Optimizing First and Last-Mile Processes for SMEs in Thailand : Implementing a TMS with Lean Concept and SCOR Model for Measurement Efficiency, a Case Study

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Abstract

This research focuses on improving operational efficiency in small transportation companies. The primary objectives are creating a model for SMEs in the transport industry, developing appropriate performance indicators, and implementing a Transportation Management System (TMS) to reduce work redundancies. The study applied the TMS concept based on LEAN and SCOR principles. Results showed that executing TMS reduced working time by 53 minutes for certain activities. However, issuing delivery orders increased from 70 to 120 seconds per bill for 150. Some processes could not be reduced due to legal constraints. The SCOR model helped identify 14 crucial " A Focusing Set of KPIs" suitable for the company's limited resources. The study involved a sample of 12 participants, ranging from operational staff to company owners, using observation and focus group discussions to extract practical indicators for the business. This study demonstrates the feasibility of improving operational efficiency in small transportation companies despite resource and knowledge limitations, using internationally recognized tools and concepts. The results can be applied to other SMEs in the transport industry with similar characteristics and constraints to enhance operational efficiency and competitiveness.

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Introduction

In the current dynamic and competitive business landscape, Thailand's small and medium-sized enterprises (SMEs) are grappling with numerous challenges in streamlining their logistics processes and optimizing supply chain management. (Supply Chain Management for Small and Medium Size Enterprises, 2015), (Goh and Pinaikul, 1998). According to SMEONE (2020, September 16), in the vibrant Thai economic landscape, SMEs and Micro SMEs are critical to Thailand's economy, contributing 35% of GDP and providing 85% of formal employment, according to the Office of SMEs Promotion (OSMEP) data. Their significant impact on economic growth and job creation underscores the need for targeted policies to enhance competitiveness and resilience, thereby supporting inclusive economic development and social stability.

In addition to these internal challenges, the SME faces external pressures, such as the increasing inflation rate driven by rising diesel prices and the ongoing economic recession. Integrating sustainable practices into the transport process is imperative to mitigate these challenges, such as optimizing routes for fuel efficiency (Chen & Hu, 2021). Due to peopleware issues, the inadequate technological infrastructure is exemplified by the lack of a Transportation Management System (TMS) (Rijavec et al., 2023; Tripathi et al., 2023; Manrodt, 2003). It reflects a waste of investment and hinders its ability to manage its transport processes effectively. Consequently, there is a lack of real-time visibility and tracking of shipments (Qi et al., 2010), forcing customers to rely on voice calls to inquire about delivery status, resulting in longer response times. Furthermore, communication breakdown and interruptions of information flow among stakeholders (Azab et al., 2016), such as dispatchers, drivers, and customers, can lead to errors.

This research paper examines a small transportation company in Thailand that provides delivery services from five collection points (CPs) in Bangkok and the vicinity of retail distribution centers (RDCs) in Chanthaburi and Nakhon Sawan provinces. The company faces several operational challenges, including work redundancy, scattered information, communication breakdowns between CPs and RDCs, and inefficient resource utilization, leading to high transportation costs and reduced productivity.

Objective

This research aims to develop and implement a performance measurement framework for Small and Medium-sized Enterprises (SMEs) in the transportation sector. Explicitly focusing on integrating Transportation Management System (TMS) capabilities with LEAN principles to enhance operational efficiency and establish meaningful Key Performance Indicators (KPIs). Many SMEs in the transportation industry struggle with performance measurement due to limited systematic approaches and implementation knowledge. The study addresses this gap by demonstrating how TMS implementation can streamline document processing workflows, particularly in the context of delivery order and truck manifest generation, which traditionally involves redundant manual processes despite legal requirements.

The research examines how implementing cloud-based TMS eliminates double-handling of data entry tasks and significantly improves inter-branch communication. The operational visibility enables destination hubs to proactively plan resources by accessing real-time shipment data and preparing truck assignments, including delivery teams, in advance. Through this case study of a small transportation company, the research will illustrate how the integration of TMS facilitates automated document generation. While simultaneously capturing operational data that can be leveraged for performance measurement, thereby creating a more efficient and measurable business process. Furthermore, this study aims to develop a replicable prototype framework that other small transportation companies with similar operational processes can adopt to determine how technology implementation can improve performance and enhance cross-functional communication in SME transportation operations.

The research will specifically focus on identifying and implementing essential KPIs that can be easily tracked through TMS data, providing business owners with actionable insights for decision-making and continuous improvement.

This comprehensive approach not only addresses the immediate needs of the case study company but also establishes a blueprint for other SMEs in the transportation sector. To follow, potentially transforming how small transportation companies approach performance measurement, operational efficiency, and inter-branch coordination. This research will create a valuable knowledge base to share across the transportation SME sector by documenting the implementation process, challenges, and solutions. This mainly benefits companies with similar operational characteristics and faces comparable performance measurement, process optimization, and cross-location communication challenges.

The study analyzes the company's logistics process from goods receipt to final delivery, encompassing document preparation, truck loading, freight collection, and distribution center delivery. It also considers self-collection by customers, delivery to receivers, and resolution of unsuccessful deliveries and freight charge disputes. The primary objectives of this research are:

1. To serve as a model for improving operations in similarly sized transportation companies, reflecting the importance of SMEs in global economies.

2. To apply LEAN principles to identify and reduce non-essential or redundant activities by implementing TMS

3. To develop appropriate key performance indicators (KPIs) for small transportation companies with limited financial resources and fewer highly skilled employees compared to larger, better-equipped companies using the globally recognized SCOR tool.

This research proposes integrating a TMS with Lean concepts and the Supply Chain Operations Reference Model (SCOR). SCOR's concept is used to map the existing workflow to a standard process (Wang et al., 2010). The TMS, enhanced by Lean principles, aims to minimize waste and optimize processes for maximum efficiency (Manrodt, 2003). This integrated approach offers potential benefits such as improved shipment visibility, optimized delivery routes based on vehicle capacity, and reduced transportation costs.

Notably, implementing TMS will lead to a paperless organization promoting green transportation practices. Additionally, it aims to stabilize human resource requirements even as job volumes increase, allowing for more efficient scaling of operations without proportional increases in staffing. By achieving these objectives, this study aims to improve the operations of the case study company and provide a blueprint for enhancing efficiency and competitiveness in small-scale local transportation businesses across Thailand and potentially beyond.

Literature review

Logistics is crucial to SMEs' success, particularly in transportation and last-mile delivery. A study highlights logistics' benefits, including enhanced competitive advantage and reduced operational costs, while identifying challenges (Mafini & Omoruyi, 2013) such as financial constraints and a lack of logistics skills. Pronello et al. (2017) emphasized the need for a dynamic and participatory platform to optimize last-mile urban logistics, addressing the gap between stakeholders' needs and administrative strategies. The studies focus on last-mile logistics' importance in improving efficiency and reducing delivery costs (Yekimov, 2023; Escudero-Santana et al., 2022), with Escudero proposing a distribution policy with multiple delivery locations.

SMEs in the transportation and last-mile delivery sector face various challenges, including work redundancy, information scattering, high transportation costs, manual work processes, and external pressures. (Pronello et al., 2017; Mafini & Omoruyi, 2013) These challenges can be addressed through improved cost management (Bokor & Markovits-Somogyi, 2015), outsourcing logistical activities (Rifai & Hashem, 2018), and digital technologies. However, the impact of these strategies on the construction supply chain, particularly in New Zealand, needs further quantification (Dhawan et al., 2023).

Siegfried and Zhang (2021) and Wodalski et al. (2011) highlight the importance of sustainability and implementation challenges in the transportation industry. They suggest optimizing last-mile delivery through pricing strategies, collaboration models, and smart logistics concepts (Leyerer et al., 2020; Ko et al., 2018). Additionally, Lauenstein and Schank (2022) and Slabinac (2015) emphasize the importance of differentiation in the logistics industry and advocate for introducing innovative delivery vehicles to enhance efficiency and minimize environmental impact.

The successful implementation of Transportation management systems (TMS) in transport operations is stalled by various challenges, including peopleware issues such as resistance to change and lack of training (Munir et al., 2019; Chen, 2018). Effective communication and information flow are crucial for mitigating these risks (Samsudin et al., 2021; Salamadija et al., 2019). Strategies for improving communication and information flow include using centralized communication platforms, providing regular employee training and feedback, and establishing clear protocols for information sharing (Bazaras et al., 2023). The use of TMS is part of a broader trend of Information Communication Technology (ICT) adoption in the transport and logistics industry (Marchet et al., 2013), which has been driven by the need for economically viable and sustainable solutions (Hidalgo & Albors, 2010). Leveraging modern information and communication technologies can significantly enhance the quality of transportation services (Salamadija et al., 2019), and the development of technological infrastructure is essential for the successful implementation of TMS. However, the successful transition to digital technologies in the transport and logistics industry requires a range of factors, including the availability of professional personnel, financial resources, and awareness of the need for change (Khan et al., 2022)

The SCOR has been widely applied in various industries, including logistics, retail, and manufacturing. Alomar and Pasek (2014) and Wang et al. (2010) both highlight the benefits of using the SCOR in small and medium-sized enterprises (SMEs). While Alomar and Pasek (2014) propose a performance assessment model, Wang et al. (2010) discuss the alignment of business process reengineering. Janjevic et al. (2017) and Girjatovičs et al. (2018) studied the model's effectiveness in evaluating urban consolidation centers and enhancing supply chain processes in a retail company. The tool has also been adapted for use in developing countries (Georgise et al., 2012) and applied to analyze the supply chain performance in a steel-producing company (Seifbarghy et al., 2010). Lastly, Soe et al. (2022) emphasize the importance of applying the SCOR to improve supply chain management practices in the heavy equipment machinery industry and to measure and improve supplier performance.

Continuous improvement is crucial in last-mile delivery processes, with employee training significantly enhancing performance (Wijayanti et al., 2020). Training empowers employees, improving workplace results (Hoti & Fejza, 2019). In the pharmaceutical industry, training is essential for employee efficiency (Aydogdu, 2012). However, employees' motivation and openness to continuous improvement can vary across companies (Stadnicka & Sakano, 2017). The effectiveness of training programs in IT companies is positively related to employee productivity and organizational benefits (Singh & Malhotra, 2018). Process management can be used to improve the training process in production companies. Training is a key factor in employee performance, and its effectiveness can be enhanced through continuous improvement initiatives (Khilukha, 2021).

Methods

The study employs TMS, SCOR, and other tools to analyze the transportation company's operations. This approach assesses current performance, identifies improvement areas, and generates a comprehensive report with actionable recommendations, highlighting the company's strengths and weaknesses.

Research Framework and Design

Figure 1 shows research that examines the business model of a last-mile delivery company. The study begins with a comprehensive survey and observation of current operational practices. The initial phase involves diagramming the existing work system and interviewing key team members to gain insight into the company's workflows. The focus group was for the decision-making to select a crucial KPI impacting the performance of the operation reflecting the cost reduction.

Figure 1

Research Design

1. Survey, observe, and study the Last-Mile company's business model.
2. Diagram the current work system and conduct initial team interviews.

3. Apply lean concepts to identify areas for process reduction or elimination.
4. Study the Transportation Management System (TMS) to streamline the delivery process.
5. Apply the process to SCOR to extract workflow standardization with key performance indicators.
6. Employ a collaborative KPI Selection Process, using a focus group to make a balanced decision tailored to the company's needs.
7. Analyze and interpret the data and give recommendations.

Next, Lean principles are then employed to identify process reduction or elimination areas to enhance operational efficiency. SCOR is applied to standardize processes and establish KPIs for measuring and tracking efficiency's organization. The research further explores the company's TMS to optimize the billing process for delivery orders. A collaborative KPI selection process is conducted through focus groups and in-depth interviews, ensuring that the KPIs chosen reflect a balanced and tailored approach to the company's specific needs. Finally, the study analyzes the collected data and provides recommendations for further process improvement and optimization based on the findings.

Data Collection, Business Model Analysis, and Research tool

This step is crucial for understanding the company's operations' current practices, processes, and overall structure. The case study company has Collection Points (CPs) and Retail Distribution Centers (RDCs). The five CP areas in Bangkok and Nakhon Pathom province are the first mile for receiving and consolidating goods, and they cater to less-than-truckload (LTL). The RDCs in Chanthaburi and Nakhon Sawan function as the last mile, located 250 and 290 kilometers from HQ, respectively.

The CPs lead to communication issues between branches when coordinating daily collections. Full truckloads (FTL) are dispatched directly from each CP to distribution centers. For LTL loads, branches communicate via mobile calls to combine shipments and optimize truck utilization. Goods are consolidated onto ten-wheel trucks for delivery to RDCs by collecting each CP to achieve economies of scale. At RDCs, items are sorted by delivery routes. Last-mile delivery uses pickup or six-wheel trucks to comply with local traffic regulations, such as truck ban hours during morning and evening. The following section will provide a detailed explanation of the flow process.

AS-IS and TO-BE Flow Process Chart

Table 1 illustrates the work step in bold font, indicating areas (an asterisk (*) symbol) where the transportation system can reduce redundant work and time spent, including utilizing the system to optimize delivery route planning. In step 12, the Delivery Order (DO) module replaces the handwriting DOs and prints a hard copy by dot matrix printer. However, the time taken to issue the DO has increased from 70 to 120 seconds due to unfamiliarity with the TMS system, the lack of computer literacy and typing proficiency. Step 15 highlights a significant improvement; the officer can instantly print the Truck Manifest (TM) report in the legally required form the transportation law and regulation with a few mouse clicks. The system can also immediately summarize the revenue without needing a calculator, reducing the potential for human error by the staff, as mentioned in step 40 in the case of freight prepaid at the CP.

The cloud-based TMS enhances RDC efficiency through real-time incoming goods visibility, automated zoning, QR-coded DOs for easy tracking, and instant revenue summarization, streamlining operations from preparation to delivery completion and payment collection. Furthermore, in step 25, the system automatically sorted the DOs by district before loading them onto last-mile trucks for delivery to receivers. After successful delivery, the staff used a scanner to update the delivery status or incomplete for the second delivery attempt or further investigation with the reminding system until the problem is resolved (step 39). The system can then summarize the revenue for each truck by combining the collections from both the origin and destination, instantly generating a revenue summary report.

Table 1

Flow Process Chart comparison, AS-IS and TO-BE

Comparison between AS-IS and TO-BE Flow Process Chart				X MAN	MATERIAL
ORGANIZATION: A case of the transportation company				X PRESENT	X PROPOSED
				DATE: 15/06/2024	
PROCESS:	SUMMARY				
Comparison of current (AS-IS) and improved (TO-BE) work procedures	ACTIVITIES	AS-IS	TO-BE	DELTA (TO BE - AS IS)	
Due to the nature of the less-than-truckload (LTL) service, where customers may send as little as 1 box or 10 boxes, the time spent calculation becomes complex and varies greatly. To simplify the calculation process and provide a representative value, the Pareto principle is applied.	○ OPERATIONS	26	27	1	
	⇨ TRANSPORTATIONS	7	7	0	
	□ INSPECTIONS	6	6	0	
The DO issued is 150, according to the collection data period at CP headquarters.	D DELAYS	0	0	0	
CHARTED: KULANIST PUNKEAW	▽ STORAGES	0	0	0	
APPROVED:	DISTANCE (Meter)	263,042	263,042	-	
	DISTANCE (Kilometer)	263	263	-	
	TIME (Second)	111,218	108,003	- **3,215**	
	TIME (HH:MM)	30:53	30:00	**0:53**	

		DISCRIPTIONS	AS IS TIME (Sec)	AS IS DIST. (M)	TO BE TIME (Sec)	TO BE DIST. (M)	○	⇨	□	D	▽	REMARKS
							The symbol in the black color means workflow					
Process for receiving goods from the sender at the Collection Point (CP)	1	Unload goods from the vehicle	600	-	600	-	●	⇨	□	D	▽	Sender
	2	Walk to the administration to inform the product details	5	3	5	3	○	➡	□	D	▽	Sender
	3	Receive goods, count, and check for correctness	300	-	300	-	○	⇨	■	D	▽	Goods Handling Officer
	4	Record the number on a paper note	30	-	30	-	●	⇨	□	D	▽	Goods Handling Officer
	5	Submit the note to the administration	30	3	30	3	○	➡	□	D	▽	Goods Handling Officer
	6	Receive goods information from customers and obtain the count from the officer	30	-	30	-	●	⇨	□	D	▽	Administration Officer
	7	Verify the amount of the goods	120	-	120	-	○	⇨	■	D	▽	Administration Officer
	8	Inquire about freight collection (origin/destination)	30	-	30	-	●	⇨	□	D	▽	Administration Officer
	9	**Implementing Transportation Management System (TMS)***	**N/A**		**-**	**-**	●	⇨	□	D	▽	Administration Officer
	10	**Calculate the freight charge and inform the payment amount (Prepaid)***	**40**	**-**	**10**	**-**	●	⇨	□	D	▽	Administration Officer
	11	Receive payment (Prepaid)	20	-	20	-	●	⇨	□	D	▽	Administration Officer
	12	**Issue a delivery order (DO) to the customer***	**70**	**-**	**120**	**-**	●	⇨	□	D	▽	Administration Officer
	13	Customer receives the DO	3	-	3	-	●	⇨	□	D	▽	Sender
	14	Sort physical goods by zone (Nakhon Sawan/Chantaburi)	1,800	-	1,800	-	●	⇨	□	D	▽	Goods Handling Officer
Process for sending products from the collection point to the Retail Distribution Center (RDC)	**15**	**Summarize the DOs by zone***	**1,500**	**-**	**60**	**-**	●	⇨	□	D	▽	Administration Officer
	16	**Issue Truck Manifest and summarize expenses by zone***	**1,500**	**-**	**30**	**-**	●	⇨	□	D	▽	Administration Officer
	17	Load goods onto trucks sorted by zone	3,600	-	3,600	-	●	⇨	□	D	▽	Goods Handling Officer
	18	Walk to inspect goods	180	6	180	6	○	➡	□	D	▽	Administration Officer
	19	Verify goods matching with Delivery Orders (DOs)	60	-	60	-	○	⇨	■	D	▽	Administration Officer
	20	Release the truck	600	-	600	-	●	⇨	□	D	▽	Administration Officer
	21	Drive to the distribution center	54,000	238,000	54,000	238,000	○	➡	□	D	▽	Line Haul Driver
	22	Arrive at the distribution center, park the truck	600	-	600	-	●	⇨	□	D	▽	Line Haul Driver
	23	Hand Over DOs to sort in the office	1,200	15	1,200	15	○	➡	□	D	▽	Line Haul Driver
	24	Unload goods and sort by district	7,200	-	7,200	-	●	⇨	□	D	▽	Distribution Goods Handling Officer
	25	**Sort DOs by district***	**1,800**	**-**	**10**	**-**	●	⇨	□	D	▽	Distribution Officer
	26	**Assign routes***	**1,800**	**-**	**10**	**-**	●	⇨	□	D	▽	Distribution Officer
	27	**Calculate expenses and collect payment on delivery***	**120**	**-**	**5**	**-**	●	⇨	□	D	▽	Distribution Officer
	28	**Issue an expense truck voucher for each route***	**600**	**-**	**180**	**-**	●	⇨	□	D	▽	Distribution Officer
	29	Verify goods with the DOs	900	-	900	-	○	⇨	■	D	▽	Distribution Goods Handling Officer
	30	Load goods onto trucks by assigned routes and customer orders by location	2,700	-	2,700	-	●	⇨	□	D	▽	Distribution Goods Handling Officer
	31	Verify goods match with DOs	30	-	30	-	○	⇨	■	D	▽	Distribution Officer
	32	Dispatch the vehicles	300	-	180	-	●	⇨	□	D	▽	Distribution Officer
	33	Deliver goods to the receiver location	180	-	180	-	●	⇨	□	D	▽	Distribution Driver
	34	Customer inspects goods, accepts or rejects	120	-	120	-	○	⇨	■	D	▽	Receiver/Retail Distribution Driver
	35	Collect the freight charge (for cash on delivery)	60	-	60	-	●	⇨	□	D	▽	Distribution Driver
	36	Goods handover	30	-	30	-	●	⇨	□	D	▽	Distribution Driver
	37	Return to the RDC after completing deliveries	14,400	25,000	14,400	25,000	○	➡	□	D	▽	Distribution Driver
	38	Return goods and DOs to the truck	30	-	30	-	●	⇨	□	D	▽	Distribution Driver
	39	Submit DOs to the administration and report returned goods	3,600	15	600	15	○	➡	□	D	▽	Distribution Driver
	40	**Summarize daily deliveries and manage returned goods***	**600**	**-**	**60**	**-**	●	⇨	□	D	▽	Distribution Officer

Implementing TMS significantly reduces time in key processes, notably in instant TM report printing (steps 15-16) and automated zoning (steps 25-28). Despite initial challenges like staff training and typing skills, the system minimizes redundancies and enhances efficiency. This optimization allows for increased efficiency without proportional resource expansion, demonstrating the TMS's effectiveness in streamlining operations within the legal framework.

Refining Key Performance Indicator Set

The TO-BE process column from Table 1, comprising 40 steps from customer arrival at the CP to handover to receivers, is mapped to the relevant SCOR principle of sD-Delivery as level 1. Key performance indicators (KPIs) are identified for each sub-process, column Metrics (KPIs), enabling comprehensive performance evaluation.

Several steps in Table 1 fall outside the SCOR model, including customer interactions (steps 2, 4, 5), system implementation (step 9), and document receipt (step 13). The model also does not explicitly cover distribution center operations (steps 23-25), financial processes (step 27), verification (steps 29-31), and dispatching (step 32). These non-standard steps are excluded from the SCOR-based comparison. The SCOR (Supply Chain Operations Reference) model has five categories that reflect the performance perspective: Reliability (RL), Responsiveness (RS), Agility (AG), Cost (CO), and Asset Management Efficiency (AM) (SCOR Ver 12.0).

A diverse focus group of 12 participants, comprising the owner, three managers (from CP and RDC, undergraduate to a vocational degree), three supervisors (vocational), and five operational staff members (high school degree), worked with the company for an average of 10 years. A focused set of KPIs was achieved considering resource constraints and implementation feasibility. This process, guided by the researcher's explanations, balanced, comprehensive performance measurement with practical implementation, ensuring alignment with industry standards and the company's operational realities. As a result, it derived from SCOR guidelines and collaborated with a “Focusing set of KPIs” of 14 significant, as shown in Table 2.

While collecting KPI data was beyond the study's scope, the research contributes a framework for KPI selection and implementation adaptable for similar companies. Strategic discussions within the focus group resulted in a “Focusing set of KPIs,” balancing comprehensive measurement with practical implementation within the company's resource constraints, such as data collection capabilities, staff knowledge, and long-term objectives. The total is 14 KPIs for operations improvement. By monitoring these KPIs, the company can identify areas for future improvement, reduce costs, and enhance overall operational efficiency.

Table 2

A Focusing Set of KPIs for Operations Improvement

No	Focusing set of KPIs	SCOR attribute	Formula	Impact on Company	Data Use for Improvement and Cost Reduction
1	RS.3.105 Receive Product from Transform or Source Cycle Time	RS	[Sum of actual cycle times for all receipts] / [Total number of receipts]	Measures efficiency of receiving process	Identify bottlenecks in receiving; streamline the process to reduce labor costs.
2	RS.3.106 Receive, Enter, and Validate Order Cycle Time	RS	[Sum of actual cycle times for all orders] / [Total number of orders]	Indicates order processing efficiency	Optimize order entry process; reduce errors and associated costs
3	RS.3.23 Pick Product Cycle Time	RS	[Sum of actual pick cycle times] / [Total number of order lines picked]	Reflects warehouse picking efficiency	Improve picking strategies; reduce labor costs and increase throughput
4	RL.3.46 Fill Rate	RL	[Total number of items delivered] / [Total number of items ordered] x 100	Shows ability to meet customer demand	Improve inventory management; reduce stockouts and excess inventory costs
5	RS.3.18 Stage Finished Product Cycle Time	RS	[Sum of actual staging cycle times] / [Total number of orders staged]	Measures efficiency of order staging	Optimize staging area layout; reduce handling time and associated costs
6	RL.3.3 Customer Commit Date Achievement	RL	[Number of orders delivered on time] / [Total number of orders] x 100	Indicates reliability of delivery promises	Improve scheduling and delivery processes; reduce late delivery penalties
7	RL.2.3 Customer Order Documentation Accuracy	RL	[Number of orders processed without errors] / [Total number of orders processed] x 100	Reflects accuracy of order processing	Reduce errors in documentation, decrease rework costs, and improve customer satisfaction.
8	RS.3.21 Load Product & Generate Shipping Documents Cycle Time	RS	[Sum of actual loading and document generation times] / [Total number of shipments]	Measures efficiency of shipping preparation	Streamline loading and documentation processes; reduce labor costs and improve throughput.
9	RL.3.30 Percentage of Faultless Invoices	RL	[Number of invoices issued without errors] / [Total number of invoices issued] x 100	Indicates the accuracy of the billing process	Reduce billing errors, decrease administrative costs, and improve cash flow.
10	AM.2.1 Days Sales Outstanding	AM	[Accounts Receivable] / [(Annual Sales / 365)]	Reflects efficiency of payment collection	Improve collection processes; reduce working capital requirements
11	RL.2.9 On Time	RL	[Number of orders delivered on time] / [Total number of orders delivered] x 100	Measures delivery performance	Improve delivery scheduling and execution; reduce late delivery costs
12	RS.3.29 Ship Product Cycle Time	RS	[Sum of actual cycle times from release to ship] / [Total number of orders shipped]	Indicates efficiency of the shipping process	Optimize shipping procedures, reduce labor costs, and improve customer satisfaction.
13	RL.2.1 Percentage of Orders Delivered In Full to the Customer	RL	[Number of orders delivered in full] / [Total number of orders] x 100	Reflects order fulfillment accuracy	Improve order accuracy; reduce costs of returns and customer dissatisfaction.

No	Focusing set of KPIs	SCOR attribute	Formula	Impact on Company	Data Use for Improvement and Cost Reduction
14	RL.2.4 Customer Order Perfect Condition	RL	[Number of orders delivered in perfect condition] / [Total number of orders delivered] x 100	Indicates quality of the delivery process	Improve packaging and handling; reduce costs of returns and damage claims

Results

Based on the focus group's result, this paper will focus on three categories to provide concise recommendations: RS, RL, and AM.

1. Responsiveness (RS): This category includes six metrics (RS.3.105, RS.3.106, RS.3.23, RS.3.18, RS.3.21, RS.3.29) that measure task speed, helping to identify bottlenecks and improve operational efficiency. Responsiveness is crucial in swiftly adapting to supply chain demands. Kaur (2021) states, "Advanced processes and better operational efficiency enable organizations to respond to ad hoc events and task speed more effectively, ensuring agility in logistics performance." This illustrates how responsiveness directly affects the ability to manage supply chain variability and ensure efficient operations.

2. Reliability (RL): Reliability is assessed using seven metrics (RL.3.46, RL.3.3, RL.2.3, RL.3.30, RL.2.9, RL.2.1, RL.2.4), which evaluate task accuracy, focusing on order fulfillment, delivery timeliness, and customer service quality. Cho et al. (2012) mentioned, "Reliability and responsiveness are essential to measuring supply chain performance as they reflect the accuracy and promptness in handling orders and managing delivery schedules." This connection between reliability and responsiveness underscores the need for accurate performance tracking to maintain a well-functioning supply chain.

3. Asset Management (AM): One metric (AM.2.1) evaluates efficient asset utilization, focusing on customer payment collection and cash flow management. Efficient asset management optimizes resources to reduce costs and increase liquidity. Kusrini and Miranda (2021) define "Asset management efficiency involves not only the physical handling of resources but also the financial management related to payments and collections, crucial for maintaining cash flow and overall supply chain health." This highlights the importance of managing assets effectively to support the financial and operational performance of the supply chain.

These KPIs serve as a guide for data-driven decisions for continuous operational improvement. The advantages of having a "Focusing set of KPIs" are numerous. These KPIs enable the company to monitor and enhance its performance in crucial areas of its logistics operations, ensuring a balance among customer satisfaction, operational efficiency, and financial health. The selected KPIs encompass a balance of RL (7), RS (6), and AM (1) metrics, reflecting a focus on service quality and operational efficiency. Additionally, the emphasis on customer satisfaction is evident in the RL metrics, while the RS metrics enable a comprehensive operational efficiency evaluation. Including the AM metric demonstrates consideration for financial aspects, providing a holistic view of the company's performance.

Conclusions

This research successfully fulfilled its three primary objectives, demonstrating the effectiveness of implementing a Transport Management System (TMS) based on Lean principles for small transportation companies. Here is how each objective was addressed:

1. Model for SMEs: The study provides a practical framework for improving operations in small transportation companies, demonstrating efficiency enhancements despite supply restraints.

2. Application of LEAN principles: Implementing TMS based on Lean methodology reduced manual process times by 53 minutes, showcasing tangible efficiency gains while acknowledging regulatory constraints.

3. Development of appropriate KPIs: The research adapted the SCOR model to create a focused set of 14 KPIs tailored for small transportation companies with limited resources.

The study bridges theory and practice by offering a method to adapt standardized models like SCOR to specific organizational contexts. It presents a carefully selected "Focusing set of KPIs" starting point for similar companies. This approach recognizes the challenges faced by SMEs and provides a balanced solution for enhancing performance measurement without overwhelming existing resources. The research contributes to both TMS implementation and last-mile delivery performance measurement, offering a roadmap for SMEs to improve efficiency and competitiveness in the transportation industry.

Suggestions for Further Research

The adoption of TMS transforms paper-based processes into digital workflows, enhancing documentation efficiency and information accuracy. While TMS primarily optimizes administrative and planning aspects rather than physical transportation activities, it brings significant benefits:

1. Streamlined operations: TMS eliminates redundant steps, reducing manual record-keeping and calculation errors.

2. Data integrity: Single-point data entry ensures consistency across the transportation chain, minimizing discrepancies.

3. Route optimization: Advanced algorithms improve route planning, enhancing resource utilization and delivery times.

4. Real-time traceability: Web-based TMS enables instant access to delivery order information, improving customer service.

5. Environmental impact: Digital processes reduce paper usage and support green initiatives.

These improvements lead to time savings, increased operational efficiency, and enhanced customer satisfaction. However, physical transportation activities still rely on traditional methods and human labor. The TMS implementation positions the company as an efficient and environmentally responsible transportation provider, paving the way for future technological advancements in the industry.

The approach contributes to the academic understanding of performance measurement in logistics and provides practical guidance for industry practitioners. It serves as a template for further study and application in various environments, emphasizing that there is no universal solution but a need for customization based on individual company needs and constraints.

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