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CLEAN AIR LIMITED: FORECASTING FOR A BETTER FUTURE

Vigneashwaran K, Rohit Kapoor and Ramaswamy Gnaniar wrote this case solely to provide material for class discussion. The authors do not intend to illustrate either effective or ineffective handling of a managerial situation. The authors may have disguised certain names and other identifying information to protect confidentiality.

In January 2024, Ram Prakash enrolled in the reputed Indian business school Central Institute of Management and Consulting, Indore to attend courses at the school's Executive Program in Supply Chain and Logistics. Prakash hoped to gain new insight and expert advice for incorporating forecasting models that would capture seasonality and trends. At the time, Prakash was working at Clean Air Limited (CAL) as general manager of sourcing and supply chain. CAL was an emission treatment solution provider that catered to India's commercial vehicle industry. The business relied heavily on a sensitive and efficient cash management program to ensure its sustenance. Prakash felt that incorporating forecasting models that capture seasonality and trends would enable CAL to achieve better forecasts, which would reduce stockouts during peak demand periods and overstocking during low demand periods.

After three years of surges in consumer demand, a flattening trend seemed to be prevalent—for CAL specifically, and for India's commercial vehicle industry in general. Projections to suppliers were made based on historic purchase rates, which inevitably led to an increase in stock at CAL. The result was working capital being locked up, rather than used for better deployment. CAL used the metric on-time-in-full as a guide, which had increased from 55 per cent in 2021 to 72 per cent in recent years, with 85 per cent set as the immediate target. CAL was seeking an analytical method that would help the company optimize the ordering process from import suppliers. The goal was to achieve a consistent level of supplies, improve the management of cash flows, and obtain components at the optimal cost. As head of the company's sourcing and supply chain area, Prakash was tasked with developing a scientific method to help the company meet its objectives.

CLEAN AIR LIMITED: CORPORATE BACKGROUND

Established in 2008, CAL was a vehicle emission after-treatment system supplier with leading original equipment manufacturers as its clients. CAL was the Indian business unit of a larger European multi-national corporation. The Indian manufacturing facility was set up to serve the country's commercial vehicle industry while it was transitioning into stricter emission regulations. CAL primarily followed European emission standards. The technology was licensed from the parent company in Europe to be deployed in the Indian market. To provide emission treatment solutions, the industry invested deeply in technology that included catalysts, chemicals and chemical reactions, sensors, software, controllers, dosing pumps, and several other automotive components. These items were mounted on vehicles to control tailpipe emissions and comply with governmental emission standards. With a workforce of approximately 50 employees, the Indian factory assembled essential components for the industry. CAL's automotive product portfolio comprised all emission control systems that a vehicle needed, from the point at which exhaust gases left the engine to the point they were emitted into the environment.

The company's early years were market by volatility and cyclicality in India's commercial vehicle industry. In addition, a graduated implementation of the emission road map and complex system maintenance made the emissions environment very challenging. CAL was only able to attract only one key client that was interested in a small share of the company's entire business. Despite its superior technology and a diverse product portfolio, CAL found it difficult to compete against market incumbents that were offering cost-effective products and were deeply entrenchment in the industry. During the 2010s, CAL's attempts to establish a position in the market failed, resulting in a catastrophic financial impact. CAL entered bankruptcy in 2010 and remained unprofitable until 2020 (see Exhibit 1). The company was unable to achieve a break-even point during its first decade. The lack of consumer demand and financial prospects led the company's investors to consider selling CAL, feeling that any further investment was unjustified. However, years of accumulated losses coupled with a weak demand outlook hindered even a potential sale of the company. CAL was facing high barriers against any advancement in new businesses or technologies.

In 2015–16, the Government of India announced the adoption of Bharat Stage (BS) 6 emission regulations, which were based on the European Union's Euro 6 standards. Starting in 2020, the country would implement this sixth level of emission regulations, effectively skipping the precursing BS 5 (or Euro 5) standards entirely. Cal saw this initiative as a renewed opportunity to offer its products and solutions to the industry, with its parent company widely seen as an established expert in the market. Millions of emission systems had been in operation in the European continent since 2016, after Europe implemented the Euro 6 norms well before India's decision to do the same. After CAL was successful in attaining a major contract from a large Indian commercial vehicle manufacturer, the company's journey toward redeeming its sinking fortunes was relaunched.

SOURCING AT CLEAN AIR LIMITED

CAL's operations used the assemble-to-order manufacturing model. This strategy was chosen because the raw material components of an emission after-treatment unit were highly valued, categorized as "class A" under the ABC analysis for inventory management.[1] The supplier base of CAL comprised a mix of local and global suppliers from China, Germany, and Singapore. CAL imported approximately 35 per cent of the company's bill of materials value. Stringent contractual clauses were maintained by overseas suppliers, which had different lead times, minimum order quantities, and ordering and delivery sequences. With a wide range of components required to assemble an emission after-treatment unit, it was a considerable challenge to synchronize delivery from suppliers, who operated on different minimum order quantities and lead times. CAL ordered materials from suppliers based purely on customer projections, keeping approximately 30 days of inventory of imported parts on hand. For locally procured parts, CAL used a three-day rolling production plan, although the company typically added a small buffer to the projections it received from customers. After an order was released to overseas suppliers, CAL had minimal flexibility on the normally tightly scheduled contracts.

CAL's global suppliers demanded that a year's confirmed schedule be provided ahead of time, with only minor variations (less than 5 per cent) allowed. For example, the schedule for calendar year 2025 had to be confirmed by October 2024. A full-year projection for calendar year 2026 was also expected at that time. Any delays in placing a confirmed order meant that CAL would incur losses in the supplier's capacity to provide the required goods. In addition to confirmed schedules, some suppliers based their pricing on minimum order quantities, which further complicated the purchasing decision for CAL. The company favoured the lower prices for higher volumes that some of its suppliers offered, which made it challenging to meet the fluctuating customer demands.

[1] This analysis categorized items by importance: Class A held the highest value with tight control, Class B had moderate value and oversight, while Class C involved many low-value items managed with simpler, less frequent reviews.

For any changes in the schedule, suppliers required a minimum of six months lead time, which carried its own associated monetary impact. Exceeding the allowed variation space resulted in increased expedition costs for CAL. Limiting the variation space resulted in monetary compensation to be paid to the supplier for unused capacities, in terms of fixed costs or raw material inventories. CAL operated on India's fiscal year schedule for businesses, whereas its overseas suppliers operated on a calendar fiscal year.

Another factor was the drastically increased demand for certain goods in Western countries due to the high retail year-end season of Thanksgiving, Christmas, and New Year. During this period, when sales increased exponentially, the use of shipping containers and liners increased considerably to accommodate the high surplus of goods manufactured in China and South East Asia. Surging demand and costs created a challenging logistics scenario for CAL during this time, forcing the company to stock a large inventory of components to avoid stockouts. The already challenging situation was further complicated by the Chinese New Year holiday season that occurred early in the year (usually, in February) and affected sourcing goods from China. All these factors resulted in complex issues for CAL's global supply chain.

THE PROBLEM AT HAND

The Indian government's mandate to use BS 6 emission norms for all vehicles produced for the Indian market started on April 1, 2020. This initiative coincided with the onset of COVID-19 across the world, which had a devastating impact on the global economy. As a fledgling venture, CAL had suffered a challenging first decade of operation and was once again facing major hurdles. The company had to manage global supply chains during a global crisis, with one-third of its components imported from global suppliers. With cash flows severely constrained, CAL struggled to pay suppliers on time, but borrowed funds and a capital infusion from a key investor helped CAL emerge unscathed from the pandemic. However, the challenge left an indelible mark on the company. CAL had to start planning for exigencies and become more efficient and flexible in managing its plant and operations.

After 2021, the emissions control industry recovered and customer demand began to surge. In response, CAL increased its production capacity and its workforce grew to 100 employees. Although global crises and supply chains difficulties were overcome, a new complication was the sudden rise in consumer demand. The increased business ushered its own new sets of challenges, especially for planning imports of components. Difficulties arose from the perspective of ordering and planning and from the perspective of inventory and cash management.

Faced with multiple challenges, Prakash had to develop an inventory planning model for imported parts. The Indian commercial vehicle industry was highly volatile. The current surge in demand from clients would not be sustainable for CAL over the long term. Fixed order quantities and extended lead times made it extremely difficult to plan appropriately. Any unmet demand from clients made CAL liable for demurrage fees to customers, in addition to any incurred expediting costs.

PRAKASH'S INTENDED QUICK FIX

Prakash joined CAL in December 2020 as general manager of the company's sourcing and supply chain team. In his new position, he was mainly tasked with strengthening and stabilizing CAL's supply chain to meet India's BS 6 requirements, which were based on Euro 6 regulations. The immediate challenge for Prakash was to help CAL rise from the depths of the COVID-19 pandemic. He then had to address geo-political issues such as the Suez Canal blockade in early 2021 and the impact from the Russian invasion of Ukraine in February 2022. After assuming his role as head of the sourcing team, Prakash had to address

cash flow management during volatile times and CAL's limited borrowing abilities due to a decade of financial difficulties. Prakash wanted to avoid making the same mistakes of the past. Financial management had to improve so that CAL could sustain and scale its operations. Before long, the company would need more technology investments for future implementations of the next phase of emission norms—BS 7 (or Euro 7). He decided that a scientific inventory modelling process had to be implemented. Therefore, in 2024, he made the choice to enrol in the Executive Program in Supply Chain and Logistics at the Central Institute of Management and Consulting.

Prakash's interactions with the business management school's professors and research associates introduced him to the fundamentals of demand forecasting and how they translated to a master production schedule. He understood time series forecasting principles and their extended versions. In February 2024, after completing the on-campus module of the program, he set out to create a local spreadsheet planner for sample import data of the raw material components of CAL (see Exhibit 2 and Exhibit 3). From his research work, he recalled some key advice that a professor had given during the introductory class on forecasting:

> Forecasts must be made frequently, monthly or weekly, on a routine basis. There are certain desirable characteristics of these forecasts that need to be able to introduce the latest sales information easily and cheaply.

He was aware that the forecasting model had to incorporate the cyclic nature of demand values and other typical considerations such as a baseline level, any observed trends, and seasonality patterns. Prakash developed the forecast planner, conducted sensitivity analyses, and obtained forecast validation results, while allowing for flexibility in parametric settings. He used these forecasts as the input for the master production schedule planner. He compared the costs of the different available strategies for setting up the master production schedule, including heuristic approaches such as the Silver-Meal algorithm and the optimal methods.[2]

Prakash felt that incorporating forecasting models that capture seasonality and trends would enable CAL to achieve better forecasts, which would reduce stockouts during peak demand periods and overstocking during low demand periods. The improved forecast models would also enable better supplier coordination. In turn, suppliers would be able to provide delivery schedules to help CAL reduce efforts for makeshift arrangements, when it was necessary to expedite raw material components during crucial situations. Prakash knew that this project was the foundation for the continuous developmental of CAL's sourcing team and wanted to establish a replicable mechanism. He hoped to do so in coordination with his sourcing team and with several people he had met during his studies at the Central Institute of Management and Consulting.

[2] Assumptions for this demonstration included fixing the set-up cost at ₹500 and the inventory cost per item per month at ₹0.01 (₹ = INR = Indian rupee; ₹1 = US$0.012 on April 1, 2024).

EXHIBIT 1: NET PROFIT FIGURES OF CLEAN AIR LIMITED

Financial Year	Net Profit (in ₹ Million)
2009	–20.10
2010	–18.55
2011	–25.45
2012	–27.60
2013	–35.22
2014	–27.42
2015	–30.20
2016	–35.35
2017	–38.25
2018	–38.63
2019	–22.27
2020	–29.13
2021	38.30
2022	309.30
2023	720.90

Note: ₹ = INR = Indian rupee; ₹1 = US$0.012 on April 1, 2024
Source: Created by the case authors based on company documents.

EXHIBIT 2: RAW MATERIAL IMPORTS

Supplier	A			B	C		D	E	F
Country	**China**			**China**	**Germany**			**Singapore**	
Item	1	2	3	4	5	6	7	8	9
Unit value	₹1,200	₹400	₹200	₹7,000	₹1,200	₹1,200	₹3,500	₹2,500	₹5,500
Lead time (in months)	6	6	6	6	6	6	12	12	12
Cost of line stoppage	₹75,000	₹75,000	₹75,000	₹75,000	₹75,000	₹75,000	₹75,000	₹75,000	₹75,000
2021 annual demand	63,830	60,000	60,000	53,000	64,560	64,560	60,000	60,000	36,408
2022 annual demand	110,000	100,000	100,000	100,352	85,920	85,920	100,000	72,000	80,160
2023 annual demand	120,000	130,000	130,000	131,837	120,000	120,000	100,000	126,300	80,640

Note: All demand values are in unit numbers; ₹ = INR = Indian rupee; ₹1 = US$0.012 on April 1, 2024
Source: Created by the case authors based on company documents.

EXHIBIT 3: MONTHLY DEMAND VALUES OF RAW MATERIALS

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9
Jan-21	2,940	1,993	6,136	2,049	1,177	10,063	1,216	9,240	1,219
Feb-21	4,280	2,265	6,125	4,530	2,827	10,590	1,466	11,891	2,109
Mar-21	4,951	3,628	7,993	4,760	3,906	10,791	1,904	11,526	3,004
Apr-21	5,230	4,675	6,458	4,630	3,380	10,569	2,248	12,089	3,072
May-21	4,340	2,035	1,363	4,340	1,875	10,116	1,507	11,631	1,102
Jun-21	6,533	2,877	615	4,450	724	11,383	463	12,727	615
Jul-21	6,706	2,378	743	4,500	391	11,206	516	12,826	383
Aug-21	2,900	1,981	2,396	3,530	2,392	4,830	1,176	5,630	2,096
Sep-21	4,100	2,817	4,069	4,980	4,586	4,401	2,501	4,893	3,909
Oct-21	4,850	4,522	4,863	6,700	5,623	7,676	3,109	9,879	4,220
Nov-21	4,300	4,750	4,459	5,350	4,407	9,350	3,655	10,503	3,258
Dec-21	4,548	3,751	3,928	5,324	4,588	12,000	4,334	12,158	2,992
Jan-22	7,040	5,253	6,393	7,240	5,232	10,300	3,796	11,585	4,782
Feb-22	6,950	7,875	7,969	6,730	6,038	11,020	5,931	13,172	5,451
Mar-22	8,157	8,730	10,892	7,672	8,335	18,173	7,139	19,616	7,130
Apr-22	8,120	7,304	7,849	8,310	7,381	12,610	5,429	14,142	6,156
May-22	8,466	7,712	9,486	9,306	8,337	15,066	5,481	17,279	7,225
Jun-22	9,104	7,835	8,816	9,821	8,583	13,736	5,413	16,163	6,662
Jul-22	9,143	7,442	9,584	9,860	8,312	13,977	4,427	16,198	7,054
Aug-22	6,588	4,649	6,308	7,430	5,962	10,933	4,650	12,649	5,348
Sep-22	8,045	8,602	8,681	7,100	8,732	15,963	5,517	15,716	7,511
Oct-22	10,065	9,006	8,830	9,275	9,319	11,855	6,038	11,233	7,374
Nov-22	10,790	8,324	9,422	10,224	9,588	18,581	7,120	18,614	7,502
Dec-22	9,805	11,186	11,346	8,525	11,003	17,122	7,489	16,613	9,906
Jan-23	11,744	10,443	11,807	11,845	11,273	15,883	6,424	17,468	10,367
Feb-23	14,794	12,435	13,997	14,602	12,246	17,434	7,653	21,473	11,847
Mar-23	12,357	12,671	14,445	13,860	12,861	17,604	5,568	21,063	11,369
Apr-23	8,914	9,872	9,332	10,355	10,374	13,076	5,578	16,486	7,984
May-23	12,355	11,681	9,704	12,740	9,144	18,213	6,010	22,747	8,348
Jun-23	11,468	10,758	7,565	11,402	8,106	15,173	6,647	18,992	7,199
Jul-23	7,352	8,031	8,663	8,702	9,845	10,722	5,294	13,551	8,243
Aug-23	12,019	12,083	11,073	11,910	11,514	17,798	7,129	20,440	9,985
Sep-23	14,692	12,893	11,495	13,171	11,223	17,573	7,540	20,801	10,915
Oct-23	12,235	13,453	12,759	9,957	10,009	15,168	5,735	16,424	10,417
Nov-23	13,321	11,770	12,516	10,692	9,362	16,545	5,356	16,838	9,892
Dec-23	10,011	10,134	8,589	8,234	7,050	11,602	5,657	12,012	7,309

Note: All demand values are in unit numbers.
Source: Created by the case authors based on company documents.