# An Exploratory Deep Learning-Based Inventory Management Solution in the Manufacturing Execution System

Md Javed Ahmed Shanto†, Love Allen Chijioke Ahakonye†, Ahmad Zainudin§,
Jae-Min Lee†, Dong-Seong Kim†, Taesoo Jun†
†Department of IT Convergence Engineering, Kumoh National Institute of Technology, Gumi 39177, South Korea
§Department of Electronic Engineering, Kumoh National Institute of Technology, Gumi 39177, South Korea
(shantoa729, loveahakonye, zai, ljmpaul, dskim, taesoo.jun)@kumoh.ac.kr

***Abstract*—The expeditious growth of online purchasing ushers a new era of digitization in warehousing, bringing many types of data with it. We can observe its features after evaluating the data, and it provides a new door to Artificial intelligence (AI). Furthermore, since inventory management is a continuous data source, applying AI in this industry globally is simply a question of time. Although some organizations are aiming to merge AI with inventory data to estimate product sales, currently there are few applications of AI models in this area, and the inventory management sector's fast development necessitates reliable data prediction for enhanced operations. This research provides a deep learning-based solution for inventory management utilizing multilayered LSTM neural networks in an exploratory examination.**

***Index Terms*—AI, Deep learning, LSTM Inventory Management, MES.**

## I. Introduction

Artificial intelligence (AI) has shown to be extremely valuable in today's technological age, when every online transaction creates data. This data is transformed into useful knowledge by machine learning and notable data professionals [1], [2]. Furthermore, correctly interpreting information and forecasting a consequence results in knowledgeable decisions. Existing studies show that AI appears to have enormous control in MES; hence, the research on inventory management is increasing gradually. On a review highlighting the influence of AI in the supply chain, authors [3] identified significant sub-fields of AI applications such as inventory management. Recently, authors [4] have published a pilot analysis projecting demand for hospital consumption assets during disruptive situations. The study's goal was to predict the hospital's asset demands during an emergency. Although the preliminary study offered a forecasting model, it lacked a detailed description of methods and results to allow for further research.

As a response, this study attempts to reduce the mean absolute error (MAE) in order to enhance the performance of inventory management forecasts. In practice, a comprehensive examination of consumer demand for commodities can reduce the likelihood of customer order forecast errors. However, experts in supply chain and inventory management are debating how to precisely determine customers' product demand [3] based on mean absolute error (MAE), which is one of the standard parametric metrics for time-series regression problems, and it is considered in this study to validate the proposed model's performance. Based on the deep learning theory of multi-layered long short-term memory (LSTM), it aims to forecast customer demands in order to make informed decisions about MES (IM) [5]. This paper's notable contributions are summarized below:

1) This study formulates the inventory management prediction issue into an optimal model that considers several inventory management aspects, primarily to reduce the Mean Absolute Error (MAE).
2) In this research, multilayered LSTM is used to analyze product demand in a supply chain and inventory management problem.
3) For reliability testing, we compared the performance of the proposed approach to that of many prominent deep-learning models.

Section II demonstrates the proposed system paradigm after that, Section III evaluates the proposed AI solution. Lastly, Section IV also addresses the conclusion as well as future approaches.

## II. System Methodology

### A. MES Inventory Management (IM)

A Manufacturing Execution System (MES) is a sophisticated software system that enhances manufacturing operations and overall efficiency. They will require the assistance of inventory management to gather all of the data from the IM and evaluate and optimize the information for prediction.

### B. Proposed Methodology

This concept makes use of a multilayered long short-term memory. It consists mostly of one input node, one hidden note, and one output node. The proposed system in this article, on the other hand, includes three separate levels. Fig. 1 illustrates the workflow and system model of the proposed model. This model initially collects data from the IM and divides it into two sections. The data is split into two categories:: training data (80%) & testing data (20%). Then, after thoroughly inspecting

the columns, we remove the id value (SKU) because it serves no purpose in our model.

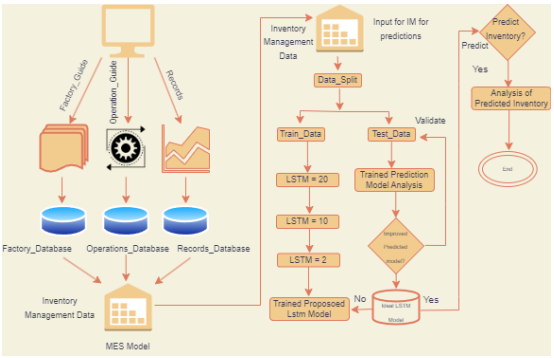


Fig. 1. System Model of the Proposed LSTM-Based Deep learning Solution

To generate more accurate results, instead of removing them, replace any null values with the Nan value and use one hot encoder for the category columns. After that, we used the sklearn minMaxscaler function to estimate scales and translate each feature in the training set separately such that it fell within the provided range. Then there are 20 neurons in our first layer, 10 in the second layer, and 2 in the last layer. This model outperforms the other common models in terms of MAE in the same amount of time/step and epoch.

### C. Data-Set Description

This data-set is from Kaggle's "Can You Predict Product Back-orders" data-set [6] which has 23 columns. It includes all of the prospective data for predicting the data.

## III. Performance Evaluation

To assess the usefulness of AI in MES inventory management, this study used a multi-stack deep learning technique. In comparison to other prominent deep learning models, the simulation result shows a much lower mean absolute error (MAE). The trials were done using the Google Collaborative Simulation environment using Python programming.

TABLE I
Mean Absolute Error (MAE) Comparison of the Proposed Approach with other Popular Techniques

| Parameter & Metrics | Proposed LSTM | GRU | LSTM-128 | DNN |
|---|---|---|---|---|
| MAE (%) | 1.49564 | 1.94285 | 1.96058 | 98.85463 |
| Epoch | 25 | 25 | 25 | 25 |
| Loss | 0.0088 | 0.0088 | 0.0088 | 0.9912 |
| Time/Step | 4ms/step | 4ms/step | 4ms/step | 2ms/step |

Table I demonstrates that our suggested model displayed the least amount of MAE, which is excellent. We chose GRU, traditional LSTM-128, and DNN to study and compare with other models since they are the most prominent in terms of time regression challenges.

As shown in Figure 2 and table I, the experimental results indicate that the proposed LSTM model outperformed the parameter assessment measure. The MAE of the proposed

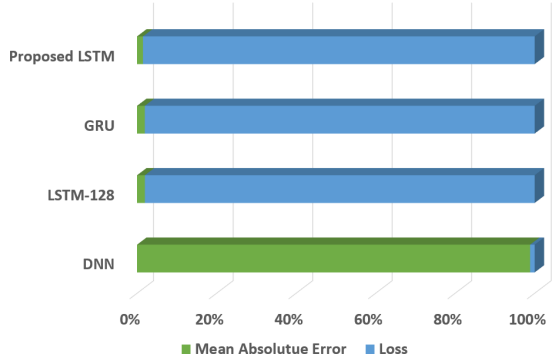


Fig. 2. Result Evaluation for the Proposed LSTM, GRU, LSTM-128, & DNN in terms of MAE

LSTM model is just 1.50%, while GRU has 1.94%, LSTM-128 has 1.96%, and DNN has the highest value of 98.85%. Except for DNN, which takes 2ms/step, each model takes around 4ms/step and requires 25 epochs.

## IV. Conclusion

This study developed a three-layered LSTM-based model for forecasting the IM. When compared to other popular models, this result indicates much-enhanced performance due to reduced MAE and time/step in the same period. It demonstrates its use as an early outcome of using AI in inventory management in MES. Soon, In the same time frame, this study aims to enhance the model's Mean Squared Error (MSE) and Root Mean Squared Error (RMSE).

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