Comprehensive Journal of Science
Volume (10), Issue (37), (NOV. 2025)
SICST2025, www.sicst.ly
ISSN: 3014-6266

مجلة العلوم الشاملة
عدد خاص بالمؤتمر الدولي الثالث للعلوم والتقنية
المجلد (10)، العدد (37)، (نوفمبر2025)
ردمد: 3014-6266

Forecasting Rebar Product Sales Using a Linear Regression Model: A Case Study of the Bar Rolling Mill at the Libyan Iron and Steel Company (LISCO)

Ali Abubaker Elshouki[1] **Jamal Mohamed Eljamel[2]** **Ali Elhadi Kridish[3]**

Higher Institute of Science and Technology – Misurata[1]

Libyan Iron And Steel Company[2]

General Electricity Company of Libya (GECOL)[3]

elshouki.ali@gmail.com[1]

Received: 30-09-2025; Revised: 10-10-2025; Accepted: 31-10-2025; Published: 25-11-2025

ABSTRACT

This the study investigates the use of linear regression to forecast rebar sales for the Libyan Iron and Steel Company from November 2023 to January 2025. Employing a descriptive analytical and case study approach, 12 months of sales data were analyzed using Excel and statistical methods. Results indicated the linear model was statistically significant (F=4.9253, p=0.05074) but with only a medium correlation (R=0.5745). The model explained 33% of variance, with a high standard error of 7666.63, suggesting low predictive accuracy. Recommendations include: adding more independent variables, exploring alternative models (multiple regression, time series), expanding data samples, and conducting market studies to improve forecasting and optimize sales strategies. These efforts are to improve sales forecasting.

Keywords: Linear Regression, Sales Forecasting, Rebar Products, Libyan Iron and Steel Company.

1. Introduction

The importance of this research stems from its focus on the topic of sales estimation, which is the main driver for the operations of any organization, as it directs efforts towards achieving financial returns. Furthermore, all profitable institutions are based on the marketing feasibility of projects, which is a key factor or an incentive to enter the field.

Forecasting the demand for products or services is also a key part of the planning process during future time periods. The methods used to estimate demand vary, and one of the most important is linear regression models, which help provide sales forecasts that can be relied upon in making effective decisions.

This the study will incorporate a practical case study utilizing study using the simple linear regression method to determine the relationship between variables in estimating sales of rebar products for the Libyan Iron and Steel Company. This is based on historical data for the period from 01/01/2024 to 31/10/2024, and the estimation of sales for the next 03 months is also included. This will be done by developing a simple linear regression equation using the Excel program.

2. Literature review

A review of demand forecasting literature reveals the widespread application of regression and time series analysis across various industries. For instance, Shahout and Shtewan (2023) utilized multiple linear regression to successfully model 85.5% of sales variance for building materials, identifying advertising and price as key predictors[1], while Farizal et al. (2020) developed a similar model for fast - moving products that proved three times more accurate than company forecasts[5]. Likewise, linear regression has been effectively applied to predict future demand trends for SIM cards (Monica Sitompul, 2023)[2], forecast long-term energy consumption for operational planning (ADE-IKUESAN et al., 2019)[6], and confirm the direct relationship between industrial inputs and production costs (Jamal Al-Jamal, 2014)[8]. Alongside regression, time series models are also prominent, with Awainia Amira (2022) using autoregressive models for forecasting commodity sales [3] and Maher Al-Hallak (2021) applying both linear and non-linear time series to create an effective forecasting mechanism for a food manufacturer[4]. Crucially, studies have also compared these methods, with Sengupta and Dutta (2014) concluding that non-linear regression is more accurate for volatile demand scenarios, while linear regression is better for stable demand[7]. Similarly, Ashour Badar (2006) determined that a time series model outperformed simple regression for mill sales because it better accounted for seasonality and was more robust when data for key independent variables was lacking[9].

Collectively, these studies demonstrate the broad utility of statistical forecasting for strategic decision-making, while also highlighting that the optimal choice of model depends on factors like data availability, demand stability, and seasonality. In this research, the simple linear regression method will be used to forecast sales of rebar at the rod rolling mill, which is considered one of the most important finished product plants of the Libyan Iron and Steel Company in Misurata.

3. Research Methodology and Tools

This the study employs a descriptive analytical approach for its theoretical framework, covering concepts in demand forecasting, correlation, and regression. The practical component utilizes a quantitative case study, applying a simple linear regression model to analyze rebar sales at the Libyan Iron and Steel Company. The model will be developed using 12 months of historical sales data (November 1, 2023, to October 31, 2024) to forecast sales for the subsequent three months (November 2024 – January 2025).

The data will be analyzed in Microsoft Excel to create the linear regression equation between time and sales quantity. The statistical analysis will involve:

- Calculating the slope and intercept (a,b) using the method of least squares.
- Determining the Pearson correlation coefficient to evaluate the strength of the linear relationship.
- Using ANOVA to analyze the variance and verify the significance of the relationship.
- Conducting a residual analysis to verify the model's suitability.
- Measuring the forecasting model's accuracy and error.

4. Causal Methods for Forecasting and Error Measurement:

4.1 Simple Linear Regression Method:

The purpose of using the simple linear regression method is to study and analyze the effect of one quantitative variable on another quantitative variable. Examples of this include estimating sales volumes for later periods and studying the effect of production on cost[10].

4.1.1 The Linear Regression Model:

In the simple regression analysis, the effect of one of the two variables is studied. It is called the independent or predictor variable, on the other variable, which is called the dependent or predicted variable. The linear regression model can then be represented in the form of a linear equation of the first degree, which reflects the dependent variable as a function of the independent variable as follows[8]:

$$y = \beta_0 + \beta_1 x + e ....(1)$$

Where:

y: is the dependent variable (which is affected)

x: is the independent variable (which affects)

β_0: is the intercept of the vertical axis (y) which reflects the value of the dependent variable when the independent variable is equal to zero (x = 0).

B_1: is the slope of the straight line ($\beta_0 + \beta_1 x$), which reflects the amount of change in y if x changes by one unit.

e: is the random error, which expresses the difference between the actual value y and the estimated value ˆ $y = \beta_0 + \beta_1 x$; i.e., $e = y-(\beta_0 + \beta_1 x)$.

This error can be shown on the scatter plot in Figure 3.5[8].

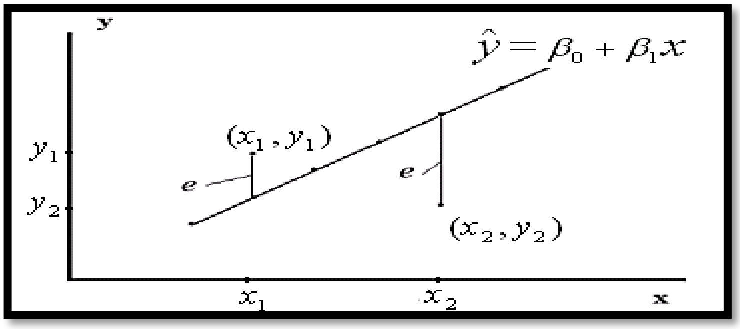

Figure1: Scatter Plot in Linear Regression Model[8]

The regression coefficients (β_0, β_1) in the model can be estimated using the method of least squares. This estimator is the one that makes the sum of squares of random errors $\sum e^2 = \sum(y - (\beta_0 + \beta_1 x)^2$ less than any other, and this estimator is calculated by the following equation[8]:

$$\hat{\beta}_1 = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2} \text{..........}(2)$$

$$\hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x} \text{...............}(3)$$

Where $\bar{x}$ is the arithmetic mean of the values x, $\bar{y}$ is the arithmetic mean of the values y. The estimated value of the dependent variable is $\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x$. This estimate is called "the estimation of the regression equation of Y on x."

4.2 Correlation Method

Correlation is a statistical method for analyzing the relationship between two variables, whereas regression analysis is used to study the effect of one variable on another[8]. A scatter plot of paired data for two variables (x, y) can be used to visualize the different forms this relationship may take[8].

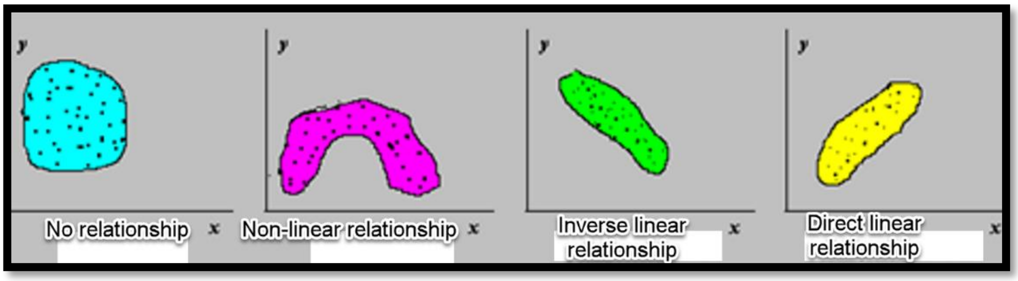

Figure 2: shows the scatter plot to illustrate the type of relationship between y and x [8]

4.2.1 Simple Linear Correlation

Correlation analysis is used to determine the type and strength of a relationship between two variables, whereas regression analysis studies the effect of one variable on another. which assumes a linear relationship and is applied to quantitative or ordinal data[8].

The purpose of the analysis is to evaluate the sample correlation coefficient (r), an estimate of the population coefficient (ρ), based on two key points[8]:

1. **The type of relationship**, which is determined by the coefficient's sign:
   - A **negative sign (r < 0)** indicates an inverse relationship, where the variables move in opposite directions.
   - A **positive sign (r > 0)** indicates a direct relationship, where the variables move in the same direction.
   - A **value of zero (r = 0)** indicates the absence of a linear relationship.
2. **The strength of the relationship**, which is judged by the coefficient's proximity to ±1. The value of the correlation coefficient always falls within the range $-1 \le r \le 1$, and statisticians have classified its degrees of strength as shown in Figure 3[8].

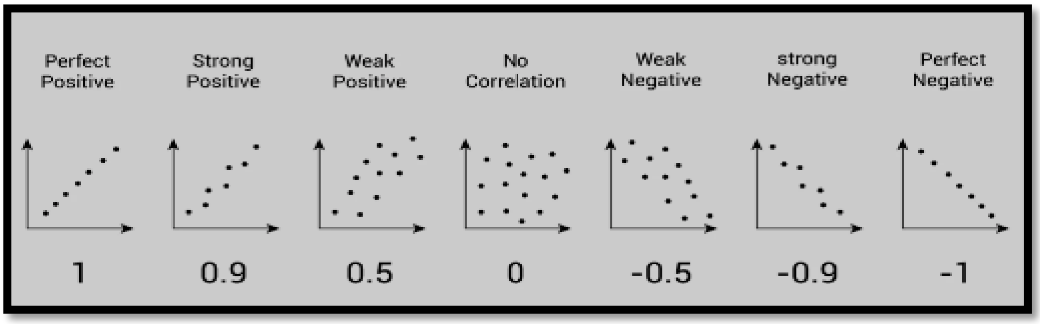

Figure3: Degrees of Strength of Correlation Coefficient [8]

1. Pearson's Simple Linear Correlation Coefficient

When collecting data on two quantitative variables (x, y), the correlation between them can be measured using the "Pearson" method. Examples of this include: measuring the relationship between weight and height, the relationship between production and cost, and the relationship between consumer spending and income. To calculate the correlation coefficient in the sample, the following "Pearson" formula is used[8]:

$$r = \frac{S_{xy}}{S_x \cdot S_y} = \frac{\frac{\sum(x-\bar{x})(y-\bar{y})}{(n-1)}}{\sqrt{\frac{\sum(x-\bar{x})^2}{(n-1)}}\sqrt{\frac{\sum(x-\bar{y})^2}{(n-1)}}} \qquad \text{.................}(4)$$

Where:

$S_{xy} = \sum \frac{(x-\bar{x})(y-\bar{y})}{(n-1)}$: is the covariance between x and y

$S_x = \sqrt{\sum \frac{(x-\bar{x})^2}{(n-1)}}$: is the standard deviation of the values of x

$S_y = \sqrt{\sum \frac{(y-\bar{y})^2}{(n-1)}}$: is the standard deviation of the values of y

4.3 Random Error

This error indicates the changes that occur to demand for unknown reasons. Therefore, the random error cannot be predicted because it does not involve a specific pattern[10].

The random error of the time series is defined as the residual element of the series after the other elements have been identified[10].

4.4 Measuring Forecasting Error

Despite the existence of a quantitative method capable of forecasting demand with great accuracy, knowing the forecasting error helps to evaluate the forecasting method used and to take corrective actions. In case there is a discrepancy between the forecast being made and the realized demand, it is normal. The reason for this is that demand for products is the result of the interaction of a large number of internal and external factors and variables. Companies aim, through reviewing the forecast, to reach a method that minimizes the forecasting errors to the lowest possible level[12]. The methods for measuring forecasting error depend on calculating the difference between the forecast and the actual demand, and there are several criteria for this[12]:

1. The absolute mean of deviations.
2. The rate of error in the estimate or bias.
3. The rate of squared errors.
4. The ratio of the absolute mean of deviations.
5. The rate of the mean error in the estimate.

5. The Case Study

The case study examines the rod rolling mills at the Libyan Iron and Steel Company, which have been operational since 1989. The facility has a design capacity of 400,000 tons per year, producing 12-40mm diameter smooth and grooved round rods[13]. The plant processes low, medium, and high carbon steels, along with some low alloy steels, and is designed to meet German Industrial Standards (DIN)[14].

The plant consists of:

a. Storage area for billets.

b. Reheating furnace.

c. Rolling line consisting of 03 zones (roughing, intermediate, and finishing).

d. Finishing area.

5.1 Data Collection

Data was collected from the sales system of the marketing department at the Libyan Iron and Steel Company. Monthly sales data for (12) months were collected from the rod rolling mill for the period from 11/01/2023 to 10/31/2024. The sales data was as per Table (1):

Table1: Monthly Sales Quantities from 11/01/2023 to 10/31/2024 [12]

Sequence	Month	Quantity (Tons)
1	11/2023	34,199.00
2	12/2023	49,711.00
3	1/2024	48,694.00
4	2/2024	43,226.00
5	3/2024	23,675.00
6	4/2024	32,425.00
7	5/2024	31,885.00
8	6/2024	23,076.00
9	7/2024	26,589.00
10	8/2024	28,207.00
11	9/2024	33,644.00
12	10/2024	31,163.00

The total sales during the period was 406,494.00 tons, with an average monthly sales of 33,874.50 tons/month and a standard deviation of 8550.19 tons.

5.2 Using Simple Linear Regression Model

A simple linear regression model was developed to analyze monthly sales. Time in months was designated as the independent variable (x), and monthly sales quantity in tons was the dependent variable (Y). Using Excel, the model was built according to equation (5). It was then statistically analyzed to determine the significance, form, and strength of the relationship, and to evaluate its forecasting accuracy. The resulting relationship is shown graphically in Figure (4).

$$Y = a + bx \ldots\ldots\ldots\ldots\ldots(5)$$

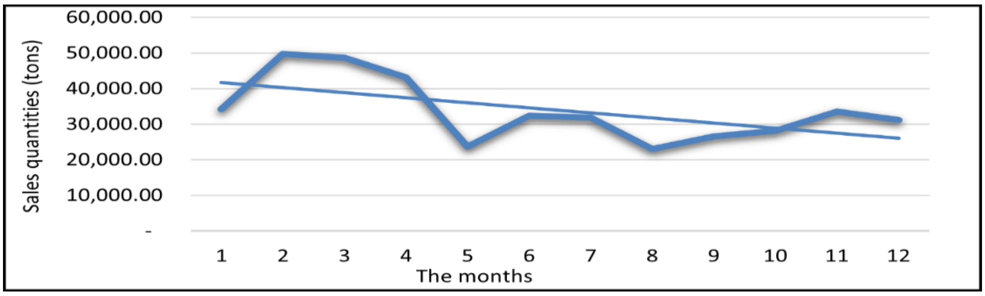

Figure4: Relationship Between Sales Quantity and Months

The equation obtained was as follows:

$$Y=43{,}122-1422.832X \ldots\ldots\ldots\ldots\ldots(6)$$

Based on the regression indicators in Table (2), the model shows moderate performance. The multiple correlation coefficient of 0.5745 indicates a medium-strength relationship. However, the coefficient of determination (R^2) is low at 0.33, showing the model explains only 33% of the variance in the dependent variable, with the adjusted R^2 of 0.263 confirming its limited effectiveness. Furthermore, the large standard error of 7666.63 suggests poor predictive accuracy.

Table 2: Regression Model Statistics

Regression Statistics	
0.574454008	Multiple R
0.329997407	R Square
0.262997148	Adjusted R Square
7666.632964	Standard Error
12	Observations

The Analysis of Variance (ANOVA) in Table (3) yields an F-statistic of 4.9253 with a significance level (p-value) of 0.05074. Since this p-value is marginally above the standard 0.05 threshold, the model is not considered statistically significant. This confirms a potential but weak relationship between the variables, consistent with the large sum of squares for residuals compared to the explained variance.

Table 3: Analysis of Variance (ANOVA)

Significance F	F	MS	SS	df	
0.050754	4.925315	2.89E+08	2.89E+08	1	Regression
		58777261	5.88E+08	10	Residual
			8.77E+08	11	Total|

According to Table (4), the model's intercept is 43122.91 and the coefficient for the independent variable (month) is −1422.83, indicating an inverse relationship.

The intercept is highly statistically significant (p = 3.60E-06, t = 9.14). However, the month variable (p = 0.050754, t = 2.22) is not statistically significant at the conventional α = 0.05 level, though it is borderline. The large standard errors for both the intercept (4718.49) and the month variable (641.2) suggest a high degree of uncertainty in the coefficient estimates.

Table 4: Follow-up Analysis of Variance (ANOVA)

P-value	t Stat	Standard Error	Coefficients	
3.6041E-06	9.139140252	4718.486411	43122.90909	Intercept
0.050754273	−2.219305155	641.1160559	−1422.832168	Month (x)

In Figure (5), the distribution of the residuals is shown. The residuals appear to be randomly distributed around zero, with some outliers or anomalies. This suggests that the model may be acceptable with some values that are not well explained by the model.

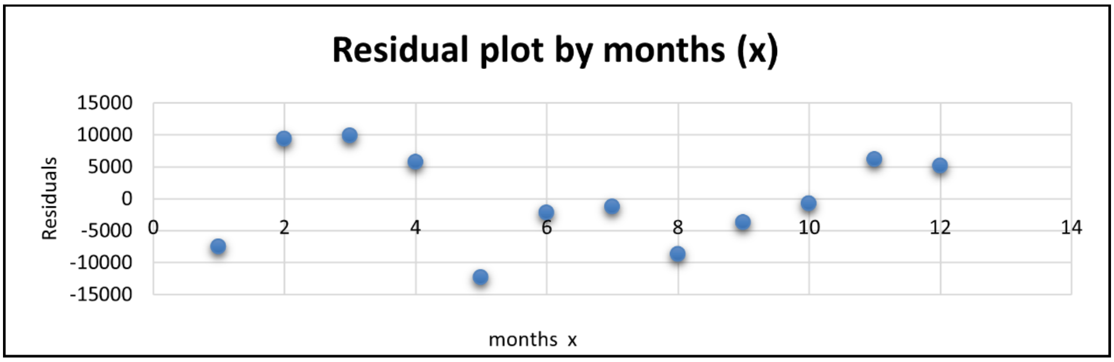

Figure 5 : Residual Distribution

In Figure (6), the data distribution is shown. The data takes a quasi-linear pattern, which indicates that the data is distributed close to the normal distribution, with some deviations from the straight line. This indicates that there may be outliers or minor deviations from the normal distribution.

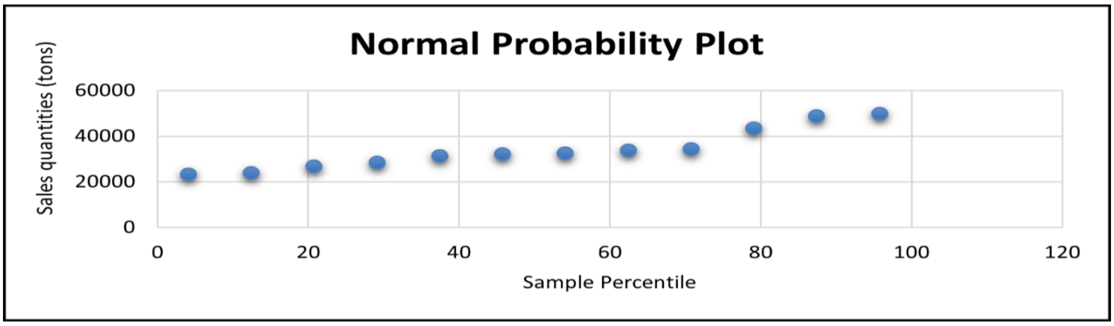

Figure 6 : Data Distribution

Table (5) assesses the model's forecasting accuracy by comparing predicted sales values against actual data. The analysis reveals inconsistent performance, with significant residuals (the difference between actual and predicted values) and an error rate reaching as high as 52% in some months.

This high level of error indicates that the simple linear regression model is insufficient to adequately explain the variance in sales data and therefore lacks reliable predictive power.

Table 5: Measuring Model Accuracy

Month	Actual Sales (Tons)	Expected Sales (Tons)	Residuals	Error Rate
11/2023	34,199.00	41700.07	-7501.07	22%
12/2023	49,711.00	40277.24	9433.75	19%
01/2024	48,694.00	38854.41	9839.58	20%
02/2024	43,226.00	37431.58	5794.41	13%
03/2024	23,675.00	36008.74	-12333.74	52%
04/2024	32,425.00	34585.91	-2160.91	7%
05/2024	31,885.00	33163.08	-1278.08	4%
06/2024	23,076.00	31740.25	-8664.25	38%
07/2024	26,589.00	30317.41	-3728.41	14%
08/2024	28,207.00	28894.58	-687.58	2%
09/2024	33,644.00	27471.75	6172.24	18%
10/2024	31,163.00	26048.92	5114.07	16%
11/2024		24,626.60		
12/2024		23,203.80		
01/2025		21,781.00		

Figure (7) shows the differences recorded between the actual and expected sales quantity (predicted through the model). Through the figure, there are significant differences which confirm that the model lacks accuracy in forecasting.

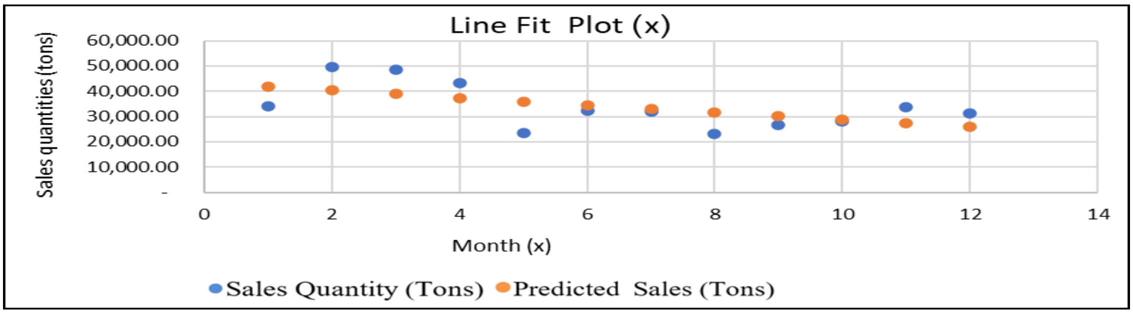

Figure 7: Differences between Actual and Expected Values

6. Results and Discussion:

Through the analysis of the study data using the EXCEL program, the results can be extracted as shown. From Table (2), it was found that the regression indicators in the obtained regression model show that the multiple correlation value obtained is 0.5745, which is considered of medium strength, while the value of the coefficient of determination was 33% of the variance in the dependent variable that can be explained by the model, and that there is a large variance that is still unexplained, reaching 67%. Also, from the value of the coefficient of determination which was recorded at 0.263, this indicates that the model is not very effective in explaining the variance. The value of the standard error (the average difference between the predicted values and the actual values) is 7666.63, which is considered a large value, and that the forecasts may be far from the actual values.

From Table (3) for the Analysis of Variance (ANOVA), the amount of unexplained data was found to be greater than the amount of explained data. Also, the analysis of the significance of the regression, which showed a value of F of 4.9253 with a significance level of 0.05074, which is very close to the value of 0.05, indicates that there is a potential relationship between the independent variable and the dependent variable, but the strength of this relationship is not high, and the model may be statistically significant, and it needs further improvements.

From Table (4), the value of the coefficients for the dependent variable y (intercept) appear to be 43122.91, while the value of the coefficient for the independent variable (x) is −1422.83. This shows a negative relationship between the month and the dependent variable. Also, the standard error shows the degree of uncertainty in the estimate of the coefficient, and shows that there is a large variance in the estimation. This value is 4718.49 for the intercept, while the standard error value for the independent variable is 641.2 and also shows a large variance which is however less than that of the intercept, The test (t) reflects the strength of the relationship between the variables, where 9.14 indicates that the intercept has a significant effect, while −2.22 indicates that the effect of the month on the dependent variable is statistically significant, but not as strong as the effect of the intercept.

The P value for the intercept was 3.60E-06 which is less than 0.05 indicating that the effect of the intercept is statistically significant. This means that this coefficient can be considered significant. While the P value for the month was 0.050754 which is close to 0.05, which indicates that the negative effect of the month on the dependent variable is significant at a 5% level. This means that the relationship can be considered meaningful.

The model obtained for forecasting the sales, from table (5) and figure (5) and shown in equation (6) is:

(Sales Quantity) Y = 43,122-1422.832(Month)

In Figure (6), the distribution of residuals is shown, which shows that they are randomly distributed around zero, with some outliers or anomalies. This suggests that the model may be acceptable with some values that are not well explained by the model.

In Figure (7), the data distribution is shown. The data takes a quasi-linear pattern, which indicates that the data is distributed close to the normal distribution, with some deviations from the straight line. This indicates that there may be outliers or minor deviations from the normal distribution.

Table (5) shows the accuracy of the model in forecasting based on the comparison between the expected values of sales quantities based on the model, and the actual values taken from the data of the company's marketing department. These values represent what the model expects based on the independent variables used.

The residual values show the difference between the actual values and the predicted values, and they indicate the accuracy of the model. Some residual values indicate that the model is not accurate in some cases, while in others, the performance is acceptable.

By using the regression model obtained, sales can be estimated for the next three months, and through the relationship between the independent and the dependent variable, which is a negative relationship, we notice a decrease in sales quantity. Also, by determining the error rate in the model, which is shown in Table (5), some months show a high error rate, reaching 52%. This indicates that the statistical model used may not be sufficient to explain the variance in the sales data.

Also, as can be noted from Figure (8) which shows the recorded differences between actual sales quantity and the expected (predicted) sales quantity through the model, there are significant differences, which confirm that the model lacks accuracy in forecasting.

The sample size had an impact on the model accuracy where only 12 observations were used, especially considering the nature of demand being volatile and non-standard for products being studied.

Through analyzing the sales data for rebar products (rods), which showed fluctuations in the demand for the products during the study months. This affected the accuracy of the forecasting model used in this study. Through conducting interviews with officials of the local marketing department at the company, and analyzing the internal and external factors that could potentially affect the demand for rebar products, the most important factors can be determined as follows:

Among the important external factors:

- The instability of the foreign exchange rate affected the level of sales. This is because some customers re-export these products, which creates a state of anticipation.
- Seasonal demand appeared in the data with a decline during the month of Ramadan as a result of the market stagnation and a general slow down in construction activities.

- Also, the loss of some markets (the Eastern and Southern regions) due to increased transport prices and monopolies directly affected demand.
- The rise in raw material prices in the global market affected the prices of finished products, which opened up opportunities for competition from imported products, and some private sector companies have a manufacturing share which affected the marketing gap.

Among the important internal factors:

- The lack of availability of the required sizes of rebar in the required quantity and time reflects on the level of demand, and this is shown through inventory data during the study period.

Through the results and findings of the study, from the analysis of information and data related to the sales of the rod rolling mill during 12 months, and the forecasting of sales for the next 03 months, we suggest a number of recommendations that may contribute to improving the level of forecasting sales in the future. They are as follows:

1. Improve the accuracy of the statistical model by adding other independent variables that affect the sales quantities. Use other statistical models such as multiple linear regression or time series analysis.
2. Increase the sample size or expand the scope of the data to improve the representation of the sales quantities and improve the accuracy of forecasting.
3. Conduct periodic market studies to analyze and identify patterns and trends of demand, and to understand the impact of external factors.
4. Develop marketing strategies targeting markets in which the company has lost its share, and work to strengthen the relationship with existing clients.
5. Improve inventory management to ensure the availability of the required sizes of rebar in time to meet demand.

7. Conclusions

This the study investigated the use of simple linear regression to forecast rebar sales for the Libyan Iron and Steel Company. While the model showed a statistically significant relationship between time (months) and sales, its predictive accuracy was limited. The model only explained 33% of the variance, with a high standard error, indicating substantial unexplained variability and potential for inaccurate forecasts. The study identified a negative relationship between the month and sales, suggesting a decreasing trend. Analysis of the residuals revealed some outliers and anomalies.

External factors like exchange rate instability and seasonal demand fluctuations, alongside internal issues such as inconsistent product availability, impacted sales and contributed to the model's limitations. The small sample size of 12 months also played a role. The study concludes that a simple linear regression model alone is insufficient for robust forecasting in this context. Recommendations include exploring more complex statistical models, increasing data size, conducting market studies, and improving internal operational efficiency for more reliable sales forecasts.

8. References

[1] M. A. Shahout and A. Q. Shtewan, “Forecasting Sales Volume Using the Multiple Linear Regression Method,” Technical Research Journal, vol. 1, no. 1, 2023.

[2] M. Sitompul, “Forecasting Simcard Demand Using Linear Regression Method,” IT Journal Research and Development (ITJRD), pp. 48-60, 2023. E-ISSN: 2528-4053, P-ISSN: 2528-4061.

[3] A. Awainia, “Forecasting Sales Volume Using Autoregressive Models, A Case Study of FERPHOS Tebessa - in the Period 2002-2022,” Master's thesis, University of Muhammad Al-Sharif Al-Musaidia, 2022.

[4] M. Al-Hallak, "Demand forecasting for sales and raw materials using linear and non-linear time series, a case study of Terco Company for food manufacturing," Master's thesis, Higher Institute of Business Administration, 2021.

[5] F. Farizal, Y. Qaradhawi, C. I. Cornelis, and M. Dachyar, "Fast Moving Product Demand Forecasting Model with Multi Linear Regression," AIP Conference Proceedings, vol. 2227, pp. 040028-1 to 040028-6, 2020. https://doi.org/10.1063/5.0001031.

[6] O. O. Ade-Ikuesan, "Linear Regression Long-Term Energy Demand Forecast Modeling in Ogun State Nigeria," J. Appl. Sci. Environ. Manage, vol. 23, no. 4, pp. 753-757, 2019.

[7] S. Sengupta, "Comparative Study of Demand Forecast Accuracy for Healthcare Products Using Linear and Non Linear Regression," Int. J. Business Manag. Invention, vol. 3, no. 5, pp. 1-10, May 2014.

[8] J. M. Al-Gamal, "A study of the causes of increased consumption of rolling tools at the rod rolling mill at the Libyan Iron and Steel Company," M.S. thesis, Eng. Project Manag., Libyan Academy, Misurata, Libya, 2014.

[9] A. Badar, "The Comparison between Time Series Model and Simple Regression Model in Forecasting Sales in an Economic Institution: A Case Study of the Al-Hadna Mills in M'sila," M.S. thesis, Bus. Admin., Muhammad Boudiaf Univ., 2006.

[10] A. K. Mohsen and S. M. Al-Najjar, "Production and Operations Management", 3rd ed. Baghdad: Al-Dhakira Library, 2009.

[11] A. Y. Al-Barbar, "Market demand forecasting," M.S. thesis, Dept. Bus. Admin., Faculty of Commerce, Damietta Univ., 2020.

[12] S. Abidat and M. A. Salem, "Production Operations Management". Cairo: Arab United Co. for Marketing and Supplies, 2013.

[13] Local Marketing Department, Libyan Iron and Steel Company, “Sales Reports for the products of the rod rolling mill,” 2023-2024.

[14] Libyan Iron and Steel Company. Available: http://libyansteel.com/lisco