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# A-Frame Reverse Logistics, Inventory Management & Forecasting Analysis: A Case of Saint-Gobain's Bhiwadi Plant

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**Abstract**

Managing A-frame returns at Saint-Gobain Bhiwadi is a critical operational problem and needs strategic solutions. Moreover, ensuring the presence of a buffer stock also enables the operations at the manufacturing plant to be more sustainable. This is crucial, as the results from the statistical analysis estimated that 80% of the 10,951 units being manufactured remain non-returnable by the customers. The use of Simple Moving Average (SMA) and Weighted Moving Average (WMA) forecasting models, as well as the use of GPS-based tracking systems by the company are also helpful in the identification of operational hindrances, asset tracking and potential demand of the customers regarding the use of A-frames. Based on the evidence gathered in the literature review and statistical analysis, the company is recommended to re-validate the WMA analysis results in a few months, implement a real-time tracking system through the use of JIO tags and improve the quantity of buffer stocks.

## 1.0 Introduction

Returnable transport items are reusable logistic equipment that include pallets, crates, totes, and frame carriers. Inefficiency in handling and managing these RTIs can lead to disruptions in the production flow. According to Katsanakis (2023), global trading activities rely heavily on several billion-transport packaging and returnable transport items, including pallets, containers, and crates. The A-frame is now an essential logistical resource used by Saint-Gobain in the process of manufacturing its products in order to handle and transport finished products efficiently and safely from one location to another. At the Bhiwadi Plant, management of these returnable transport units is a critical problem since almost 80% of the total number of A-frames manufactured (10,951) have not been returned to the company. This paper explores the reverse logistics, inventory management, and demand forecasting operations of the Bhiwadi plant using the information collected during a two-month internship conducted between June and July 2025. With an analysis of the link between issued quantity, pending quantity, and returned quantity, and a comparison of simple moving average with weighted moving average forecasting, the paper attempts to find some useful solutions that can increase return rate and inventory management. The results generated in this research will further enhance the debate about sustainability in the field of supply chain management in the construction material industry.

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## 2.0 Literature Review

### 2.1 Demand forecasting: Simple versus weighted moving averages

The forecasting of demand for A-frames in the market is a critical factor for the rationalisation of the manufacturing operations at the manufacturing units in a sustainable manner. According to a study, understanding by the leadership of manufacturing companies about the strengths and weaknesses of calculating the value of moving averages plays a key role in supporting future planning (Tang et al. 2022). This also enables the manufacturing units, particularly SMEs, to ensure financial stability and help in the expansion of operations in the global market. On the other hand, simple moving averages (SMA) and weighted moving averages (WMA) values are crucial to understand the demand of a particular product in the market (Tliche et al. 2023). However, the use of both these processes has a negative impact on estimating the weightage of the products and leads to reduced forecast mean-squared error.

On the other hand, working in close proximity regarding the determination of the most suitable angle of opportunity for best fitting of the manufactured frames is crucial for financial sustainability. Failure to analyse these factors, such as rapidly changing consumer demands in the market, also leads to strategic failure and increases project cost. In relation to the use of Bhiwadi plant data, consideration of this data is crucial to support the growth of operations and better inventory management.

### 2.2 Safety Stock and buffer inventory design

Maintaining a buffer product stock to ensure the safety of operations during supply chain crises and support the manufacturing operations. The presence of a safety stock adds to material variation and manages the risk of stockout situations in times of variation of demand and supply in the market (Hedvall, Mattsson & Wikner, 2025). Moreover, in a safety stock approach, the number of days available to complete the manufacturing operations is also being calculated to satisfy the needs of the companies. In the case of the manufacturing of A-frame in the current project, maintaining 10% buffer stock as a safety measure to ensure better compliance with the regulations and customer expectations seems reasonable. Despite this, continuous tracking of the return rate data is essential to boost the operational resilience of the manufacturing unit.

### 2.3 Reverse logistics for returnable transport items

The concept of reverse logistics has grown in prominence significantly in recent decades and has a positive impact on satisfying the needs of better inventory management. According to the reverse logistics model proposed by Rivera and Nahmias, the market demand for remanufactured and repaired items is not the same as that for fresh products (Forkan, Rizvi & Chowdhury, 2022). On the other hand, ensuring the development of sustainable reverse logistics solutions also enables the manufacturing units to manage the environmental impact and boost the sustainability credentials for future generations (Ali et al. 2020). In the current project, associated with the manufacturing of A-frame nodules at the Bhiwadi plant of Saint-Gobain, it is found that there is a major focus on inventory control and network design at the plant. This led to increased uncertainty regarding the availability of sustainable products and may hamper the financial returns for the company in the international market. For instance, it was assumed that the plant would achieve a 20 per cent return rate after the sales of the manufactured frames (10,951 A-frame) units. However, this can lead to an increase in losses for the company and requires a fresh operational strategy.

### 2.4 IoT-based low-cost asset tracking

The application of digital technologies such as blockchain and AI with the use of IoT devices plays a key role in helping manufacturing companies with real-time inventory tracking and better supply chain management. According to Taj et al. (2023), the integration of IoT devices into the supply chain processes of companies helped to boost collaborations and ensure better decision-making within the manufacturing ecosystem. Technologies such as RFID offer a low-cost option for the tracking of materials and help warehouses achieve a high rate of operational accuracy (Akeem & Sonu, 2025). The technology functions on the basis of scanning specific barcodes and offers companies real-time solutions and satisfies key needs. The use of Android network-based GPS tracking (JIO Tag GO) at the manufacturing facility at Bhiwadi has key benefits in terms of operational resilience and support for future growth. The indoor localisation of the identified network, however, mainly depends on the availability of products and machinery used for the purpose of manufacturing (Ullah, Younas & Saharudin, 2025). Therefore, the deployment of RFID technology in an environment which functions with the use of GPS-based tracking has increased the risk of cross-purpose and hampers its popularity, based on the Technology Acceptance Model (TAM).

## 3.0 Methodology and Data Collection

### 3.1 Data description

All the data to analyse the manufacturing operations followed at the Bhiwadi plant of Saint-Gobain was gathered during the internship period, within the months of June and July, 2025. After gathering the relevant data, it was placed in an Excel sheet for better understanding and future analysis.

The gathered dataset includes the types of A-frames, the pending quantity of such frames, the issued quantity and the received quantity with dates. Moreover, the location and other details of the plant were also collected for this research. This was implemented to ensure there is no missing return-related information, which makes the calculation of total cost highly difficult (Genchev, Glenn Richey & Gabler, 2011). Therefore, the gathering of information related to the length, weight and type of material used in the manufacturing of A-frames, as well as the quantity manufactured, is important.

### 3.2 Methodology

The methodology in this research process involves the determination of the inventory logic, the forecasting techniques and the development of a comprehensive process flow. It was found that the information related to issued and received quantities is incomplete and remains inconsistent with the raw records of the manufacturing plant. As a result, some key assumptions were made to describe the manufacturing process of A-frames within the plant.

After the determination of the quality and consistency of the gathered data, the process flow was constructed. Thereafter, monthly demand of A-frames in the market from January through June was estimated and two different forecasting techniques: a three-month Simple Moving Average and a three-month Weighted Moving Average were applied. The calculation of moving averages (MA) helps in better monitoring of the quality characteristics of the distribution variables (Raza et al. 2023).

#### *Forecasting Analysis*

The weighted averages were assessed for the values of 0.5, 0.3 and 0.2 for the most recent. Lastly, forecast accuracy was compared using Mean Absolute Deviation (MAD) over the April–June out-of-sample window. This is justified, as MAD enables better quantification of data variability and improves the understanding of the problem

(Arnold et al. 2024). Moreover, the selection of WMA weights with values 0.2, 0.3 and 0.5 was applied, as the latest data indicates that the demand for A-frames is maximum for these weights over the preceding two months.

On the other hand, the selection of the A-frame structure with these weight values is appropriate because the demand showed an upward trend during the study period, increasing from 1,200 units in January to 1,561 units in June. Therefore, providing 50% weight for the latest month improves responsiveness to change, while 30% and 20% weight reduces potential excessive sensitivities to short-term demand fluctuations at the Bhiwadi plant.

***Field trial***

After the completion of the forecasting analysis, a field trial will be set up and completed within a 4-day period. In this step, on day 14 after the initial development of the tracker, it was welded onto a sample A-frame. On day 15 and 16 of the field trial, the welding position of the tracker was marked with red paint as a secondary visual identifier. After that, on day 17, subsequent JIO Tag GO Android-network tracker was installed and tested under the live operational conditions of the plant. The definition of success, which will enable the plant managers to accept the tracker as a viable solution to manage reverse logistics, is related to the achievement of WMA error rate of less than 40%. It is justified, as the fall of error by 1.2% results in 9% improvement of cost-benefit analysis regarding the use of an A-frame (Reddy et al. 2024). The results of this field trial will enable the managers of Saint-Gobain to order the required number of A-frames as per demand to support reverse logistics.

## 4.0 Results

### 4.1 Inventory position

The results of the reconstructed inventory position for the manufacturing of A-frames at the Bhiwadi plant, Saint-Gobain, are given below.

| Category | Units | Basis of Estimation |
|---|---|---|
| Total A-frames | 10,951 | Pending/0.8 |
| Pending (in circulation) | 8,761 | Directly recorded in Excel sheets |
| Received (returned) | 2,190 | Assumed 20% of issues |
| Buffer stock (reserve) | 1,095 | 10% of issues |

**Table 1: Result of inventory position**

(Source: Self-made)

The result from the inventory position at the Bhiwadi plant of Saint-Gobain showed that the total number of manufactured A-frames stood at 10,951. If it is assumed that 20% of the products were returned by the customers in the market, the number stood at 2,190, while the buffer stock for operational safety was up to 1,095 units. This indicated that the manufacturing facility is at increasing risk of operational failure and loss of brand image if the optimal production capacity of A-frames were not achieved.

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### 4.2 Forecast comparison

The monthly demand for the A-frame products from 6-month data is given in Table 2 below.

| Month | Unit demand of A-frame |
|---|---|
| January | 1200 |
| February | 1350 |
| March | 1500 |
| April | 1600 |
| May | 1550 |
| June | 1561 |

**Table 2: Monthly demand of A-frame**

(Source: Self-made)

The results from Table 2 indicate a steady increase in the demand for A-frames in the market.

Now, it is assumed that, for the month of July, the SMA forecast will be 1570 units, while the WMA forecast will be 1558 units.

| Month | Actual | SMA forecast | WMA forecast | WMA error |
|---|---|---|---|---|
| April | 1,600 | 1,350 | 1,425 | 175 |
| May | 1,550 | 1,483 | 1,530 | 20 |
| June | 1,561 | 1,550 | 1,580 | 19 |
| **MAD** | | 109.3 | 71.3 | 35% |

**Table 3: Error Analysis**

(Source: Self-made)

The result from the error analysis shows that WMA produced a MAD of 71.3 against the simple moving average of 109.3, with a 35% reduction in forecasting error. Therefore, analysing the WMA is helpful to determine the demand for A-frame manufactured from the Bhiwadi plant in the market. However, a key limitation of this analysis is related to the validation of data of only three months, which is problematic for future planning for the company. This limited window of validation further may require revalidation by Saint-Gobain to plan for the future strategy of the plant. *[Referred to Appendix 1]*

### 4.3 Field Implementation of low-cost tracking

Based on the results from the forecasting analysis, a 4-day field trial was conducted, where a tracker bracket was welded into the sample A-frame and identified using JIO Tag GO Android-network tracker. The trial involved designing and welding a tracker bracket into a sample A-frame. This will be followed by marking the frame with red paint as a secondary visual identifier.

This is because the findings from the tracker demonstrates a better understanding of the logistics situation of the plant, in comparison with the network tracking device from Apple. It is justified, since the MAD value indicated that, WMA error rate is 35%, with forecast of 71.3. The result also indicated that a low-cost Android-network solution could be integrated into the A-frame return-monitoring process without requiring fixed RFID infrastructure. Therefore, based on the results the Saint-Gobain company can successfully place 60 orders per month without any hindrance to manufacturing and maintaining product quality.

## 5.0 Discussion

This part critically analyses the implications of the findings from an operational, financial, and relational point of view. It puts the findings into context by reviewing other works done in academia on reverse logistics, forecasting of demand, and Internet of Things-based asset management. This is not just a review of the findings but a critical assessment of the meaning of those findings in practice.

### Implication of the plant operating model

The inability to retrieve A-frames undermines the effectiveness of the business operation strategy because it interrupts the flow of recycling transport products between producers, carriers, and consumers. Theoretically, a closed-loop returnable transport item system assumes that assets re-enter the production cycle within a predictable timeframe, thereby amortising their cost across multiple trips and maintaining dispatch capacity without proportionate increases in fleet size. Schneikart et al. (2024) demonstrates The concept of Returnable Transport Items (RTIs) appears promising in replacing one-way parcels, which contribute to the increasing production of waste considerably. However, Park et al. (2024) argues on the environmental burden of returnable packaging is primarily affected by total trip distance and the number of reuses. In case the returnable packaging is idle within customer yards and/or logistics systems, the manufacturers have to incur costs in two areas: replacement of missing assets and keeping excessive stocks to cover any shortage. Badr & Ahmed (2023) review demand forecasting methods and explain that moving average extrapolation is a forecasting method that uses the average of past values to predict future values. The 80% non-return rate seen in Bhiwadi is higher than the usual industry standard, which indicates that not having any unique identification for each A-frame has caused a visibility problem.

The comparative analysis of SMA and WMA for predicting A-frame demand yielded meaningful insights. From January to June 2025, the monthly demand data ranged from 1200 units to 1561 units, showing an upward trend. The findings show that the weighted moving average is more appropriate for making forecasts of the demand for A-frame when there is an increasing trend in demand. It gives more accurate predictions due to the higher consideration given to the latest demand trends. This result is consistent with recent findings indicating that a weighted moving average will outperform a simple average when there is a trend in demand. Cai & Li (2022) compare MMSE, SMA, and Weighted Moving Average (WMA) for supply chain demand forecasting and conclude that WMA performs better than SMA, although MMSE achieves the highest accuracy. The forecast for the Bhiwadi factory with WMA in July was 1,558 units, whereas that of SMA was 1,570 units. These results support the adoption of WMA as the preferred forecasting technique for A-frame demand planning.

The results also show that increasing the availability of A-Frames is dependent on proper demand forecasting for the WMA and improved RTI management. Cost-effective IoT monitoring and RTI returns will increase asset visibility and increase partner accountability in the process of reverse logistics.

**Implication of cost structure**

The successful field trials of the JIO Tag GO tracker demonstrate the growing belief that cheap IoT solutions can be used to bridge RTI visibility gaps. These results have shown that the company is capable of handling 60 tracker orders per month without any difficulty in production or any reduction in quality. The implementation aligns with broader trends toward hybrid tracking architectures, where a subset of assets carries cellular trackers while others utilize lower-cost alternatives. Demiray Kırmızı (2024) examines the optimal inventory management strategy to minimise costs and determine ideal safety-stock levels. Overall, it can be seen that WMA demand forecasting with the use of cost-efficient IoT tracking is an effective solution for the increase of A-frame availability and RTI visibility.

## 6.0 Recommendations

**Recommendation 1 :** ***Implement RFID-Based Tracking improved Visibility***

The most important recommendation would be the gradual roll-out of an RFID-based tracking system in all A-frames. Although the JIO Tag GO pilot program proved the effectiveness of GPS tracking systems, the scope of the challenge, which is 8,761 missing A-frames, requires a more robust and efficient approach in ensuring fleet visibility. The use of RFID tags proves to be cheaper per unit than cellular devices, which makes it economically feasible to tag each one of the A-frames rather than just a few. Each of the A-frames needs to be issued with an identification number in a database. RFiD Discovery (2024) demonstrates the practical value of RFID tracking through its deployment across six French harbours, where 50,000 reusable fish boxes were individually tracked, improving real-time stock visibility, return rates and loss prevention. Passive UHF RFID tags designed for use on metal are generally cheaper per unit than cellular trackers, although the exact price depends on the supplier and order volume and should be confirmed through quotations. The JIO Tag GO tracker launched at ₹1,499 per unit (Business Today, 2024). Deploying such trackers across all 8,761 pending A-frames would cost roughly ₹131 lakh at that price. The payback period is favourable. The initial investment of the RFID system (approximately 800,000 CNY) achieved full ROI

within 12 months through reduced production downtime and rework costs. Overall, a phased RFID implementation offers the most cost-effective and scalable solution for achieving complete A-frame visibility while significantly reducing future asset losses and improving operational efficiency.

**Recommendation 2**: ***Establish Structured Return Protocols with Transporter Accountability***

The second recommendation will seek to rectify the gaps in the behaviour and process which are responsible for low return rates. This is in addition to the other suggestions that have been made previously. Saint-Gobain should formalize return contracts with all the logistic service providers and customers with clear details of the return period, penalties in case of late return, and rewards for early return of assets. Every dispatch must have a return deadline.

## 7.0 Conclusion

In conclusion, the findings indicate that improving A-frame availability requires a shift from reactive recovery to proactive asset governance. For the Bhiwadi Plant, integrating demand forecasting, IoT tracking, and conceptual accountability can strengthen operational efficiency. This indicates that, in order to improve the management of operations in the Biwadi plant, Saint-Gobain is facing key issues related to the returning of A-frames

and needs improvement of the structural design of the product in the future. However, based on the results of WMA analysis, the likelihood of error in predicting future demand was significantly reduced. The results are further confirmed by the use of GPS-based tracking devices. Therefore, the leadership of Saint-Gobain should focus on the use of RFID-based tracking to boost operational resilience and improve the availability of resources in the inventory.

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**Appendices**

**Appendix 1: Excel sheet graph plotting of the WMA analysis results**

| | Month | Demand (A-frames) | 3-Month Moving Avg Forecast | 3 month weighted moving ave | calculation |
|---|---|---|---|---|---|
| 2 | Jan | 1200 | | | |
| 3 | Feb | 1350 | | | |
| 4 | Mar | 1500 | 1275 | | |
| 5 | Apr | 1600 | 1350 | 1425 | (1500×0.5)+(1350×0.3)+(1200×0.2) |
| 6 | May | 1550 | 1483.333333 | 1530 | (1600×0.5)+(1500×0.3)+(1350×0.2) |
| 7 | Jun | 1561 | 1550 | **1580** | (1550×0.5)+(1600×0.3)+(1500×0.2) |
| 8 | Jul (Forecast) | | 1570.333333 | **1557.8** | (1561×0.5)+(1550×0.3)+(1600×0.2) |




(Source: Self-made)