at PT Bali Towerindo Sentra, Tbk from 2020 to 2023

Year	Total Order (IDR)	Total Actual (IDR)	Gap (IDR)	Causes of Non-Achievement
2020	38,640,680,000	33,050,700,000	5,589,980,000	Differences due to early operational inefficiencies and vendor price changes
2021	40,789,640,000	34,900,320,000	5,889,320,000	Inaccurate estimates of distribution and installation costs
2022	40,230,000,000	35,480,000,000	4,750,000,000	Actual costs increased due to higher logistics & labor costs
2023	39,797,433,200	33,056,992,500	6,740,440,700	Large gap due to high demand not matched by supply chain efficiency
Average	39,889,438,400	34,372,003,150	5,517,435,250	Significant average gap due to discrepancies between initial estimates and actual costs

Source: Processed Sales Order Data by Researcher. (2025)

The total actual cost exceeded the estimated cost by approximately Rp 5.5 billion annually, indicating inefficiencies in logistics and vendor management (Table 4.4). The gap is mainly due to increased logistics costs and unforeseen resource requirements.

Table 5 Cash to Cash Cycle Time at PT Bali Towerindo Sentra, Tbk from 2020 to 2023

Year	DIO	DSO	DPO	CTC (Days)	Target (Days)	Gap (Days)	Causes of Non-Achievement	Improvement Recommendations
2020	46	1500	32	1514	7	1507	Slow receivables collection, minimal aging control	Digitalize invoicing and tracking system
2021	52	1600	29	1623	7	1616	Delays in payments from large customers	Improve SLA and renegotiate payment terms
2022	53	1540	31	1562	7	1555	No automated reminder system	Implement ERP system and automate invoice reminders
2023	49	1556	28	1577	7	1570	Lack of analysis on receivables age & minimal follow-up	Train finance team & improve receivables monitoring
Average	50	1549	30	1569	7	1562		

Source: Processed Sales Order Data by Researcher. (2025)

The average CTCCT for 2020–2023 was 27 days, much longer than the target of 7 days. This reflects slow receivables collection and inefficient management of inventory and accounts payable.

Table 6 Actual Data at PT Bali Towerindo Sentra, Tbk from 2020 to 2023

No	Performance Attribute	Metric	Actual Data
1	Supply Chain Reliability	POF	86.1%
2	Supply Chain Responsiveness	OFCT	65 Days
3	Supply Chain Cost	TCTS	IDR 5,517,435,250
4		COGS	66.2%
5	Supply Chain Management	CTCCT	27 Days

Source: Processed Sales Order Data by Researcher. (2025)

Based on the evaluation of the actual performance against SCOR benchmarks, the company's supply chain performance largely falls into the "Below Parity" category across most metrics,

highlighting the need for improvements in efficiency, responsiveness, and cost management. The opportunity to improve POF, OFCT, and COGS indicates potential for enhanced customer satisfaction and profitability. The company needs to focus on streamlining processes, improving scheduling, optimizing procurement, and strengthening cash flow management to close the performance gaps and achieve superior supply chain performance.

Table 7 Gap and Opportunity

Metric	Benchmark	Actual Performance	Gap	Opportunity
Perfect Order Fulfillment (POF)	95% (Advantage)	68.1%	-26.9%	Improve customer satisfaction, reduce complaints and returns.
Order Fulfillment Cycle Time (OFCT)	7 days (Advantage)	65 days	+58 days	Accelerate order fulfillment process → improve service speed.
Total Cost to Serve (TCTS)	IDR 6 M (Average)	IDR 5,517,435,250	-	Optimize logistics costs to maintain margin and operational efficiency.
Cost of Goods Sold (COGS)	55% (Advantage)	66.2%	+11.2%	Production cost efficiency can improve profitability.
Cash to Cash Cycle Time (CTCCT)	15 days (Advantage)	27 days	+12 days	Reduce cash cycle → improve liquidity and capital turnover.

Source: Processed Sales Order Data by Researcher. (2025)

Summarizes the gap and opportunity analysis, showing the potential for significant improvements in customer satisfaction, operational efficiency, and profitability by meeting target performance levels.

Level 2 Mapping Results

In the Level 2 mapping, each core process within the SCOR model is broken down more specifically to show the supply chain processes at PT Bali Towerindo Sentra, Tbk. The SCOR model identifies three processes: Planning (P), Execution (E), and Enable (En), which support the transition between planning and execution. Level 2 mapping can be seen in a picture below:

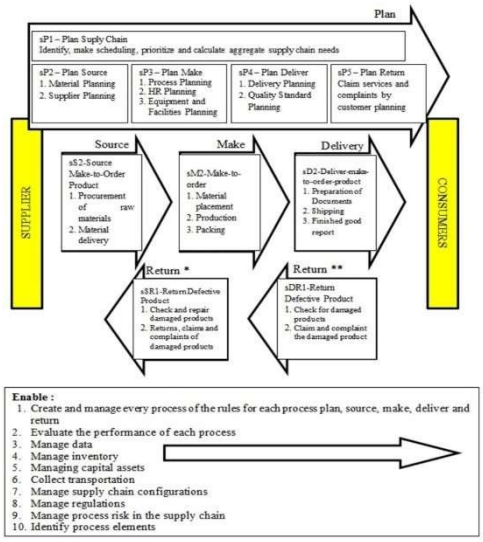

Figure 1. Supply Chain Level 2 Mapping

Below is the overview of these level 2 mapping processes:

1. **Planning (P)**
   The planning process at PT Bali Towerindo Sentra, Tbk has been effective. It includes planning the entire supply chain, which covers internet installation for customers, equipment and material needs, inventory management, installation scheduling, and customer service. The company has successfully balanced supply and demand, achieving its business objectives.
2. **Execution (E)**

The execution of SCOR processes is also performing well. The IKR FTTH department has efficiently scheduled daily installations, ensuring timely service provision as per customer expectations. The warehouse department ensures that the required materials and tools are available for installation, maintaining good customer relations.

3. **Enable (En)**
   PT Bali Towerindo Sentra, Tbk has an integrated information system that supports both planning and execution. The company uses a centralized system to connect employees, the company, and customers through a unified call center system.

Level 2 processes in the company's supply chain are mapped into 30 core process categories, as shown below:

Table 8 Level 2 Supply Chain Mapping

Level 2	Level 2 (Detailed Process)	Activity Description
Plan	P1.1 – Demand Planning	Forecast FTTH service demand based on customer trends.
	P1.2 – Supply Planning	Schedule suppliers for tools and network material.
	P1.3 – Capacity and Network Planning	Allocate human resources and network capacity for installations.
Make	M1.1 – Installation Preparation	Prepare technicians and tools for FTTH installation.
	M1.2 – Project Implementation	Install and activate services at customer homes.
	M1.3 – Testing and Validation	Test network speed, stability, and reporting.
Deliver	D1.1 – Customer Order Management	Receive and verify customer orders and locations.
	D1.2 – Service Delivery Scheduling	Schedule technicians based on customer availability.
	D1.3 – Material & Technician Distribution	Distribute equipment and deploy technicians to sites.
	D1.4 – Order Completion Confirmation	Report completed work and activate services.
Return	R1.1 – Handling Complaints & Returns	Handle service disruptions and cancellation requests.
	R1.2 – Re-inspection & Corrections	Re-diagnose technical issues and fix failed services.
Enable	E1.1 – Supply Chain HR Management	Train technicians and manage workload.
	E1.2 – Technology and Data Management	Monitor supply chain performance with dashboards and integrated systems.

Source: Processed by Researcher (2025)

The Planning processes (P1-P5) focus on managing demand, supply, production, delivery, and returns. The ensure that the company's resources and information systems support the overall supply chain operations.

The SCOR Level 2 processes include 12 execution types and 5 planning types that help manage material, production, and distribution. These processes are crucial for optimizing the supply chain performance, particularly in the telecommunications industry.

- **Planning**: The company has a well-structured supply chain plan, balancing customer demands with available resources.
- **Execution**: The execution processes are functioning effectively, with good scheduling and resource allocation.
- **Enable**: PT Bali Towerindo Sentra, Tbk's integrated system supports seamless communication and resource management.

Table 9 Gap and Opportunity Table

Metric	Deliver	Make	Source
POF (%)	86%	75.0%	64%
OFCT (Days)	60	<1	2

Source: Processed Sales Order Data by Researcher. (2025)

From the table above, it is clear that the Deliver process has the lowest performance with POF at 86% and OFCT at 60 days. This indicates issues with meeting customer expectations for delivery timeliness. The Make process has relatively better performance, with a POF of 75.1% and OFCT under 1 day. Source processes show a POF of 75.1% and OFCT of 2 days, indicating supplier efficiency.

The Deliver process, with lower POF and higher OFCT, is identified as a critical area for improvement. Delays in delivery can severely affect customer satisfaction and business objectives. Further analysis at Level 3 will explore the root causes and suggest solutions to improve this process.

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Level 3 Mapping Results (Delivery Process "Input, Process, Output")

Level 3 mapping focuses on analyzing the Delivery process, which showed the lowest performance in the Level 2 analysis. The mapping highlights the input, process elements, and outputs involved in PT Bali Towerindo Sentra, Tbk's delivery activities, as depicted in the current configuration (as-is process) diagram.

1. **DR.1 – Process Inquiry and Quote**
   - **Problem**: Slow responses to service requests due to lack of staff training, undocumented procedures, and outdated technology.
   - **Improvement Suggestion**: Regular sales staff training, development of a standardized quoting process, and upgrading to a digital quoting system.

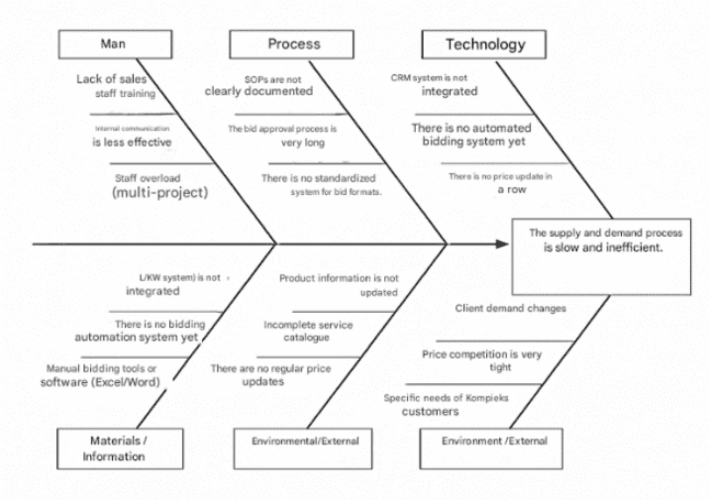

Figure 2. Fishbone Diagram for DR.1

2. **DR.2 – Receive, Enter, and Validate Order**
   - **Problem**: Manual order entry leads to errors and delays, directly affecting POF.
   - **Improvement Suggestion**: Strengthen data input oversight, revise SOP for order validation, and integrate ERP and ordering systems.

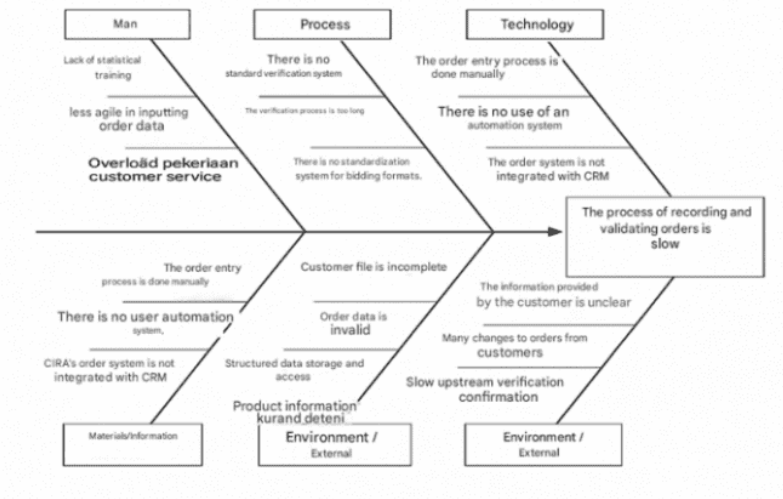

Figure 3. Fishbone Diagram for DR.2

3. **DR.3 – Reserve Inventory and Schedule Resources**
   - **Problem**: Poor coordination between inventory availability and technician schedules, caused by a lack of integrated systems.
   - **Improvement Suggestion**: Implement real-time inventory systems and improve scheduling integration.

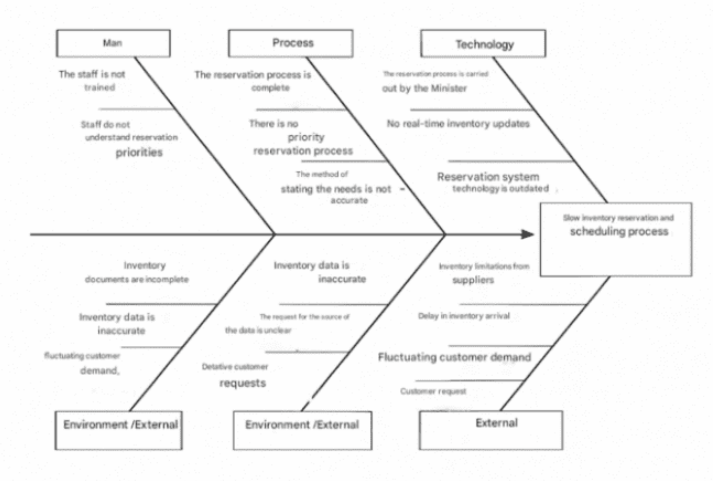

Figure 4. Fishbone Diagram for DR.3

4. **DR.4 – Consolidate Orders**
   - **Problem**: Inefficient order consolidation due to lack of real-time spatial data and dashboard distribution.
   - **Improvement Suggestion**: Implement ERP/logistics systems for real-time batch order consolidation, periodic evaluations of delivery efficiency.

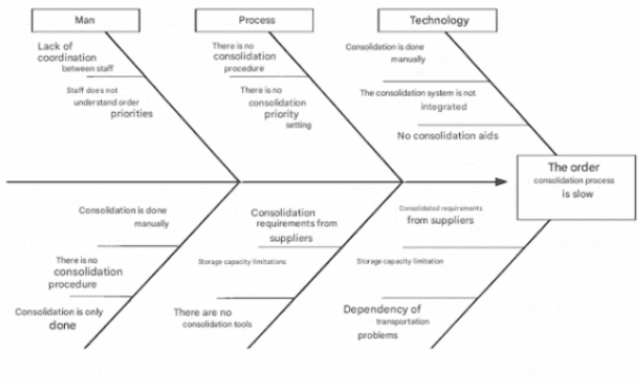

Figure 5. Fishbone Diagram for DR.4

5. **DR.5 – Ship Product**
   - **Problem**: Coordination issues between warehouses and field technicians lead to material shortages during installation.
   - **Improvement Suggestion**: Upgrade fleet management, improve internal communication, and introduce GPS tracking systems.

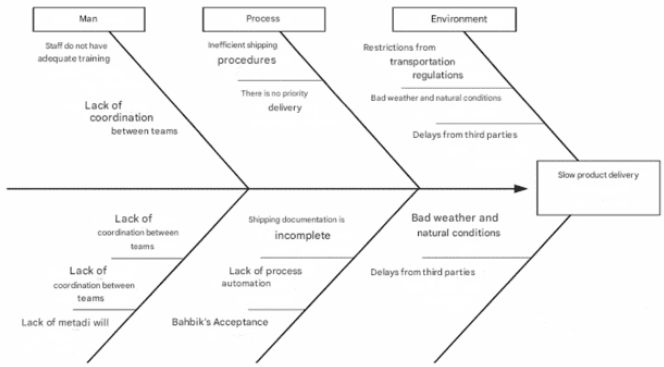

Figure 6. Fishbone Diagram for DR.5

6. **DR.6 – Install Product**
   - **Problem**: Delays in installation due to poor technician coordination, lack of SOP enforcement, and external site issues.
   - **Improvement Suggestion**: Regular technician training, SOP implementation, and location surveys prior to installation.

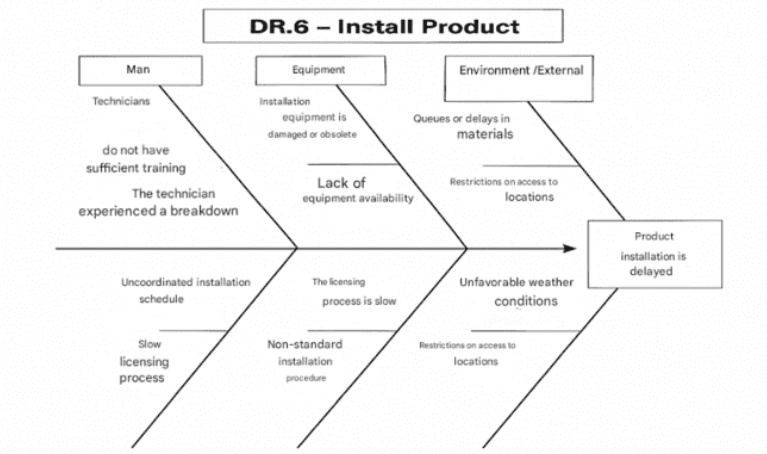

Figure 7. Fishbone Diagram for DR.6

7. **DR.7 – Invoice**
   - **Problem**: Delayed invoicing due to manual reporting from technicians and slow approval processes.
   - **Improvement Suggestion**: Automate invoicing, implement an e-invoice system, and conduct regular audits on billing data.

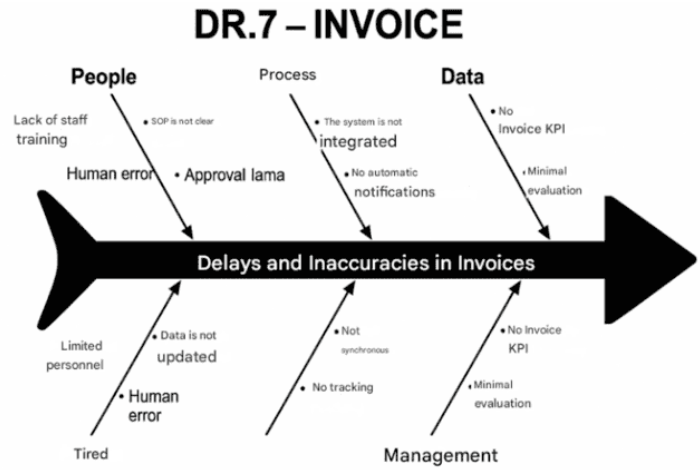

Figure 8. Fishbone Diagram for DR.7

From several problems that occurred in the Delivery section and the identification of the main causes of these problems, then continued with finding solutions that were implemented and approved by top management to be able to improve the process and performance of the supply chain of PT Bali Towerindo Sentra, Tbk located in Central Jakarta. Based on the results of level 3 mapping, the findings of the fishbone analysis can be summarized as follows:

Table 10 Fishbone Summary

No.	Problem in IKR/FTTH	Root Causes	Suggested Improvements
1	Slow or inaccurate quotations	Lack of training, undocumented procedures, slow systems	Regular sales staff training, standardize the process, and digitalize quoting system
2	Slow order validation	Human error, inefficient SOP, lack of ERP integration	Strengthen oversight, revise SOP, integrate ERP and ordering systems
3	Scheduling and stock	Real-time data unavailable, poor	Implement real-time inventory systems,

No.	Problem in IKR/FTTH	Root Causes	Suggested Improvements
	mismatch	interdepartmental coordination	improve scheduling
4	Inefficient order consolidation	No automated system, manual and slow process	Implement digital batch order system, evaluate delivery efficiency
5	Product shipment delays	Logistics fleet issues, poor coordination	Update fleet, improve internal communication, add GPS tracking
6	Delayed installations	Inexperienced technicians, ineffective SOPs, access issues	Regular training, SOP enforcement, pre-installation site surveys
7	Delayed/inaccurate invoicing	Manual reporting, lack of SOPs, no automation	Automate invoicing, e-invoice system, audit billing data

Source: Processed by Researcher (2025)

The Delivery process, particularly in DR.3 (scheduling and resource management) and DR.6 (installation), exhibits significant inefficiencies. Key improvements include digitalizing systems, enhancing staff training, and better system integration across departments. Addressing these issues will reduce OFCT and improve the overall supply chain efficiency at PT Bali Towerindo Sentra, Tbk.

Improvement Suggestions Based on Fishbone Analysis

Based on the root cause identification analysis using the Fishbone (Ishikawa) diagram, several issues in the supply chain process, particularly in the FTTH Service Installation at PT Bali Towerindo Sentra Tbk, were identified. These issues stem from six main categories (6M): Man, Method, Machine, Material, Measurement, and Environment. The problems were grouped and analyzed according to the SCOR Model's five main processes: Plan, Make, Deliver, Return, and Enable.

This systematic approach helps the company identify critical points in the supply chain and design targeted solutions. Below is the table summarizing the improvement suggestions based on the Fishbone analysis and SCOR Model framework.

Table 11 Fishbone Analysis Improvement Suggestions

Process (SCOR)	Problem	Fishbone Category (6M)	Root Cause	Improvement Suggestions
Plan	Inaccurate material requirement planning	Method	No historical data-based planning	Use a forecasting system based on historical data and AI-based demand planning
Make	Delayed FTTH installation	Man	Lack of trained technicians	Recruit new technicians and provide regular intensive training
Deliver	Delayed product delivery to location	Material	Product stock not available in the warehouse	Implement safety stock and automatic reorder point in the inventory system
Deliver	Lack of real-time delivery status updates	Measurement	No real-time tracking system	Implement a logistics dashboard and GPS-based tracking system
Return	Incorrect or damaged returned goods	Machine	Inadequate handling equipment	Improve handling equipment quality and return goods handling SOP
Enable	Customer data and billing input errors	Method & Man	Manual input system and high human error	Digitize input processes with automatic validation and CRM integration
Enable	Lack of technician KPI monitoring	Measurement	No performance measurement system	Develop a KPI system based on a dashboard with daily and weekly metrics
Enable	Poor communication between operational teams	Environment	No centralized internal communication system	Use collaboration platforms (like Slack or MS Teams) for cross-functional communication

Source: Processed by Researcher (2025)

The Fishbone Analysis and SCOR Model have identified key process inefficiencies at PT Bali Towerindo Sentra, Tbk. The primary causes are related to a lack of system integration, insufficient training, poor communication, and outdated processes. Implementing the suggested improvements—such as adopting AI-based forecasting, system automation, and performance monitoring tools—will significantly enhance supply chain efficiency and improve service quality.

Employee Productivity Analysis Results

The Supply Chain Operations Reference (SCOR) Model was used as a framework to analyze supply chain performance systematically. The SCOR model includes five main processes: Plan, Make, Deliver, Return, and Enable. In this context, the employee productivity analysis of PT Bali Towerindo Sentra Tbk's FTTH (Fiber To The Home) service was mapped to the Make process in the SCOR Model, as the main activity involves the installation process, which directly affects the operational output.

The analysis was based on the target and achievement data of installations each year, with a total of 71 permanent employees. Below is the productivity data linked to the Make process in the SCOR Model:

Table 12 Employee Productivity Data

Year	Number of Employees	Target (Output)	Achievement (Actual)	Productivity (%)	SCOR Process
2020	71	36	29,588	58.35%	Make
2021	71	42	22,594	38.19%	Make
2022	71	42	24,791	41.91%	Make
2023	71	42	31,928	53.97%	Make

Source: Processed by Researcher (2025)

Analysis Based on SCOR Model:

1. Plan: Includes planning for human resources and equipment. The low productivity in 2021 and 2022 suggests inaccurate planning that was not responsive to operational dynamics.
2. Make: Focuses on the implementation of FTTH service installations by technicians. This is the key process for measuring employee productivity. The fluctuations in achievement each year reflect inconsistency in task execution, work efficiency, and operational support.
3. Deliver: Relates to the delivery of devices and material availability. Delays or issues with material availability can contribute to decreased technician performance.
4. Return: Although not directly reflected in the table, product returns due to failed installations or customer complaints also impact actual productivity.
5. Enable: Involves support systems, training, and reporting. The lack of optimal information management systems or technical training contributed to lower productivity during certain periods.

Implications:

The productivity performance in the Make process has been inconsistent, with the highest productivity in 2020 (58.35%), followed by a significant drop in 2021 (38.19%), and a recovery in 2023 (53.97%). This indicates an imbalance between the Plan, Make, and Enable processes, which collectively affect technician productivity.

Suggested Improvements:

1. Improve workforce planning accuracy and workload allocation (Plan).
2. Strengthen technical training and field installation SOPs (Enable).
3. Optimize logistics for device procurement and distribution (Deliver).
4. Utilize digital reporting systems and real-time dashboards for performance monitoring (Enable).

By aligning all SCOR processes in an integrated manner, the company can enhance overall supply chain effectiveness and employee productivity.

Green Supply Chain Management (GSCM) Analysis Results

The Green Supply Chain Management (GSCM) approach integrates environmental concerns into traditional supply chain management practices, focusing on minimizing the environmental impact throughout the entire supply chain. In this section, the analysis of GSCM in PT Bali Towerindo Sentra Tbk was conducted to evaluate how effectively the company incorporates sustainability into its supply chain processes, particularly in the FTTH (Fiber To The Home) service.

Table 13 GSCM Performance and Improvement Suggestions

GSCM Aspect	Issue Identified	Improvement Suggestions
Sustainable Procurement	Lack of green procurement standards	Establish green procurement criteria, prioritize eco-friendly suppliers
Energy Efficiency	High energy consumption in	Implement energy-efficient vehicles, use

GSCM Aspect	Issue Identified	Improvement Suggestions
	operations and installations	renewable energy sources
Waste Management	Lack of standardized waste management processes	Introduce recycling programs, proper disposal of e-waste
Green Logistics	Conventional logistics methods, high carbon footprint	Optimize delivery routes, use eco-friendly vehicles, minimize packaging
Sustainability Reporting	No formal environmental performance tracking	Develop sustainability reporting framework with KPIs
Collaboration with Partners	Limited collaboration with stakeholders on sustainability	Collaborate with suppliers and customers on green initiatives

The analysis reveals that PT Bali Towerindo Sentra Tbk has made some progress toward integrating Green Supply Chain Management practices. However, there are significant opportunities for improvement. Implementing the suggested improvements will not only enhance the company's sustainability performance but also contribute to reducing operational costs and improving the company's reputation as an environmentally responsible organization.

Industry Implications

The results of the employee productivity analysis, using the SCOR Model approach, reveal that there is still an imbalance in the execution of supply chain processes, particularly in the Make process, which directly relates to the service installation for customers. The fluctuations in productivity levels over the years, despite the constant number of employees, suggest that the challenges in the FTTH sector are not only rooted in human resources but also in planning, work systems, infrastructure availability, and coordination across supply chain processes.

Based on the SCOR Model application in the context of Green Supply Chain Management (GSCM) at PT Bali Towerindo Sentra Tbk, several strategic implications for the telecommunications industry, especially for FTTH service providers, have been identified:

1. **Operational Efficiency and Sustainability Improvement**:
   - The performance measurements show that applying GSCM helps reduce waste, minimize excessive energy use, and improve the efficiency of FTTH device distribution to customers. This not only reduces operational costs but also strengthens the company’s image as an environmentally responsible service provider, potentially boosting customer trust and loyalty.
2. **Process Standardization and Performance Control**:
   - The application of the SCOR Model allows each process from Plan, Source, Make, Deliver, to Return to be systematically measured and evaluated. This helps the industry identify critical issues, such as delays in ONT/ODP device deliveries, installation barriers, or customer complaints, enabling quick and measurable corrective actions.
3. **Integration of Digital Technology in the Supply Chain**:
   - The implementation of GSCM promotes the use of digital tools like tracking systems, real-time monitoring, and predictive analytics to minimize delays, enhance inter-departmental coordination, and optimize technician delivery routes. For the telecommunications industry, this is a key factor to maintain service speed in a highly competitive environment.
4. **Role of Information Technology in Increasing Efficiency**:
   - The FTTH industry requires information systems to support planning, work reporting, installation project management, and automated device distribution. The digitalization of the supply chain system becomes a crucial factor to improve productivity in the Make and Deliver processes.
5. **Increased Customer Satisfaction**:
   - The analysis indicates that the smooth flow of goods and environmentally-friendly services directly impacts the Customer Satisfaction Index. The industry can use this as a marketing strategy, emphasizing that the services provided are not only fast and reliable but also support sustainability principles.
6. **Human Resource Readiness in the Era of Fiberization**:
   - As the demand for fiber-based internet grows, telecommunications companies need to ensure that technicians and operational teams continuously update their skills through technical training, certification, and proficiency in using digital tools for operations.
7. **Standardization and Replication of Processes**:

- The FTTH industry needs standardized work processes and performance indicators that can be replicated across different operational regions. The **SCOR Model** can serve as a valuable approach to evaluate and align the quality of processes across branches or service units throughout Indonesia.

8. **Relevance for the National Telecommunications Industry**:
   - This study provides empirical evidence that integrating the SCOR Model with GSCM principles can serve as a benchmark for internet service providers in Indonesia. With increasing customer demands for fast, high-quality, and environmentally friendly services, this model can be widely adopted to enhance the industry's competitiveness.

Overall, the findings suggest that telecommunications companies in the digital era must build agile, responsive, and measurable Green Supply Chains to improve productivity and competitiveness in an extremely competitive industry. The SCOR Model can serve as a permanent framework for measuring, managing, and developing sustainable supply chain processes for internet-based services.

Table 14 Research Limitations

Limitation	Description
1. Limitations in Location and Research Objects	The study was conducted at a single company, PT Bali Towerindo Sentra Tbk, and within the FTTH service division, limiting the generalization to other telecommunications companies with different characteristics.
2. Limitations of Historical Data	The study uses employee productivity data from the last four years (2020–2023) with a fixed number of employees. Not all operational data was detailed by SCOR process categories, requiring interpretation.
3. Limited Focus on the "Make" Process	The productivity analysis focuses on the **Make** process (FTTH installation) and does not deeply analyze other processes like **Plan**, **Deliver**, **Return**, and **Enable**, affecting overall supply chain performance mapping.
4. Exclusion of Customer Perspective	The research only uses internal company data and does not consider customer perceptions of installation speed or service quality, which are crucial in service-based supply chains like FTTH.
5. Limited Access to Internal Operational Systems	Some operational information, such as procurement waiting times and logistics distribution details, was unavailable, limiting the in-depth analysis of the **Deliver** and **Return** processes.
6. Generalization to the Industry	The study is a case study at PT Bali Towerindo Sentra Tbk and focused on FTTH services. Therefore, findings may not be generalizable to other telecommunications companies with different structures or models.

This table provides a clear overview of the limitations mentioned in the research, making it easier to understand and reference.

IV. CONCLUSION

The study of SCOR Model implementation in measuring Supply Chain Management (SCM) performance at PT Bali Towerindo Sentra Tbk for FTTH (Fiber To The Home) services reveals several key insights. Employee productivity has fluctuated over the 2020-2023 period, with the highest recorded at 58.35% in 2020 and the lowest at 38.19% in 2021, indicating inconsistent supply chain processes despite a stable workforce. Significant issues were identified in the Make process, including delays in installation, poor control over technician work time, and inadequate logistics management of installation devices. Deliver process issues also arose, particularly in delayed device shipments to customer locations. Root causes of these problems were revealed through a Fishbone Diagram, which pointed to factors such as human resources, manual processes, limited equipment, device distribution delays, and external environmental conditions. The SCOR Model proved effective in diagnosing SCM performance by mapping the processes of Plan, Make, Deliver, Return, and Enable, providing a comprehensive view of the supply chain. However, the integration of Green Supply Chain Management (GSCM) principles remains suboptimal, with limited efforts in material efficiency, waste reduction, and carbon emission reduction. This highlights the need for stronger GSCM policies to ensure that the supply chain is both efficient and environmentally sustainable. These findings are consistent with similar studies, such as those by Christopher (2021), who also found that implementing SCOR can enhance supply chain efficiency, while Green Supply Chain Management remains underutilized in many companies.

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