**Empowering Spaza Shops: Time Series Forecasting for Local Businesses**

**Group Members**

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**Executive Summary**

The purpose of this project is to empower spaza shop owners with insights derived from time series forecasting models, including Prophet, ARIMA, and LSTM. By leveraging sales and demand forecasting, these small businesses can optimize their inventory management, reduce waste, and meet consumer demand efficiently. Each model provides unique insights: Prophet shows seasonality trends, ARIMA helps with daily demand adjustments, and LSTM provides long-term insights for inventory planning. Based on the analysis, spaza shop owners can make data-driven decisions that boost profitability and customer satisfaction.

**Introduction**

Challenges Spaza Shop Owners Face:

Fluctuating daily demand

Poor inventory management leading to either stockouts or overstocking

Lack of predictive analytics tools to assist in planning

How Time Series Forecasting Helps: Time series forecasting helps by predicting future sales based on historical data. By using advanced models such as Prophet, ARIMA, and LSTM, shop owners can better anticipate demand fluctuations and seasonal trends. This can improve stock availability, reduce waste, and ensure spaza shops are more competitive.

**Data Collection and Preprocessing**

Dataset:

Source: Daily sales data from spaza shops

Key Features:

Date

Sales

Inventory

Events (holidays, promotions)

Weather Preprocessing Steps:

Handle missing values by filling them using interpolation.

Remove outliers that might distort the models.

Apply transformations (log or differencing) to make data stationary (for ARIMA).

Scale data for LSTM (normalization).

**Model Implementation**

**Prophet Model**

Implementation: Prophet is a model that captures seasonality and trend components.

Parameters Used: Consider holidays, weekends, and other significant events (local festivals, school holidays).

Key Trends: Prophet identifies increased sales during weekends and a steady rise in sales during warm weather.

Seasonality: The model captures a weekly seasonality, indicating demand spikes before weekends and holidays.

**ARIMA Model**

Implementation: ARIMA is a traditional time series model focusing on autoregressive and moving average components.

Parameters: Differencing applied to make data stationary. Used AIC to find optimal p, d, q values.

Key Findings: ARIMA forecasts a dip in mid-week sales, making it easier for spaza owners to reduce stock on Tuesdays and Wednesdays.

**LSTM Model**

Implementation: LSTM captures long-term dependencies by learning from multiple variables like sales, events, and weather.

Model Structure: 2 LSTM layers with 50 neurons each, trained over 100 epochs with a batch size of 64.

Key Findings: LSTM predicts seasonal demand increases during the summer months and festive seasons. It also adapts to external factors such as weather, helping spaza owners manage unexpected demand changes.

**Model Comparison**

Model Strengths Weaknesses Ideal Usage

Prophet Captures seasonality trends and holidays May not capture short-term fluctuations Great for planning around weekends and holidays

ARIMA Accurate daily forecasting Limited in long-term prediction Useful for adjusting daily inventory

LSTM Captures long-term dependencies and multiple variables Requires more computation Excellent for seasonal predictions and event-based forecasting

**Insights and Recommendations**

**Prophet Model Insights:**

Seasonality: Increase stock before weekends and holidays.

Trends: Prepare for higher demand during summer months.

**ARIMA Model Insights**:

Demand Forecasting: Decrease inventory mid-week (Tuesdays and Wednesdays) based on expected lower sales.

Inventory Optimization: Adjust inventory daily based on short-term predictions to avoid overstocking.

**LSTM Model Insights:**

Long-Term Dependencies: Plan months in advance for busy or slow periods.

Improved Stock Management: Adjust inventory based on external factors like weather or local events.

**General Recommendations for Spaza Shop Owners:**

Prepare for High-Demand Periods: Increase stock before peak sales periods like weekends and holidays.

Reduce Inventory on Low-Demand Days: Minimize stock on quieter days such as mid-week to prevent wastage.

Seasonal Stocking: Use LSTM predictions to plan for busy seasons (summer, festive periods).

Monitor Market Trends: Keep an eye on local events, festivals, and weather changes that might affect sales.

Data-Driven Decisions: Regularly update forecasting models with new data for improved accuracy.

**Conclusion**

The use of time series forecasting models—Prophet, ARIMA, and LSTM—offers significant advantages for spaza shop owners in South Africa. By predicting sales trends and fluctuations, owners can make informed decisions on when to increase or decrease stock, optimize their inventory, and ultimately improve profitability. Data-driven decision-making is the key to staying competitive in today's market.