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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

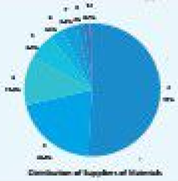
DATA

- 5 Different Groups
  - UGES, HBT, MGEO, REHİS, SST
  - 5 Different Factories
  - Different Production Planning and Purchase Order department
- 2014-2018
- 288 Group A Materials
  - Critical materials determined by the company
  - Groups have no common material
- 11061 Purchase Orders
- 39 Countries 220 Suppliers
  - 153 materials have more than one supplier

SYSTEM ANALYSIS

1 It was seen that 80% of the materials' early, late, timely arrivals were highly correlated with the time given for production. In other words, when the time given for production is given less than a certain limit (ie., when the order is created late) the order came late. The duration of delayed time decreases as the given time for production increases.

2 153 of the materials have more than one supplier while the rest has only one supplier. The number of suppliers of the materials ranges from one to twelve. Lead times differ from supplier to supplier.



3 Data were analyzed in order to observe the change in the lead time and order quantity by months and years. It is observed that order creation date, year and month, have an effect on the lead times.

4 Analyses were made to observe whether the unit price of an order depend on the order quantity and the lead time. For this purpose, correlation analysis was performed for each material and it is observed that there is generally a negative correlation between the lead time and the unit price as well as between the order quantity and the unit price.

As a result of analyses, the factors, which have direct effect on the lead time, were determined:

Lead Time – Supplier, Month and Year, Order Quantity, Given Production Time

PROBLEM DEFINITION

The main problem is defined as the inability to obtain the desired efficiency from the material procurement process. 49% 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 587 million, 576 million, and 525 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 order, 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
  - 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
- Extraction of orders that the entry of material hasn't been done yet
  - Deciding to use these orders as test data
- Extraction of orders that created for re-work
- Removal of outliers based on some features
  - 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.

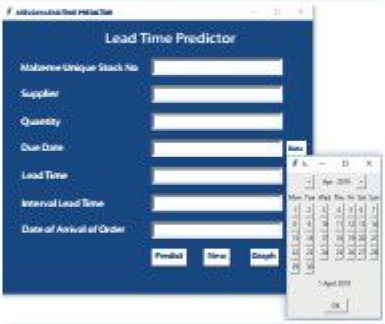
Machine Learning Regression Models

- Multiple Linear Regression
- Decision Tree
- Random Forest
- Support Vector Regression

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.

3 Decision Support System

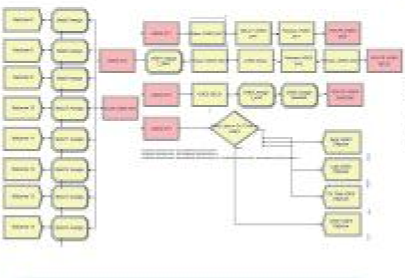
A user-friendly computer-based interface has been developed to enable the company staff to use the results of prediction as a result of machine learning methods. In this application, firstly, a purchaser enters the stock number of the material. After that, he/she enters the supplier number and the order 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 purchasers to help them about purchase order creation time.



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's 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 Given Time Interval to Create Purchase Order (A)	Accuracy Rate of DSS for A	Actual Given Time Interval to Supplier for Production (B)	Accuracy Rate of DSS for B
1	373089	10 - 70	82%	10 - 120	59%
33	210883	100 - 300	90%	60 - 610	79%
11	210880	10 - 400	82%	10 - 400	82%
	210731	50 - 420	80%	70 - 420	80%
	210737	100 - 280	90%	20 - 580	53%
64	720388	140 - 400	77%	30 - 400	67%
69	726704	110 - 300	83%	100 - 150	44%
106	210633	130 - 200	73%	20 - 250	40%
	210481	20 - 120	89%	20 - 220	63%

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