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Predicting total shipping and clearance time for Al-Ghanim Sahara transportation

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Abstract-Understanding factors affecting the Lead Time provides Supply Chain Management with better insight about the amount of time it takes to deliver products to the market. Lengthy procedures and wide variability of Lead Time also reduce the probability that firms will enter markets for time-sensitive products and prevents from gaining competitive advantage. This investigation sought to identify the factors influencing the Lead Time of shipment services at Al-GhanimSahra Transportation (AST). The data was collected from AST over three years (2014 2016) including customers orders, actual time of shipments and clearance date over several stages of shipment. A multivariate fixed and random regression models were employed using stepwise variable selections to identify significant independent factors; including their interaction to Lead Time. The findings revealed that Supplier, Commodities, Departure Port and Shipping line along with their interaction were significant shipping-related contributors to Lead Time, explaining about 38.7% of the total variation in Lead Time. These factors are used to predict the lead time.

keywords: Lead Time; Supply Chain Management; Delivery Time; Shipment Services.

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1 Introduction

The delivery Lead Time and price in global markets have become one of the most important factors to achieve competitive advantages and customer satisfaction (Pan and Yang, 2002). A delivery lead time generally is defined as the time starting when the order is placed and ending with receiving the order and storing it in the warehouse of the customer organization. Predicting the real delivery Lead Time is a critical issue that affects the financial state of the company and customer satisfaction. Being able to estimate the actual delivery time of the shipments will solve many cost related problems, help to avoid having products out of stock and provide the required inventory space for the products in the warehouse. By solving these problems and having the products on the expected time, customer satisfaction and loyalty can be achieved (Mohamed and Coutry, 2015; Li and Bai, 2016; Pan and Yang, 2002). Delivery lead time for freight companies usually consists of two main processes: shipping the products from departure ports to local ports and clearance of goods and placing them in the warehouse. The whole delivery Lead Time process is a long and complex process that has specific rules and regulations and may be affected by many variables and factors. For example, despite the shipping company is complied with all regulations, the shipment process may face delays and unexpected costs due to material handling, climate conditions or transportation factors that can affect the whole process (Tarty, 2012; Rushton et al., 2014). This paper attempts to predict the total shipping and clearance time for one of the leading freight company in Kuwait as a case organization, the Al-Ghanim Sahra Transportation.. Within the context of this work, the delivery lead time involves the period between the starting from the actual time of shipments and ending with Bayan date (Bayan is an official document from the government that gives the permission to clear the goods from the port). The findings of this work is expected to improve the management of shipment supply chain, and consequently leading to a higher customer satisfaction with less problems like products stock out, limited inventory space, transportation delays, etc..

2 Research Background

Customers around the world are able to order products that they want at the time they want and at the best price possible. Companies serving those customers mainly focus on improving both the quality and the delivery time, as they have a great contribution in being a favourable choice among all other competing companies in a very competitive global market. On the other hand, companies and manufacturers are improving their profitability by increasing quality and decreasing both cost and delivery time. Delivery time or so called lead time is one of the most important competitive factors that differentiate a company from another (Kader and Akter, 2014a; Ben-Daya and Hariga, 2003a). Short lead time will increase sales and lead to an effective service delivery.

2.1 Lead Time

Shipping time is the first stage of the lead time; where this stage starts from the minute the ship leaves the departure port until it reaches the desired destination port. It is important to note that just before the ship leaves the port, the shipping line establishes a paper called (Bill of Lading) which declares that the goods were received from the Supp, the goods container are shipped on the ship and it also includes the date and time of actual shipping time when the ship left the port in addition to an estimated tLead Time is defined as the time between placing an order from a Supplier and receiving the order. Simangunsong et al. (2012) defined lead time as the time measured from the moment the customer sends a purchase order until the customer receives the order. A similar definition for lead time was mentioned by other researchers (e.g., Shams et al., 2017), and reported that lead time begins with the first receipt of customer order and ends with customer receipt of the product. Kader and Akter (2014b) defined lead time from a wider perspective starting from the date of receiving raw materials and to the date when the product is shipped to the customer. As it can be seen in different scientific papers, lead time definition varies from one company to another depending on the type of industry and depending on the point of view when planning the processes for product life cycle. The lead time is usually assigned based on different criteria that can be put in the purchase order contract based on "past history and discussion with the Supplier", (Wijaya et al., 2013). When companies work together over one supply chain, these differences may cause some variability in the lead time and delays on the agreed time of shipping or receiving the order. The variability in the lead time occurs when the actual time between ordering and receiving a product is different than the expected time (Shams et al., 2017). In order to make a good preliminary estimate of the lead time, Wijaya, emphasized on the idea that says the lead time must take into account a number of factors including setup time, processing time, material handling time and waiting time.

Companies focus on estimating the lead time because it affects the performance of companies, especially in a competitive environment. In other words, it can be said that: lead time delay is therefore defined as the number of time units when an order is delayed compared to the expected or promised lead time (Gudum, 2002). Good planning strategies help companies to determine the lead time in order to reduce it and avoid many problems related to this variability and delays. Ries (2011) supports this point as he mentioned that reducing lead time may result in lower stock out risk and consequently lower expected total cost. Toyota production systems revealed that reducing lead time has a crucial impact in productivity improvement (Ben-Daya and Hariga, 2003b). Moreover, studies show that the short cycle of lead times helps companies to stay in the safe way. The length of lead time directly affects service delivery and sales. According to Ben-Daya and Hariga (2003b), a shorter lead-time can result in a smaller safety stock, reduce the probability of stock outs and improve customer service. Accordingly, several papers show how companies divided lead time into different stages to find out which stage causes delay and increases the whole lead time of the company and what are the factors causing those delays in each stage separately. Mohamed and Coutry (2015) divided the lead time of a multinational company into three stages which are respectively: order entry, order fulfilment, and order delivery. Data analysis was applied at each stage to find out which stage has the highest delay and they defined the factors that affect significantly the lead time by applying multiple linear regression analysis techniques. According to Gudum, lead time of a focal company is divided into five time phases to determine how the accuracy of the order operating time affects the accuracy of lead time scheduling. Those stages are: customer sends the order request, Supplier receives the order request, Supplier sends the physical goods to satisfy the order, customer receives the goods, and goods are placed on shelves ready for use or sale.

On the other hand, when the demand of lead time is constant and the time of delivery for product is expected, the long lead time doesnt cause a problem for the company (Tarty, 2012). The real problem occurs when the company is not sure if the demand is suitable. As some studies stated that long lead time can be so high when the future demand is unknown (Tarty, 2012). In order to be able to accurately predict lead time, we have to define the variables that affect lead time. Ben-Daya and Hariga (2003b) has mentioned the variables that affect lead time which are: set-up time, processing time and non-productive times (waiting and handling times). According to Tarty (2012), lead time variability depends on all the operations that take place in a facility which depends on the equipment used and the decisions made including poor logistics. There are many operations that take place in facility including Decision making, Order variation, Warehouse, Listing order, Cost of inventory, Demand variability (expected or forecasted demand is different than the demand receipt) and Changing in holding (some are more expensive to hold) (Tarty, 2012).

The shipping and freight company has to deal with several factors that may cause variability in their delivery lead time. They have to deal with different Suppliers and follow certain terms. In Kuwait, the Kuwaiti general administration customs have several tests and strict rules that may take time to get the official permission to clear the shipments when they arrive to the local ports. This procedure is followed in order to prevent any prohibited products to enter the country. However, delivery lead time is very important characteristic for AST as a freight company as this concerned about predicting shipping and clearance time to help the company to avoid problems such as having products out of stock. It will also affect the companys reputation and credibility. By doing so, they will lose their customer loyalty. For example, when the company faces a problem in the shipping and clearance time like when they do not know the exact products‘ arrival time or when the goods will be placed in stores. Surely, this will negatively affect the companys reputation.

In this project, the factors that affect shipping and clearance time (delivery lead time) will be identified. These factors are called stakeholders; the factors affecting and are affected by the organization or the company. The stakeholders for any freight company are, shipping lines, Suppliers, customers, and the company itself. Unexpected delay in the lead time will affect the stakeholders in many different ways. Speaking about the shipping lines, if the delivery date of the shipments was not identified correctly to the shipping line, it will affect the shipping line scheduling system and organization. Not knowing the exact date of the delivery will cause problems in the organization of the schedule, as the shipping line will not be able to provide the needed ships and containers for the company. From the customers perspective, if the shipments arrive late or the company does not know the exact arrival date of the shipments, the company loses the quality of service (customer service) and it will lose customer loyalty. As a result, this will lead to financial loss of the company. For the company itself, if they were able to predict the accurate delivery lead time, this will decrease the unwanted cost and increase the benefits and the income of the company. From the Supplier perspective, the unexpected delivery lead time may have a negative effect in their reputation and honesty. Nevertheless, as the definition of lead time may vary from one company to another depending on the company's field and sold products (see Tarty, 2012), this work will consider that lead time has two main stages: Shipping Time and Clearance Time (Ries, 2011).

2.2 Shipping Time

Shipping time is the first stage of the lead time; this stage starts from the minute the ship leaves the departure port until it reaches the desired destination port. It is important to note that just before the ship leaves the port, the shipping line establishes a paper called (Bill of Lading) which declares that the goods were received from the Supplier, the goods container are shipped on the ship and it also includes the date and time of actual shipping time when the ship left the port in addition to an estimated time of arrival. Therefore, it is important to involve not only the shipping time, but to involve as well the actual shipping time and an estimated arrival time, as what will be consider in this work. This practice is expected to enable the company to predict the date the shipment will arrive and accordingly manage the coming stage of the lead time where more paper work and documents finalization is conducted with the Supplier. According to reference Shams et al. (2017) "Todays logistics practices are moving from inventory-based push supply chains to replenishment-based pull supply chains, leading to lower and less centralized inventory, smaller shipment sizes, and more just-in-time deliveries. As a result, industries are now demanding greater reliability in freight transportation than ever". This moves us to the second stage of the lead time.

2.3 Clearance Time

The term of Clearance Time is the second stage of the lead time that starts from the arrival of the shipment to the destination port until the end of good's clearance from the customs where goods are received by the company. However, this stage in the case of our work ends as indicated by Bayan Date. In this stage, many delays can occur due to several non-price factors; as mentioned by Crainic et al. (2015), "A number of non-price factors affect the movement of goods across international borders". The time before clearing the goods is spent on inspection of the goods or completion of the official needed documents. If those documents are not ready, a delay occurs and those "Delays and uncertainty in freight transportation are translated directly into additional inventory, higher costs of manufacturing, less economic competitiveness for businesses and higher costs of goods that are being passed on to the consumers.” (Shams et al., 2017).

3 Research Design

3.1 Data Collection

The data of around 5936 shipments was provided by Al-Ghanim Sahara along with inclusive details about the variables of each shipment during the time between 2014 and 2016. The data included the order date, departure port, Supplier (Supp), shipping line, commodities, arrival date and port. Out of those data records, the cleaning and recoding data processes prepared around 5429 shipments for the inclusion in the data analysis for this study.

3.2 Variables and Models

3.2.1 Dependent Variable Lead Time

The main purpose of this research is to identify the factors affecting the Lead Time within the context of the AST company. Lead time is the time that starts with the customer placing the order to the customer receiving of the goods. More specifically, AL-Ghanim was only concerned with the shipment time starting from the actual time of shipment until the clearance of the goods time (Bayan date). In this study the total lead time with tow partitions to stage 1 and stage 2 are considered. Total Lead time in the time between the actual time of shipment (ATA) until the Bayan time or date. This total lead time can be divided into two stages: the first stage is the time between Actual Time of Shipment (ATS) and Actual Time of Arrival (ATA). The second stage is the time between actual time of arrival (ATA) and Bayan date. This partition of the total lead time into stages was done based on a request from Al-Ghanim Sahra Transportation (AST).

3.2.2 Independent variables

Every transhipment company has several and different factors that may affect the lead time. Based on the available data from the AST, Table 1 lists the four most common factors with possible effect on the lead time, with their descriptions.

Table 1: Independent Variables Description

Variable	Description
Shipping line (SL)	Represent the companies of shipping service that the AL-Ghanim Sahara deals with.
Commodities (COMM)	Different products that the company transfer
Departure, Port (DP)	The different ports where the shipments are loaded.
Supplier (SUPP)	The company or factory that provides goods for AL-Ghanim Sahara

4 Data Analysis and Results

4.1 Descriptive statistics

Each of the independent variables (shipping line, commodities, departure port and supplier) has been described. The descriptive statistics reports the distribution of each variable along with frequency and the percentage (%) of each category of each variable during the period of 2014 to 2016 inclusive. Table 2 and Pareto chart of commodities (i.e., Figure 1) report the frequency, percentage, code, means and standard deviations for each category of the commodities shipped by the AST. The average time of the total lead time is 32.87 days with a standard deviation of 8.31. The least lead time average is for Commodity 1 (AC) with an average of 28.5 days (stdev=6.3) and the highest lead time is for commodity 11 (Tiles) with an average of 36.4 days (stdev=8), as illustrated by Table 2 and Figure 2. Pareto Chart shows that the highest percentage of shipped commodities during the period is white goods (WG) with a total of 1436 shipments (26.5%), followed by furniture with 1301 shipments with 24% and 932 shipments (17.2%) of Domestic appliances. These three commodities make 67.6% of total commodities shipped be AL-Ghanim Sahara Transportation (AST) company. The least commodity shipped by AST is water treatment appliances with only 1.5% over the period of 2014 to 2016.

Table 2: Commodities – Independent Variable

Commodities	**Code**	**Mean**	**Stdev**	**Frequency**	**%**
AC	1	28.5	6.3	160	2.95
Entertainment-TV	2	31.3	8	341	6.As
Entertainment-Audio	3	32.3	8.5	96	1.77
PM Cilek	4	32	9.1	87	1.6
PM DFA	5	32.7	8.9	116	2.14
PMFurniture	6	32.3	8.7	1301	23.96
PM-SHF	7	33.1	8.1	268	4.94
Sanitary	8	30.2	7.4	353	6.5
SHW DomesticAppls	9	33.2	9.2	932	17.17
SHW H&W, Toys, Personal Care	10	33.2	6.8	52	0.96
Tiles	11	36.4	8	206	3.79
Water Treatment	12	32.5	7.9	81	1.49
WG	13	32.4	8.4	1436	26.45
Total		**32.87**	**8.31**	**5429**	**100**

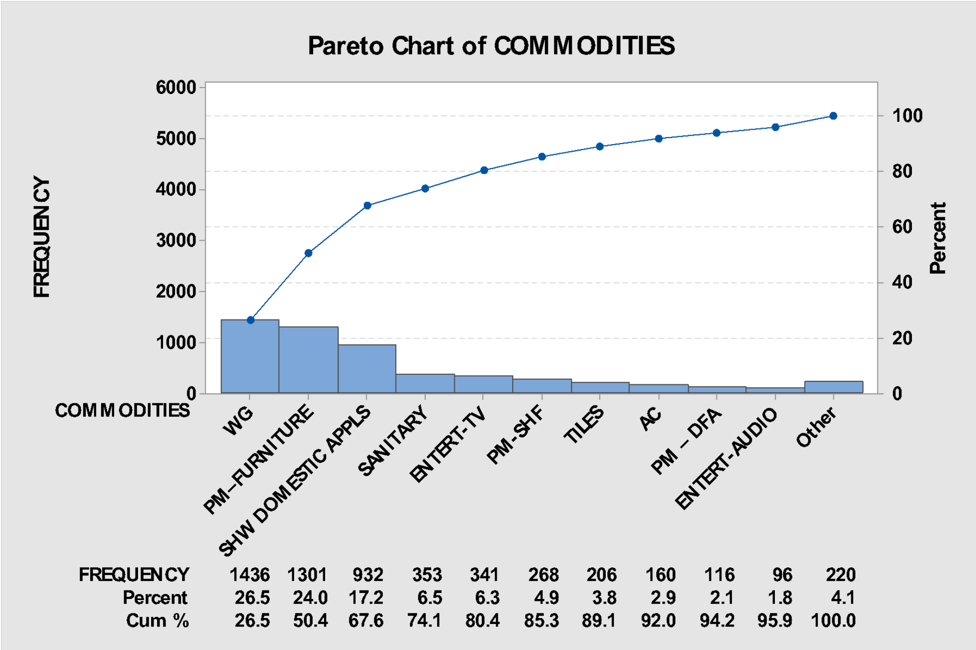

Figure 1: Pareto Chart of Commodities

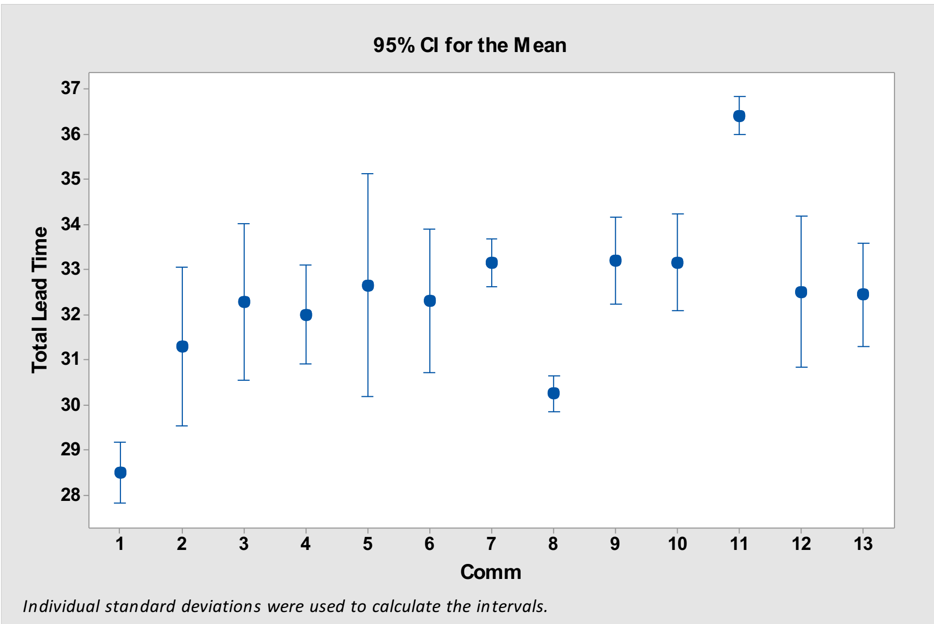

Figure 2: Interval Plot of Total Lead Time Subject to Commodities

Table 3: Shipping line Distribution

Shipping line	**Code**	**Mean**	**Stdev**	**Frequency**	**%**
APL	1	31.7	6	864	15.91
CTO ITALY	2	32.5	8	28	0.52
CMA	3	32	8.3	78	1.44
COMBI LINE	4	34.6	6.4	107	1.97
COSCO	5	31.2	7.5	609	11.22
EVERGREEN	6	33.4	7.6	437	8.05
HAPAG LlOYD	7	31.3	8.6	62	1.14
MAERSK	8	35.3	8.4	237	4.37
MSC	9	32.8	7.7	726	13.37
POLESTAR	10	29.6	7	234	4.31
SAFMARINE	11	33.3	10.3	208	3.83
Total cargo logistics	12	41.7	8.6	121	2.23
UASC	13	37.5	10.9	1718	31.64
Total		**32.87**	**8.31**	**5429**	**100**

Table 3 and Graph 2 show the distribution of the 13 Shipping Lines (SL) used by AST. Results show that the highest shipments are with United Arab Shipment Company (UASC) shipping line company with 31.6% of the total shipments, followed by APL shipping line with 15.9% and MSC with 13.4% of the total shipments. These three shipping line companies are used for more than 60% of the total AST shipments. The least SL company was COMI LINE with only 2% of shipments. The highest total lead time average was for total cargo logistic shipping line (SL12)with an average of 41.7 days and a standard deviation of 8.6. The least total lead time average was for POLESTAR shipping line (SL10) with an average of 29.6 days and standard deviation of 7 as illustrated by Table 3 and Figure 4.

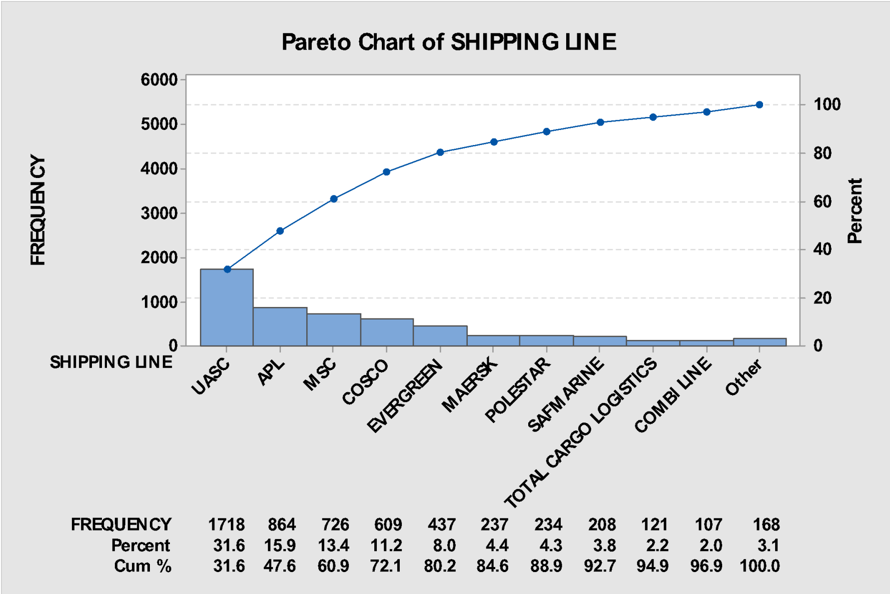

Figure 3: Pareto Chart of Shipping Line

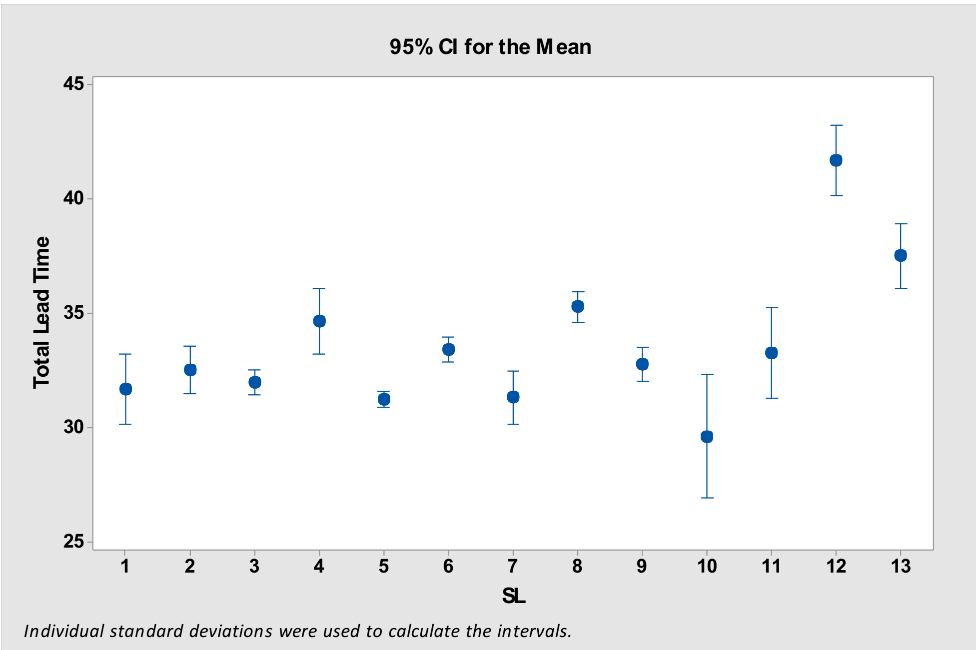

Figure 4: Interval Plot of Total Lead Time Subject to Shipping Line

Table 4 and Figure 5 reports the distribution of third independent variable which is the departure port with averages and standard deviations of total lead time subject to each departure port. Results show that most shipments (52.4%) departed from China (Group G) and the least shipments are departed from USA or Mexico with only 1.95% of the total shipments (54380) over the three years of study (2014 2016). The highest total lead time is for France and Portugal (Group N) departing port with an average of 42.1 days and standard deviation of 6.9, while the least total lead time is for Turkey and Romania (Group A) with an average of 25.3 days and standard deviation of 9.8 days as illustrated by Table 4 and Figure 6.

Table 4: Departing Port-Independent Variable

Code	Content	Departure port	Mean	Stdev	Frequency	%
1	Turkey, Romania, Slovakia	Group A	25.3	9.8	482	8.88
2	Italy, Slovenia, Croatia	Group B	31.6	8.1	377	6.94
3	Belgium, Denmark, Germany, Netherlands, UK	Group C	28.4	9	161	2.97
4	Thailand, Vietnam	Group D	29.7	7.6	175	3.22
5	Indonesia, Philippines, New folk	Group E	33.1	7.4	139	2.56
6	Malaysia, Singapore	Group F	34.2	6.6	354	6.35
7	China	Group G	33	7.7	2849	52.48
8	South Korea, Japan	Group H	33	7.6	89	1.64
9	USA, Mexico	Group I	34.4	7.7	106	1.95
10	India	Group J	39.2	6.7	316	5.82
11	GCC, Egypt	Group K	39.6	10.8	161	2.97
12	Poland	Group L	36.9	10.1	94	1.73
13	France, Portugal, Spain	Group N	42.1	6.9	135	2.49
Total			**32.87**	**8.31**	**5438**	**100**

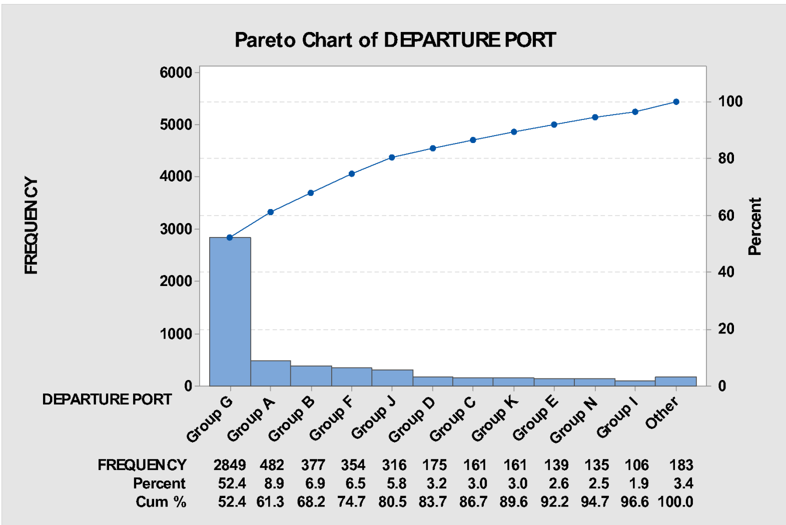

Figure 5: Pareto Chart of Departure Port

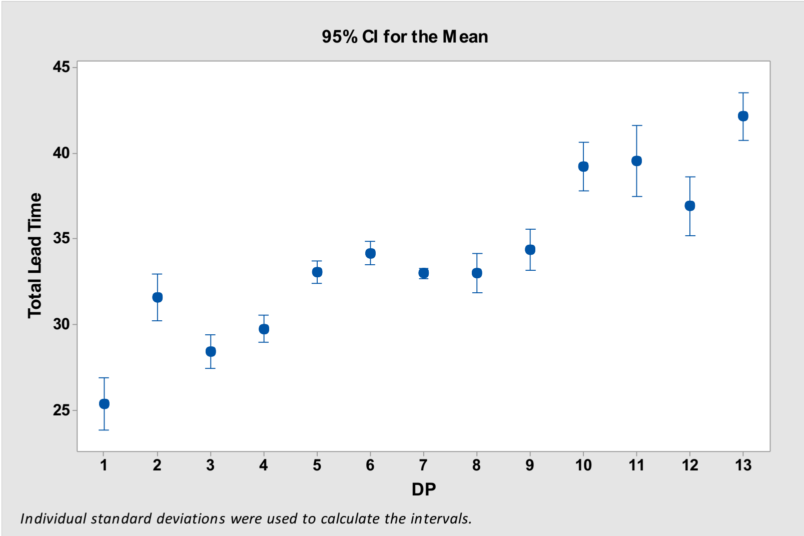

Figure 6: Pareto Chart of Departure Port

Table 5 and Figure 7 show the distribution of Al-Ghanim Sahra Transportation (AST) goods suppliers. Results show that the highest shipments is obtained from supplier 8 with 18.4%, followed by supplier 5 (15.0%), supplier 4 (14.1%) and supplier 3 (10.6%). These four suppliers provide AST with 58% of the total shipments over 2014 to 2016. The least supplier was supplier 1 (other) with only 4.6%. The highest total lead time is for supplier 10 with an average of 38.4 days and standard deviation of 8.1 days, the least lead time is for supplier 1 with an average of 26.2 days and a standard deviation of 7.7 days, as illustrated in Table 5 and Figure 8.

Table 5: Supplier-Independent Variable

Supplier	Mean	Stdev	Frequency	Percentage
1	26.2	7.7	250	4.6
2	29.7	6.8	420	7.74
3	31.8	8.8	573	10.55
4	31.4	7.2	764	14.07
5	31.8	7.9	816	15.03
6	33.6	8	417	7.68
7	32.2	8.5	433	7.98
8	35.5	7.6	997	18.36
9	35.5	8.3	437	8.05
10	38.4	8.1	322	5.93
TOTAL	**32.87**	**8.31**	**5429**	**100**

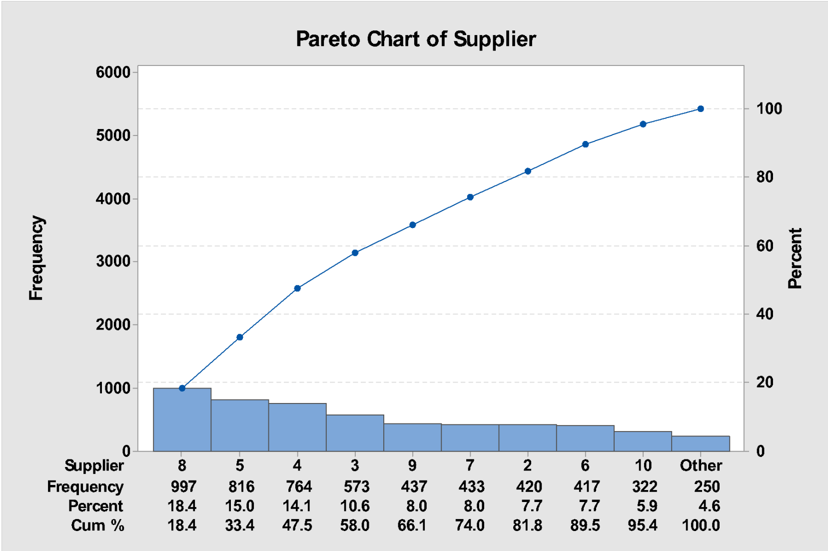

Figure 7: Pareto Chart of Supplier

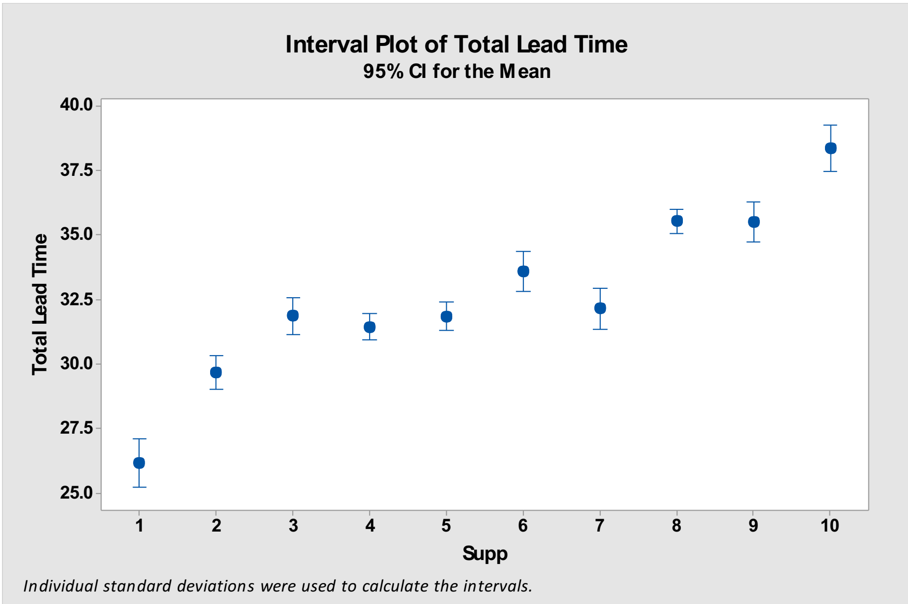

Figure 8: Interval Plot of the Total Lead Time subject to Suppliers

The results above showed that there are differences in lead time subject to each one of the factors discussed above (supplier, commodity, departing port, and shipping line). In the next section, the four independent variables are modelled using multiple regressions to test if these factors have a significant effect on the lead time.

4.2 Analysis of the Lead Time Stages

As defined earlier, the total Lead Time in this study is the time between the actual time of shipment (ATA) until the Bayan time or date. This time has been divided into two stages and two different models have been used to analyse each of these stages as follows:

4.2.1 Model A

This model considers the two stages of shipments. The first stage is the time between Actual Time of Shipment (ATS) and Actual Time of Arrival (ATA), and the second stage is the time between actual time of arrival (ATA) and Bayan date. This partition of stages was done based on a request from AST.

4.2.2 Model B

This model considers the whole total lead time starting the actual time of shipment (ATA) until the Bayan date. Table 6 provides a statistical summary of the lead time for the whole lead time and each stage of the lead time. Stage 1 and stage 2 (Model A) have approximate means of 28 days and 4 Days, respectively. As the lead time is the sum of the two stages, the average of total lead time is approximately 32 (the sum of two stages averages). Stage 1 consumes 87% of the total lead time with minimum equals to 3 days and maximum equals to 59 days. Stage 2 represents only 13% of the total lead time with minimum equals to 0 day (can be done in the same day) and a maximum of 26 days. Total lead time has a minimum of 6 days and maximum of 61 days.

Table 6: Descriptive Statistics of the lead time with the two stages

Descriptive Measures	**lead time Stages (Days)**		
	Stage 1 Model A	**Stage 2 Model A**	**Stage Model B**
Mean	27.624	4.247	31.871
Percentage	87%	13%	100%
Standard Deviation	8.7	3.47	8.31
Quartiles 1	22	2	27
Quartiles 2	27	3	31
Quartiles 3	33	6	37
Min	3	0	6
Max	59	26	61

4.3 Results of the Lead Time Analysis and Discussions

The multiple linear regression technique used here to determine the significant factors/variables and the significant interactions between them that impact the lead time. Several interactions were removed from regression model because they do not affect the lead time significantly. For model A two regression models are needed to represenThe lead time analysis is based on Talpey et al. (2017) and Oskrochi et al. (2018) technique which employed regression technique using both fixed and random effects to find the best model fits the data. Oskrochi et al. (2018) used both Linear Mixed Model (including random component) and multiple regression (fixed effect model) employing stepwise regression to identify the most significant factors to lead time and estimate it. However, after fitting the multiple regression models, some variables (or their interaction) no longer remained statistically significant in terms of predicting the lead time and so were removed from the final model to improve its fit. Decisions as to which variables to retain in the final model were based on comparisons of the differences in the Akaike information criterion as assessed by a chi-square test ($p < .05$). These methods were employed for both models, Model A and Model B.

4.3.1 Models Results

The multiple linear regression technique with random and fixed effects used here to determine the significant factors/variables and the significant interactions between them may affect the lead time. Stepwise regression retains only the significant factors and their interactions. Model A model the lead time of the two stages 1 and stage 2. Model B model the total lead time Three regression models have been used to model the shipment time with the independent variable; shipping line, commodities, Supplier, departure port, and interactions. The random effects were added after the fixed effects into the models imposing a nesting of these factors but none of them was found to be significant.

$$y = \beta_0 + \beta_1 Supp + \beta_2 SL + \beta_3 DP + \beta_4 Comm + \beta_5 Supp * SL + \beta_6 Supp * DP + \beta_7 Supp * Comm + \beta_8 SL * DP + \beta_9 SL * Comm + \beta_{10} Comm * DP + \epsilon. \quad (1)$$

Model A

Table 7 shows the significant factors resulting from fitting Model A for stage 1. Shipping line, departure port and Supplier are all significant with a p-values less than the significant level ($\alpha = 0.1$). Only Commodities is not significant. All interactions of the 4 independent variables were significant except supplier and commodities. The same process used for model A stage 1 was applied for stage 2. Results of significant factors and their interactions are reported in Table 7.

Table 7: Model A Estimate of Significant Factors and their p-value

Source	**P-Value**	
	Stage 1	**Stage 2**
Corrected Model	0.000	0.000
Intercept	0.000	0.000
Supp	0.000	0.000
SL	0.000	0.080
Comm	0.722	0.000
DP	0.004	0.042
COMM*DP	0.013	0.301
Supp * Comm	0.042	0.000
SL * Comm	0.000	0.042
Supp * DP	0.000	0.001
SL * DP	0.009	0.021
Supp * SL	0.003	0.000

Model B The same process used for model A was implemented to model B. Model result of significant factors with p-values are summarised in Table 8. Model B result is very much the same as Model A stage1, Commodities and its interaction with Supplier were not significant. Commodities are not removed from the final model as commodities interactions with departing port (DP) and shipping line (SL) were significant.

Table 8: Model B estimate of significant factors and their p-values

Source	P-Value
Corrected Model	0.000
Intercept	0.000
Supp	0.000
SL	0.000
Comm	0.581
DP	0.000
COMM*DP	0.007
Supp * Comm	0.366
SL * Comm	0.000
Supp * DP	0.000
SL * DP	0.062
Supp * SL	0.000

Details of each model and each factor coefficients are reported in Tables 9 11. As we reported in Table 7, all factors were found to be significant to lead time (stage 1) except commodities. Table 9 reports coefficients of these factors. Estimated intercept coefficient (6.25) represent the average number of lead time in days if we choose Shipping Line 1, Commodities 1, and Departing port 1. The estimated coefficients for each factor are basically the average difference between each one of these categories (of the factor) and the reference category. For suppliers, supplier 1 was the reference category; meaning that all suppliers lead time is compared to supplier 1. For example, supplier 2 estimated coefficient is 2.89, which means that on average supplier 2 has a higher average (positive coefficient) in lead time than supplier 1 by 2.89 days. In the same way, supplier 3 has on average a higher lead time of 4.43 than supplier 1, etc. So, supplier 1 has the least lead time. In the same way for Shipping Lines (SL), Commodities (Comm) and Departing Port (DP). The reference categories for each factor have the least average lead time, and all other categories are significantly higher than the reference categories (as all coefficients are positive). Lead time in stage between suppliers can be different by a maximum of 13.88 days (Supplier 10) compared to reference category (supplier 1). Difference in stage 1 lead time between Shipping lines can be by a maximum of 9.2 days (SL13). Difference in stage 1 lead time can vary by a maximum of 6 days (minimum difference among factors). The highest difference in stage 1 lead time can be up by a maximum of 16 days if the shipment departed from port 13 instead of port 1. In other words, the most significant factors which have the highest impact on lead time of stage 1 is Departing port factor.

4.3.2 Models Stages Analysis

Table 9: Coefficients for Model A stage 1

Source	Estimate coefficients	Source	Estimate coefficients	Source	Estimate coefficients	Source	Estimate coefficients
(Intercept)	6.26	SL 1	Reference Category	Comm 1	Reference Category	DP 1	Reference Category
Supp 1	Reference Category	SL 2	0.7	Comm 2	2.13	DP 2	4.57
Supp 2	2.89	SL 3	1.33	Comm 3	2.78	DP 3	4.83
Supp 3	4.43	SL 4	1.89	Comm 4	3.97	DP 4	6.6
Supp 4	5.24	SL 5	1.84	Comm 5	4.42	DP 5	8.06
Supp 5	6.23	SL 6	2.02	Comm 6	4.53	DP 6	8.17
Supp 6	6.95	SL 7	2.64	Comm 7	4.7	DP 7	8.21
Supp 7	7.9	SL 8	3.11	Comm 8	5.04	DP 8	9.14
Supp 8	8.68	SL 9	3.07	Comm 9	5.32	DP 9	9.63
Supp 9	10.35	SL 10	4.48	Comm 10	5.9	DP 10	12.3
Supp 10	13.88	SL 11	5.36	Comm 11	6.65	DP 11	12.48
		SL 12	8	Comm 12	6.75	DP 12	11.93
		SL 13	9.2	Comm 13	6.08	DP 13	16.08

All factors including commodities were significant for lead time (stage 2). Estimated coefficients of Model A (stage 2) are illustrated in Table 10. Results shows the average time for stage 2 is 5.65 days when the shipment has commodity 1, departing from port 1 and using shipping line 1. Some of these estimated coefficients are positive (higher than reference category) and some of them negative (has an average less than the reference category). Among suppliers the best lead time (least) was for supplier 10 with an estimated coefficient of -1.14, which means supplier 10 has on average less lead time than the reference supplier (supplier 1) by 1.14 days in stage 2. The highest average lead time was for supplier 2, which has on average 0.14 days higher than the reference supplier (supplier 1). The best commodity lead time at stage 2 was commodity 12, which has 0.12 days less lead time than the reference commodity (commodity 1). Commodity 3 has the highest lead time at stage 2 with an estimated coefficient of 2.83 days higher than commodity 1. For the departing ports, the best (least) lead time for stage 2 was for departing port 13 (estimated coefficient of -0.80) and the highest lead time was for departing port 3. In the same way, the best shipping line was for shipping line 12 (with an estimated coefficient of -1.51) and the highest lead time was for shipping line 10 (with an estimated coefficient of 0.14).

Table 10: Estimated Coefficients for Model A stage 2

Source	Estimate coefficients	Source	Estimate coefficients	Source	Estimate coefficients	Source	Estimate coefficients
(Intercept)	5.65	Comm 1	Reference Category	DP 1	Reference Category	SL 1	Reference Category
Supp 1	Reference Category	Comm 2	2.49	DP 2	0.05	SL 2	-0.44
Supp 2	0.14	Comm 3	2.83	DP 3	0.88	SL 3	-0.22
Supp 3	-0.2	Comm 4	1.56	DP 4	-0.03	SL 4	-0.29
Supp 4	-0.64	Comm 5	1.02	DP 5	0.19	SL 5	-0.91
Supp 5	-0.73	Comm 6	1.07	DP 6	-0.17	SL 6	-0.76
Supp 6	-0.1	Comm 7	0.45	DP 7	0.37	SL 7	-0.97
Supp 7	-0.94	Comm 8	0.55	DP 8	-0.36	SL 8	-0.66
Supp 8	-1.03	Comm 9	0.87	DP 9	-0.62	SL 9	-0.59
Supp 9	-0.72	Comm 10	1.01	DP 10	0.46	SL 10	0.17
Supp 10	-1.14	Comm 11	0.52	DP 11	0.56	SL 11	-0.04
		Comm 12	-0.26	DP 12	-0.71	SL 12	-1.51
		Comm 13	0.86	DP 13	-0.8	SL 13	-0.53

Model B The Overall Stage

As mentioned above commodities with its interaction with supplier were not significant. Estimated coefficients are summarised in Table 11. The results of estimated coefficients for total lead time model (Model B) is very much the same with the results of Model A (stage 1) lead time. The overall average (intercept) is 10.91 days, which represent the average lead time for the shipment using reference categories for all factors (supplier, commodity, departing port, and shipping line). All estimated coefficients are positive which means that the reference categories of all factors have the least lead time. The higher the coefficient the more the lead time. For example, in supplier factor, the highest lead time is for supplier 10 with an estimated coefficient of 12.74, which means that on average supplier 10 has 12.74 days of lead time than the reference category (supplier 1). Similarly commodity 13, departing port 14 and shipping line 13 have the highest average lead time with estimated coefficients of 6.94, 15.28 and 8.66, respectively. Most of the delay in lead time come from departing port as the difference between departing port 13 and the departing port 1 is 15.28 days.

Table 11: Estimated Coefficients for Model B

Source	Estimate coefficients	Source	Estimate coefficients	Source	Estimate coefficients	Source	Estimate coefficients
(Intercept)	10.91	Comm 1	Reference Category	DP 1	Reference Category	SL 1	Reference Category
Supp 1	Reference Category	Comm 2	4.62	DP 2	4.62	SL 2	0.26
Supp 2	3.04	Comm 3	5.61	DP 3	5.71	SL 3	1.11
Supp 3	4.24	Comm 4	5.54	DP 4	6.56	SL 4	1.6
Supp 4	4.59	Comm 5	5.44	DP 5	8.24	SL 5	0.93
Supp 5	5.5	Comm 6	5.6	DP 6	8	SL 6	1.26
Supp 6	6.85	Comm 7	5.15	DP 7	8.59	SL 7	1.66
Supp 7	6.96	Comm 8	5.59	DP 8	8.78	SL 8	2.46
Supp 8	7.66	Comm 9	6.2	DP 9	9.02	SL 9	2.48
Supp 9	9.63	Comm 10	6.91	DP 10	12.76	SL 10	4.65
Supp 10	12.74	Comm 11	7.18	DP 11	13.04	SL 11	5.31
		Comm 12	6.48	DP 12	11.22	SL 12	6.49
		Comm 13	6.94	DP 13	15.28	SL 13	8.66

4.4 Models Results Discussions

Finally, R-squared for Model A stage 1 without interaction was equal to 28.3% and with interaction was equal to 38.7%.Forstage 2.A, the R-square for the model without interaction was equal to 5.5We see that the value of R-square for the model without interaction is lower than the value of R-square for the model with interaction which is expected. In general, the R-square is low so the variables we have only explain approximately 40% of the variance of the lead time. The company needs to provide us with more variables in order to have a better estimate of the lead time, according to Freud and Littell (2000). The above models were programmed in Excel to provide AST with an estimated shipment time for each shipment after they enter the values of the 4 predictors (supplier, commodity, departing port, and shipping line).

5 Conclusions

In this article we used multiple regression models to model the lead time for more than 5000 shipments of Al-Ghanim Sahra Transportation (AST) over the period of 2013 to 2016 inclusive. The total shipment time consisted of solve a real life problem of predicting the total shipping and clearance time for Al-Ghanim Sahara Trans. (AST). Just like other freight and transportation companies, AST a leading freight and transportation company in Kuwait, is facing a problem with the unexpected lead time of their shipments leading in higher costs and less customer satisfaction. The problem was defined as the unexpected lead time of the their shipments where one of the mean reasons behind this is that AST has raw data about the shipments that was not used or studied to guess any kind of pattern. We started by defining the lead time for AST which was agreed on to be the duration of time between the actual time of shipping until the Bayan date, then we cleaned the data to be able to use the useful needed information, after that we started defining our variable and using descriptive statistics and inferential statistical tools finding the significant ones among them. After reading several case studies of other companies facing the same problem, we started fitting our data into a general linear model that enables us reach a statistical model that relates all the factors (inputs) and see their effect on the duration of the lead time (output). This was done using SPSS which is statistical software. At the end we can say that we reached our objectives from this report by constructing a statistical model that enables AST to predict their shipments delivery lead time which will contribute in the future in saving them money, time, and other customer dissatisfactions.

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