

Forecasting Retail Coffee Demand Using SARIMA: The Role of Weather Variables

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Abstract

The accurate demand forecasting is fundamental to efficient retail supply chain management, helping businesses optimize inventory levels and align operations with consumer needs. This study focuses on forecasting demand for a coffee vending machine using Seasonal Autoregressive Integrated Moving Average (SARIMA) models. To enhance predictive accuracy, weather variables such as temperature, humidity, etc., are incorporated, recognizing their potential influence on coffee consumption patterns. The analysis combines sales data with contextual weather information to develop models capable of capturing seasonal and trend variations more effectively. The forecasting performance is evaluated using Mean Absolute Percentage Error (MAPE) and Mean Absolute Error (MAE) as the primary metrics, with the results showing a MAPE of 32.19% and an MAE of 2.59. These findings demonstrate that the inclusion of weather data significantly improves the model's reliability. The findings underscore the value of integrating external variables in demand forecasting, offering actionable insights for retailers to refine inventory strategies, minimize waste, and respond to dynamic consumer behavior. By highlighting the interplay between environmental factors and retail demand, this study contributes to advancing data-driven approaches for robust and adaptive forecasting in complex retail environments.

Keywords

Demand Forecasting, SARIMA, SARIMA(X), Predictive Analytics, Coffee Retail

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Biographies

Ferdous Sarwar is a distinguished Professor in the Department of Industrial and Production Engineering (IPE) at Bangladesh University of Engineering and Technology (BUET). He holds a Ph.D. in Industrial and Manufacturing Engineering from North Dakota State University, USA, along with B.Sc. and M.Sc. degrees from BUET. Dr. Sarwar's research areas include advanced manufacturing, operations management, decision analysis, and supply chain optimization. He is a prolific contributor to esteemed international journals and is actively involved in consultancy, leveraging his expertise to enhance operational efficiencies and manufacturing practices within Bangladesh's industrial landscape.

Shashwata Sengupta is a final-year undergraduate student in the Department of Industrial and Production Engineering at Bangladesh University of Engineering and Technology (BUET). With a keen interest in the real-world applications of mathematical models, he is at the beginning of his research career. His research interests include predictive analytics, decision analysis, risk management, and supply chain management, reflecting his enthusiasm for using data-driven approaches to solve complex industrial challenges.