

Artificial Intelligence: Transforming Supply Chain Management

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Abstract

The case provides an understanding about the importance of artificial intelligence (AI) in supply chain management. The case illustrates interesting discussion points when Indian Consumer Goods Company Ltd. (ICGC) plans to implement AI to improve supply chain services. ICGC, a big FMCG company, relies heavily on the supply network for fluctuating demands. The company has a supply department comprising operation, procurement, and services teams. The company was keen to modernize the supply chain network to have a competitive advantage over competitors. The case presents the application of AI in various supply chain domains such as purchase and procurement, operations management, and planning and forecasting. The case will be helpful for managers and executives to take decisions regarding the application of AI in the supply chain.

Key words: *Artificial intelligence, supply chain management, machine learning, internet of things,*

Introduction:

Mr. Rajeev Sharda, the Chief Executive Officer (CEO) of the Indian Consumer Goods Company Ltd. (ICGC), a reputed fast-moving consumer goods (FMCG) company, envisioned sustainable growth for the company. Therefore, he decided to discuss the matter with the functional directors of the company. Rajeev organized a meeting with the directors of the company, where he solicited their ideas and requirements for sustainable growth.

In the meeting, the Director of Marketing and Sales stated, “The company has a product portfolio which is in demand due to the current Covid-19 scenario.” He further added, “The growth of the company can be further increased if the supply of these products becomes more agile and quicker.”

At ICGC, the supply department was headed by Mr. Rajan, an experienced professional in the FMCG supply sector with a vast knowledge of operations, procurement, and supply network. Rajan asked the Director of Marketing and Sales to provide an example where agility in supply was required.

The Marketing and Sales director provided the example of the floor disinfectant's whose demand had increased in Covid-19; however, the supply was not adequate to provide the required quantities within the desired time. He also gave an example where the procurement process could not procure the materials because of dependency on manual procedures, which increased the lead time.

Rajeev also put forward his point in the discussion, "We are facing challenges in demand forecasting, and the supply network planning is struggling to meet the forecasting accuracy."

The Director of the Information Technology (IT) division was also present in the discussion. He pointed out that "The rival companies have implemented artificial intelligence (AI) technologies, and they are getting the desirable results from AI. Therefore, the supply department should now plan to implement AI to reduce dependencies and improve accuracy."

The Director of Finance present in the meeting added "It is true that advanced technologies like AI creates opportunities for the firm. However, we also need to consider the significant investment cost incurred in the implementation of these technologies. We need to do some cost-benefit analysis before implementing AI technologies."

Rajeev listened to the discussions carefully. He believed that the Supply department would need to be more agile to the market demands to sustain in the market. Rajeev handed this task to Rajan to explore the possibility of implementing AI to improve services in the supply division. Rajan discussed with the senior managers of the Supply division. They identified the following issues which needed to be addressed:

1. A lot of documentation and manual dependency
2. Inaccurate forecasting
3. Procurement with old technologies
4. Inventories dependency on manual inputs
5. Quality checks are slow and manually done

Rajan and the supply team wanted to address the above-listed issues. However, they wanted a dedicated person who could explore the applicability of AI in supply chain management. The senior managers of the supply division suggested to Rajan, "We need to externally hire a person who has a good understanding of the AI and supply chain. The existing internal employees may resist change

because advanced technologies such as AI will be impacting the existing processes of the company. Therefore, the hiring of an external resource is a better option.”

Rajan agreed to the suggestions provided by the senior managers of the supply division. He had a discussion with the HR director about the requirement of an employee to do the job. Ms. Lata, the HR Director, started looking for a person who had a good understanding of AI and the supply chain.

Parth, a brilliant student of a top management institution in India, was offered the job in ICGC. He was given the opportunity to identify the supply chain areas to improve efficiency and service the market at a higher fill rate. Parth had to explore various AI technologies that could be implemented in ICGC to modernize the supply chain network to better service the market. Rajan was excited about the project. However, at the same time, he knew the challenges involved in the implementation of AI in supply chain.

Company Background:

ICGC is an FMCG company that had been around for 30 years and had a net revenue of \$ 6.4 bn. ICGC produced consumer goods and pharmaceutical products. The company had a wide variety of products from soaps to disinfectants to pain killers (**see Exhibit 1**)

ICGC had developed a wide variety of household and FMCG products in the last few years. Therefore, it had seen tremendous growth over the years. The revenue growth of the company in the past five years can be seen in **Exhibit 2**.

ICGC had a supply department with the operation, procurement, and services teams taking care of end-to-end inbound and outbound processes. ICGC's supply chain enabled the flow of goods and services from the suppliers to customers (refer to **Exhibit 3** for the supply chain network of ICGC). The ICGC supply chain had an active streamlining of business requirements and supply-side activities to cater to the market adequately. At ICGC, broadly, the four primary elements for supply chain were Integration , Operations, Purchasing and Distribution

A significant degree of integration and coordination was required in ICGC's supply chain to ensure a seamless flow from plan to completion. Rajan realized that the company should look for something beyond human intelligence because it required a competitive advantage in the marketplace. After discussion with the team members and some of the other supply experts, he entrusted Parth with the task of looking at the application of artificial intelligence (AI) to improve the processes' efficiency and effectiveness.

Applications of Artificial Intelligence (AI):

AI is a technology where machines are developed and created to mimic, learn, and replace human intelligence. AI has been useful in effective decision-making that increases productivity in various business endeavors (Duan et al., 2019; Dwivedi et al., 2019). AI is also known to recognize business patterns and learn the business phenomena while seeking information and analyzing data intelligently (López-Robles et al., 2019). Researchers (Chae et al., 2014; Sahay & Ranjan, 2008; Souza, 2014) have advocated the use and application of AI in supply chain management (SCM) that could be exploited more. The global software market for AI services was increasing very fast. It was expected that the global AI software market would reach 126 billion dollars by 2025, as shown in **Exhibit 4** (Liu, 2020). According to Gartner's survey (2019), organizations grew from 4% to 14% during 2018-19 after implementing AI solution. Supply chain management also had enormous potential for the implementation of AI. Researchers and analysts have suggested various methods to implement AI in the supply chain. Min and Yu (2008) have proposed an agent-based forecasting system that can predict end-customer demand based on the information exchanged amongst various supply chain partners. Artificial neural networks have been applied by experts to traditional lot-sizing problem (Gaafar & Choueiki, 2000).

With the amount of advocacy for AI in SCM that prevailed, it was not surprising that Parth started reviewing AI applications in SCM and identifying the most applicable areas of AI in SCM. Parth also focused on big data, a large set of structured, semi-structured, and unstructured data that can be generated, analyzed, and used by the internet of things (IoT). IoT provides a system where physical objects are connected through the internet. Rajan introduced the company's requirements to the Parth and further told him to come up with a proposal for the applicability of AI in the supply chain of ICGC.

Supply Chain Process at ICGC:

Parth had an idea to speed up and improve the processes of SCM using AI and big data analytics. Therefore, he decided to study ICGC's current process in the supply chain domains of A) Purchase and procurement B) Operations management and C) Planning and forecasting to design a framework for the easy application of AI.

A) ***Purchasing and inventory control.*** Parth had multiple rounds of discussions with the procurement manager to study ICGC's procurement process. He broadly classified the purchasing process into seven areas to understand the feasibility of the application of AI. The areas were Supplier risk management, Strategic sourcing, Contract management, Spend analysis, Quality check, Payments and Inventory control.

Parth carefully studied all the areas of the purchasing process. He tried to determine the scope of improvements in these areas to make the overall purchasing process effective and efficient.

i) *Supplier risk management.*

Importance: Organizations are highly dependent on suppliers for raw material for achieving their business objectives to ensure the continuous flow of raw material to maintain production.

Findings: Parth reviewed that ICGC had many suppliers, and the procurement manager was finding it difficult to keep track of every supplier manually to ensure proper raw material flow in the future. Interestingly, Parth found problems with some of the enlisted suppliers who had suddenly gone bankrupt and closed their operations.

ii) *Strategic sourcing*

Importance: Strategic sourcing helps the organization target the lowest total cost of ownership (TCO) while reducing the minimal supply chain risk such as supply delay or cost elevation.

Findings: Parth observed that there were a lot of open opportunities that needed to be reviewed, which could lower the total cost. The procurement manager told Parth that manually scanning was a difficult job.

iii) *Contract management*

Importance: Contract management allows a firm to create and execute the contracts with proper analysis. It aims to increase the operational and financial performance of the organization while reducing the financial risk.

Findings: At ICGC, Parth found that contracts had been written in contractual terms and were usually kept offline. This practice made these informative documents not available readily to the procurement teams, which could extract meaningful information like re-negotiation rights.

iv) Spend analysis

Importance: Organizations always aim to optimize procurement costs and increase profits. Indeed, cost-cutting in the procurement process helps in generating huge savings every year.

Findings: At ICGC, the procurement process created a complex hierarchy of categories and sub-categories that made it difficult to maintain high data quality.

v) Quality check

Importance: Firms produce raw materials used by other firms to make final products. These organizations face high competitive pressure to produce the best quality raw material and make sure no defective material is passed to the customer firm.

Findings: Parth found that the organization was using probabilistic theories to identify the defective materials in coils' production. Coils are low seasonal-affective goods, and there is high competition in the coil-making market. Many times, these probabilistic theories become inefficient in competition with competitor firms.

vi) Payments

Importance: Firms process huge amounts of payments to various vendors and suppliers according to legal contracts, stating the timeline of payments.

Finding: Parth observed that a significant workforce was needed to verify the timeline and process many transactions to make it an error-free process.

vii) Inventory control

Importance: Inventory control is essential to SCM. Firms stocking all the products and then deliver according to the orders they receive. So, they must maintain enough inventory to ensure that the supplies keep moving.

Findings: At ICGC, the major problem corresponding to inventory management was that the systems did not know what amount of inventory was required to meet customers' needs. Consequently, they faced challenges in knowing not to overpopulate inventory and block cash. Some estimates were done but they were not able to clearly identify the items that needed to be procured.

B) Operations planning and control. Parth was aware that the operations planning in a firm directly affected a company's functioning and made it run smoothly and efficiently. Various industries such as manufacturing, information technology (IT), and service provider firms work very hard to ensure that their business runs properly to earn profits. For firms like

ICGC, they needed to manufacture their products on time, with less cost, better quality than competitors, and meet the customers' expectations.

Parth's interaction with the operations team revealed scope for improvement in many areas. The operations team wanted to work at a faster pace to achieve their goals efficiently. They had generated enormous data regarding the anomalies in the product built by them. Many of the applications and softwares reported the crashing of a process that was being carried out in them. There was a possibility of many reports regarding failures in multiple stages, and analyzing all the records and doing root cause analysis was a bit tedious and time taking job. There was a possibility of security breaches on the company's servers, and these threats were needed to be handled before they could start attacking the resources of ICGC.

C) Demand forecasting and planning. With the emerging use of AI and ML in supply chain analytics, demand forecasting had become one of the most important applications of AI in supply chains. However, AI-demand forecasting was still evolving and research was happening in this area. AI analyzes and learns the historical patterns or past experiences that help understand complex relationships and various factors affecting demand. Efficient demand forecasting can provide a firm with numerous advantages over other firms in planning and preparing for customer demand and supply. But most of the firms were in a dilemma and asking, "How were these new techniques like AI and ML performing as compared to already established forecasting practices?"

Parth observed that for household products such as bathroom cleaner, ICGC had seen stability in demand. The demand for bathroom cleaners was predictable due to fewer variants of the product. ICGC observed the high competition in this segment in the market. To sustain this competition, ICGC needed to keep inventory and transportation costs to a minimum to gain an advantage over other firms. An extra inventory could lead to additional transportation used in procuring that material. So proper inventory management could act as a direct cost-cutting tool. A firm could beat the competition in the market if it provided attractive lead times to its customers.

Findings: Parth found that at ICGC, the traditional forecasting practices such as Holt-Winters and Damped trend were used to predict the product demands. Parth observed that these traditional methods did not handle irregular patterns in the data well. In this era, a product's demand fluctuated and moved up and down depending on various factors and

macroeconomic forces. Consequently, traditional forecasting methods were not competitive enough in today's time.

After gaining an understanding of all the processes in the supply chain at ICGC, Parth started wondering what suggestions could be based on the findings to support implementation of AI. The question was should ICGC go ahead with the use of AI at this time and which field should be targeted to achieve maximum benefits.

Feasibility of Implementation of AI at ICGC:

Parth's objective was to study the usages and feasibility of the implementation of AI in the SCM. To do this, he needed to understand the various processes of SCM to improve the efficiency and accuracy of the SCM.

Purchasing and inventory control. Parth discussed with Rajan and the procurement managers to study the ICGC's current procurement process to explore the possibility of AI implementation (Cavalcante et al., 2019).

Supplier risk management. Parth suggested to Rajan that the supplier problem could be solved through AI that could analyze a huge amount of data to identify risks and send alerts to the suppliers regarding future issues, thereby reducing the supplier risk to ensure proper flow of raw material.

Strategic sourcing. To overcome this, Parth suggested the use of cognitive computing, a branch of AI. Cognitive computing performs operations like a human. With the help of cognitive computing for the buyers and procurement teams, new options could be identified or non-strategic sourcing activities could also be automated. Technical assistants such as chatbots, an example of cognitive computing, could also be used.

Contract management. To overcome this, Parth's suggested the use of optical character recognition (OCR). With OCR, organizations identified text automatically from scanned images of legal contracts and digitized them in text files. After that, text mining, sentiment analysis, and various natural language processing techniques could also be applied to the text extracted from the OCR application. Organizations could mine legal contracts to get valuable information from it.

Spend analysis. Parth suggested to Rajan that, with machine learning algorithms, procurement expenditures could be easily segmented based on various cost elements. New incoming

expenses could also be categorized using this technique to find out the important patterns to make informed decisions.

Quality check. This problem according to Parth could be solved using AI to segregate the defective material from good material. A camera could be used to get the grain images of a commodity. AI algorithms such as image analytics could identify the texture and quality that would help find out any defect by learning the attributes of good material.

Payments. Parth believed even this task could be automated with the use of AI to help perform the process of payment according to legal contracts and identify the frauds or anomalies in the payment process. The application of AI would reduce the human effort as well as the errors and frauds in the payment process.

Inventory control. Parth strongly recommended that AI could be used to forecast the amount of inventory that a company needed on a day to meet the requirements of its customers. Many techniques could be used for inventory forecasting. A time series forecasting could be used on the historical inventory data. This technique would help understand the past demand patterns by understanding the trend, seasonality, cyclic fluctuations, and irregular variations in the time series data (Yolcu et al., 2013). Various time series forecasting techniques such as autoregressive integrated moving average (ARIMA), artificial neural network (ANN), long short-term memory (LSTM), recurrent neural network (RNN), etc. (Gonçalves et al., 2019; Pradeepkumar & Ravi, 2017; Sermpinis et al., 2012). The reinforcement learning method could be used for proper inventory control. In this method, there is a model punishment if it lets a raw material run out of stock. Punishments are also put for creating a large stock and holding cash reserves.

Operations planning and control. Operation planning and control helps in controlling and scheduling of materials, human resources, and financial inputs to produce the effective and desired products. The objective of operation planning and control is resource optimization to provide maximum throughput of the work. Better operation planning helps to simulate the various effects of the changes in materials and resources. AI helps organizations integrate the data from multiple sources such as manufacturing information systems, equipment data coming from the internet of things (IoT) technologies, customer data coming from various e-commerce platforms, and product data related to consumers' usage. Further, data exploration, data cleaning, and data visualization help understand the overall operations planning and control process better. After that, machine learning models could be trained on the available data. The trained models could then be used for better

prediction and recommendations. Effective recommendations based on AI helps to form better customer and supplier relationships.

To support his facts, Parth corroborated to Rajan that Amazon was using AI to hire a new employees. Amazon used an AI algorithm to generate a score depending upon the education and qualification of a new candidate. The AI models were trained over previous hiring data, and every year, they could hire a person having a score above the previous year's score so as to hire a better employee every year compared to the previous year.

Demand forecasting and planning. Parth noted that ICGC was using old traditional methods. He found out the scope for the implementation of AI tools. AI-enabled forecasting methods are more advanced to address challenges that were not adequately handled by traditional forecasting methods. The application of AI could lead to both supply chain efficiency and meeting customer demands and engagements.

Improving efficiency by application of hybrid algorithms. Many firms aim to obtain hybrid solutions that could combine old traditional methods of forecasting with AI-enabled forecasting. For example, steel manufacturers deployed the combination of ARIMAX (an extended version of the ARIMA model) and Neural Networks. In the FMCG sector, organizations used the ARIMAX model, which uses the information of inventory sold in the past. It puts an autoregression on moving averages of the inventory demanded in the past time. However, many factors may affect future demands, such as publicity campaigns organized by ICGC and sentiment analysis corresponding to ICGC's certain product (for example, sentiments corresponding to pandemics like Corona, which out broke the demand for sanitizers). With the emerging technology of AI, advanced models like Neural Networks could be built, which could provide the information corresponding to the external factors that significantly impacted demand for any product of ICGC. Information regarding the campaigns on social media and customers' sentiments regarding product and company can be used to make more informed forecasting of future demands. So, if a hybrid model was built by using ARIMAX (which will be providing auto regressive demands by taking information from the past) and AI-enabled Neural Network model (which will be giving important information regarding sentiments and campaigns which are being organized by ICGC), then this hybrid model would work more logically and accurately in predicting demands in future.

Looking Forward:

Rajan discussed with the Parth the possibility of applying AI in the supply chain of ICGC. Parth explained to Rajan, “Supply chain of ICGC needs AI implementation to make the intelligent knowledge network, which is essential to solving the complex business problem. In today’s world supply chain is emerging with the latest trends. Knowing the supply departments and learning from the past data and patterns by automating the supply chain process has become critical. Therefore, AI can be used as an essential decision tool that provides organizations relevant information regarding their suppliers, partners, customers, and retailers across the supply chain.” Rajan agreed to Parth’s points. However, he was aware that the implementation of AI would significantly affect the existing processes of the ICGC. AI technologies would also require significant investments from the company. Therefore, he was planning to meet the CEO, Rajeev, and other functional directors to take further action.

Exhibits**Exhibit 1: *Range of Products manufactured by ICGC***

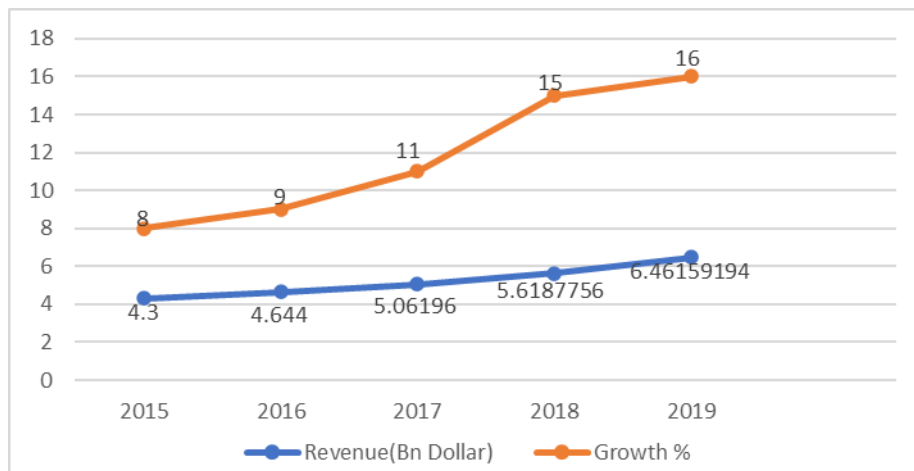
ICGC manufactures the following FMCG products:

1. Antiseptic Soaps
2. Handwash liquid
3. Floor disinfectants
4. Toilet Cleaners
5. Mosquito replicants

The company also has the following products in the pharmaceuticals segment:

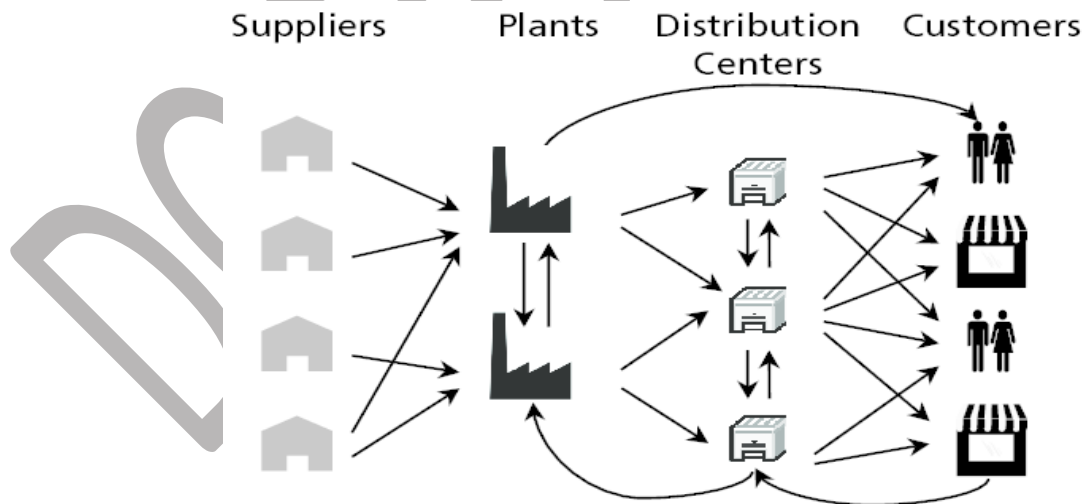
1. Joint pain ointments
2. Cough syrups
3. Fever tablets
4. Sanitizers

Exhibit 2: The growth of ICGC ltd. for the last five years

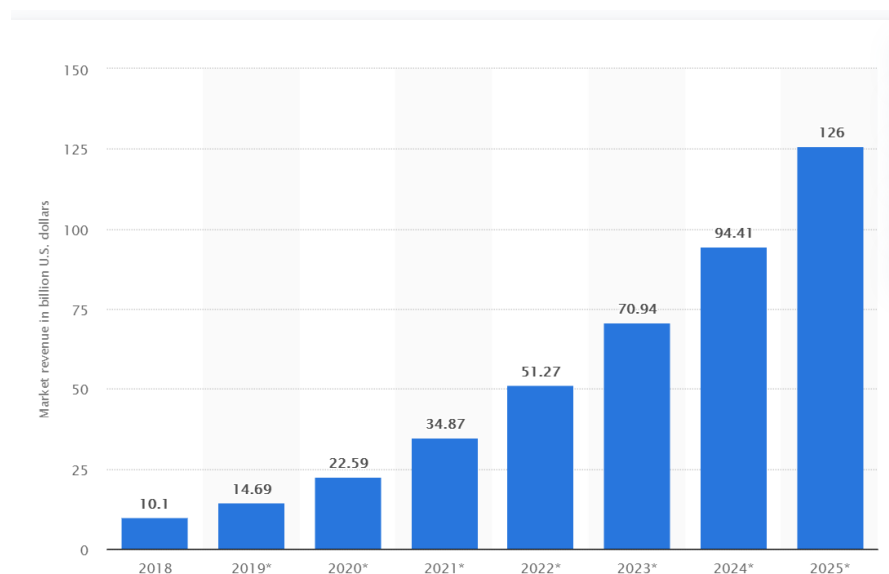


Source: Authors own

Exhibit 3: ICGC supply chain network



Source: Authors own

Exhibit 4: Worldwide revenue from AI software market

Source: Statista 2020

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