Predictive Analytics

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Introduction

Our smart inventory system incorporates predictive analytics to optimise stock management and improve decision-making. This document outlines the key models used, their benefits, and how they've been integrated into our system.

Models and Their Explanations

Economic Order Quantity (EOQ)

Explanation

The Economic Order Quantity (EOQ) model is used to determine the optimal quantity of inventory to order that minimises the total inventory costs, including holding costs and ordering costs.

Formula

The EOQ is calculated using the following formula:

$EOQ = \sqrt{((2DS) / H)}$

Where: - D = Annual demand quantity - S = Fixed cost per order - H = Annual holding cost per unit

How it Works

The EOQ model assumes that demand is constant and known, lead time is fixed, and there are no stockouts. It balances the trade-off between ordering costs (which decrease with larger order quantities) and holding costs (which increase with larger order quantities).

Benefits

- Minimises total inventory holding and ordering costs
- Provides a clear, quantitative ordering policy
- Helps maintain optimal inventory levels

Integration

The EOQ model is used to estimate how much of each inventory item needs to be reordered, ensuring cost-effective inventory management.

Reorder Point (ROP)

Explanation

The Reorder Point (ROP) is the inventory level at which a new order should be placed to replenish stock. It considers the lead time for receiving new inventory and the demand during that lead time.

Formula

The basic ROP formula is:

ROP = (Average Daily Demand × Lead Time) + Safety Stock

A more detailed formula that includes variability in demand and lead time is:

$ROP = \mu D\ \mu L + z\sqrt{(\mu L\ \sigma D^2 + \mu D^2\ \sigma L^2)}$

Where: - μD = Average daily demand - μL = Average lead time - σD = Standard deviation of daily demand - σL = Standard deviation of lead time - z = Number of standard deviations for desired service level

How it Works

The ROP model determines the point at which to place a new order by considering the expected demand during the lead time plus a safety stock to account for variability in demand and lead time.

Benefits

- Prevents stockouts by triggering reorders at the right time
- Considers lead time in inventory management
- Optimises inventory levels to meet demand without overstocking

Integration

The ROP model estimates the stock threshold at which each item should be reordered, ensuring timely replenishment.

Facebook Prophet Model for Future Order Prediction

Explanation

Prophet is an open-source time series forecasting model developed by Facebook. It uses decomposable time series with three main components: trend, seasonality, and holidays.

Model

The core equation for the Prophet model is:

$y(t) = g(t) + s(t) + h(t) + \varepsilon t$

Where: - $y(t)$ is the forecast - $g(t)$ is the trend component - $s(t)$ is the seasonality component - $h(t)$ is the holiday component - εt is the error term

How it Works

Prophet fits these components to historical data using a decomposable time series model. It can automatically detect changepoints in the trend and handles missing data and outliers effectively.

Benefits

- Provides accurate forecasts of future order quantities
- Handles seasonality and trends in data
- Offers flexible forecasting at various periods (daily, weekly, monthly)
- Robust to missing data and shifts in trends

Integration

The Prophet model analyses previous inventory history to predict future inventory. This information is reported back to the user at varying levels of detail.

ABC Analysis

Explanation

ABC Analysis is an inventory categorisation method which divides items into three categories (A, B, and C) based on their importance to the business, typically measured by annual consumption value.

How it Works

ABC Analysis follows the Pareto Principle, also known as the 80/20 rule. It typically categorises items as follows:

- Category A: Top 10-20% of items that account for 70-80% of annual consumption value.
- Category B: The next 30% of items that account for about 15-25% of annual consumption value.
- Category C: The remaining 50-60% of items that account for only 5% of annual consumption value.

The annual consumption value is calculated as:

Annual Consumption Value = Annual Demand × Item Cost per Unit

Benefits

- Focuses attention on the most critical inventory items
- Allows for differentiated control and management strategies for each category
- Optimises inventory costs by applying appropriate stocking policies to each category
- Improves cash flow by identifying slow-moving or obsolete items
- Enhances customer service levels by ensuring high availability of important items

Integration

The ABC Analysis is integrated with other predictive models to provide a comprehensive inventory management strategy:

- Category A items are given the highest priority in reordering, with tighter control and more frequent reviews.
- The EOQ model is applied more rigorously to Category A items to optimise order quantities.
- ROP calculations for Category A items may include higher safety stock levels to prevent stockouts.
- Prophet model predictions are used to forecast demand for all categories, but with more frequent updates for Category A items.
- Category C items may have more relaxed control measures, with less frequent orders and lower safety stocks.

This categorisation allows the system to focus reordering efforts and resources on the most important items, while still maintaining appropriate control over less critical inventory.

Additional Insights and Reporting

The Smart Inventory system leverages these predictive models to provide valuable insights through a comprehensive reporting page:

1. **Reorder Forecasts:** Expected reorder quantities and associated costs based on Prophet model predictions, prioritised by ABC category.
2. **Item Frequency Analysis:** Identification of frequently and infrequently reordered items within each ABC category.
3. **Seasonal Trends:** Identification of seasonal patterns in ordering, with special attention to Category A items.
4. **Cost Optimisation:** Suggestions for optimal order quantities balancing cost and demand, tailored to each ABC category.
5. **Stock-out Risk Assessment:** Highlights items at risk of stockouts, with emphasis on preventing stockouts of Category A items.
6. **Inventory Turnover Ratio:** Calculation of how efficiently inventory is being used and reordered, compared across ABC categories.

7. **Demand Variability:** Analysis of fluctuations in demand to adjust safety stock levels, with more precise control for Category A items.
8. **ABC Analysis Dashboard:** Visual representation of inventory value distribution across categories.

These insights, powered by our predictive analytics models and ABC Analysis, enable data-driven decision-making and more efficient inventory management across Helix's system. By categorising items and focusing efforts on the most critical inventory, the system helps optimise resources, improve cash flow, and enhance overall inventory performance.