Optimize Cost and Inventory Management for an Interior Designing firm
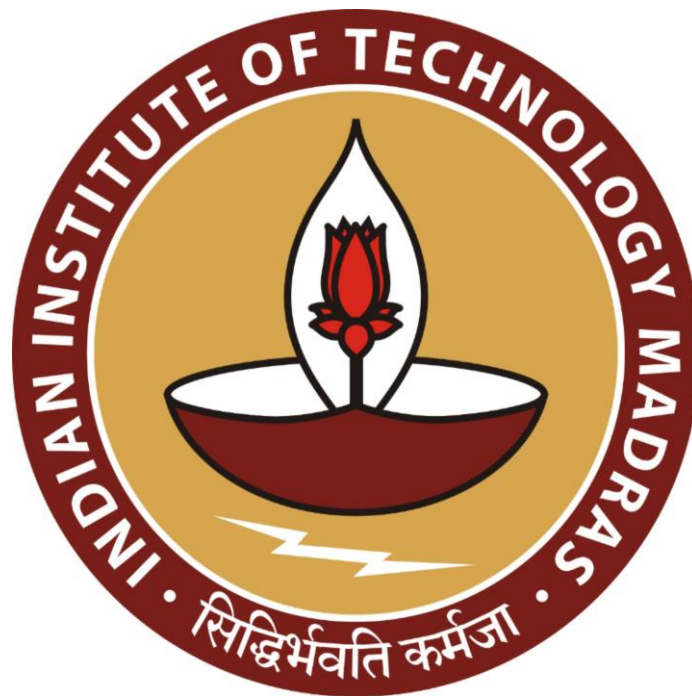## Final Report for BDM Capstone Project

Submitted by

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Contents

1. Executive Summary

Title:

Optimize Cost and Inventory Management for Design De Interiors, An Interior Design Firm.

Design De Interiors is a leading interior designing firm based in Ranchi, It faces several operational challenges which were related to fluctuating raw material prices and inefficient inventory management. Due to these issues, it resulted in increased costs and delays in project delivery. We went through their 25 project sites data of 2024 and analysed them properly.

To address these challenges, we procured data of 25 different projects from january to december 2024, did basic data cleaning and organized in a tabular format. Descriptive statistics of the data revealed that there are volatile pricing patterns of mostly all the raw materials and also unpredictable demand of items were found. In analysis we employed diverse methods, including the Economic Order Quantity (EOQ) model to optimize material's demand, and the ABC-XYZ classification to prioritize inventory based on value and demand variability. Moving averages were also used to analyse, study and to get insights from those trends of the data over time.

The study found consistent mid year price spikes for various important raw materials such as wood, ceramic tiles, and PVC pipes due to seasonal demand. This demand variability analysis showed most of the raw materials have a very unpredictable consumption and price patterns throughout the year, which is a big challenge for smooth operations. High value items with irregular demand increases complexity in the firm's procurement process. EOQ calculations suggested optimal order quantities that would balance ordering and holding costs effectively. Hence, it would provide stability to the firm.

Based on several insights and findings, recommendations include ordering bulk purchases before seasonal price peaks, applying EOQ-driven inventory orders and management, and having a continuous monitoring of price trends. These actions would reduce material costs, improve inventory efficiency, timely project completions and enhanced profitability. Given recommendation should be applied with proper executions so that we get desired outcomes.

2. Detailed Explanation of Analysis Process/Method

Data Collection and Cleaning

The data for this project was sourced directly from our firm Design De Interiors internal from there procurement records, which included prices and quantity of all raw materials that were used across 25 different project sites throughout the year of 2024. The data included material/item names, quantities purchased and consumed in which site, unit prices of each item, date of transactions, and amount spend on each transaction of the items.

Proper data cleaning was essential to ensure data quality so that we have proper analysis. Data cleaning involved:

- **Removing duplicate records** that occurred due to multiple data entries.

- **Correcting inconsistent data formats**, particularly for dates, currency values, and item names to ensure uniformity.

- **Handling missing** by cross-verifying with purchase orders or excluding incomplete records when corrections were not possible.

- **Standardizing measurement units** to maintain consistency across all entries.

- **Transforming data into Tabular format** so that we can handle data properly for any kind of analysis, as shown in the Fig 1 below

Date	Flat ID	Item	Unit	Quantity	Rate	Amount
Item: Ceramic Tiles						
		Count: 55 ▼		Sum: 14712 ▼	Avg: 48.2 ▼	Sum: 713536.43 ▼
01 February 2024	10	Ceramic Tiles	Sqft	209	43.36	9062.24
01 February 2024	23	Ceramic Tiles	Sqft	110	43.36	4769.6
01 March 2024	20	Ceramic Tiles	Sqft	128	44.07	5640.96
01 March 2024	23	Ceramic Tiles	Sqft	383	44.07	16878.81
01 March 2024	23	Ceramic Tiles	Sqft	219	44.07	9651.33
01 April 2024	5	Ceramic Tiles	Sqft	316	45.21	14286.36
01 April 2024	13	Ceramic Tiles	Sqft	372	45.21	16818.12
01 April 2024	13	Ceramic Tiles	Sqft	289	45.21	13065.69
01 April 2024	23	Ceramic Tiles	Sqft	174	45.21	7866.54

Figure 1 : Data in Tabular format

This process was very important so that data will be reliable, which will directly impact the findings of our analysis. The tabulated data is then used for making dynamic dashboard as shown in Fig. 2 below along with various visualisations so that we can infer key insights and observations from the provided data through using spreadsheets functionalities.
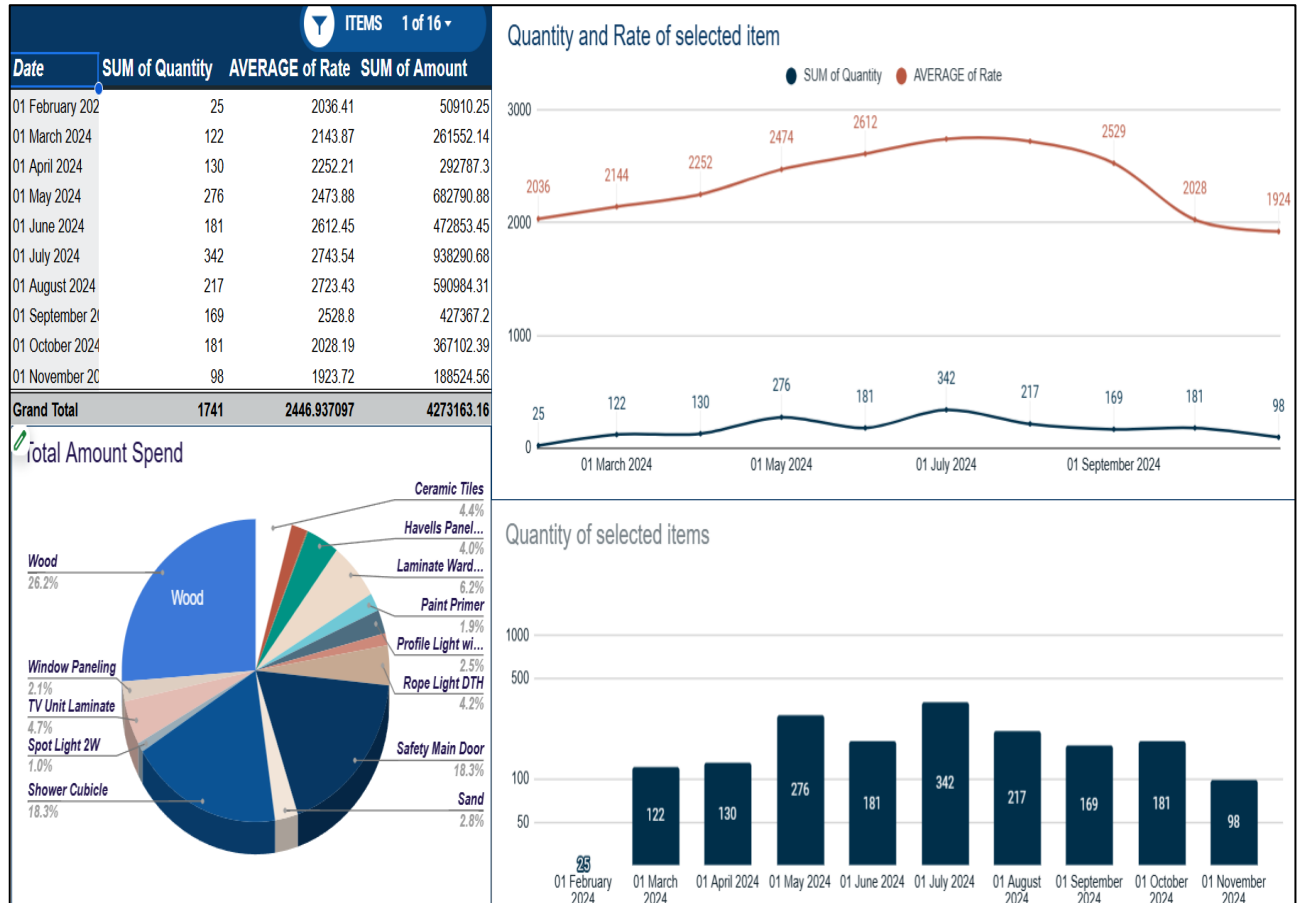

Figure 2: Dashboard for analysing

Approaches Used

To address and find meaningful insights for our problem statements of cost volatility and inventory management inefficiency, several analytical approaches were used:

Economic Order Quantity (EOQ) Model

The EOQ model was used to find the optimal order quantity that minimizes total inventory costs by balancing ordering costs with holding costs. It is a inventory management approach which is used to determine the optimal order size that minimizes the total cost of ordering and holding inventory. It balances two key costs, the fixed cost of placing orders and the variable cost of holding items in stock. It helps us in making data backed informed decisions which lowers our operating cost and helps us in managing inventory in a better manner.

The formula used: $$EOQ = \sqrt{\frac{2DS}{H}}$$

where:

- D = Annual demand for the item (units)

- S = Ordering cost per order (₹500 assumption as per the firm)

- H = Holding cost per unit per year (assumed as 20% of the average unit cost for storage)

EOQ is used here as it helps to determine efficient ordering and holding insights from the data so that we can order materials at efficient price and of optimal quality. It reduces all the errors due frequent ordering and stockings extra materials.

ABC-XYZ Inventory Classification

The ABC-XYZ Inventory Classification is a simple yet great inventory management method which helps business to decide which items need more focus and planning. It works by dividing items in two dimensions: value and demand consistency. The ABC part sees at how much value each item contributes in a year. 'A' items are the most valuable items. 'B' items are of medium value, while 'C' items are low-value items. This helps businesses to look after important items and identify key items statically. The XYZ part looks at how stable the demand is for each item. Items with predictable demand are labelled 'X', and those which have some variations are 'Y', and those with very unpredictable demand are 'Z'. The analysis is done using coefficient of variation.

The ABC analysis categorized materials based on their annual monetary consumption into:

- **A**: High value (top 70-80% of cumulative consumption value)

- **B**: Medium value

- **C**: Low value

Simultaneously, XYZ analysis classified items based on demand variability:

- **X**: Stable demand (<10% variability)

- **Y**: Moderate variability (10-25%)

- **Z**: High variability (>25%)

This approach is being used as both ABC and XYZ classifications are combined, and then we can see which items are both high in value and risky due to unstable demand. This helps us to plan better, more efficiently and hence through that we can make more informed decisions.

Min-Max Normalisation

We have applied Min-Max normalisation on each material over their prices for the entire year. Each material has its own price range hence we can't compare a material with another over their pricing. Therefore, this normalisation will help us to compare fluctuating data of each material over the year as per we were provided data of.

Formula for Min-Max Normalisation: $\text{Normalized Rate} = \frac{\max(\text{Rate}) - \min(\text{Rate})}{\text{Rate} - \min(\text{Rate})}$

Where:

- **min (Rate)** is the minimum rate observed for that item across all dates in your dataset.

- **max (Rate)** is the maximum rate observed for that item across all dates.

This normalisation converts every rate for a given item so that the minimum rate for that item is 0 and the largest is 1, and all the other rates are proportionally mapped between 0 and 1.

Moving Averages for Price Trend Analysis

Moving averages is used to identify and smooth short-term fluctuations in raw material prices, it takes the average of a set number of past data points and moves this window forward one step at a time. It is a fundamental time series analysis technique used to see short-term fluctuations in numeric datasets and it highlight longer term trends in any data. Moving averages helps us for identifying price trends, which helps in reducing the risk of temporary, sudden, or seasonal price hikes.

Using moving average and comparing it with the usual line graph gives us a better over view about the data. As the moving average smoothens the sudden spikes or drops in the price since we use average data of current and some previous timelines. Hence, we should compare the usual line graph with a moving average graph for better analysis.

Justification for each approach

- **EOQ** was chosen to optimize inventory and holding costs due to fluctuating prices and uncertain demand, which helps in solving inefficient inventory holding and ordering practices.

- **ABC-XYZ classification** is used as it provides a data backed strategic focus, where optimize resource allocation by identifying which materials are price volatile and demand patterns, which is crucial for managing goods across different projects sites efficiently.

- **Min-Max Normalisation** is used for analysing different items price range throughout the year with a comparative lens against each other items.

- **Moving average analysis** equips the firm with insights on price seasonality, reducing cost risks linked to price volatility.

Together, these methodologies provide us a wholistic approach in our analysis which will help in our goal of addressing our problem statements.

3. Results and Findings

After cleaning the data and then preparing the data for analysis, we used numerous analytical tools and advanced techniques to gain valuable insights and findings from the data, which will be used for providing solutions for the problem statements that we are solving in our project.

We found a very interesting insight from our data that the overall monthly spend of the firm is not uniform and majority of purchase by amount happens in mid year months, which shows a high demand in months from May to September as we can see in the Fig 3 below.
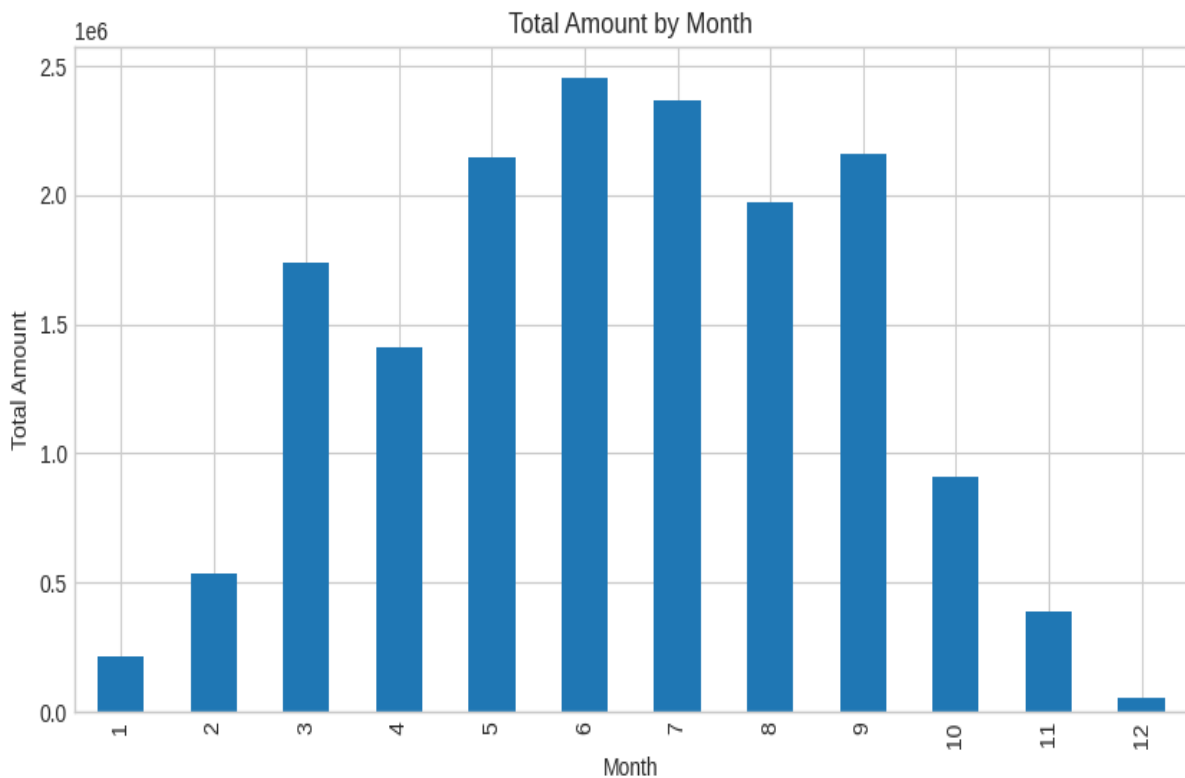

Figure 3 : Total spending by months

This shows a strong requirement of materials in months of May to September, and ironically, we found that these months have comparatively high prices compared to the entire year.

We also made a visualisation on the different materials and their contribution to the total amount spend by the firm, Fig 4 shows that Wood, Safety main door and Shower cubical alone contributes to more than 60% of total amount spend by the firm on raw materials.
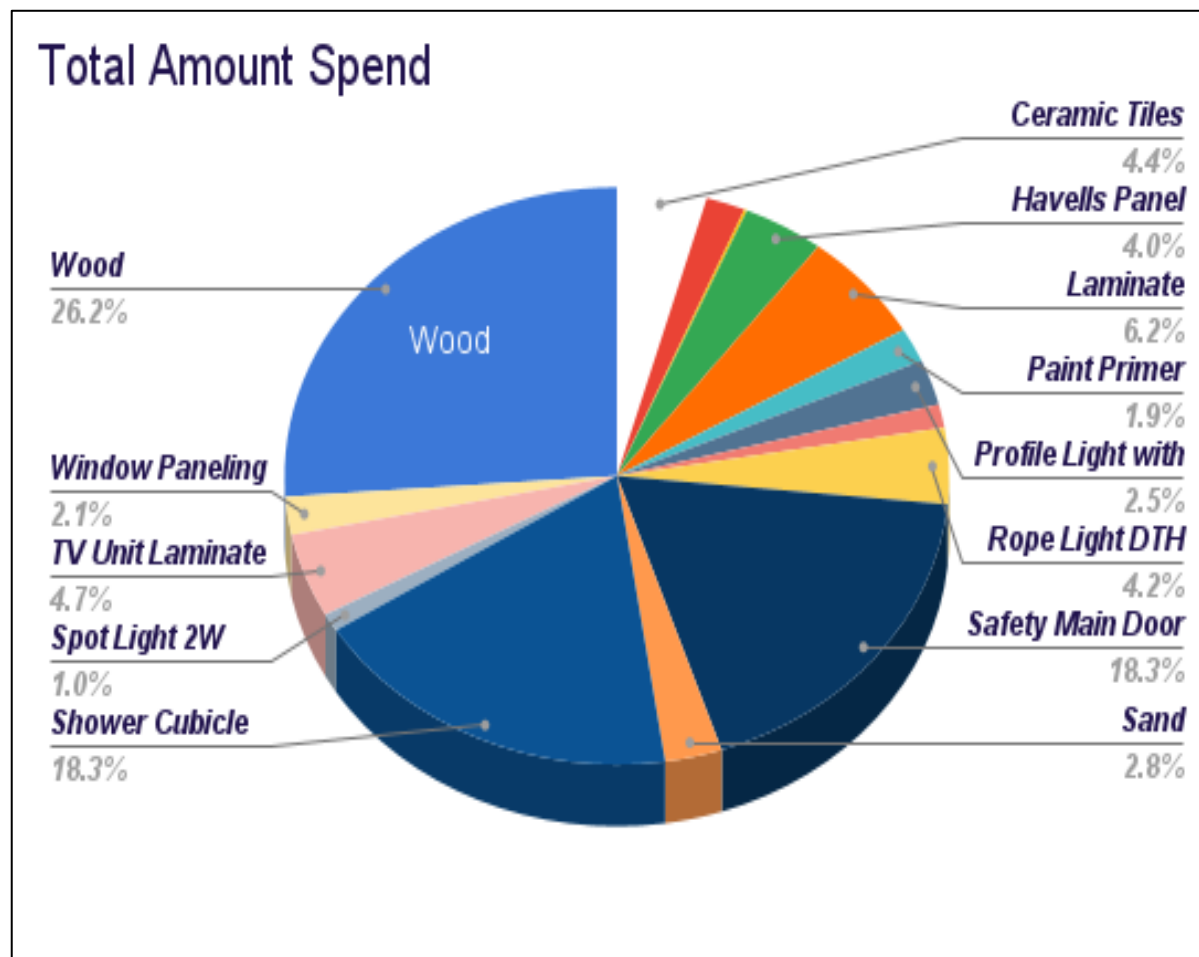

Figure 4 : Total amount spends on different materials

❖ Price Trend Analysis

We analysed the raw materials procurements prices throughout the year using data visualisation such as line graphs along with descriptive data of the items as seen in the Fig. 5 below and then we do get an essential pattern in the prices suggest a seasonal pricing for few items. Regression slope is also calculated for the items.
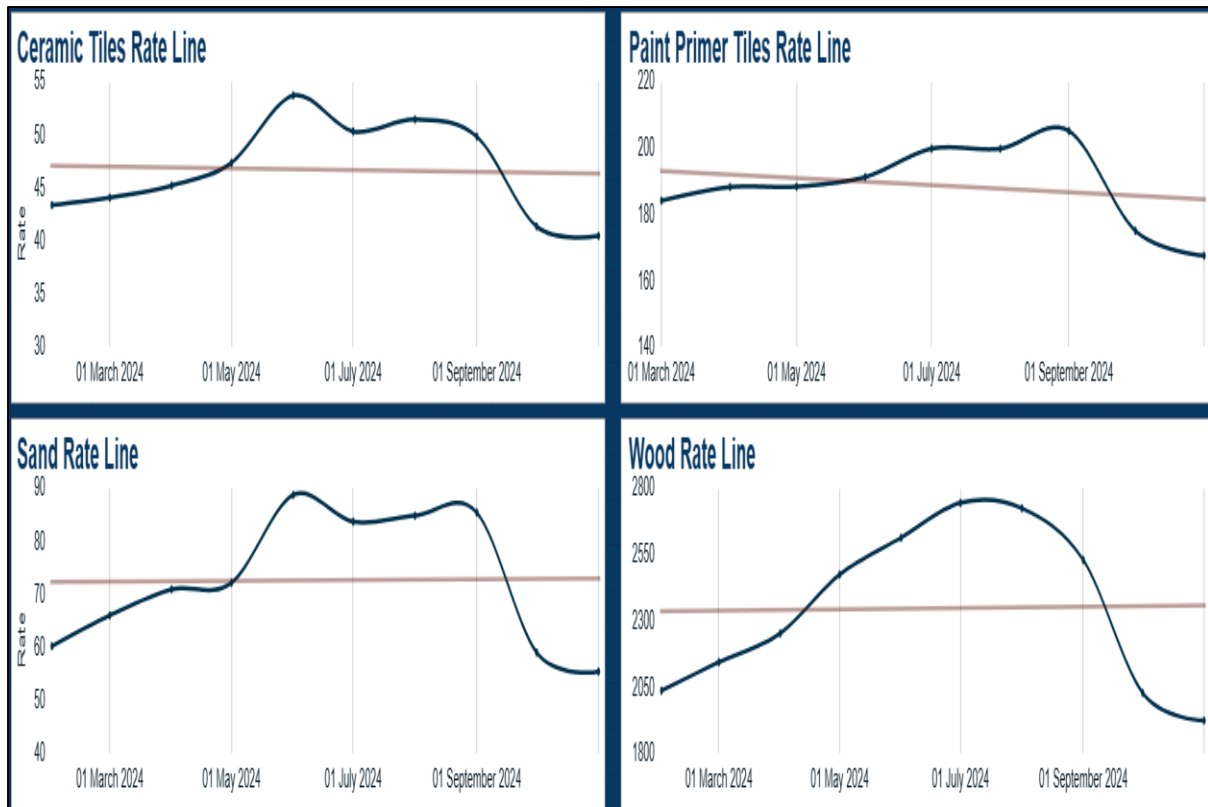
Figure 5: Price Trend Analysis

Key Findings from Price trend analysis:

a. Ceramic Tiles

- Trend: Gradual increase till June, then a drop from Sep onwards.
- Regression Slope:
  - +₹0.7/month (till June), then negative.
- Finding:
  - Tiles saw a price spike in the middle of the year, then fell.

b. Paint Primer

- Trend: Steady rise till Sep, then a drop in Oct/Nov.
- Regression Slope:
  - +₹2.6/month (till Sep), then negative.
- Finding:
  - Paint primer prices increased most of the year, then dropped.

c. Sand

- Trend: Rises till Sep, then drops sharply in Oct/Nov.
- Regression Slope:
  - +₹0.7/month (but with a spike in June–Sep, then sharp drop).
- Finding:

- Sand prices are highly seasonal, peaking mid-year.

d. Wood
- Trend: Strong increase from Feb to Jul, then sharp decline after Aug.
- Regression Slope:
  - Using all months: +₹58.6/month (but note the sharp drop after August skews the trend).
- Finding:
  - Prices rose steadily till July, then dropped sharply. Likely seasonal or supply-driven.

- ❖ *Min-Max Normalisation-* We did the min max normalisation to analyse the total amount of each material across the entire year comparative to each other, so that we can get insights from it. In Fig. 6 below we can see cumulative chart of all materials after applying the min max normalisation on our data of materials and its amount.
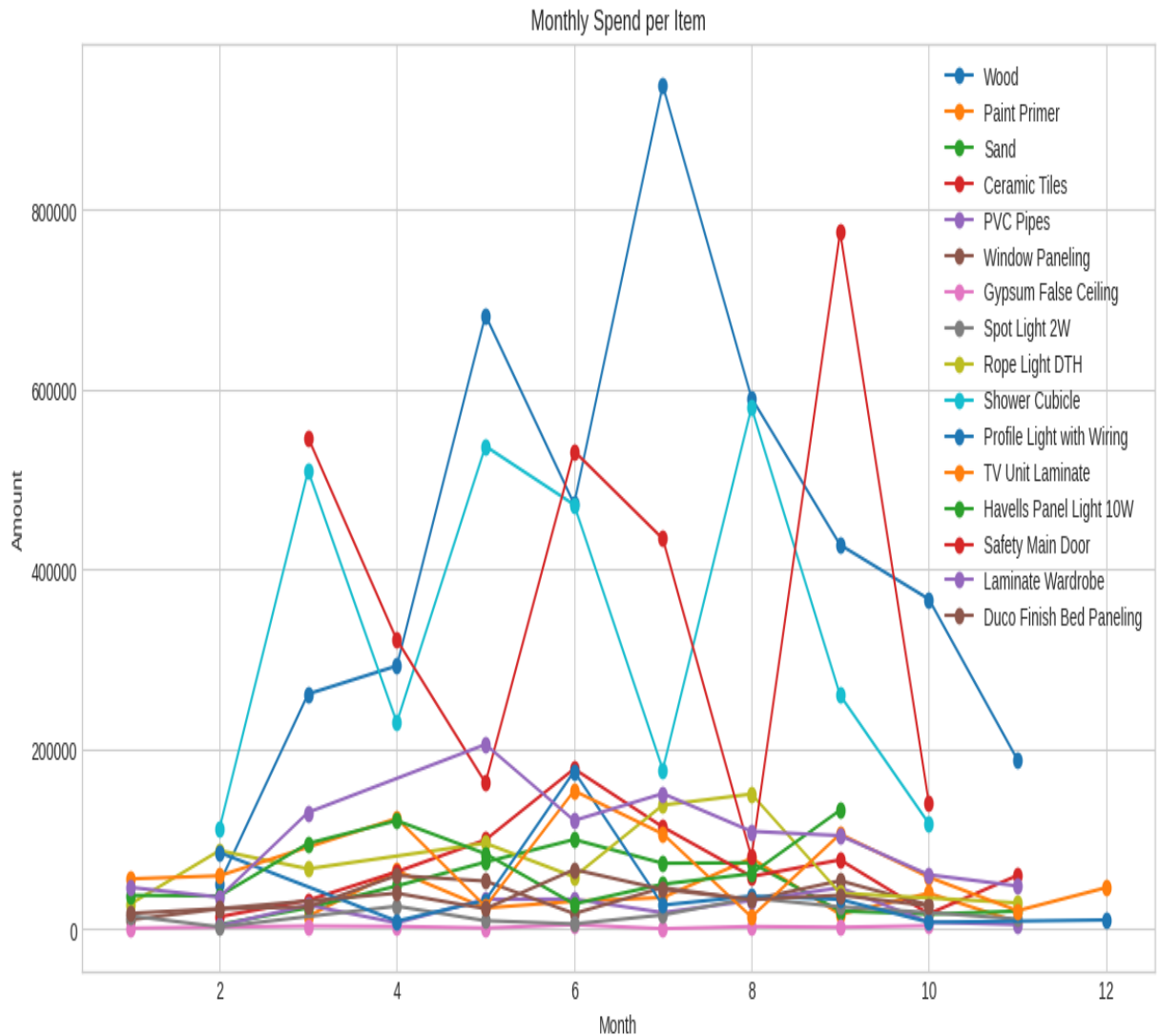

Figure 6 : Min Max Normalisation of materials amounts

❖ *ABC/XYZ analysis*- We have classified items which were raw materials using abc/xyz classification. It is a great tool for analysis as it classifies the items as per their volatility in the demand and its amount value to the total amount deployed. The analysis is done using coefficient of variation. Both classifications are combined, and hence we can classify which items are high in value and risky due to unstable demand. In the following table 1 below, we can find the items in which they are classified.

Table 1 : ABC/XYZ classification

Item	Total Value	ABC Class	XYZ Class	ABC-XYZ
Safety Main Door	3,53,60,084.85	A	Z	AZ
Shower Cubicle	1,87,35,506.13	B	Z	BZ
Wood	42,73,163.16	B	Z	BZ
Laminate Wardrobe	10,10,463.43	B	Z	BZ
TV Unit Laminate	7,67,728.23	B	Z	BZ
Ceramic Tiles	7,13,536.43	B	Z	BZ
Rope Light DTH	6,94,211.73	C	Z	CZ
Profile Light with Wiring	6,59,824.09	C	Z	CZ
Havells Panel Light 10W	5,82,347.12	C	Z	CZ
Gypsum False Ceiling	5,01,236.45	C	Z	CZ
Duco Finish Bed Paneling	4,97,832.11	C	Z	CZ
Spot Light 2W	4,12,120.60	C	Z	CZ

Key Findings from ABC/XYZ classification:

All items in our data are classified as Z for demand variability, which indicates high unpredictability in monthly consumption of the items. There is no uniform trend in procurement of the items monthly. The high-value items fall into AZ or BZ categories, while lower-value items are CZ. Here only Safety main door is classified as AZ, that means it contributes very high in terms of amount value.

It is a very insightful finding that every item is identified as Z, it shows that there is very high volatility in procurement of raw materials across the months. This classification also shows that any project cost is majorly depended on safety main door, and to some extend shower cubicle and wood. Whereas even these items are not having uniform procurement.

❖ Economic Order Quantity (EOQ) model- We have used a classic inventory management model for our analysis, which is used to determine the optimal order size that minimizes the total cost of ordering and holding inventory. Using this we found some great insights and findings which will be very helpful for us in solving our problem statements. The detailed model insights is view below in the Table 2.

Table 2 : EOQ Model

Item	Annual Demand	Average Rate	Holding Cost	EOQ (units)
Ceramic Tiles	14,712	48.2	9.64	1,235
Duco Finish Bed Paneling	351	883.79	176.76	45
Gypsum False Ceiling	401	58.43	11.69	185
Havells Panel Light 10W	368	1,757.03	351.41	32
Laminate Wardrobe	481	2,100.50	420.1	34
PVC Pipes	1,618	132.16	26.43	247
Paint Primer	1,638	191.33	38.27	207
Profile Light with Wiring	352	1,190.26	238.05	38
Rope Light DTH	439	1,590.72	318.14	37
Safety Main Door	39	77,080.72	15,416.14	2
Sand	5,909	76.81	15.36	620
Shower Cubicle	56	53,417.49	10,683.50	2
Spot Light 2W	413	391.72	78.34	73
TV Unit Laminate	455	1,687.26	337.45	37
Window Paneling	436	799.51	159.9	52
Wood	1,741	2,446.94	489.39	60

Key Findings from EOQ Analysis

1. High volume and low unit cost Items (Ceramic Tiles, Sand, Paint Primer, PVC Pipes):
   - Ceramic Tiles and Sand have the highest annual demand, with EOQs of approximately 1,235 units and 620 units, respectively.
   - The large EOQs are is due to high consumption and its low holding costs, which indicates that we can order these items in large quantities and store them.
   - Paint Primer and PVC Pipes also show high EOQs (207 and 247 units), which reflects they are regularly used with moderate unit costs.

2. High value and low volume items (Safety Main Door & Shower Cubicle):
   - Safety Main Door and Shower Cubicle have very low EOQs, despite their high unit costs.

- It is because the holding cost per unit is substantial, which makes it very uneconomical to keep large stocks of these items.
- Such items should be ordered as per the given requirement rather than stocking them.

3. Moderate volume and moderate cost items (Wood, Laminate Wardrobe, TV Unit Laminate):
- Wood has an EOQ of about 60 units, having a balance between relatively high unit cost with consistent demand.
- Laminate Wardrobe and TV Unit Laminate have EOQs in the 34–37 unit range, such items can be ordered in a bit large quantities
- These items should be monitored for price fluctuations and can be ordered accordingly.

4. Lighting and Electrical Items (Havells Panel Light 10W, Spot Light 2W, Rope Light DTH, Profile Light with Wiring):
- These items have EOQs ranging from 32 to 73 units, reflecting moderate demand, and holding costs.
- Batch ordering is can be done of such items, but with proper planning it should be done.

These findings from the EOQ analysis is very insightful and will efficiently contribute in our solutions for the problem statements.

❖ **Moving averages-** 3 month moving average is used for the item's prices which smooths the price series by averaging each month's rate with the two preceding months. This approach highlights the trends in the graph and reduces the impact of outlier spikes or drops in prices. We can see the differences in Fig 7 and Fig 8.
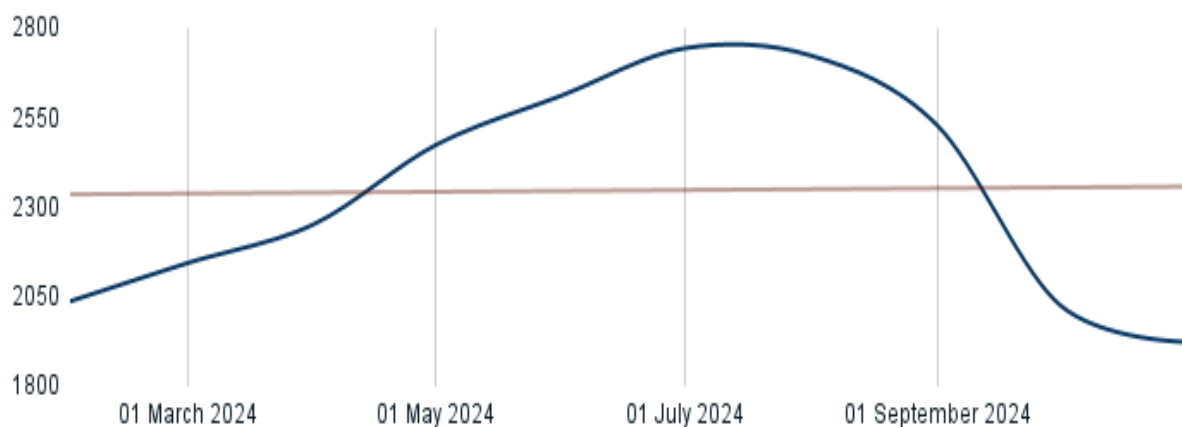

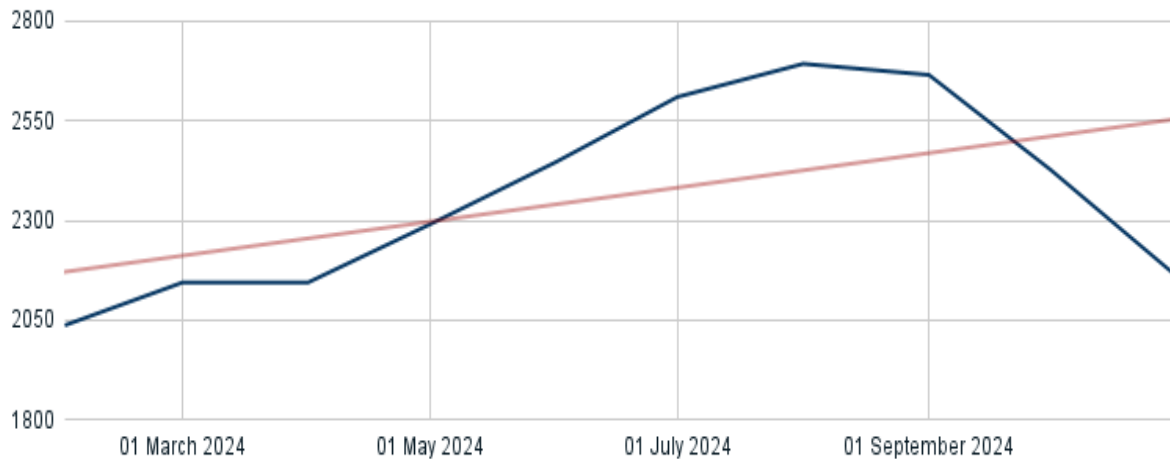*Figure 7 : Normal line graph of wood*

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Figure 8 : Moving average graph (3 months) of wood

Key Findings from moving average analysis:

- **Wood:** The moving average for Wood increased from ₹2,036 in February to a peak of ₹2,693 in August, before declining to ₹2,160 in November and ₹1,976 in December. This revealed a clear upward trend in the first half of the year, followed by a reversal in the last.

- **Sand:** The moving average rose from ₹60 in February to a high of ₹85 in August, then dropped to ₹57 by December. This pattern shows a seasonal increase in prices.

- **Ceramic Tiles:** The moving average rose from ₹43 in February to ₹52 in August, then fell to ₹41 in October and ₹40 in November, indicating a mid-year price increase in prices followed by stabilization.

- **Paint Primer:** The moving average remained stable around ₹186–₹201 for most of the year, with a slight dip towards the end.

- **PVC Pipes:** The moving average increased from ₹116 in February to ₹143 in August, then declined to ₹111 in December, again highlighting a mid-year price peak.

4. Interpretation of Results and Recommendation

The analysis of procurement data and inventory patterns at Design De Interiors is used for analysis and hence using the findings and insights for solving operational challenges of fluctuating prices and inefficient inventory management. After a various rigorous task of collecting data, cleaning the data, and then performing various data analysis techniques over the data like, from simple data visualisation, descriptive statistical analysis to EOQ modelling and ABC/XYZ classifications we found various key insights and findings that got mentioned in the results and finding section of the report.

Now its time to interpret the results and use these findings for gaining insights and converting into actionable recommendations for the firm so that they can address and solve the operations challenges what they were facing due to regular fluctuation of raw material prices and inefficient inventory management.

Interpretation of Results

The analysis reveals clear seasonal price fluctuations in various key raw materials, with this mid year price peaks for ceramic tiles, wood, PVC pipes, and sand due to sudden demands because of the project peaks. This cyclical pricing pattern highlights a critical need for our firm i.e. Design De Interiors to align procurement timing with market trends to avoid inflated costs along with data backed holding patterns for lowering cost employed.

The ABC-XYZ classification highlights the complexity of inventory management faced by the firm. Most materials fall within the 'Z' demand variability category, which indicates a highly unpredictable consumption patterns that complicate stock control. Apart from that, high value items like Safety Main Doors are categorized as 'AZ', which require particularly very attentive and cautious procurement practices to balance cost and availability without excessive stockholding.

The EOQ analysis further supports data backed informed ordering approaches, items with predictable demand and moderate costs benefit from optimized batch sizes which reduce overall inventory costs and hence, thereby reduce the overall operational cost. Therefore, high cost and materials with variable demand requires smaller and more responsive/frequent order quantities which would minimize holding expenses and efficient ordering of goods at a good pricing.

Monthly Spending and Demand Seasonality

Our analysis shows that the firm's monthly procurement spending is highly uneven over the year, with a majority concentration from the months of May to September (as shown in Figure 3). This period shows projects and seasons peak activity due to seasonal demand, which results in high demand and approximately 60-70% of total raw material purchase costs concentrated in these months. Importantly, this sudden increase coincides with the highest

raw material prices of the year, which indicates the firm is currently facing high cost pressure when materials are most needed for their projects.

Material Cost Contributions

Figure 4 reveals that Wood, Safety Main Doors, and Shower Cubicles together account for over 60% of total raw material expenditure. This high spending shows these materials as primary cost drivers which require focused procurement properly along with monitoring there prices that too with right inventory management strategies. Controlling these procurement cost and holding cost of goods are really important to the firm.

Price Trends and Seasonal Patterns

Price trend analysis (Figure 5) quantifies monthly price changes and confirms seasonal pricing:

- Ceramic Tiles price increases by approximately ₹0.7 per month until June, which signals a gradual price rise during early and mid year, then declines post september.
- Paint Primer prices increase more sharply, by about ₹2.6 per month until September, which indicates consistent inflation through most of the year.
- Sand prices rise moderately by ₹0.7 per month, peaking between June and September before dropping, after a strong seasonal demand.
- Wood prices have a sharp increase, which is averaging from +₹58.6 per month over the year, it has a sharp decline after August, which highlights both seasonal and supply dynamics.

This price variation shows the firm can potentially have a proper procurement strategy before these upward trends, so that they can optimize the costs.

Normalization and Comparative Trends

The min-max normalization (Figure 6) of cumulative material spending allows us to have relative comparison of cost contributions across materials normalized to a 0-1 scale. This shows the dominance of Wood, Doors, and Cubicles in expenditure..

Recommendations

Based on these insights, the following SMART recommendations are proposed:

- **Strategic Bulk Purchasing**: Implement advance bulk procurements of essential materials such as wood and ceramic tiles before forecasted mid-year price surges. The most ideal time for bulk buying and holding it will be May or June. (through this we aim for 7-10% cost savings due to price volatility surge, along with that logistic cost due to frequent ordering will be saved to nearly one-third). This implementation should begin in or after a quarter for effective impact.

- **EOQ Based Order Management**: Adopt EOQ guided ordering for materials with stable or moderately stable demand (e.g., Paint Primer, PVC Pipes) to optimize inventory holding costs and reduce order frequency. This would reduce of the costing of goods for roughly 8-10% within 6 months. This should begin implementation in next quarter of 2025 for effective impact.

- **Flexible Procurement for Variable Demand Items**: For 'Z' category and high-value 'AZ' materials especially safety main door and shower cubicles, firm should establish attentive procurement processes which should be relying on smaller, in time orders and strong vendor partnerships along with monitoring price from other trustable vendors, to maintain availability without excess stock. This would reduce holding cost of goods to nearly 20% within an year of implementing. This should begin implementation in next quarter of 2025 for effective impact.

- **Inventory Management System** : The firm should invest in a decent inventory management software service and use it for complete procurement and usage of every materials, this will automate the firm with continuous real time data which can be used for dynamic approaches of ABC-XYZ classification, EOQ order management, monitoring waste of each material in various project sites along with other analytical practices.

   This would help the company to have a dynamic analytical approach to the firm which would strengthen their ability to take data backed efficient decision frequently. Hence, impacting the firm in very positive way. Through this we can plan the waste usage properly which will cut the materials costs to 3-4%.
   This should begin implementation in 1-2 quarter from now for effective impact.

- **Vendor Relationship Management**: Negotiate flexible contracts and just in time delivery arrangements, especially for high value and unpredictable demand classified goods, to improve supply chain responsiveness. This would help to reduce the holding cost to nearly 10% and procurement cost to

nearly 5%. This should begin implementation in this quarter of 2025 for effective impact.

Impact of Recommendations

Early adoption of these strategies and practices will definitely have huge impact of the firm. Initially the practices may find to be exhaustive but these practices will help the firm to cut overall expenses (including materials procurement cost, goods holding and storing cost, logistic and other costs) to nearly 15-20% along with better and efficient management with would boost profitability of the firm to nearly 10-12%. All these implementations of the recommendations are expected to generate significant cost savings through addressing price volatility, reducing unnecessary inventory holdings, and enhancing material availability along with reducing wastage across projects. These improvements will translate into smoother project execution that to on stipulated timeline, It would also reduce working capital requirements, and improve the overall functioning for Design De Interiors.