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Data Mining Using Multiple Linear Regression Method for Stock Prediction

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Abstract

This study aims to apply data mining techniques using multiple linear regression to predict inventory at PT. Sumber Jaya Motor's website. In today's digital era, companies face challenges in managing inventory, which can impact operational efficiency and customer satisfaction. Therefore, accurate inventory prediction is essential to improve inventory management efficiency. The multiple linear regression method was chosen because of its ability to link multiple independent variables with the dependent variable, thus providing more accurate predictions regarding required inventory. The data used in this study includes information related to sales, suppliers, and demand obtained from PT. Sumber Jaya Motor. The results of the multiple linear regression application indicate that the developed model can provide inventory predictions with a high degree of accuracy. This system is implemented on a website to facilitate real-time data-driven monitoring and decision-making. With the implementation of this method, it is hoped that PT. Sumber Jaya Motor can manage inventory more efficiently, reduce inventory costs, and improve customer service.

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1. Introduction

Determining stock levels is crucial in any business process, specifically meeting the high demand for vehicle spare parts. The demand for spare parts is currently quite high due to the annual increase in vehicle usage. One example is PT. Sumber Jaya Motor, located at Jl. William Iskandar/Pancing No. 32a. PT. Sumber Jaya Motor generates relatively high daily sales volumes, significantly impacting warehouse inventory. The impact of product availability is crucial, particularly for the most sought-after and best-selling spare parts.

PT. Sumber Jaya Motor is a company engaged in the sales and distribution of automotive spare parts. In carrying out its business operations, the company relies on stable and accurate inventory availability to optimally meet customer demand. However, in practice, inventory management often encounters challenges such as overstock or stockouts, which directly impact operational efficiency and customer satisfaction.

One of the main causes of these problems is a suboptimal inventory forecasting and management

system. Until now, the process of planning the quantity of goods to be stored in warehouses has been done manually and based on rough estimates based on previous experience, without using a systematic, data-driven approach. This makes it difficult for companies to anticipate market demand and sales trends for specific products.

With the advancement of information technology, particularly in the field of data mining, companies can utilize data analysis techniques to uncover patterns and relationships in historical sales data. One method that can be used for prediction is multiple linear regression. This method allows companies to analyze the influence of several variables on inventory, such as previous sales volume, seasonal trends, prices, and product types, thus allowing for more accurate stock requirement estimates.

The implementation of the multiple linear regression method in a website-based information system is an effective solution because it allows for automated data management and prediction processes, in real time, and is easily accessible by warehouse management and marketing departments. The website-based system also provides convenience in monitoring and decision-making, without having to rely on a specific physical location.

With this data mining-based stock prediction system, PT. Sumber Jaya Motor is expected to improve inventory management efficiency, reduce the risk of losses due to estimation errors, and increase customer satisfaction through better product availability. Therefore, this research is important to design and implement a website-based stock prediction system using an integrated and effective multiple linear regression method.

2. Research Methodolgy

In developing the system, the author uses the waterfall model or software life cycle, the software life cycle has the following stages:

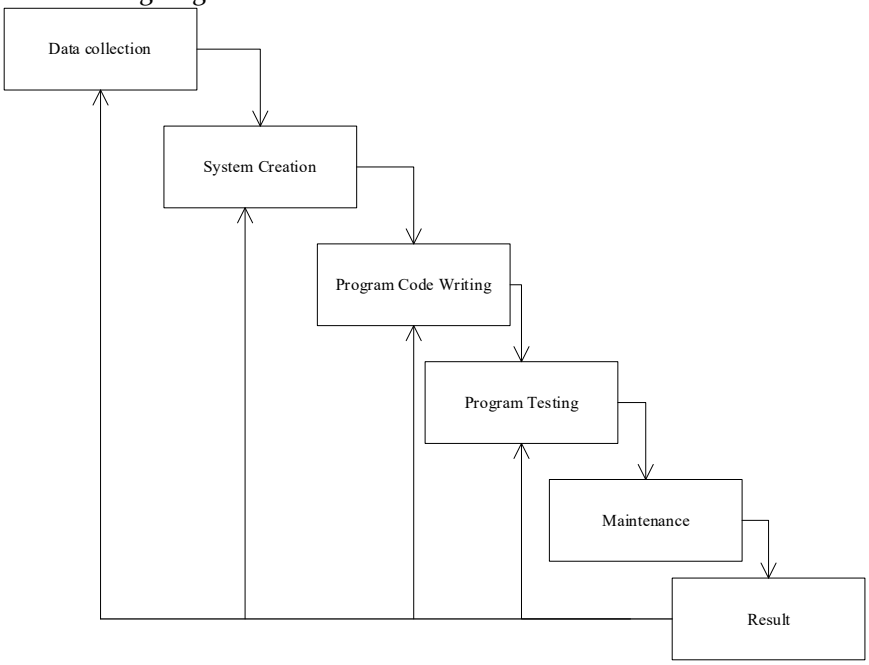

Figure 1. Waterfall Diagram

The Waterfall method has several stages in its development: requirements analysis, system design, coding, program testing, and system maintenance.

1. Data Collection
   The researcher collected data containing the elements that must be included in the design to solve the existing problems and meet the objectives. The data required for system design included

product stock prediction data, user data, and the programming language used to create the application, PHP. The author conducted a field study by conducting direct field visits to collect data, including direct visits to the study location. The data collection techniques used by the author were:

a. Observation
The author observed product data, stock data, and sales data on inventory.

b. Interview
This technique involved direct face-to-face meetings with relevant parties to obtain clarification on previously unclear issues, including the system mechanisms used in the company, and to ensure that the data collected was accurate. The interview process was conducted with Mrs. Imelda Aritonang, a sales representative, as follows:

1) What are the challenges frequently encountered in inventory management at PT. Sumber Jaya Motor?
Answer: We often experience overstock or understock because demand forecasts are still done manually, based solely on experience or previous sales data without in-depth analysis.
2) Does the company currently use a system to monitor or predict inventory?
Answer: We currently use an Excel-based inventory recording system. However, there is no system capable of predicting inventory needs automatically or based on historical data.
3) What is the impact of forecast errors on company operations?
Answer: The impact is significant. If inventory runs out, customers cannot be served properly. Conversely, if inventory is overstocked, inventory piles up in the warehouse, increasing storage costs.
4) Is previous sales and inventory data available and well-documented?
Answer: Yes, we have documented monthly sales data and incoming/outgoing inventory data for the past several years, but it has not been fully utilized for analysis.
5) What would you think if a stock forecasting system could be automated using website-based technology?
Answer: It would be very helpful, as such a system would speed up the decision-making process, reduce errors, and be accessible from anywhere. We hope to have a system that is user-friendly and accurate.
6) What variables or factors do you think influence inventory requirements?
Answer: Some important factors include: previous sales trends, seasonality (because some spare parts are in demand at certain times), selling price, type of item, and sometimes market conditions such as promotions or discounts from manufacturers.
7) Does the company have an internal IT team for system development?
Answer: We don't have an internal IT team. We typically collaborate with third parties or external developers if we want to create a technology-based system.
8) So far, what is the company's procurement and inventory recording workflow?
Answer: The workflow begins with recording daily sales, then at the end of each month, warehouse staff conducts a stock recap. After that, the purchasing department orders goods from distributors based on the estimated stock requirements for the following month.
9) What are your expectations for the inventory forecasting system that will be developed?
Answer: We hope this system can help estimate stock accurately, reduce the risk of stockouts or stockpiling, and support the company's overall operational efficiency.

2. System Development
In general, the Predictive Information System uses the Multiple Linear Regression Method and uses Unified Modeling Language design models, namely use case diagrams, class diagrams, activity diagrams, and sequence diagrams.

3. Method
The author chose the Multiple Linear Regression method to design sales estimates using the Linear Regression method. This method is one of the most important approaches in engineering for: (a)

regression or equation formation from discrete data points (in modeling), and (b) measurement error analysis (in model validation).

4. Program Testing
   At this stage, comprehensive application testing is conducted, including functional testing and system robustness testing. Black-box (interface) testing is software testing that tests the application's functionality against its internal structure or operation.
5. Maintenance
   Software that is difficult to deliver to system users will inevitably undergo changes. These changes can occur due to errors as the software must adapt to the new environment.
6. Results
   The researcher used the system to predict inventory using data mining techniques using the Multiple Linear Regression method.

3. Results and Discussion

The author will forecast the sales of Shock Absorber vehicle spare parts for the period January 2020 to December 2024. Sales data can be seen in Table 1.

Table 1. Shock Absorber Sales Data (2020-2024)

No	Product name	Month	Year	Sold	Initial Stock	Product in
1	*Bantalan Shok*	Januari	2020	104	67	80
2	*Bantalan Shok*	Februari	2020	120	120	200
3	*Bantalan Shok*	Maret	2020	120	89	120
4	*Bantalan Shok*	April	2020	140	120	90
5	*Bantalan Shok*	Mei	2020	120	78	100
6	*Bantalan Shok*	Juni	2020	145	210	60
7	*Bantalan Shok*	Juli	2020	145	120	80
8	*Bantalan Shok*	Agustus	2020	120	54	80
9	*Bantalan Shok*	September	2020	120	90	100
10	*Bantalan Shok*	Oktober	2020	140	120	180
11	*Bantalan Shok*	November	2020	80	180	90
12	*Bantalan Shok*	Desember	2020	230	165	80
13	*Bantalan Shok*	Januari	2021	210	187	90
14	*Bantalan Shok*	Februari	2021	210	180	90
15	*Bantalan Shok*	Maret	2021	100	200	120
16	*Bantalan Shok*	April	2021	190	320	100
17	*Bantalan Shok*	Mei	2021	230	200	100
18	*Bantalan Shok*	Juni	2021	180	200	100
19	*Bantalan Shok*	Juli	2021	200	180	54
20	*Bantalan Shok*	Agustus	2021	80	204	87
21	*Bantalan Shok*	September	2021	200	120	120
22	*Bantalan Shok*	Oktober	2021	120	120	80
23	*Bantalan Shok*	November	2021	90	140	200
24	*Bantalan Shok*	Desember	2021	100	120	120
25	*Bantalan Shok*	Januari	2022	60	145	90
26	*Bantalan Shok*	Februari	2022	80	145	100
27	*Bantalan Shok*	Maret	2022	80	120	60
28	*Bantalan Shok*	April	2022	100	120	80
29	*Bantalan Shok*	Mei	2022	180	140	80
30	*Bantalan Shok*	Juni	2022	90	80	100
31	*Bantalan Shok*	Juli	2022	80	330	180
32	*Bantalan Shok*	Agustus	2022	90	210	90
33	*Bantalan Shok*	September	2022	90	210	80
34	*Bantalan Shok*	Oktober	2022	120	100	90
35	*Bantalan Shok*	November	2022	100	190	90
36	*Bantalan Shok*	Desember	2022	100	230	120

No	Product name	Month	Year	Sold	Initial Stock	Product in
37	*Bantalan Shok*	Januari	2023	100	180	100
38	*Bantalan Shok*	Februari	2023	54	200	100
39	*Bantalan Shok*	Maret	2023	87	80	100
40	*Bantalan Shok*	April	2023	120	200	54
41	*Bantalan Shok*	Mei	2023	120	120	87
42	*Bantalan Shok*	Juni	2023	120	90	120
43	*Bantalan Shok*	Juli	2023	140	100	145
44	*Bantalan Shok*	Agustus	2023	120	60	187
45	*Bantalan Shok*	September	2023	145	80	89
46	*Bantalan Shok*	Oktober	2023	145	80	110
47	*Bantalan Shok*	November	2023	120	100	120
48	*Bantalan Shok*	Desember	2023	120	180	200
49	*Bantalan Shok*	Januari	2024	140	90	130
50	*Bantalan Shok*	Februari	2024	80	80	190
51	*Bantalan Shok*	Maret	2024	330	200	150
52	*Bantalan Shok*	April	2024	210	90	210
53	*Bantalan Shok*	Mei	2024	210	120	120
54	*Bantalan Shok*	Juni	2024	100	100	130
55	*Bantalan Shok*	Juli	2024	190	100	130
56	*Bantalan Shok*	Agustus	2024	230	100	130
57	*Bantalan Shok*	September	2024	180	54	280
58	*Bantalan Shok*	Oktober	2024	200	87	120
59	*Bantalan Shok*	November	2024	145	120	170
60	*Bantalan Shok*	Desember	2024	150	130	130

Based on the explanation of the table above, the results of the Constant Value and Regression Coefficient are as follows:

Table 2. Constant Values and Regression Coefficients

Month	Year	Sold (X1)	Stock (X2)	Product in (Y)	X1*Y	X2*Y	X1*X2	X1^2	X2^2	Y^2
Januari	2020	104	67	80	8.320	5.360	6.968	10.816	4.489	6.400
Februari	2020	120	120	200	24.000	24.000	14.400	14.400	14.400	40.000
Maret	2020	120	89	120	14.400	10.680	10.680	14.400	7.921	14.400
April	2020	140	120	90	12.600	10.800	16.800	19.600	14.400	8.100
Mei	2020	120	78	100	12.000	7.800	9.360	14.400	6.084	10.000
Juni	2020	145	210	60	8.700	12.600	30.450	21.025	44.100	3.600
Juli	2020	145	120	80	11.600	9.600	17.400	21.025	14.400	6.400
Agustus	2020	120	54	80	9.600	4.320	6.480	14.400	2.916	6.400
September	2020	120	90	100	12.000	9.000	10.800	14.400	8.100	10.000
Oktober	2020	140	120	180	25.200	21.600	16.800	19.600	14.400	32.400
November	2020	80	180	90	7.200	16.200	14.400	6.400	32.400	8.100
Desember	2020	230	165	80	18.400	13.200	37.950	52.900	27.225	6.400
Januari	2021	210	187	90	18.900	16.830	39.270	44.100	34.969	8.100
Februari	2021	210	180	90	18.900	16.200	37.800	44.100	32.400	8.100
Maret	2021	100	200	120	12.000	24.000	20.000	10.000	40.000	14.400
April	2021	190	320	100	19.000	32.000	60.800	36.100	102.400	10.000
Mei	2021	230	200	100	23.000	20.000	46.000	52.900	40.000	10.000
Juni	2021	180	200	100	18.000	20.000	36.000	32.400	40.000	10.000
Juli	2021	200	180	54	10.800	9.720	36.000	40.000	32.400	2.916
Agustus	2021	80	204	87	6.960	17.748	16.320	6.400	41.616	7.569
September	2021	200	120	120	24.000	14.400	24.000	40.000	14.400	14.400

Month	Year	Sold (X1)	Stock (X2)	Product in (Y)	X1*Y	X2*Y	X1*X2	X1^2	X2^2	Y^2
Oktober	2021	120	120	80	9.600	9.600	14.400	14.400	14.400	6.400
November	2021	90	140	200	18.000	28.000	12.600	8.100	19.600	40.000
Desember	2021	100	120	120	12.000	14.400	12.000	10.000	14.400	14.400
Januari	2022	60	145	90	5.400	13.050	8.700	3.600	21.025	8.100
Februari	2022	80	145	100	8.000	14.500	11.600	6.400	21.025	10.000
Maret	2022	80	120	60	4.800	7.200	9.600	6.400	14.400	3.600
April	2022	100	120	80	8.000	9.600	12.000	10.000	14.400	6.400
Mei	2022	180	140	80	14.400	11.200	25.200	32.400	19.600	6.400
Juni	2022	90	80	100	9.000	8.000	7.200	8.100	6.400	10.000
Juli	2022	80	330	180	14.400	59.400	26.400	6.400	108.900	32.400
Agustus	2022	90	210	90	8.100	18.900	18.900	8.100	44.100	8.100
September	2022	90	210	80	7.200	16.800	18.900	8.100	44.100	6.400
Oktober	2022	120	100	90	10.800	9.000	12.000	14.400	10.000	8.100
November	2022	100	190	90	9.000	17.100	19.000	10.000	36.100	8.100
Desember	2022	100	230	120	12.000	27.600	23.000	10.000	52.900	14.400
Januari	2023	100	180	100	10.000	18.000	18.000	10.000	32.400	10.000
Februari	2023	54	200	100	5.400	20.000	10.800	2.916	40.000	10.000
Maret	2023	87	80	100	8.700	8.000	6.960	7.569	6.400	10.000
April	2023	120	200	54	6.480	10.800	24.000	14.400	40.000	2.916
Mei	2023	120	120	87	10.440	10.440	14.400	14.400	14.400	7.569
Juni	2023	120	90	120	14.400	10.800	10.800	14.400	8.100	14.400
Juli	2023	140	100	145	20.300	14.500	14.000	19.600	10.000	21.025
Agustus	2023	120	60	187	22.440	11.220	7.200	14.400	3.600	34.969
September	2023	145	80	89	12.905	7.120	11.600	21.025	6.400	7.921
Oktober	2023	145	80	110	15.950	8.800	11.600	21.025	6.400	12.100
November	2023	120	100	120	14.400	12.000	12.000	14.400	10.000	14.400
Desember	2023	120	180	200	24.000	36.000	21.600	14.400	32.400	40.000
Januari	2024	140	90	130	18.200	11.700	12.600	19.600	8.100	16.900
Februari	2024	80	80	190	15.200	15.200	6.400	6.400	6.400	36.100
Maret	2024	330	200	150	49.500	30.000	66.000	108.900	40.000	22.500
April	2024	210	90	210	44.100	18.900	18.900	44.100	8.100	44.100
Mei	2024	210	120	120	25.200	14.400	25.200	44.100	14.400	14.400
Juni	2024	100	100	130	13.000	13.000	10.000	10.000	10.000	16.900
Juli	2024	190	100	130	24.700	13.000	19.000	36.100	10.000	16.900
Agustus	2024	230	100	130	29.900	13.000	23.000	52.900	10.000	16.900
September	2024	180	54	280	50.400	15.120	9.720	32.400	2.916	78.400
Oktober	2024	200	87	120	24.000	10.440	17.400	40.000	7.569	14.400
November	2024	145	120	170	24.650	20.400	17.400	21.025	14.400	28.900
Desember	2024	150	130	130	19.500	16.900	19.500	22.500	16.900	16.900
Rata-rata		137	139	116						
Total	n = 60	8.220	8.345	6.983	970.045	940.148	1.148.258	1.292.326	1.369.255	929.085

Based on Table 2, the following equation is obtained using the multiple linear regression method:
Equation I
$\sum Y^2 = \sum Y^2 - n\ Y^2$
$\sum Y^2 = 929085 - (60 * (116 * 116))$
$\sum Y^2 = 929085 - 60 * 13456$

$\sum Y^2 = 929085 - 807360$
$\sum Y^2 = 121725$
Equation **II**
$\sum X_1^2 = \sum X_1^2 - n\ X_1^2$
$\sum X_1^2 = 1292326 - (60 * (137 * 137))$
$\sum X_1^2 = 1292326 - 60 * 18769$
$\sum X_1^2 = 1292326 - 1126140$
$\sum X_1^2 = 166186$
Equation **III**
$\sum X_2^2 = \sum X_2^2 - n\ X_2^2$
$\sum X_2^2 = 1369255 - (60 * (139 * 139))$
$\sum X_2^2 = 1369255 - 60 * 19321$
$\sum X_2^2 = 1369255 - 1159260$
$\sum X_2^2 = 209995$
Equation **IV**
$\sum X_1Y = \sum X_1Y - n\ X_1Y$
$\sum X_1Y = 970045 - (60 * (137 * 116))$
$\sum X_1Y = 970045 - 60 * 15892$
$\sum X_1Y = 970045 - 953520$
$\sum X_1Y = 16525$
Equation **V**
$\sum X_2Y = \sum X_2Y - n\ X_2Y$
$\sum X_2Y = 940148 - (60 * (139 * 116))$
$\sum X_2Y = 940148 - 60 * 16124$
$\sum X_2Y = 940148 - 967440$
$\sum X_2Y = -27292$
Equation **VI**
$\sum X_1X_2 = \sum X_1X_2 - n\ X_1X_2$
$\sum X_1X_2 = 1148258 - (60 * (137 * 139))$
$\sum X_1X_2 = 1148258 - 60 * 19043$
$\sum X_1X_2 = 1148258 - 1142580$
$\sum X_1X_2 = 5678$
Thus, the results obtained for the constant value a and the regression coefficients b1 and b2 are as follows:
$b_1 = (\sum X_2^2)(\sum X_1Y) - (\sum X_1X_2)(\sum X_2Y) / (\sum X_1^2)(\sum X_2^2) - (\sum X_1X_2)^2$
$b_1 = (209995 * 16525) - (5678 * -27292) / (166186 * 209995) - (5678)^2$
$b_1 = (3470167375 - (-154963976) / 34898229070 - 32239684$
$b_1 = 3625131351 / 34865989386$
$b_1 = 0.10397328212506$
$b_2 = (\sum X_1^2)(\sum X_2Y) - (\sum X_1X_2)(\sum X_1Y) / (\sum X_1^2)(\sum X_2^2) - (\sum X_1X_2)^2$
$b_2 = (166186 * -27292) - (5678 * 16525) / (166186 * 209995) - (5678)^2$
$b_2 = -4535548312 - 93828950 / 34898229070 - 32239684$
$b_2 = -4629377262 / 34865989386$
$b_2 = -0.13277630560683$
$a = Y - b_1X_1 - b_2X_2$
$a = 116 - (0.10397328212506 * 137) - (-0.13277630560683 * 139)$
$a = 116 - 14{,}24433936 - (-18{,}4559071)$
$a = 120.21156682822 = 120$
So that the regression equation model is obtained from the results of the calculations in the case above, it can be seen that the results of the stock forecast for Shock Bearings for the 2025 period are as follows:

Y = a + b1X1 + b2X2 + ... bnXn

Month	Year	Y = a + b1X1 + b2X2	Forecast Amount
Januari	2025	Y = 120 + (0.10*104) + (-0.13*67)	121.91720886535 atau dibulatkan = 122
Februari	2025	Y = 120 + (0.10*120) + (-0.132*120)	116.54363718219 atau dibulatkan = 117
Maret	2025	Y = 120 + (0.10*120) + (-0.13*89)	120.659702656 atau dibulatkan = 121
April	2025	Y = 120 + (0.10*140) + (-0.13*120)	118.62310282469 atau dibulatkan = 119
Mei	2025	Y = 120 + (0.10*120) + (-0.13*78)	122.12025202167 atau dibulatkan = 122
Juni	2025	Y = 120 + (0.10*145) + (-0.13*210)	107.1931017307 atau dibulatkan = 107
Juli	2025	Y = 120 + (0.10*145) + (-0.13*120)	119.14296923531 atau dibulatkan = 119
Agustus	2025	Y = 120 + (0.10*120) + (-0.13*54)	125.30687335224 atau dibulatkan = 125
September	2025	Y = 120 + (0.10*120) + (-0.13*90)	120.52692635039 atau dibulatkan = 121
Oktober	2025	Y = 120 + (0.10*140) + (-0.13*120)	118.62310282469 atau dibulatkan = 119
November	2025	Y = 120 + (0.10*80) + (-0.13*180)	104.41812756078 atau dibulatkan = 104
Desember	2025	Y = 120 + (0.10*230) + (-0.13*165)	122.00576446364 atau dibulatkan = 122

4. Conclusion

Based on the implementation of data mining using the Multiple Linear Regression method for predicting spare part inventory at PT. Sumber Jaya Motor, it can be concluded that the developed web-based system significantly enhances the accuracy and efficiency of stock management. By utilizing historical sales data and relevant variables, the system successfully reduces errors in determining the required stock levels, enabling the company to anticipate future demand more effectively. The system, built using PHP and a MySQL database, also simplifies the process of recording, monitoring, and updating inventory, allowing users to work more quickly and with fewer mistakes. This improvement not only increases operational efficiency but also helps the company address recurring challenges in forecasting spare part needs for upcoming periods. Furthermore, this research highlights several opportunities for future development. The system may be enhanced by integrating additional forecasting models such as ARIMA, Random Forest, or Artificial Neural Networks to compare and improve prediction accuracy. Incorporating external variables such as seasonal trends, market fluctuations, and supplier data could further strengthen the forecasting results. The addition of interactive analytical dashboards, automatic stock-level notifications, and a mobile-based application would also expand usability and support real-time decision-making. Overall, the designed system provides a strong foundation for continuous improvement in inventory forecasting and management.

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