

# THE IMPROVEMENT OF MATERIAL PROCUREMENT PROCESS

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## MOTIVATION

Aselsan Inc. is one of the companies with the widest product range in terms of material and project diversity. Each material that needs to be supplied is an important place for the process because the shortcomings in the procurement of raw materials and semi-finished products required for production cause delays in the delivery of the final product, directly or indirectly, and financial loss. The aim of the project that we do with Aselsan Central Supply Chain Directorate is to analyze the material procurement process and to present sustainable solutions based on the results of the analysis.

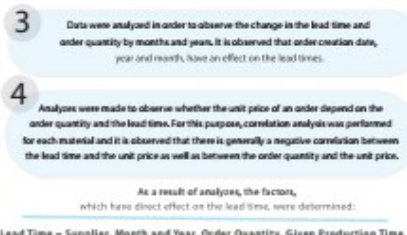
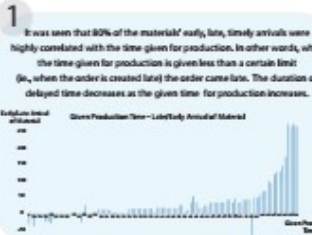
## MATERIAL PROCUREMENT PROCESS



## DATA



## SYSTEM ANALYSIS



## PROBLEM DEFINITION

The main problem is defined as the inability to obtain the desired efficiency from the material procurement process. 40% of the orders between 2014-2018 were reached early, 30% were late and the remaining 21% reached to the company on time. The total cost of the orders were \$87 million, \$78 million, and \$25 million. In case of early arrival of orders, keeping the materials within the company until the requirement date causes a significant increase in inventory holding costs. In case of delay of the orders, production cannot be started on the desired date and the project calendar can be disrupted. The delays in the project calendar causes that the firm pays the financial penalty for each delayed product according to the agreement with the customer.

### Current System

- The planned delivery time is used by the production planning personnel and the orders are expected to be created according to this time.
- It is a constant number that does not change according to different factors.
- It is created based on experience.



### Proposed System

- The planned delivery time is used by the purchasing personnel. The planning personnel creates the orders according to the Planning Horizon.
- PDT is calculated according to different factors.
- PDT is created based on mathematical methods.



## METHODOLOGY

### 1 Data Preprocessing

- Obtained information is used in data analysis process
  - Extraction of orders that the entry of material hasn't been done yet
  - Extraction of orders that created for re-work
  - Removal of outliers based on some features
- Duration of Creation of Purchase Request  
Duration of Creation of Purchase Order  
Lead Time of Order  
Late or Early Arrival of Order  
Unit Price of Order  
Deciding to use these orders as test data
- Lead Time  
Late or Early Arrival of Order

### 2 Machine Learning Models

- Regression models were decided to be used because the lead time is continuous value.
- Machine learning regression models were created to make accurate estimation of material arrival times. The main purpose of these models is to create a learning algorithm on the training dataset that can best estimate the material arrival times and to obtain the best estimation result in the test dataset. These models were implemented through the Python programming language.
- Machine Learning Regression Models
  - Multiple Linear Regression
  - Decision Tree
  - Random Forest
  - Support Vector Regression

### 3 Decision Support System

A user-friendly computer-based interface has been developed to enable the company staff to use the results of prediction as a result of machine learning methods. In this application, firstly, a purchaser enters the stock number of the material. After that, he/she enters the supplier number and the order quantity. After entering the requirement date from the calendar window, the decision support system predicts the lead time and the interval for lead time. The system gives the date interval for purchaser to help them about purchase order creation time.

# Material Stock Prediction

Lead Time Predictor

Material Unique Stock No

Supplier

Quantity

Due Date

Lead Time

Interval Lead Time

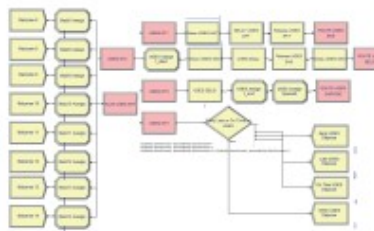
Date of Arrival of Order

Predict Time Delay

The decision support system, in addition to the prediction of the arrival time of the group A critical materials, is also suitable for predicting the arrival times of other group materials. At the same time, the system has been designed to have a wide range of functions so that company staff who work in different sectors can use it.

### 4 Simulation Model

The current material procurement process is simulated by using Arena program. As a result of the simulation model, the total number of early, late and timely arrived orders are obtained for 5 years. After the current system simulation, the process is simulated using the results of decision support system and the arrival situation of orders are obtained for 5 years. Finally, the increase in number of timely arrivals is observed.



Material procurement process of all sectors are simulated. The figure shown below is just a part of model of UGES' material procurement process.

### 5 Results

The proposed decision support system is used for the test dataset containing 115 orders for prediction of the arrival time of the Group A critical materials.

|                      | Before Proposed System | After Proposed System |
|----------------------|------------------------|-----------------------|
| Early Arrival Rate   | 27%                    | 17%                   |
| On Time Arrival Rate | 14%                    | 33%                   |
| Late Arrival Rate    | 59%                    | 50%                   |

Decrease in the number of early arrival of orders decreases inventory holding cost

Decreased from \$ 8,400 to \$ 800

It is important to inform the purchaser about in what time he or she should give the order to the supplier. By using decision support system, we determined in which time interval an order should be given before the material requirement date for each material. For the intervals, we assigned accuracy rates. A purchaser can give the order by these intervals and the accuracy rates.

| Material | Supplier | Proposed Lead Time Interval in Days (Purchase Order -) | Accuracy Rate at 2013 for A | Actual Lead Time Interval in Days (Supplier to Production) | Accuracy Rate at 2013 for B |
|----------|----------|--------------------------------------------------------|-----------------------------|------------------------------------------------------------|-----------------------------|
| 1        | 910480   | 10-70                                                  | 43%                         | 10-120                                                     | 58%                         |
| 23       | 210002   | 100-200                                                | 54%                         | 60-170                                                     | 76%                         |
|          | 210000   | 10-100                                                 | 43%                         | 10-100                                                     | 60%                         |
| 11       | 210171   | 70-100                                                 | 60%                         | 70-100                                                     | 88%                         |
|          | 210171   | 100-200                                                | 60%                         | 20-100                                                     | 10%                         |
| 64       | 220989   | 100-100                                                | 71%                         | 30-100                                                     | 87%                         |
| 65       | 220700   | 110-200                                                | 43%                         | 100-120                                                    | 68%                         |
| 109      | 210001   | 110-200                                                | 71%                         | 20-100                                                     | 68%                         |
|          | 210001   | 20-100                                                 | 68%                         | 20-100                                                     | 63%                         |

## REFERENCES

- Banerjee, A. G., Kundu, K., Yang, D., Kowalski, P., Carlson, L. & Saha, I. (2016). A Hybrid Statistical Method for Accurate Prediction of Supplier Delivery Times of Aircraft Engine Parts. 15th Computers and Information in Engineering Conference, 16, Boston, MA, USA.
- Liu, L., Sheng, L., Yang, H., Rong, L., & Banerjee, A. G. (2016). Predicting Purchaser Orders Delivery Time Using Regression Models with Decision Production. 15th Computers and Information in Engineering Conference, 16, Quebec City, MA, USA.