A PROJECT REPORT ON SUPPLY CHAIN MANAGEMENT

Study on people, process, and technology at Supply Chain Department of TATA Motors Limited, Dharwad for the financial year 2025.

TATA Motors Ltd, Dharwad

Table of Contents

1. Supply Chain Management

Overview of Supply Chain Management

Introduction

This report delves into the intricacies of supply chain management (SCM) in the commercial vehicle manufacturing sector, exploring its impact on the production and delivery processes. SCM in this industry involves coordinating a vast network of suppliers, assembly plants, inventory systems, and distribution channels, making it a complex and dynamic function. Efficient supply chain operations are essential for timely vehicle production, cost management, and maintaining high standards of quality and customer satisfaction. In this report, we will examine the people, processes, and technologies that drive successful SCM, offering insights into industry frameworks, best practices, key performance indicators (KPIs), and the challenges faced by manufacturers. Additionally, the report will highlight the transformative potential of emerging technologies, such as blockchain and artificial intelligence (AI), in reshaping supply chain practices for the commercial vehicle industry.

Frameworks

This section of the report explores various frameworks that guide supply chain management (SCM) in the commercial vehicle manufacturing industry. These frameworks aim to improve efficiency, quality, and adaptability throughout the production and delivery processes.

1	Agile Supply Chain: Enables responsiveness to demand fluctuations and market conditions.
2	Total Quality Management (TQM): Focuses on continuous improvement through employee engagement.
3	SCOR Model: Offers a comprehensive roadmap for assessing and improving processes from planning to delivery.
4	Lean Manufacturing: Minimizes waste while maximizing resource utilization.
5	Six Sigma: Enhances process quality by reducing variability.
6	Production Planning and Scheduling: Aligns production with customer demand for optimal resource use.
7	Decision-Making Frameworks: Supports data-informed decisions across transportation, sourcing, and logistics.

Table 1

The **SCOR Model** (Supply Chain Operations Reference) is central to optimizing SCM by providing a structured approach that spans from planning to delivery, helping manufacturers assess performance and identify areas for continuous improvement, such as in production and logistics. **GSCF** (Global Supply Chain Forum) Takes a more holistic view of the entire business, not just logistics and operations. It involves all business functions and focuses on relationships between suppliers and customers.

DCOR (Design Chain Operations Reference): Specifically focuses on product design and development processes within the supply chain. It covers five processes: Plan, Research, Design, Integrate, and Amend. **Lean Manufacturing** focuses on minimizing waste and optimizing resources, ensuring streamlined workflows and efficient use of labor and inventory. Meanwhile **Six Sigma** is a data-driven approach that enhances process quality and reduces variability in production, addressing inefficiencies in vehicle manufacturing.

In a fast-paced, competitive industry, the **Agile Supply Chain framework** proves crucial by fostering flexibility and responsiveness, enabling manufacturers to adapt quickly to shifts in customer demand and market conditions. **Total Quality Management (TQM)** emphasizes the ongoing improvement of processes and products, engaging employees at all levels to achieve excellence in every aspect of production.

Production Planning and Scheduling ensures that manufacturing processes are aligned with customer demands, optimizing resource allocation and scheduling. Finally, **Decision-Making Frameworks** support strategic and operational decisions across all supply chain stages, from transportation to sourcing, ensuring that decisions are data-informed and contribute to the optimization of the entire supply chain.

Together, these frameworks provide a comprehensive roadmap for enhancing the efficiency, adaptability, and quality of supply chain operations in the commercial vehicle manufacturing sector.

Best practices

This section outlines the key best practices for supply chain management (SCM) in the commercial vehicle manufacturing industry, emphasizing strategies to enhance efficiency, quality, and sustainability throughout the production process.

Vendor Relationship Management is crucial for building strong, collaborative partnerships with suppliers, ensuring timely and high-quality procurement of parts and materials. This approach includes regular communication, joint forecasting, and shared risk management strategies. Just-in-Time (JIT) Inventory is another critical practice, aiming to reduce inventory costs by having parts delivered exactly when needed, which minimizes storage expenses and reduces the risk of obsolescence.

Demand Forecasting and Planning leverages data analytics and historical data to accurately predict market demand, enabling better production planning, resource allocation, and inventory management. Implementing Integrated Systems and ERP streamline operations by connecting procurement, production, logistics, and inventory functions, enhancing decision-making across the supply chain. Given the growing focus on sustainability, adopting Sustainability and Green Logistics practices, such as energy-efficient production and waste reduction, aligns well with the automotive industry's increasing environmental concerns. Additionally, Collaborative Planning, Forecasting, and Replenishment (CPFR) promotes alignment between suppliers and distributors, ensuring production demand is met efficiently without overstocking.

Supplier Relationship Management helps build long-term, reliable partnerships with suppliers, ensuring the steady supply of quality materials. The integration of Just-in-Time (JIT) and Just-in-Sequence (JIS) Production methodologies further reduces inventory costs and enhances production efficiency. Risk Management strategies, including contingency plans and supplier diversification, help mitigate potential disruptions in the supply chain.

Finally, fostering Cross-functional Collaboration between departments ensures a smooth flow of information, enabling better decision-making and synchronization across the entire supply chain.

By applying these best practices, commercial vehicle manufacturers can optimize their supply chains, improve efficiency, and stay competitive in a dynamic market.

Key KPIs to measure efficiency.

This section focuses on key performance indicators (KPIs) that are critical for measuring the efficiency of supply chain management (SCM) in the commercial vehicle manufacturing sector. These KPIs provide valuable insights into various aspects of the supply chain, from inventory management to production and delivery processes.

1	Inventory Turnover Rate: Measures the frequency of inventory renewal.
2	On-Time Delivery (OTD): Tracks timely delivery rates to maintain customer satisfaction.
3	Production Lead Time: Monitors the time from order receipt to vehicle delivery.
4	Supplier Lead Time: Evaluates the speed of raw material and part deliveries.
5	Cost Per Unit: Calculates production efficiency by factoring in labor, materials, and overhead.
6	Capacity Utilization: Assesses the effective use of manufacturing capacity.
7	Defects Per Unit: Ensures product quality and minimizes rework costs.
8	Cash-to-Cash Cycle Time: Measures the time from raw material purchase to payment receipt.
9	Perfect Order Rate: Evaluates orders delivered on time, complete, and error-free.

Table 2

Inventory Turnover Rate measures how quickly inventory is sold and replaced, with a higher turnover rate indicating more efficient inventory management. On-Time Delivery (OTD) tracks the percentage of orders delivered on schedule, which is essential for maintaining customer satisfaction and ensuring smooth production workflows. Production Lead Time tracks the time from receiving an order to delivering the completed vehicle, with shorter lead times boosting responsiveness to market demand.

Supplier Lead Time is the time it takes for suppliers to deliver raw materials and parts, and reducing this time helps minimize delays in manufacturing. Cost per Unit calculates the cost of producing each vehicle, factoring in materials, labor, and overhead. Reducing this cost through efficient processes is a key objective for manufacturers aiming to stay competitive. Capacity Utilization gauges how much of the production capacity is being used, and optimizing this without overburdening resources is crucial for maximizing cost efficiency.

Quality Metrics, such as defects per unit, track the quality of vehicles produced and are essential for maintaining brand reputation and minimizing rework costs. The Order Fulfillment Cycle Time measures how long it takes to complete an order from placement to delivery, while Supplier Quality Index evaluates the quality of parts provided by suppliers. Additionally, the Cash-to-Cash Cycle Time tracks the time from purchasing raw materials to receiving payment for finished vehicles, which impacts cash flow. Lastly, the Perfect Order Rate measures the percentage of orders delivered complete, on time, and without errors, a critical indicator of overall supply chain performance.

These KPIs collectively enable commercial vehicle manufacturers to evaluate and refine their supply chain operations, helping to ensure efficiency, cost-effectiveness, and high customer satisfaction in a competitive industry.

Daily operational challenges

This section highlights the daily operational challenges faced in supply chain management (SCM) for commercial vehicle manufacturing. These challenges impact production schedules, costs, and the overall quality of the product.

Supply Chain Disruptions are a major issue, arising from delays in part procurement, transportation bottlenecks, or labor shortages, all of which can delay vehicle delivery and increase operational costs. Demand Variability adds another layer of complexity, as shifts in market demand for commercial vehicles can make it difficult to manage production schedules and maintain optimal inventory levels.

Inventory Management is a constant balancing act, especially in the automotive industry, where manufacturers rely on multiple suppliers for parts. Achieving the right stock levels without overstocking can be challenging due to unpredictable demand patterns. Quality Control is also critical, as maintaining high standards for components and finished vehicles is essential to prevent costly recalls and uphold customer satisfaction.

Supplier Reliability is crucial in ensuring timely and quality delivery of key parts like engines, transmissions, and tires. Dependence on external suppliers increases the risk of delays and potential quality issues, impacting production timelines and costs. Logistics Coordination is another complex aspect, as the transport of large commercial vehicles requires precise scheduling and coordination to meet delivery deadlines.

These challenges require careful management and proactive solutions to ensure the efficient flow of materials, maintain quality, and align production with fluctuating demand in the competitive commercial vehicle market.

How to leverage technology

This section outlines how technology can be strategically leveraged to enhance supply chain management (SCM) in the commercial vehicle manufacturing industry, improving efficiency, accuracy, and adaptability across operations.

Automated Supply Chain Operations —such as the use of robotics, automated guided vehicles (AGVs), and warehouse automation—enable faster picking, packing, and handling, reducing human error and speeding up warehouse processes. Cloud-Based Integration further connects procurement, production, and logistics on a shared platform, allowing for seamless data sharing, better visibility, and streamlined collaboration with suppliers and internal teams.

Predictive Maintenance powered by IoT sensors can monitor equipment in real-time, alerting teams when maintenance is required to avoid unexpected downtimes and ensure a steady production pace. For Demand Forecasting, advanced analytics and machine learning can analyze sales data and external factors to make more accurate predictions, optimizing inventory and production schedules to align with demand.

Blockchain for Supply Chain Transparency creates a secure, decentralized record of all parts and components, ensuring full traceability and enhancing quality control throughout the manufacturing and delivery process. Automation using AI allows for efficient data handling, reducing manual intervention and enabling faster decision-making.

Cloud Computing offers scalable, accessible data storage solutions, while Mobile Applications provide real-time supply chain updates, enhancing responsiveness. Lastly, Digital Twin Technology can create virtual models of the supply chain to evaluate and optimize processes before implementing them in the real world, helping anticipate and mitigate potential bottlenecks.

By integrating these technologies, commercial vehicle manufacturers can build a resilient, efficient, and customer-responsive supply chain that supports growth and adaptability in a competitive market.

Tech stacks available

This section provides an overview of the technology stack available to support supply chain management (SCM) in commercial vehicle manufacturing, highlighting key tools that enhance efficiency, traceability, and decision-making across the supply chain.

1	ERP Systems: SAP, Oracle, Microsoft Dynamics for process integration.
2	WMS Platforms: Manhattan Associates, Blue Yonder for warehouse efficiency.
3	TMS Software: Descartes, Mercury Gate for optimizing transportation.
4	Predictive Analytics: Tableau, Power BI for actionable insights.
5	Blockchain Solutions: IBM Food Trust for traceability and transparency.
6	IoT for Monitoring: Real-time tracking of parts and shipments.

Table 3

Enterprise Resource Planning (ERP) Systems, like SAP, Oracle, and Microsoft Dynamics, integrate data across production, procurement, and logistics, providing visibility and centralized control over supply chain processes. Warehouse Management Systems (WMS), such as Manhattan Associates, Blue Yonder, and High Jump, streamline warehouse operations by tracking inventory and managing picking, packing, and shipping, improving warehouse efficiency.

Transportation Management Systems (TMS) tools like Descartes, Mercury Gate, and Transplace help optimize route planning, carrier selection, and freight management, ensuring cost-effective and timely deliveries. Customer Relationship Management (CRM) platforms like Salesforce and Microsoft Dynamics CRM enhance demand forecasting and customer satisfaction by centralizing customer interactions and sales data.

Predictive Analytics and Data Science Tools (Tableau, Power BI, RStudio) provide insights into demand forecasting, inventory control, and production planning, enabling data-driven decision-making. IoT for Real-Time Monitoring uses connected devices to track components, vehicles, and shipments in real time, helping mitigate disruptions and ensure smooth operations.

Blockchain for Traceability platforms, including IBM Food Trust and VeChain, offer immutable records for tracking parts and vehicles, increasing transparency, reducing errors, and preventing fraud. Artificial Intelligence and Machine Learning platforms further enhance SCM by optimizing processes, improving demand prediction, and automating repetitive tasks.

Together, these tools create a robust digital ecosystem, allowing commercial vehicle manufacturers to enhance supply chain responsiveness, traceability, and customer satisfaction while improving operational efficiency and cost control.

Impact of blockchain and AI on SCM processes

In the commercial vehicle industry, blockchain and AI are transformative technologies that significantly enhance supply chain management (SCM) processes, fostering transparency, efficiency, and predictive capabilities.

Blockchain introduces a transparent and immutable ledger for tracking parts and vehicles across the supply chain, which bolsters trust among all stakeholders. This traceability ensures the authenticity of parts and aligns with compliance standards. Smart Contracts on the blockchain automate processes like contract execution and payment processing, reducing manual intervention, cutting delays, and lowering the risk of errors. Furthermore, blockchain facilitates Improved Supplier Relations by allowing suppliers to share verified data on the quality and origins of parts, reducing the risk of counterfeit components entering the supply chain.

Artificial Intelligence (AI) drives advanced demand forecasting and production planning by analyzing historical and real-time data to better predict customer demand, minimizing stockouts and overproduction. AI also optimizes Routing and Logistics within transportation management systems, using real-time data to reduce costs, shorten delivery times, and lower emissions. Through Predictive Maintenance, AI can predict potential equipment failures, allowing for timely repairs that reduce downtime and repair expenses. Moreover, AI-powered Automation and Robotics improve assembly, logistics, and quality control processes, ensuring consistent production quality with reduced human error.

These technologies collectively streamline the SCM process for commercial vehicle manufacturers, making operations more dependable, efficient, and adaptable in a rapidly changing market.

Conclusion

In conclusion, successful supply chain management (SCM) for commercial vehicle manufacturers hinges on integrating strategic frameworks, industry's best practices, and innovative technologies. By embracing AI, blockchain, and other innovative solutions, manufacturers can streamline their operations, boost efficiency, and reduce costs, gaining a competitive edge in the marketplace. Given the complexity of SCM in this sector spanning multiple suppliers, production lines, and distribution network, effective coordination across all these components is essential for meeting customer demands, ensuring quality, and maintaining smooth production schedules. By continuously optimizing these processes, manufacturers can stay ahead in the dynamic commercial vehicle industry.

2. Division Analysis

The supply chain in the commercial vehicle manufacturing sector is a multifaceted system, encompassing procurement, logistics, warehousing, scheduling, and spare parts management. The effectiveness of this system directly impacts production timelines, inventory costs, and customer satisfaction.

i. Scheduling – focused on buying schedules.

Scheduling ensures that procurement aligns with production timelines, reducing delays and optimizing costs. It serves as the blueprint for material availability, minimizing disruptions in the supply chain.

Key Activities:

- Demand Analysis: Forecasts raw material requirements based on production plans to avoid shortages or surpluses.
- Supplier Coordination: Aligns supplier deliveries with production timelines to ensure smooth material flow.
- Lead Time Management: Monitors supplier lead times to adjust schedules proactively.
- Risk Mitigation: Develops contingency plans to address supplier or transport delays.
- Schedule Optimization: Continuously update schedules to account for changes in demand, ensuring efficiency.

Scheduling forms the backbone of material planning, reducing waste and ensuring timely procurement, thereby driving cost and time efficiency.

ii. Procuring

Procurement is critical in sourcing quality materials and components at competitive prices. It establishes relationships with suppliers, ensuring a steady supply chain foundation.

Key Activities

- Supplier Identification: Evaluates and selects suppliers based on quality, cost, and reliability.
- Contract Negotiation: Secures favorable terms and pricing through effective negotiation.
- Order Placement: Issues purchase orders aligned with schedules to meet production needs.
- Compliance Management: Ensures materials meet industry standards and ethical sourcing policies.

- Supplier Performance Evaluation: Monitors and reviews supplier reliability and delivery performance.

Procurement ensures the timely and cost-effective availability of materials, balancing quality, and budget to meet production demands.

iii. Logistics

Logistics bridges the gap between suppliers, manufacturing facilities, and customers. It ensures the smooth movement of materials and finished products, optimizing supply chain flow.

Key Activities

- Inbound Logistics: Manages the transportation of raw materials and components to production facilities.
- Outbound Logistics: Oversees delivery of finished vehicles or spare parts to distributors and customers.
- Route Optimization: Plans efficient transport routes to reduce costs and improve delivery times.
- Fleet Management: Ensures availability and maintenance of transportation vehicles.
- Reverse Logistics: Manages returns, defective parts, or recycling processes effectively.

Logistics is the operational lifeline that connects all supply chain nodes, enhancing speed and reliability while minimizing costs.

iv. Warehouse

Warehousing supports supply chain continuity by providing storage for raw materials, in-process inventory, and finished goods, enabling smooth transitions between production stages.

Key Activities:

- Storage Management: Organizes materials systematically to ensure easy retrieval and optimal space use.
- Inventory Control: Tracks stock levels to prevent shortages or overstocking.
- Order Fulfillment: Picks, packs, and dispatches materials or finished products for delivery.
- Quality Assurance: Conducts regular checks to ensure stored items meet quality standards.
- Automation Integration: Utilizes warehouse management systems (WMS) for accurate tracking and operations.

Warehousing ensures that materials and products are available when needed, acting as a critical buffer in the supply chain.

v. Spare Parts Division

The Spare Parts Division supports vehicle maintenance and after-sales services, playing a key role in customer satisfaction and brand loyalty.

Key Activities:

- Demand Forecasting: Anticipates spare parts requirements based on vehicle sales and service cycles.
- Inventory Planning: Maintains optimal stock levels to minimize downtime for customers and dealerships.
- Distribution Management: Ensures spare parts reach service centers and dealerships efficiently.
- Customer Service Support: Collaborates with after-sales teams to address customer needs promptly.
- Cost Control: Streamlines processes to reduce storage and transportation costs.

The Spare Parts Division is crucial for ensuring vehicle longevity and reliability, bolstering customer confidence and post-sales service.

Each team in the supply chain contributes uniquely to the overall efficiency and competitiveness of a commercial automobile manufacturer. From scheduling and procuring materials to logistics, warehousing, and spare parts management, these teams work together to create a seamless and cost-effective supply chain. Their activities are not only pivotal to production but also to ensure long-term customer satisfaction and market success. Each department plays a critical role in ensuring the smooth functioning of the supply chain, directly impacting production timelines, cost efficiency, and customer satisfaction.

3. Project Analysis

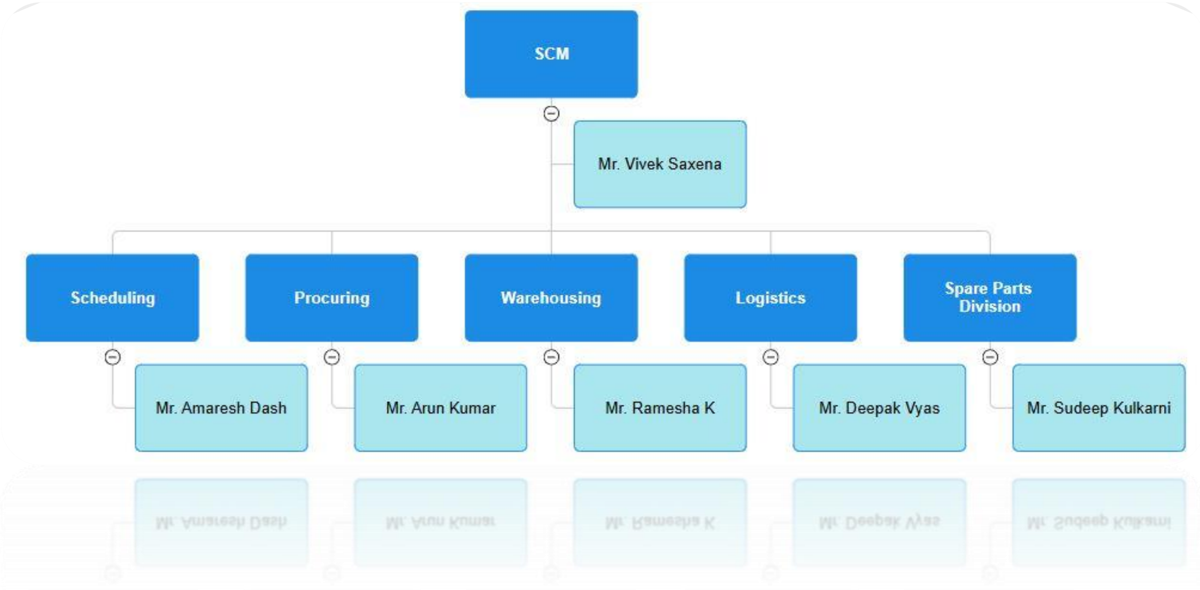
Introduction

The supply chain in the commercial vehicle manufacturing sector is a multifaceted system, encompassing procurement, logistics, warehousing, scheduling, and spare parts management. The effectiveness of this system directly impacts production timelines, inventory costs, and customer satisfaction. This report summarizes a supply chain management project undertaken for a leading automobile company specializing in commercial vehicles. The objective was to understand the current organizational setup, identify pain points, and implement actionable solutions to enhance operational efficiency.

Activities Performed

Understanding the Organizational Structure

To lay the groundwork for the project, a detailed review of the company's organizational hierarchy was conducted. This step provided clarity on the interdependence between various supply chain departments, including Scheduling, Procurement, Warehousing, Logistics, and Spare Parts divisions. Gaining insights into reporting lines, functional responsibilities, and departmental overlaps ensured a comprehensive understanding of the supply chain dynamics.



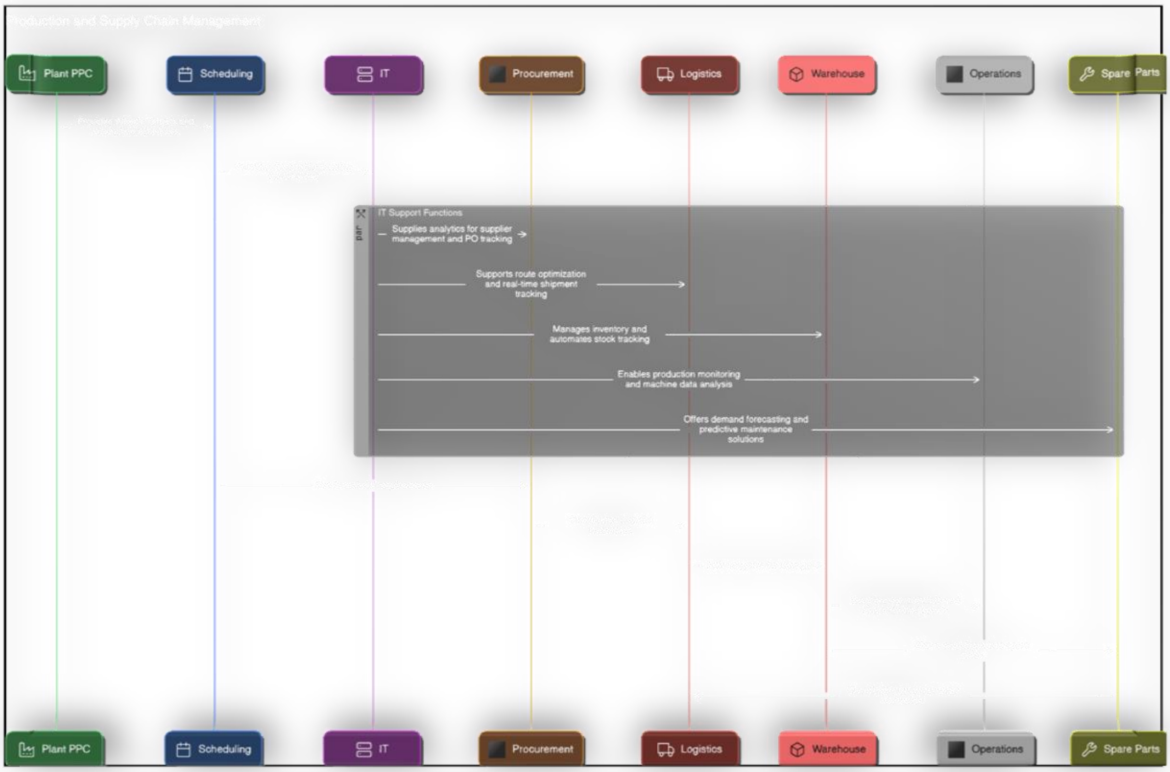
Stakeholder Interviews

Interviews were conducted with six practice leaders overseeing Scheduling, Procurement, Warehousing, Logistics, and Spare Parts. These discussions were structured to analyze their operations across three key dimensions:

- Upstream Processes: Supplier coordination, raw material procurement, and demand planning.
- Midstream Processes: In-house inventory handling, resource optimization, and internal logistics.
- Downstream Processes: Delivery to internal customers, spare parts availability, and customer service.

Additionally, emphasis was placed on understanding their people, processes, and technologies:

- People: Skill gaps, team coordination, and workload challenges.
- Processes: Inefficiencies, redundancies, and compliance gaps.
- Technologies: Utilization of ERP systems, analytics tools, and manual interventions.



Identifying Key Pain Points

Pain points were mapped for each department as follows:

- Scheduling: Fidelity, Inconsistent demand forecasts, PPC visibility, Stock variance, and inadequate lead-time buffers.
- Procurement: N7 tracker automation, Limited visibility into inventory levels, leading to overstocking or shortages, Supplier inconsistencies, Physical vs System stock variance, and Packing inconsistencies.
- Warehousing: Space utilization, unavailable skilled labor, warehouse designed based on production lines, automated picking, and delays in material handling.
- Logistics: Dedicated manpower, Vehicle tracking system.
- Spare Parts: Lack of accurate demand forecasting at material level, new team needing process maturity, dedicated manpower, and packing inconsistencies.

These pain points highlighted the need for targeted interventions in Procurement and Spare Parts divisions.

i. Selection of Focus Areas: Procurement and Spare Parts Divisions

Procurement and Spare Parts teams were identified for deeper analysis due to their critical role in bridging upstream and downstream processes. These departments had the highest potential for improvement in terms of operational efficiency and cost reduction.

Model Development for Procurement Team

An Excel-based model was developed to assist the Procurement team in determining the VCs / Models that could be manufactured using the existing inventory. Only **TWO** columns need to be updated, namely **TARGET NUMBERS** from PPC for Models and **MONTH OPENING** for parts.

Features:

- Lists feasible vehicle models based on real-time inventory data.
- Provides alerts for bottle neck part at depletion level.
- Standalone functionality (Can be shared with PPC, etc.) with optional integration into the N7 tracker system.

Standalone model

A standalone model was designed based on the existing N7 Tracker.

- A table was created using data from the N7 tracker, Sheet: PART MATRIX capturing Part num, Description, model information, configuration information, month opening, Supplier information, Supplier location and Buyer name.
- Helper columns were created for Models to calculate the total numbers required to manufacture.
- Logic of MINIMUM was applied to identify the least Manufacturable model numbers.
- Looked for respective values such as, bottleneck Part num, Part name, Model, Supplier and Location information and called upon at relevant fields.

Excel formulae used:

MIN: =MIN (IF (ISNUMBER (FP2:FP6672), FP2:FP6672))

MATCH: =MATCH (FP6674, FP2:FP6672,0)

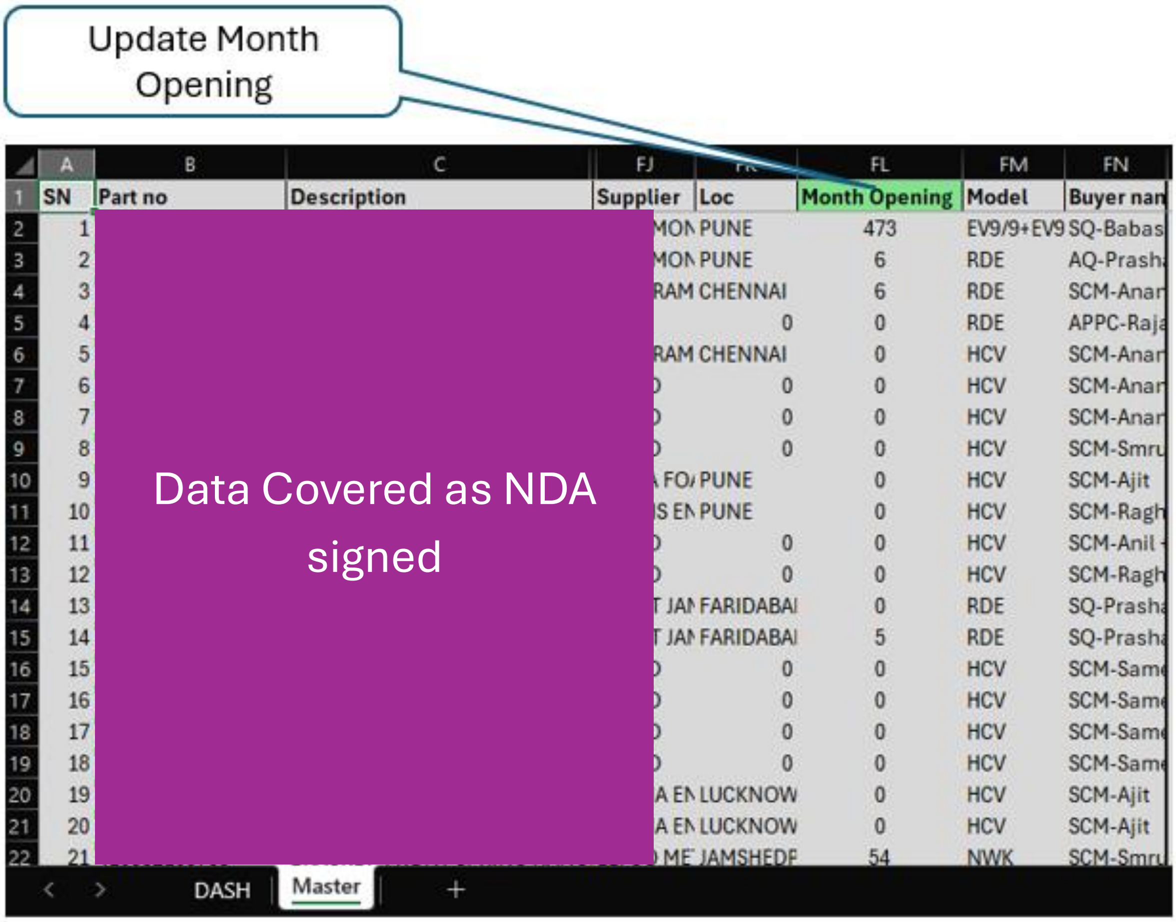
INDEX: =INDEX ($FM1: $FM6672, (FP6675) +1,0)

MATCH: =INDEX (Master! FP$6674:LU$6674, MATCH (DASH! $B2, Master! $FP$1: $LU$1,0))

How to use the model:

- On sheet: DASH, Update PPC targets from PPC for respective Model / VCs (Column: D)

- ➢ Refer Color coding for GO/NOGO (Red signifies NO GO, Yellow signifies exact match between target and manufacturable number, and Green signifies GO)
- ➢ On sheet: Master, update Month opening information for the parts (Column: FL)



Integrating with N7 – Tracker

The model can be integrated into the existing **N7 Tracker** by following steps.

- ➢ Add new sheets.
- ➢ Create table mimicking PART MATRIX sheet, keeping only row 12 (as shown in the diagrams below)
- ➢ Create Helper columns for Models to calculate the total numbers required to manufacture. Get values from updated column factoring the Month Opening and inward numbers.
- ➢ Apply the logic of MINIMUM to identify the least Manufacturable model numbers.
- ➢ If required, look for respective values such as, bottleneck Part num, Part name, Model, Supplier and Location information and called upon at relevant fields.
- ➢ Add new row on the Sheet: PART MATRIX and reformulate BALANCE Row to include Manufacturable #s.
- ➢ Call for respective minimum values for Models.

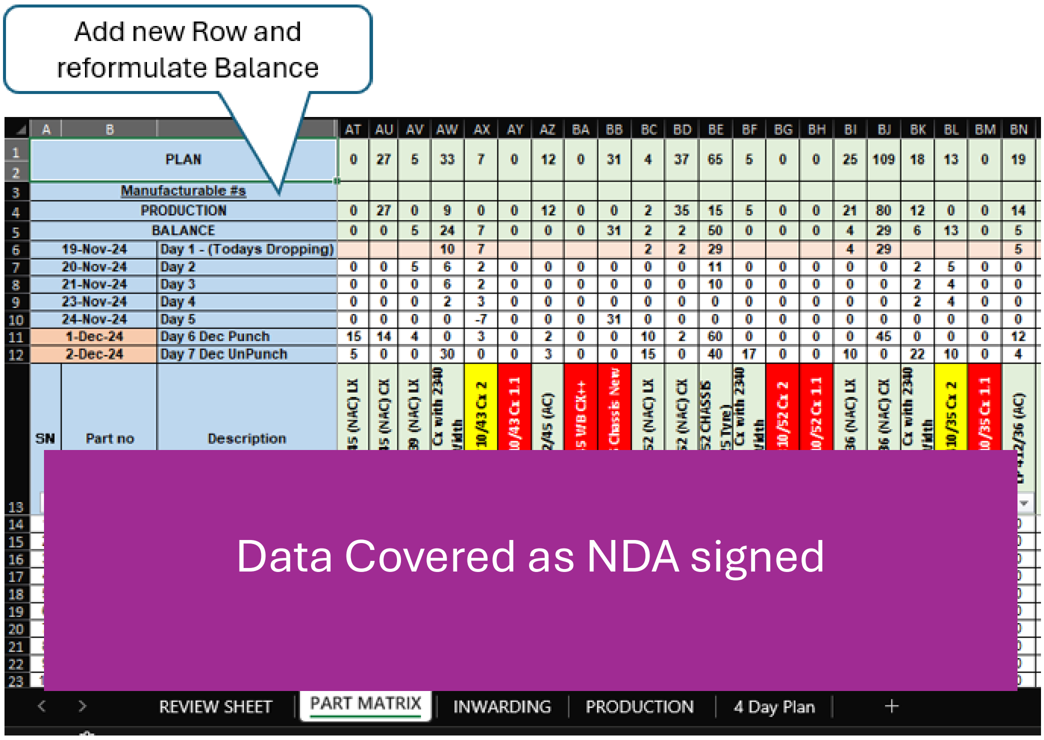
The formulae will remain the same:

MIN: =MIN (IF (ISNUMBER (FP2:FP6672), FP2:FP6672))

MATCH: =MATCH (FP6674, FP2:FP6672,0)

INDEX: =INDEX ($FM1: $FM6672, (FP6675) +1,0)

MATCH: =INDEX (Master! FP$6674:LU$6674, MATCH (DASH! $B2, Master! $FP$1: $LU$1,0))



	A	B		AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN
1–2	PLAN			0	27	5	33	7	0	12	0	31	4	37	65	5	0	0	25	109	18	13	0	19
3	Manufacturable #s																							
4	PRODUCTION			0	27	0	9	0	0	12	0	0	2	35	15	5	0	0	21	80	12	0	0	14
5	BALANCE			0	0	5	24	7	0	0	0	31	2	2	50	0	0	0	4	29	6	13	0	5
6	19-Nov-24		Day 1 - (Todays Dropping)				10	7					2	2	29				4	29				5
7	20-Nov-24		Day 2	0	0	5	6	2	0	0	0	0	0	0	11	0	0	0	0	0	2	5	0	0
8	21-Nov-24		Day 3	0	0	0	6	2	0	0	0	0	0	0	10	0	0	0	0	0	2	4	0	0
9	23-Nov-24		Day 4	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0
10	24-Nov-24		Day 5	0	0	0	0	-7	0	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0
11	1-Dec-24		Day 6 Dec Punch	15	14	4	0	3	0	2	0	0	10	2	60	0	0	0	0	45	0	0	0	12
12	2-Dec-24		Day 7 Dec UnPunch	5	0	0	30	0	0	3	0	0	15	0	40	17	0	0	10	0	22	10	0	4
13	SN	Part no	Description	45 (NAC) LX	45 (NAC) CX	39 (NAC) LX	Cx with 2340 Width	10/43 Cx 2	10/43 Cx 1.1	2/45 (AC)	5 WB CX++	Chassis New	52 (NAC) LX	52 (NAC) CX	52 CHASSIS 5 Tyre)	Cx with 2340 Width	10/52 Cx 2	10/52 Cx 1.1	36 (NAC) LX	36 (NAC) CX	Cx with 2340 Width	10/35 Cx 2	10/35 Cx 1.1	2/36 (AC)

Impact: The model significantly reduced manual effort, improved production planning accuracy, and minimized delays caused by stock shortages.

Analytics Models for Spare Parts Division

Two analytics models were built to forecast spare parts demand:

- Moving Averages Model: Used historical sales data to calculate average demand over fixed periods, smoothing out fluctuations.
- Exponential Smoothing Model: Weighted recent demand data more heavily, providing a more responsive forecast for dynamic markets.

A standalone model was designed based on historical data of 19 months.

- Collated data for 19 months using power query.
- Created table for relevant Materials (omitting Hex nuts, bolts, screws, washers, split pins, cable ties, adhesive tapes and IS* parts)
- Tried various forecasting models such as Time-Series Forecasting: (FORECAST.LINEAR, FORECAST.ETS, FORECAST.ETS.SEASONALITY, FORECAST.ETS.CONFINT), LINEST, TREND, Exponential Smoothing and Weighted Averages, Weighted mean, and Exponential growth trend projection.
- Since the data had lot of variations, a new column was created to visualize the data spread.
- Two forecasting models came close to the targeted confidence of 90% - Exponential triple smoothing and Moving averages.
- Model 1: Exponential triple smoothening: Sheet: ETS and ETS_2 have the detailed forecasting at Material and Category levels.
- Model 2: Moving averages: Sheet: Moving_Avg has the forecasted data for the coming 5 months namely- NOV, DEC of 2024 and JAN, FEB, MAR of 2025
- Sheet: Confidence contains information compared between five samples from sheets: ETS and ETS_2 and scientific analysis.

Formulae:

Forecast = FORECAST.ETS ($Y$1, $D2: $V2, $D$1: $V$1,0,0)

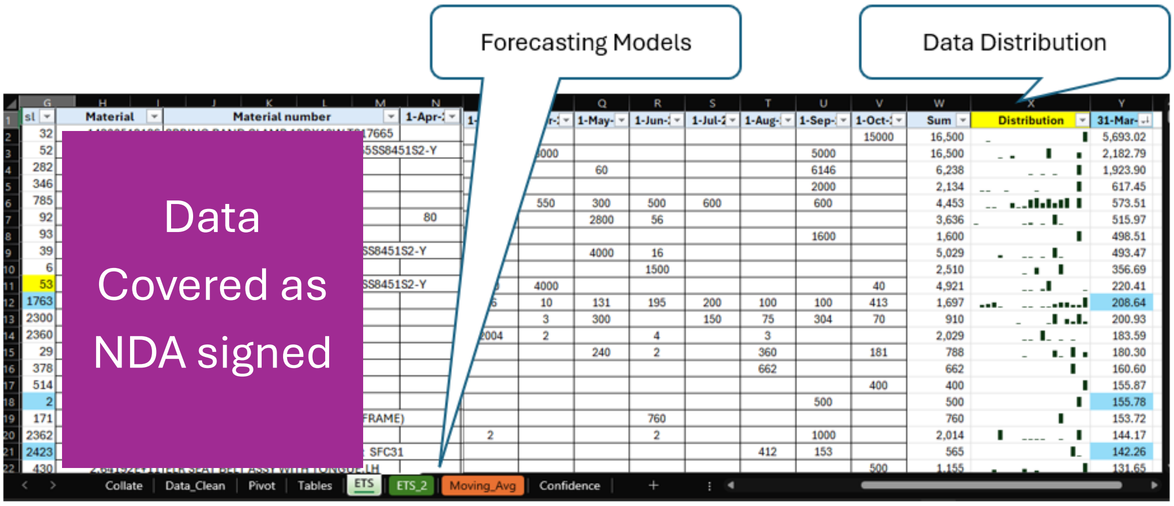
Forecast confidence =FORECAST.ETS.CONFINT(Z1, E2:W2, E1:W1,0.9,0,0)

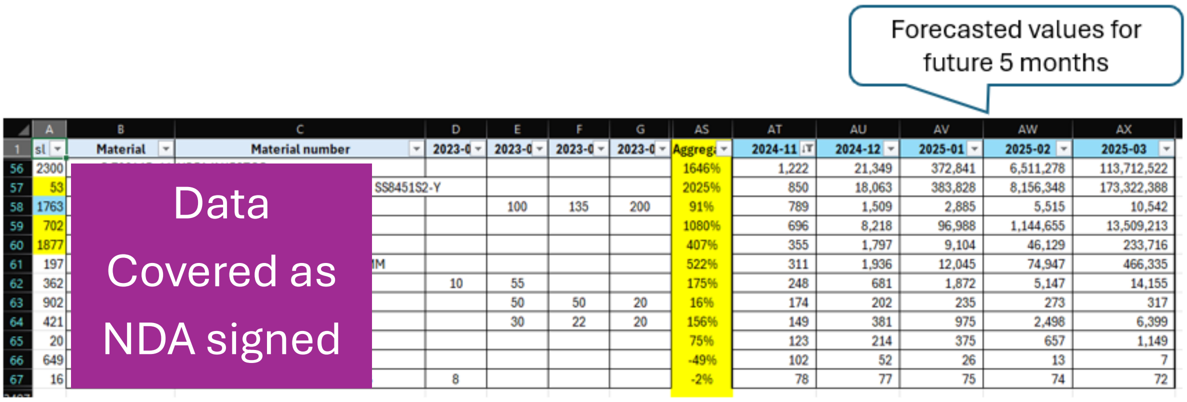
Aggregate =AGGREGATE (1,6, AA56:AR56)

How to read the sheet:

Inference: The probability of the next order for SPD team will be from **Material** (+ve values from Sheet: ETS, column: Y), split at **Category** (+ve values from Sheet: ETS_2, column: Y, {filter for material number, column: C}) are higher.

Caveats: We need to refer to all three sheets to infer the data and we need to assess the accuracy of the models for the coming months to tweak the model.





Impact:

- Enhanced forecasting accuracy.
- Reduced overstocking and stockouts.
- Improved service levels for internal and external customers.
- Both models equipped with the Spare Parts division with data-driven tools for initiative-taking inventory management and better customer satisfaction.

This project underscored the value of a structured and analytical approach to supply chain optimization. By understanding organizational nuances, engaging with stakeholders, and addressing key pain points, actionable improvements were achieved in the Procurement and Spare Parts divisions. The models developed during this project offer scalable and integrable solutions that reduce manual interventions and enhance decision-making accuracy.

The results demonstrate that targeted process enhancements, supported by data analytics and stakeholder collaboration, can drive significant operational improvements in supply chain management. These outcomes pave the way for continuous innovation and sustain efficiency in a competitive industry.

4. Conclusion

In conclusion, this project provided a comprehensive examination of the supply chain operations within the commercial vehicle manufacturing sector, focusing on identifying inefficiencies and implementing targeted improvements. The project began with an in-depth understanding of the organizational structure, followed by detailed interactions with six departmental leaders to explore the nuances of their operations across upstream, midstream, and downstream processes. This approach enabled the identification of critical pain points, such as inconsistent demand forecasts, inventory visibility challenges, and inefficiencies in spare parts management.

The Procurement and Spare Parts divisions were selected for targeted interventions due to their pivotal roles and the significant impact improvements could have on overall efficiency. For the Procurement team, a custom Excel model was developed to provide real-time insights into vehicle production feasibility based on existing inventory levels, streamlining production planning and reducing manual workload. Similarly, for the Spare Parts division, two demand forecasting models—using moving averages and exponential smoothing techniques—were implemented, offering precise predictions to reduce overstocking and stockouts.

These initiatives not only addressed immediate operational challenges but also introduced scalable solutions that integrated seamlessly with existing systems, enhancing both short-term efficiency and long-term strategic capability. Through this project, the organization gained actionable insights, practical tools, and a strengthened foundation for continuous improvement in its supply chain management.