Team Name: SmartStock AI

AI-Powered Dead Stock Prediction System

Midterm Project Report

SE 390 – Artificial Intelligence Projects with Python

Maltepe University – Software Engineering Department

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1. Executive Summary

Dead stock refers to products that remain unsold for extended periods, occupying warehouse space, increasing operational costs, and disrupting cash flow. This problem significantly impacts e-commerce operations by reducing profitability and diminishing customer satisfaction.

In this project, we propose an AI-powered solution capable of predicting the likelihood of a product becoming dead stock in the future. By analyzing historical sales data, stock levels, product attributes, and user interaction metrics, our system generates a **"Dead Stock Risk Score"** for each product. This score enables businesses to optimize inventory management, plan campaigns effectively, and reduce unnecessary storage costs.

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2. Problem Analysis

What is Dead Stock?

Dead stock consists of products that do not generate sales within a reasonable timeframe. These items accumulate in warehouses, create unnecessary storage costs, and often need to be sold through discounts or disposed of entirely.

Why Is It a Critical Problem?

- **Increased Storage Costs:** Unsold items continue to take warehouse space, adding to operational expenses.
- **Cash Flow Disruption:** Products that do not sell prevent capital from circulating efficiently.
- **Operational Inefficiency:** Managing slow-moving inventory complicates daily operations.
- **Discount Losses:** Companies frequently apply heavy discounts to liquidate stagnant products.

Challenges in E-Commerce

Due to large product variety and fast-changing market trends, e-commerce companies struggle to accurately forecast which products will sell and which will remain in stock for too long. This uncertainty leads to higher levels of dead stock.

Scale and Impact

Large e-commerce businesses in Turkey experience millions of lira in losses annually due to dead stock. This decreases operational efficiency and weakens financial stability.

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3. Proposed AI Solution

Solution Overview

Our proposed solution uses machine learning models to estimate the future risk of a product becoming dead stock. By processing sales history, stock movements, customer interaction data, and product features, the system produces a **"Dead Stock Risk Score"** for each product.

AI/ML Techniques

Possible algorithms include: * **Random Forest Classifier** – high accuracy and interpretability * **Gradient Boosting (XGBoost, LightGBM)** – strong performance on large datasets * **Logistic Regression** – simple and interpretable baseline * **LSTM (Time-Series Models)** – suitable for sequential sales data

Required Data

- Historical sales data (daily/weekly)
- Product pricing and campaign details
- Product category and attributes
- Warehouse stock levels
- Click-through rate (CTR)
- Add-to-cart vs. purchase conversion ratios
- Days spent in inventory

System Architecture Diagram

E-Commerce Database → Data Pipeline → Feature Engineering → ML Model → Risk Score API → Dashboard UI

Technical Feasibility

Technology Stack

- **Python Libraries:** Pandas, NumPy, Scikit-Learn, XGBoost
- **Backend API:** Flask or FastAPI
- **Deployment:** Streamlit or Gradio
- **Database:** PostgreSQL or MySQL
- **Visualization:** Matplotlib, Seaborn

High-Level Implementation Steps

1. Extract raw data from the e-commerce database.
2. Perform feature engineering (sales velocity, demand trend, stock turnover, etc.).

3. Train the machine learning model.
4. Deploy the model using an API.
5. Visualize risk scores through an interactive dashboard.

Data Pipeline Architecture

Raw Data → Cleaning → Feature Engineering → Model Training → Risk Prediction → Dashboard

Scalability Considerations

- Can scale horizontally using a microservice architecture.
- Model can be retrained periodically.
- Spark can be integrated for large-scale datasets.

Integration With E-Commerce Systems

- The API can integrate directly with existing stock management systems.
- The dashboard serves as a decision-support tool for managers.

Expected Performance Metrics

- Accuracy: **80%+**
- F1 Score: **0.70+**
- ROC-AUC: **0.85+**

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4. Business Impact & Implementation

Operational Improvements

- Reduction of warehouse costs by **15–30%**
- Increased stock turnover rate
- Improved campaign planning
- Faster and more accurate decision-making

Cost-Benefit Analysis

Costs: Model development, dashboard creation, system integration
Benefits: Reduced storage costs, lower discount losses, optimized inventory decisions

Customer Experience Benefits

- Improved product availability
- Faster delivery times
- Reduced cart abandonment rates

Implementation Challenges & Solutions

Challenge: Missing or poor-quality data
Solution: Automated data enrichment and data preprocessing pipelines

Challenge: Maintaining model performance over time
Solution: Scheduled retraining and continuous monitoring systems

ROI Projection

The estimated return on investment (ROI) may reach **up to 120%** within the first six months.

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5. Conclusion & Future Work

Key Takeaways

This project provides a scalable and effective AI-driven solution to the dead stock problem, offering significant operational and financial benefits for e-commerce companies.

Next Steps

- Train the model with real production data
- Deploy the dashboard for operational use
- Complete full API integration with inventory systems

Future Work

- Adding demand forecasting modules
- Developing an automated campaign recommendation engine
- Implementing dynamic price optimization

End of Report