

Dynamic Safety Stock Estimation for Medical Supplies in Emergency Departments Using Simulation and Machine Learning

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Abstract

A successful inventory management strategy requires a proper compromise between service levels to meet demand with the costs of storing products that lose quality or value with time. This research analyzes different approaches for estimating the safety stock of medical supplies using simulation tools and machine learning algorithms. The research was conducted in four stages: analysis, design, development, and validation. During the analysis stage, the number of patients coming to the emergency room over a 12-month period were collected and preprocessed. In the design stage, simulation tool, forecasting methods, machine learning algorithm, and comparison criteria were selected. In the development stage all necessary models were implemented and tested. Estimating safety stock for medical supplies using classical formulae has limitations since it does not consider variability. Instead, average number of patients in a given period is included. However, fluctuations may consume the safety stock, leading to stockouts. One alternative is to forecast the number of patients using 3-month moving averages instead of the annual average. Another approach is to apply machine learning techniques for forecasting. The simulation results showed that using safety stock based on average numbers can lead to as many as 10 stockouts per year. The model based on a 3-month moving average reduces this number to 6 annual stockouts, while the machine learning model further decreases the figure to only 2 stockouts per year. Although the results depend on the specific dataset used, the proposed models based on dynamic safety stock estimation might help reduce the occurrence of stockouts, thereby helping healthcare institution meet their service levels.

Keywords

Inventory Management, Security Stock, Service Level, Discrete Event Simulation, Machine Learning.

Biographies

Carlos Hernández is an industrial engineer and university professor. He earned Master of Sciences in Engineering and Doctor of Engineering from Technische Universität Braunschweig, Brunswick, Germany. He has taught lectures in Discrete Event Simulation, Engineering Economics, Corporate Finances, Data Mining and Machine Learning for engineering students. He has developed a professional career working for large multinational companies (PricewaterhouseCoopers, BHP Billiton, and Merck Sharp & Dohme). He also worked as a scientific researcher in the Institut für Produktionsmesstechnik at TU Braunschweig, Germany. His research interests include manufacturing process simulation, supply chain design and simulation, and machine learning for finances.

Jaime Castillo is an industrial engineer, consultant, and university professor. He earned Licentiate Degree in Forest Engineering from Universidad de Concepción, Concepción, Chile, and Master in Industrial Engineering from Universidad del Desarrollo, Santiago, Chile. He has taught lectures in Project Planning & Management, Evaluation, Decision Theory, and Process Simulation for engineering students. He has extensive experience working in sustainable

development projects for the local forest industry. During her academic tenure he has been appointed in different management positions and has mentored over a fifty students. His research interests include project management, logistic risk assessment, and decision theory.

Dafne Lagos is an industrial engineer and university professor. She obtained a Bachelor of Science in Engineering and a Master's in Management from the Universidad de La Frontera (Temuco, Chile) and a Doctor of Science from Atlantic International University (USA). She has lectured in Engineering Economics, Probability Modeling, Logistics, and Operations Research for engineering students. She has also written several scientific articles in the area of operations research. During her academic tenure, she has been appointed to different managerial positions and has mentored more than forty students. Her research interests include financial planning, supply chain management, and logistics.

Paola Leal is an industrial engineer and university professor. She earned Licentiate Degree in Engineering from Universidad de La Frontera, and Master of Sciences from Universidad Mayor, Temuco, Chile. She has taught lectures in Operations Research, Logistics, and Supply Chain Management for engineering students. During her academic tenure she has been appointed in different management positions and has mentored over a sixty students. Her research interests include logistics, optimization, and supply chain management.