Increasing Operational Effectiveness: KD Hero's Demand and Inventory Analysis

A Mid-Term Report for the BDM Capstone Project

Submitted by

Vishnu Kumar Jha
23f3004186

IITM Online BS Degree Program,
Indian Institute of Technology, Madras,
Chennai Tamil Nadu, India, 600036

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1. Executive Summary

The project, "Increasing Operational Effectiveness: KD Hero's Demand and Inventory Analysis," focuses on optimizing inventory management and improving demand forecasting for KD Hero, a motorcycle dealership. By utilizing data-driven analytical techniques, the study aims to enhance customer satisfaction, sales performance, and operational efficiency.

The analysis covers 906 purchase records and 579 sales transactions from July 2024 to December 2024 and employs the Reorder Point (ROP) System, ABC Classification, and Time Series Analysis (ARIMA, Moving Averages) to evaluate sales and inventory trends.

The findings reveal that sales peaked in October 2024 (₹11.08M) before sharply declining in November (₹7.09M) and December (₹6.46M) (Figure 1.1). This surge was driven by seasonal demand, festive purchases, and promotional activities, whereas the decline resulted from post-seasonal slowdowns, reduced purchasing power, and market saturation. Inventory levels steadily increased until November (320 units) before dropping sharply in December (Figure 1.3), indicating possible over-purchasing and inefficient stock management.

ABC analysis identified that a few high-demand models, such as Glamour, Splendor+, and Xtreme 125R, contribute to the majority of sales, following the Pareto Principle (80/20 rule) (Figure 1.2). However, low-selling models resulted in excess inventory and high holding costs. The static ROP system (~50 units) does not adjust dynamically to changing demand, leading to stockouts for popular models and overstocking of slow-moving ones, affecting both revenue and storage efficiency.

To address these challenges, Time Series Forecasting and Regression Analysis (e.g., ARIMA, Moving Averages) should be used to enhance sales predictions, while ABC Analysis and Economic Order Quantity (EOQ) should prioritize high-demand models and reduce excess stock. A dynamic ROP system will enable timely stock replenishment, ensuring availability while preventing overstocking. By implementing these strategies, KD Hero can optimize inventory levels, reduce costs, and improve overall profitability and competitiveness.

2. Proof Of Originality

2.1. Letter from the Organization Head

KD HERO
Said Nagar,
Laheriasarai,
Darbhanga District, Bihar - 846002

Date: 01-04-2025

To Whom It May Concern,

Subject: Permission to Use Sales and Purchase Data for Academic Project.

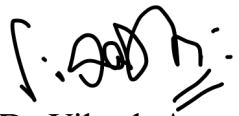
This is to formally provide Vishnu Kumar Jha**,** a student in the IIT Madras BS program, permission to use KD HERO's sales and purchases data to fulfill the requirements of their BDM (Business Data Management) project.

We agree that appropriate measures will be taken to preserve confidentiality and safeguard sensitive information, and that the data will only be used for academic purposes.

Do not hesitate to get in touch with us if you require clarification or if you have any other demands.

We wish Vishnu Kumar Jha success in his academic endeavors.

Yours sincerely,



Dr.Vikash Arora
Director, KD HERO

2.2. Video and Images

- Video with Owner: **Click**
- Image with Owner: **Click**
- Showroom Images: **Click**

3. Metadata

This metadata provides an overview of the sales and purchase dataset collected for the project. The dataset spans a six-month period (July 2024 – December 2024) and includes 579 sales transactions and 906 purchase records from the KD Hero dealership. The data was extracted from the dealership's ERP system (Enterprise Resource Planning), which records real-time sales and purchase transactions. Additional data points, such as stock levels and reorder points, were manually verified through inventory logs and staff inputs to ensure accuracy.

The dataset consists of two sheets:

3.1. Sales Sheet (579 rows, 12 columns) – Contains detailed transaction data for vehicles sold, including invoice details, customer information, pricing, and tax components.

3.2. Purchase Sheet (906 rows, 10 columns) – Records vehicles purchased from suppliers, including purchase dates, inventory details, model specifications, and pricing with tax breakdowns.

Dataset Link: Click Here

- **Sales Data Columns:**
  - Date – The date when the sales transaction occurred.
  - Invoice No. – Unique identifier assigned to each sales transaction.
  - Invoice Type – Specifies the nature of the sale (e.g., retail, wholesale).
  - Contact ID – Unique customer identification number.
  - Contact Name – Name of the customer purchasing the vehicle.
  - VIN (Vehicle Identification Number) – A unique 17-character identifier for each vehicle sold.
  - Engine No. – Unique engine number associated with the vehicle.
  - Model Name – The specific Hero MotoCorp model sold (e.g., Splendor, Passion Pro, etc).
  - Total Amount (without GST) (₹) – The price of the vehicle before taxes.
    - CGST 9% (₹) – Central Goods and Services Tax (9% of the taxable amount).
    - SGST 9% (₹) – State Goods and Services Tax (9% of the taxable amount).
  - Total Amount (with GST) (₹) – Final price after adding CGST and SGST.

- **Purchase Data Columns:**
  - Date – The date when the dealership purchased the vehicle from the supplier.
  - VIN (Vehicle Identification Number) – Unique identifier assigned to each purchased vehicle.
  - Engine Number – Unique engine number associated with the purchased vehicle.
  - Model – The specific model of the purchased vehicle.
  - Color – The color variant of the purchased vehicle.
  - Inventory Location – The warehouse or showroom location where the vehicle is stored.
  - Total Amount (without GST) (₹) – The purchase price of the vehicle before taxes.
    - CGST 9% (₹) – Central Goods and Services Tax applied to the purchase.
    - SGST 9% (₹) – State Goods and Services Tax applied to the purchase.
  - Total Amount (with GST) (₹) – The total cost of the vehicle including taxes.

4. Descriptive Statistics

Total Amount (without GST) (₹)		*CGST 9% (₹)*		*SGST 9% (₹)*		*Total Amount (with GST) (₹)*	
Mean	60362.70	Mean	5432.64	Mean	5432.64	Mean	71227.98
Standard Error	346.52	Standard Error	31.19	Standard Error	31.19	Standard Error	408.90
Median	55084.75	Median	4957.63	Median	4957.63	Median	65000.01
Mode	55084.75	Mode	4957.63	Mode	4957.63	Mode	65000.01
Standard Deviation	8338.14	Standard Deviation	750.43	Standard Deviation	750.43	Standard Deviation	9839.01
Sample Variance	69524583.06	Sample Variance	563149.12	Sample Variance	563149.12	Sample Variance	96806029.46
Kurtosis	7.75	Kurtosis	7.75	Kurtosis	7.75	Kurtosis	7.75
Skewness	2.09	Skewness	2.09	Skewness	2.09	Skewness	2.09
Range	76271.18	Range	6864.41	Range	6864.41	Range	89999.99
Minimum	50847.46	Minimum	4576.27	Minimum	4576.27	Minimum	60000.00
Maximum	127118.64	Maximum	11440.68	Maximum	11440.68	Maximum	150000.00
Sum	34950000.66	Sum	3145500.06	Sum	3145500.06	Sum	41241000.78
Count	579	Count	579	Count	579	Count	579

Table 1: Descriptive Statistics of Sales Data

4.1. Sales Data:

- Mean & Median: The average sale value is ₹60,362.70, with a median of ₹55,084.75, indicating slightly right-skewed sales distribution.
- Mode: ₹55,084.75 appears most frequently in sales, suggesting it might be a common price point.
- Standard Deviation & Variance: A standard deviation of ₹8,338.14 shows moderate variability in sales prices.

- Range: The sales range is ₹76,271.18, meaning the highest sale is ₹127,118.64, while the lowest is ₹50,847.46.
- GST Components: CGST and SGST each have a mean of ₹5,432.64, confirming uniform tax application across transactions.
- Total Amount (with GST): The mean after GST is ₹71,227.98, with a peak sale reaching ₹150,000.00.
- Sum & Count: A total of ₹41,241,000.78 from 579 transactions indicates high-value sales volume.
- Kurtosis & Skewness: A kurtosis of 7.75 and skewness of 2.09 suggest a highly skewed and peaked distribution.

Total Amount (without GST) (₹)		*CGST 9% (₹)*		*SGST 9% (₹)*		*Total Amount (with GST) (₹)*	
Mean	66508.59	Mean	5985.77	Mean	5985.77	Mean	78480.13
Standard Error	363.94	Standard Error	32.75	Standard Error	32.75	Standard Error	429.45
Median	67796.61	Median	6101.69	Median	6101.69	Median	80000.00
Mode	55084.75	Mode	4957.63	Mode	4957.63	Mode	65000.01
Standard Deviation	10954.50	Standard Deviation	985.91	Standard Deviation	985.91	Standard Deviation	12926.31
Sample Variance	120001146.97	Sample Variance	972009.29	Sample Variance	972009.29	Sample Variance	167089597.05
Kurtosis	3.77	Kurtosis	3.77	Kurtosis	3.77	Kurtosis	3.77
Skewness	1.05	Skewness	1.05	Skewness	1.05	Skewness	1.05
Range	80508.47	Range	7245.76	Range	7245.76	Range	94999.99
Minimum	46610.17	Minimum	4194.92	Minimum	4194.92	Minimum	55000.00
Maximum	127118.64	Maximum	11440.68	Maximum	11440.68	Maximum	150000.00
Sum	60256780.54	Sum	5423110.25	Sum	5423110.25	Sum	71103001.04
Count	906	Count	906	Count	906	Count	906

Table 2: Descriptive Statistics of Purchase Data

4.2. Purchase Data:

- Mean & Median: The mean purchase amount is ₹66,508.59, with a median of ₹67,796.61, indicating a slightly balanced spread.
- Mode: ₹55,084.75 occurs most frequently, similar to sales, suggesting a preferred price point.
- Standard Deviation & Variance: ₹10,954.50 standard deviation shows greater price variation than in sales.
- Range: The purchase range is ₹80,508.47, with a minimum of ₹46,610.17 and a maximum of ₹127,118.64.
- GST Components: CGST and SGST have a mean of ₹5,985.77, slightly higher than in sales, indicating higher purchase values.
- Total Amount (with GST): The mean after GST is ₹78,480.13, with a maximum recorded at ₹150,000.00.
- Sum & Count: Total purchase volume is ₹71,103,001.04 across 906 transactions, reflecting a high procurement rate.
- Kurtosis & Skewness: Kurtosis of 3.77 and skewness of 1.05 suggest moderate positive skewness with fewer extreme values than in sales.

5. Detailed Explanation of Analysis Process/Method

The report explores three key analytical methods—Time Series Analysis & Regression Models, ABC Analysis & Economic Order Quantity (EOQ), and the Reorder Point (ROP) System—that are most suitable for optimizing demand forecasting and inventory management at KD Hero Dealership. By leveraging these methods,
KD Hero can achieve better inventory optimization, cost reduction, and improved customer satisfaction while ensuring a steady supply of vehicles aligned with market demand.

5.1. Time Series Analysis & Regression Models:

KD Hero operates in a market influenced by seasonality, festivals, and economic fluctuations, time series models (like moving averages or ARIMA) can capture these patterns, helping the dealership predict future demand more precisely. Regression models further enhance the analysis by incorporating external factors such as seasonal demand, promotional events, and economic indicators to understand how different variables impact sales.

5.2. ABC Analysis & Economic Order Quantity (EOQ):

ABC Analysis divides inventory into three priority categories: A-items (high value, low quantity), B-items (mid value and quantity), and C-items (low value, high quantity), ensuring that resources are allocated efficiently. Additionally, EOQ calculates the appropriate order quantity to minimize both ordering and holding expenses. Considering the dealership's inventory imbalances and high operational costs, these strategies will ensure that the relevant models are stocked in sufficient quantities while minimizing excess capital trapped in slow-moving inventory. This will result in better cash flow management and increased operational efficiency.

5.3. Reorder Point (ROP) System:

ROP helps in automating stock management decisions, reducing dependency on manual intervention. Since KD Hero faces uncertainties in demand and lead times, an effective ROP system—integrated with sales velocity and supplier lead times—will ensure timely restocking of fast-moving models while preventing unnecessary excess stock. This method is particularly well-suited to the dealership's business model, as it enhances inventory responsiveness to market demand, ensuring that customers find the models they need while minimizing lost sales opportunities.

In conclusion, implementing Time Series Forecasting and Regression Models will enable KD Hero to predict demand fluctuations more accurately, reducing the risk of stockouts and excess inventory. ABC Analysis and EOQ Models will help in prioritizing inventory and determining optimal order quantities, leading to improved resource allocation and cost efficiency. Finally, the Reorder Point (ROP) System will automate inventory replenishment, ensuring a balanced stock level while minimizing manual intervention. Together, these approaches will drive data-backed decision-making, enhance profitability, and position KD Hero as a more responsive and efficient dealership in the competitive automobile market.

6. Results and Findings

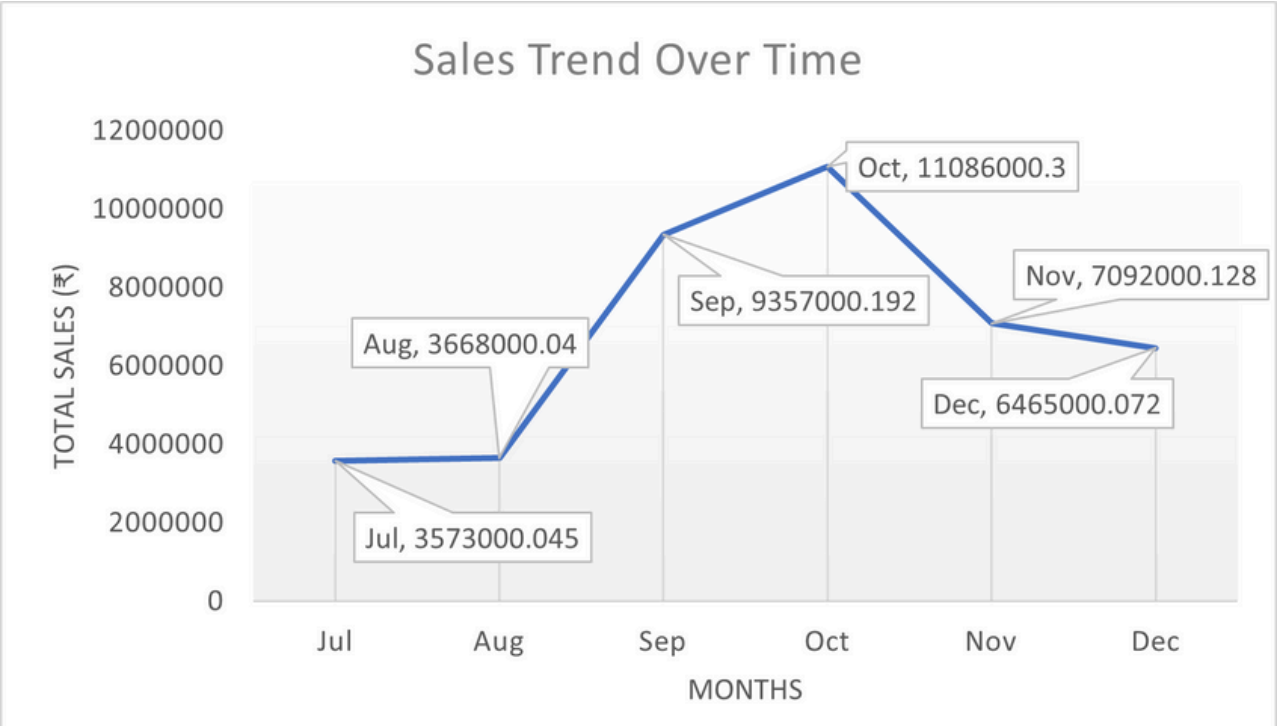


Figure 1: Monthly Sales Trends

- Steady Growth Till October
  - Sales increased from ₹3.57M (July) to ₹11.08M (October), showing a strong upward trend.
  - Possible reasons: seasonal demand, marketing efforts, or a new product launch boosting revenue.
- August saw a slight rise, but a major jump happened in September, indicating a strong sales push or demand surge.
- Peak in October, Followed by Decline
  - Sales peaked in October (₹11.08M) but declined in November (₹7.09M) and December (₹6.46M).

- **Likely reasons:**
  - Post-festive slowdown – if sales were driven by festivals or seasonal promotions, demand would naturally drop afterward.
  - Market saturation – after a strong sales push, customer demand might have been fulfilled, leading to a slowdown.
  - External factors – economic changes, competition, or reduced purchasing power could also impact sales.

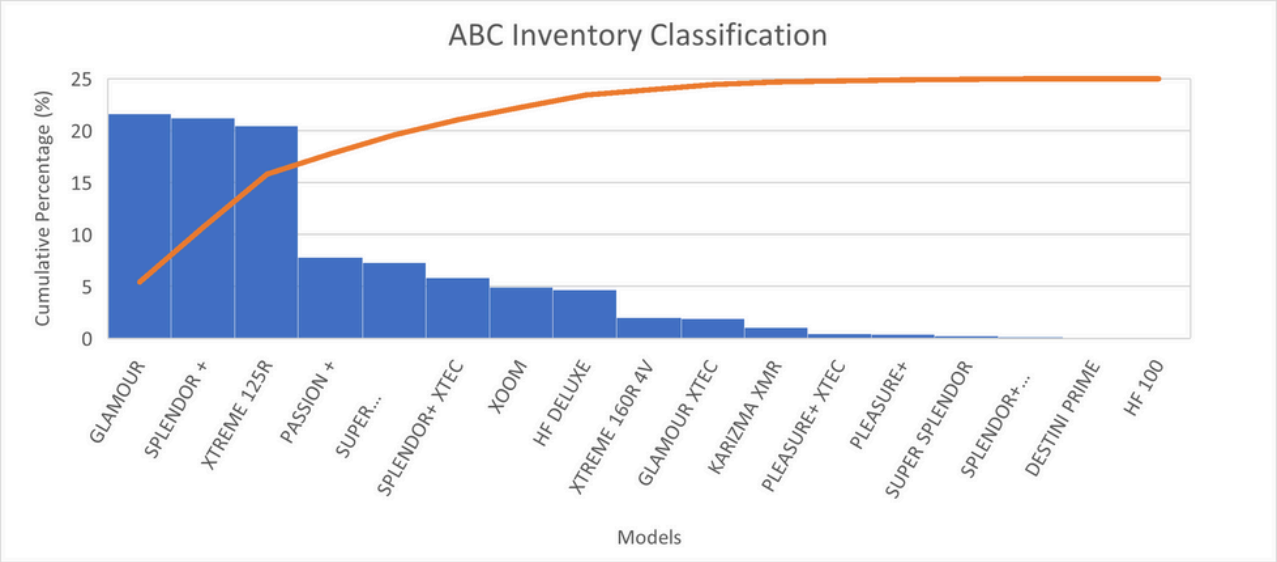


Figure 2: Inventory Classification using ABC analysis

1. Top Models Contribute Most to Sales

- Models like Glamour, Splendor+, and Xtreme 125R make up a large percentage of total inventory sales.
- This follows the Pareto Principle (80/20 rule): 20% of the models contribute to 80% of the revenue.
- These models should be prioritized for stock replenishment, promotions, and marketing investments.

2. Low-Selling Models Exist & May Need Attention

- Towards the right side of the chart, certain models have very low contribution to sales.
- Reasons for low performance:
  - Lower customer demand due to price, features, or market competition.
  - Lack of marketing focus or availability issues leading to poor visibility.

- Changing customer preferences, leading to outdated models not being in demand.
- Solutions: Either improve marketing, offer discounts, or discontinue unprofitable models.

3. Inventory Optimization Required

- Over-stocking low-selling models leads to capital being tied up in slow-moving inventory, increasing storage costs.
- Businesses must increase stock for high-selling models and minimize stock for low-performing ones.
- Better inventory classification using sales trends can improve profitability and reduce losses from unsold stock.

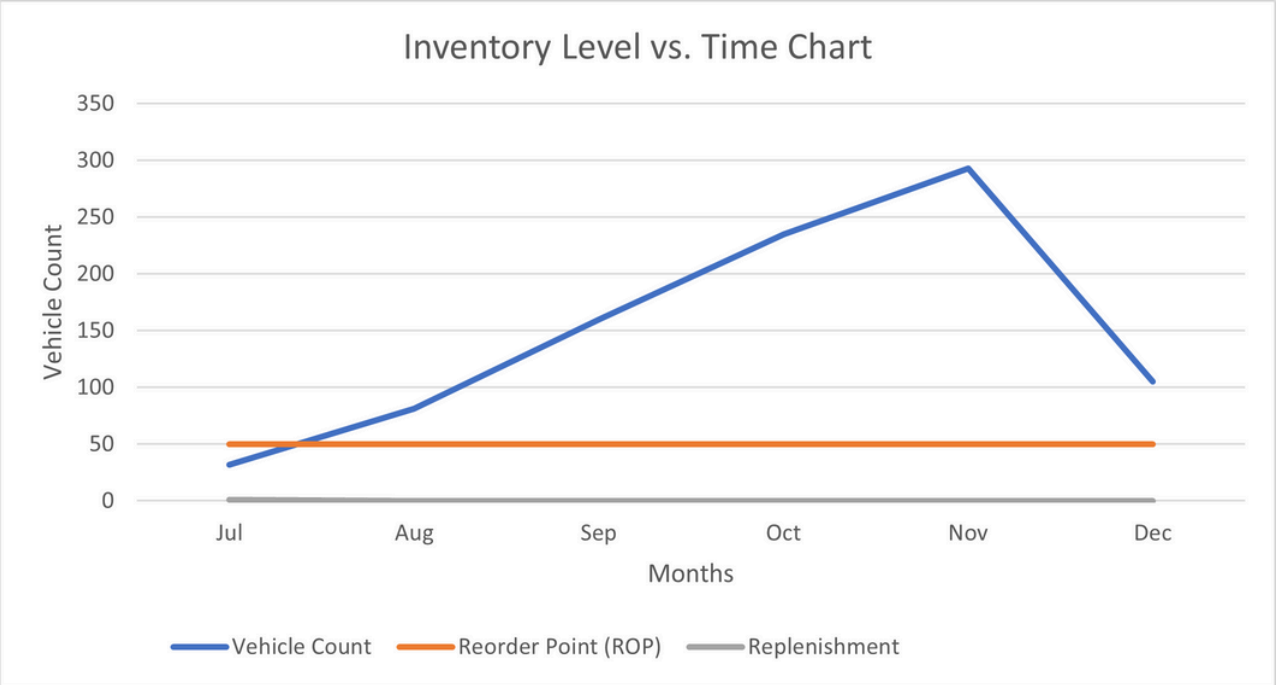


Figure 3: Real time Inventory

1. Inventory Increased Until November

- The vehicle count rose steadily from July (~50) to November (~320), showing a build-up in stock levels.
- Possible reasons:
  - Anticipation of high sales during peak season (October-November), leading to increased stockpiling.
  - New stock arrivals in preparation for demand spikes.
  - Supplier contracts and lead time—inventory might be arriving in bulk.

2. Sharp Drop in December

- Inventory levels fell sharply in December, meaning:
  - Strong sales in previous months might have cleared a significant portion of the stock.
  - Planned stock reduction—businesses might reduce stock at year-end to avoid holding costs.
  - Possible mismanagement in demand forecasting, leading to overstock in October-November and rapid depletion in December.

3. Reorder Point (ROP) Remains Constant

- The ROP stays at a fixed level (~50) despite significant fluctuations in inventory.
- This indicates a static replenishment strategy that might not be adjusting to real-time demand changes.
- Potential issue: If the demand changes dynamically, a fixed ROP may lead to stockouts or overstocking at different times.
- Solution: Implement a dynamic ROP based on real-time demand forecasting to ensure optimal stock levels.

7. Conclusion

The analysis of KD Hero's demand and inventory trends reveals inefficiencies in stock management, demand forecasting, and sales planning. Sales follow a seasonal trend, peaking in October, but without adaptive forecasting, the dealership risks overstocking before peak months and understocking afterward. Excess stock of low-demand models increases holding costs, highlighting the need for ABC Analysis and EOQ models to optimize inventory turnover.

The static Reorder Point (ROP) system fails to adapt to demand fluctuations, leading to stockouts and overstocking. A dynamic ROP strategy will enhance inventory responsiveness and ensure product availability. Implementing predictive analytics, automated stock replenishment, and optimized order management will minimize losses and improve efficiency.

By adopting these improvements, KD Hero can strengthen its market position, enhance customer satisfaction, and drive long-term business growth, ensuring competitiveness in the evolving automotive market.