UrbanGrocers Ltd. Predictive Analytics Report

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1. Executive Summary

UrbanGrocers Ltd. is a large retail supermarket chain operating in multiple urban centres across Ghana. The management has recognised that the company is struggling with high inventory costs, frequent stockout, inefficient workforce management and inadequate forecasting accuracy. This report outlines the results of predictive analytics using Python and an interactive Power BI dashboard to provide solutions to the senior management of the company to more efficiently manage inventory, optimize workforce allocation and improve overall operational efficiency.

The analysis was carried out on sales data, inventory records, workforce scheduling data, external events data and weather logs from ten retail locations across Ghana, collected over a three-year period (January 2022 to December 2024), and involved building predictive models for sales forecasting, inventory optimization and workforce optimization in relation with variables such as seasonality, promotions, weather and external events.

The analysis revealed a consistent positive sales delta (actual sales minus forecasted sales), indicating opportunities to further capitalize on high-performing products. The inventory optimization models showed a severe overstocking rate of nearly 99.9% across key products, driven largely by excess ordering and long supplier lead times. The workforce optimization models showed a near-even split between overstaffing (49.7%) and understaffing (50.3%), with external factors such as holidays and weather clearly influencing labour needs. Power BI was used to transform the predictive model outputs into actionable, real-time visual insights for UrbanGrocers' management. The three dashboards are a Sales Forecasting Dashboard, an Inventory Optimisation Dashboard and Workforce Optimisation Dashboard.

Based on the results of the analysis, this report recommends that UrbanGrocers should incorporate predictive inventory and sales models into routine planning procedures in order to address the identified inefficiencies, especially for perishable and high-volume products. To increase forecasting accuracy and facilitate more flexible, knowledgeable decision-making across departments, management should keep incorporating external data, such as event calendars and weather forecasts.

2. Introduction

UrbanGrocers Ltd. is a fast-growing supermarket chain operating ten retail outlets across Ghana's major urban centres. While the company has achieved notable expansion in recent years, it continues to face persistent operational challenges including high inventory costs, frequent stockouts, inefficient workforce deployment, and limited forecasting accuracy. These issues have hindered profitability and reduced responsiveness to market demand.

The purpose of this analysis is to apply predictive analytics and business intelligence tools to uncover the drivers of these inefficiencies and propose actionable strategies for improvement. The core objectives are to forecast sales more accurately, optimize inventory levels, improve workforce planning, and assess the influence of external factors such as weather and public events on store operations.

The analysis's scope encompasses three years' worth of historical data from weather, event, staffing, inventory, and sales records. In order to visualise insights and facilitate real-time decision-making, Power BI dashboards were developed, and predictive models were developed using Python.

Although the models and dashboards offer useful guidance, the analysis is constrained by the calibre and level of detail of the data that is currently accessible, especially with regard to supplier responsiveness and customer behaviour. Nevertheless, the results provide a strong basis for future analytics integration and operational enhancement.

3. Methodology

An integrated methodology that combined interactive business intelligence dashboards in Power BI with predictive modelling in Python was used to conduct this analysis. In order to

support UrbanGrocers' operational objectives, the methodology comprised several stages, including feature engineering, data preparation, model development, and dashboard design.

Four main datasets covering the years January 2022–December 2024 were used. The sales dataset comprised daily transaction records from ten retail locations, recording timestamps, product IDs, quantities sold, and sales amounts. Opening and closing inventory balances, receipts, waste, supplier lead times, and product-level costs were all covered in detail by the inventory dataset. Employee schedules, hours worked, shift types, roles, and attendance were all recorded in the workforce dataset. Also, the External_Events was used to incorporate contextual factors, including weather conditions and public event types such as holidays, festivals, market days, and major sports events. Also, the External Events and Weather Logs dataset was used include variables like conditions and public event types in the analysis.

Data processing and predictive modelling were conducted in Python using libraries such as Pandas, Scikit-learn, Matplotlib and XGBoost. A Sales forecasting model was developed using time series techniques that factored in seasonality, promotional activity, weather, and event variables. Inventory optimization models estimated rolling average demand, calculated safety stock buffers, and derived optimal inventory levels based on supplier lead time variability. Workforce optimization models used tree-based machine learning algorithms to predict staffing requirements in relation to demand fluctuations and external drivers.

Interactive dashboards designed with Power BI visualised model outputs and supported dynamic filtering by store, date, product, weather, and event type. Structured to support real-time decision-making and operational monitoring across sales, inventory, and workforce activities, the dashboards supported each other.

Underlying the study were several presumptions. Future demand was expected to be influenced in like manner by historical trends and outside elements including events and weather. Assumed to match recorded sales was inventory consumption; staff productivity was handled as commensurate with hours worked.

Among the constraints were limited granularity in external event classifications, absent direct view into real-time stock movement outside of recorded balances, and lack of customer demographic data.

4. Analysis and Findings

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Sales Forecasting

Three basic functional areas—sales forecasting, inventory control, and workforce allocation—aligned with UrbanGrocers' operational goals—were the focus of the study. To find inefficiencies, predictive analytics models were used in every area to measure performance differences, and pinpoint areas requiring action. External elements such as type of event and weather conditions were included to determine how much effect thay had on business outcomes. Business intelligence dashboards using Power BI were built to visualize the data and derive insights.

Using XGBoost, a machine learning algorithm, sales forecasting models were created factoring in date components (weekday, month, year), promotional flags, weather conditions, and event types. With a Root Mean Squared Error (RMSE) of roughly GHS 138,000 and a Mean Absolute Error (MAE) of about GHS 102,000 the models generated strong forecasts.

In analysing the prediction results, the sales reports confirmed the sales were greater than forecasted, so there was a positive total sales delta or difference of GHS 43,600. The three products that created the most difference or delta were P448, P276, and P402, in the highest-performing categories, Dairy and Fresh Produce. Sales on holiday events, market days, and major occasions tended to be the highest, while the weather was most often sunny or positive in correlation with more store traffic and sales.

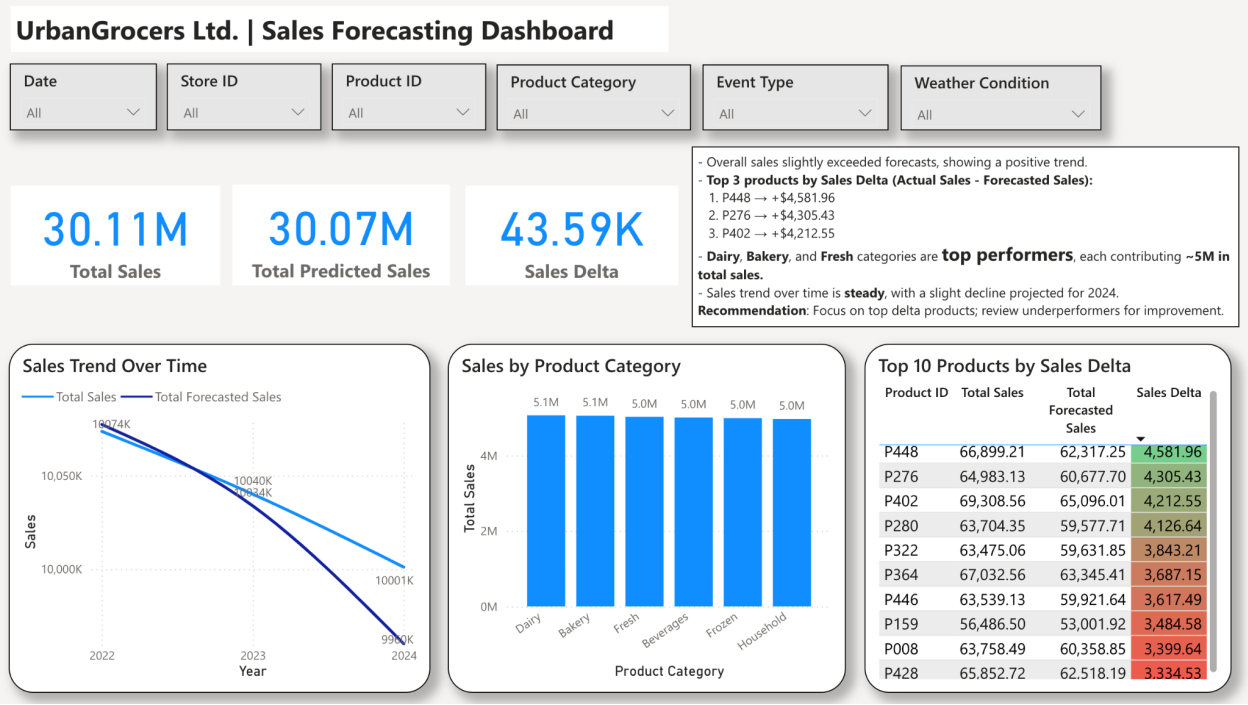

Figure 1: Sales Forecasting Dashboard

What are the main drivers of sales performance?

From the analysis, we found that promotions, events that generated business over days, good weather, and event type (i.e., holidays and market days) were the main drivers for sales. Product Category and store location were still somewhat influential on overall performance, but some categories like perishable and dairy etc., tended to do well during good weather in high traffic type locations.

How can external factors such as weather and events be incorporated into forecasts?

Also, event type and weather conditions were added to the model and improved the forecast accuracy significantly. Sales during event days (holidays and festivals) were consistently higher, while stormy weather seemed to dampen sales on stormy day events. These factors are now presented in the dashboard visualizations via slicers and interactive charts so that managers (and owners) can appreciate their influence in real-time contexts, as well as proactively evaluate sales for similar types of days and or alternate promotions in the future.

Inventory Optimisation

Inventory data were examined through rolling 14-day average demand calculations and safety stock calculations. They were based on demand variability and supplier lead time. The calculations produced inventory levels for optimal inventory performance. After producing their calculations, actual closing inventory was compared against calculated optimal inventory levels to expose inefficiencies and excess stock. The analysis identified a noticeable discrepancy between the average optimal inventory level per product in each store and the respective actual closing inventory levels which resulted in a 99.9% overstock rate.

The root mean square error (RMSE) of the optimal inventory model was 0.18 units, and it had a pretty small mean absolute error (MAE) value of 0.02 units. However, the absolute size of excess inventory above the calculated optimal was too large, across thousands of product lines it created large operational inefficiencies. Products P299, P489, and P019 had the greatest gaps from calculated optimal inventory. Furthermore, product overstock occurred more consistently as product lead time increased or was near major public events creating anticipated demand, indicating stock was ordered `too far ahead', missing the targeted period of demand stability.

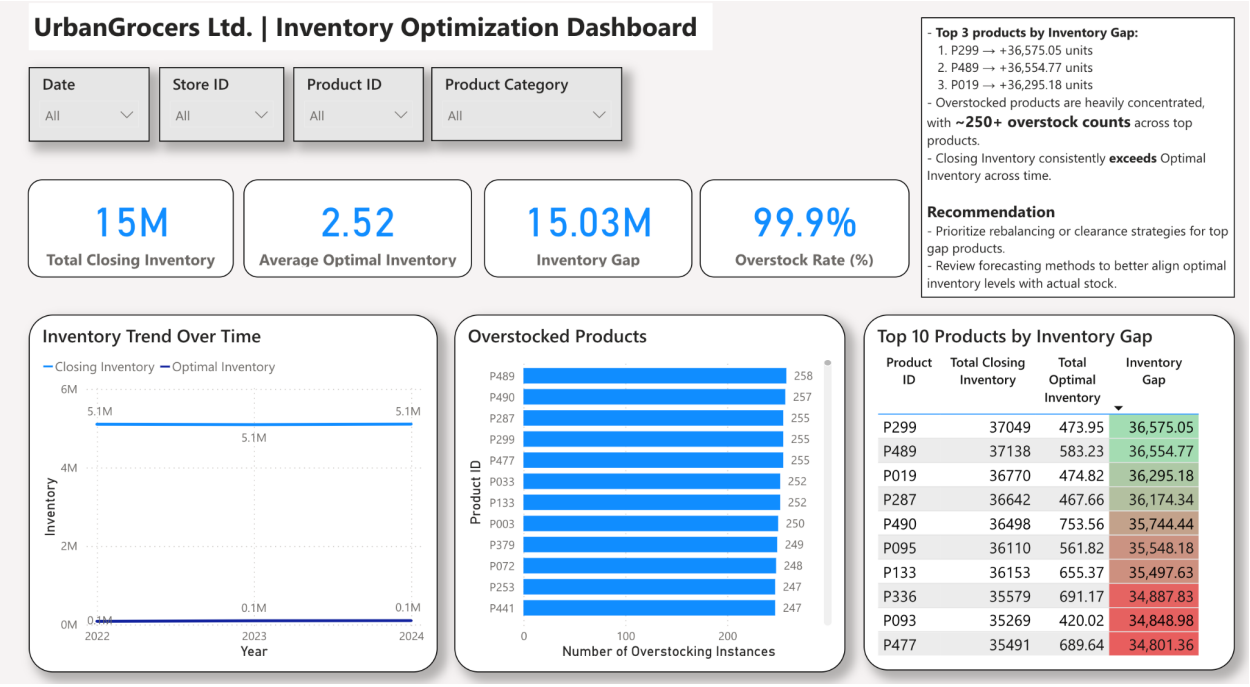

Figure 2: Inventory Optimization Dashboard

How can inventory management be optimized?

Inventory management can improve by synchronizing product orders with forecasted demand, while clearer thresholds are necessary to retroactively account for other impacts, such as events and weather. The initial findings indicate that systemic overstocking is the result of excessive ordering, long supplier lead time and limited to no analysis of available daily sales data to inform replenishment decisions. The dashboards enable store managers to assess these outcomes and address potential gaps in the data discrepancies on a more real-time basis.

Workforce Optimisation

The workforce scheduling data was also summarized to develop a total hours worked and store staff scheduled per store to summarize total hours worked during each day of operations. After deriving a predictive model to measure each store's optimal workforce hours, variable-base demand factors were identified including predicted sales, events and weather. The RMSE produced by the model on a daily basis is 3.86 hours per store per day.

Findings illustrated that overstaffing (49% and understaffing (50%) were almost equal rate but showed very high rates for Store S005 and S003 in overstaffing and chronic understaffing for Store S001. Workforce requirements increased around holiday and festival periods while stormy weather reduced in-store demand and left more scheduled labour working with limited business.

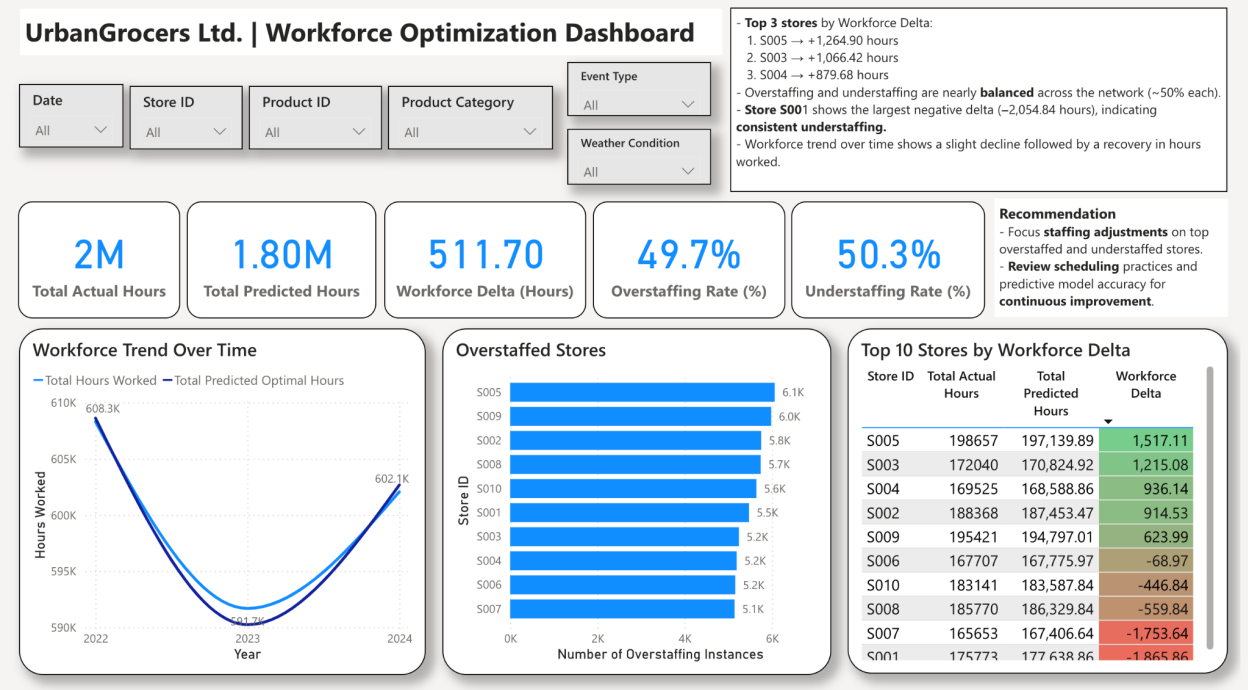

Figure 3: Workforce Optimisation Dashboard

How can workforce scheduling be optimized?

Aligning shift plans with anticipated labor demand in workforce scheduling can provide better outcomes. The models showed that event-aware and weather-sensitive forecasts could address a number of labor inefficiencies. With Power BI dashboards, managers can now assess workforce gaps and refresh shifts due to real-time event drivers.

How can external factors such as weather and events be incorporated into forecasts?

Workforce demand was evidently impacted by external public events and environmental conditions. The model accounted for both of these variables and the dashboards are able to show staffing patterns against the backdrop of the external condition, offering store managers a clear summary of when and where they could amend workforce availability.

5. Conclusion

The report illustrates the transformational possibilities of predictive analytics and decision intelligence for UrbanGrocers' operational challenges. The analysis utilized historical sales, inventory, labour, and event data which not only helped identify inefficiencies but provided evidence-based recommendations on demand forecasting, inventory management, and labour allocation.

Demand forecasting models reported, on average, demand was underestimated, usually considerably so, during significant events like holidays and festivals and identified areas to improve promotional planning and revolutionizing prediction of demand. Inventory analysis indicated unnecessary stock from inadequate lead times and incorrect order quantity and replenishment decisions. An analysis of labour identified chronic mismatches between the amount of scheduled hours, and optimal labour indicated both over and understaffing were near equal proportions across the organization.

Power BI interactive dashboards provided management the real-time ability to identify the subtleties of over and understaffing illustrated in this report, and identify at the store level sales performance, inventory deficiencies, and labour gaps. By incorporating weather and event data, more information was available to help support an understanding of the external factors influencing demand and the importance of these contextual factors in decision-making.

In conclusion, UrbanGrocers is recommended to establish predictive demand models into its inventory and staffing workflows, based on real-time forecasts and external factors. This would require being more sensitive to current forecasts and surrounding conditions, establishing a feedback loop from forecasts to ordering and scheduling, and adding more data inputs to the models, specifically local events and weather. By implementing the aforementioned tools and materializing these methods to their daily business operations, UrbanGrocers can lower costs, achieve better service levels, improve decisions made on the fly that make performance improved overall across their retail network.