

Profit Forecasting of Automotive and Component Sub Sector Companies using Monte Carlo Simulation

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Abstract:- This objective of this study is to forecast the profit of automotive and component sub sector companies using a monte carlo simulation with R Program. The data used are profit per quarter from 2019 to 2021 of five automotive and component sub sector companies listed on IDX. The method use in this study is the monte carlo simulation. This method uses a probabilistic approach so that it is able to consider uncertainty. The result of profit forecasting in 2022 to 2024 for PT Astra Internasional Tbk is IDR 62,275 trillion, PT Garuda Metalindo Tbk is IDR 53,594 billion, PT Gajah Tunggal Tbk is IDR 711,669 billion, PT Indomobil Sukses Internasional Tbk is IDR 826,315 billion, and PT Indospring Tbk is IDR 253,959 billion.

Keywords:- Forecasting, Monte Carlo Simulation, R Program.

I. INTRODUCTION

Forecasting is a technique that uses historical data to systematically estimate what the future holds. In business practices such as companies, predictions of future conditions are often carried out because business predictions are needed by almost all economic entities. Profit forecasting can show financial hazard signals, assess the company's performance and provide information related to the survival of an enterprise [1].

Research on profit forecasting using monte carlo simulation was conducted by Petru Balogh [2]. In determining the probability distribution, cumulative probability distribution, random numbers, and profit forecasting, Balogh's research uses Microsoft Excel. The research conducted by Balogh is similar to what will be carried out, which is also about profit forecasting using Monte Carlo simulations. However, in determining the probability distribution, cumulative probability distribution, random numbers, and profit forecasting, this research will use the R Program.

Another study on Monte Carlo simulations was conducted by Zulfiqar Busrah regarding forecasting changes in stock prices [3]. Busrah's research is more focused than Balogh's because the forecasting process using simulation is carried out in 30 iterations. Based on the results obtained, it can be explained that the difference between theory and

simulation depends on the number of experiments carried out, and the random numbers generated.

The purpose of this research is to forecast the profit of automotive and component sub sector companies using a Monte Carlo simulation. The selected companies are listed on IDX. Monte Carlo simulation is a pattern using random number, namely random variable used to solve stochastic and deterministic problem, the time does not play the real role. Generally Monte Carlo simulation is mor static rather than dynamic [4]. The probabilistic approach is able to consider the uncertainties that may occur. In addition, this method is quite simple in describing and solving problems. The simulation is run using Microsoft Excel and the RStudio program.

II. LITERATURE REVIEW

A. Forecasting

Forecasting is a technique that uses historical data to systematically estimate what the future holds [1]. Forecasting is a basic input in operations management's decision-making process because forecasting provides information on future demand [5]. The forecast predicts what will happen, but it is not certain that the company can implement it [6].

According to reference [7], there are five forecasting principles that need to be considered to get good forecasting results:

- Forecasts always contain errors. Forecasting reduces the factor of uncertainty but can never eliminate it.
- The forecast must include a measure of error. The magnitude of the error can be expressed in terms of a range around the forecast result either in units or as a percentage and the probability that actual demand will fall within that range..
- Grouped item forecasting is always more accurate than item-by-item forecasting.
- Forecasting for the short term is always more accurate than forecasting for the long term. In the short term, conditions affecting demand tend to remain constant/change slowly, so short term forecasts tend to be more accurate.
- If possible, it is better to estimate the number of requests based on calculations rather than forecast results.

B. Simulation

Simulation is a numerical technique to do an experiment in computer involving a certain mathematical and logical model displaying business characteristic and economic system in a long time period [4]. In the simulation, a computer is used to study the system numerically, where data is collected to perform statistical estimations to obtain the original characteristics of the system. Simulation is a great tool to use, especially when it is necessary to conduct experiments to find the best comments from system components. This is because the cost is very expensive and requires a long time if the experiment is carried out in real terms. By conducting simulation studies, the right decisions can be taken in a short time and at a low cost because everything is done by a computer. The simulation approach begins with building a real system model. The model must be able to show how the various components in the system interact so that it truly describes the behavior of the system. After the model is created, it converted into a computer program so that it is possible to simulate it.

C. Monte Carlo Simulation

Monte Carlo simulation refers to a computerized mathematical technique that provides a range of possible outcomes and their probabilities of occurrence, given specific input ranges and probabilities [8]. Monte Carlo simulation is a pattern using random number, namely random variable used to solve stochastic and deterministic problem, the time does not play the real role [4]. Monte Carlo simulation is categorized as a sampling method because the inputs are randomly generated from probability distributions to simulate the process of sampling from an actual population. In a Monte Carlo simulation, the model is built based on the actual system [2]. Each variable in the model has a value that has a different probability, which is shown by the probability distribution or commonly called the probability distribution function of each variable. The Monte Carlo method simulates the system repeatedly, hundreds or even thousands of times depending on the system under consideration, by selecting a random value for each variable from its probability distribution. The results obtained from the simulation are in the form of a probability distribution of the value of a system as a whole. Monte Carlo simulation has been applied to various fields including project management, transportation, computer design, finance, meteorology, biology and biochemistry.

D. R Program

R is a multi-paradigm statistical programming language, based on the S statistical language developed in the 1990s by Ross Ihaka and Robert Gentleman at the University of Auckland, New Zealand [9]. R software is integrated with RStudio. If analogous to a vehicle, R is the engine and RStudio is the outer shell of the car and its interior. Both are open source and free. RStudio is widely used by data analysts and researchers because this software is equipped with various practical additional features that make it easier to use. The advantages of using R according to reference by [10] is as follow:

- R is a free, open source computer language and software environment for statistical computing and graphics.
- In addition to data sharing, open access to R codes will facilitate reproduction and replication of data analysis.
- Statisticians and computer scientists have developed thousands of R packages. These packages can be used for conducting nearly any analysis imaginable.
- R have an ability to produce high-quality graphics. Because R is a command line driven language, the researcher specifies graphic elements with code.
- R is a programming language, rendering the range of possible uses and functions nearly unlimited. Its flexibility enables ideas suggested by a community professional statisticians and computer scientists to be integrated almost instantaneously.
- R can be used with MYSQL database and Apache web-server, which facilitates the development of innovative online programs or platforms.
- R can be used to analyze corpus data using natural language processing packages.

III. METHODOLOGY

The object of this research are five automotive and component sub sector companies listed on IDX. The companies are PT Astra Internasional Tbk, PT Garuda Metalindo Tbk, PT Gajah Tunggal Tbk, PT Indomobil Sukses Internasional Tbk, and PT Indospring Tbk.

This is a quantitative research. This research will be conducted using Microsoft Excel and the R Program to run a Monte Carlo simulation to obtain profit forecasts for the five automotive and component sub sector companies listed on IDX. In this research, the source of data needed and used is secondary data. The data used in this research is profit per quarter from 2019 to 2021. The profit data used is accessed from <https://www.idx.co.id/> which has prepared Financial Statements for the last few years.

The following table is profit data for automotive and component sub sector companies:

TABLE I. PROFIT (LOSS) DATA FOR AUTOMOTIVE AND COMPONENT SUB SECTOR COMPANIES

Year	Profit (Loss) (IDR)				
	ASII (in billion)	BOLT (in million)	GJTL (in million)	IMAS (in million)	INDS (in million)
2019					
Q1	6,665	28,045	168,959	655,074	22,625
Q2	5,636	(7,918)	(5,200)	(194,102)	763
Q3	7,327	29,243	(24,228)	(122,971)	16,825
Q4	6,993	2,122	129,576	(216,232)	61,252
2020					
Q1	5,687	11,230	(404,182)	(185,591)	43,125
Q2	7,450	(21,727)	263,038	(218,220)	(16,725)
Q3	3,096	(11,177)	36,548	946,033	8,740
Q4	2,338	(35,714)	423,510	(1,217,932)	23,611
2021					
Q1	4,657	20,608	113,277	(64,313)	48,385
Q2	6,486	1,410	(17,474)	116,616	41,002
Q3	7,875	21,314	(80,280)	(145,731)	54,812
Q4	6,568	39,417	64,373	(161,912)	14,000

Source: IDX, 202

Data processing uses Monte Carlo Simulation to obtain forecasting results. Forecasting is done for 12 quarters or 3 years in the future. The following steps are:

➤ Determine the probability distribution of total profit.

The formula is:

$$P = F/T$$

Description:

P : the nth probability distribution

F : frequency (number of sales in period n)

T : total (total sales amount)

1. Determine the cumulative probability distribution.
2. Determine the random number intervals.
3. Random number generation.
4. Perform forecasting using simulation procedures.

IV. RESULTS AND DISCUSSION

A. Determine the Probability Distribution of Total Profit

The calculation of determining the probability distribution is carried out for each profit in each quarter. An example of calculating the probability distribution in the first quarter of 2019 is as follows:

$$P(Q1\ 2019) = \frac{F}{T} = \frac{6,665}{70,778} = 0.0942$$

The probability distribution calculation does not need to be done manually one by one. If using RStudio, the first thing to do is enter and call data into R. As an example the data used is the profit of PT Astra International Tbk.

mid.point = c(2569, 2800, 3263, 3725, 4188, 4650, 5113, 5575, 6037, 6500, 6962, 7425)
 freq = c(6665, 5636, 7327, 6993, 5687, 7450, 3096, 2338, 4657, 6486, 7875, 6568)

Then calculate the probability distribution:

$$\text{prob.dist} = \text{freq}/\text{sum}(\text{freq})$$

The results of calculating the overall probability distribution can be seen in table 2.

TABLE II. PROFIT PROBABILITY DISTRIBUTION FOR 2020-2021

Year	ASII	BOLT	GJTL	IMAS	INDS
2019					
Q1	0.0942	0.1220	0.0976	0.1543	0.0643
Q2	0.0796	0.0344	0.0030	0.0457	0.0022
Q3	0.1035	0.1272	0.0140	0.0290	0.0478
Q4	0.0988	0.0092	0.0749	0.0509	0.1741
2020					
Q1	0.0803	0.0488	0.2335	0.0437	0.1226
Q2	0.1053	0.0945	0.1520	0.0514	0.0475
Q3	0.0437	0.0486	0.0211	0.2229	0.0248
Q4	0.0330	0.1553	0.2447	0.2869	0.0671
2021					
Q1	0.0658	0.0896	0.0655	0.0152	0.1375
Q2	0.0916	0.0061	0.0101	0.0275	0.1165
Q3	0.1113	0.0927	0.0464	0.0343	0.1558
Q4	0.0928	0.1714	0.0372	0.0381	0.0398
Total	1.0000	1.0000	1.0000	1.0000	1.0000

Source: Data Proceed, 2022

Table 2 shows the calculation of the results of the probability distribution or opportunity value that will be substituted for the frequency of occurrence of each variable. For example, the calculation results in the first quarter of ASII in 2019 obtained a probability distribution value of 0.0942 and in the second quarter a value of 0.0796 was obtained.

B. Determine the Cumulative Probability Distribution

The calculation of the cumulative probability distribution is the summation of the probability distribution of a particular variable with the previous variable, except for the first variable. The formula used is on RStudio is as follows:

```
cum.dist=cumsum(prob.dist)
cum.dist
```

The results of calculating the overall cumulative probability distribution can be seen in table 3. Table 3 is the result of the calculation of the cumulative probability distribution. For example, the calculation of the cumulative probability distribution in the second quarter of ASII in 2019 is the result of the sum of the value of the probability distribution in the first quarter and second quarter of 0.0942 + 0.0796. The calculation results from table 3 will be used as a guide in determining the interval of random numbers.

TABLE III. CUMULATIVE PROBABILITY DISTRIBUTION OF PROFIT FOR 2019-2021

Year	ASII	BOLT	GJTL	IMAS	INDS
2019					
Q1	0.0942	0.1220	0.0976	0.1543	0.0643
Q2	0.1738	0.1564	0.1006	0.2001	0.0665
Q3	0.2773	0.2836	0.1146	0.2290	0.1143
Q4	0.3761	0.2928	0.1895	0.2800	0.2884
2020					
Q1	0.4565	0.3417	0.4230	0.3237	0.4109
Q2	0.5617	0.4362	0.5750	0.3751	0.4585
Q3	0.6055	0.4848	0.5962	0.5980	0.4833
Q4	0.6385	0.6401	0.8409	0.8849	0.5504
2021					
Q1	0.7043	0.7297	0.9063	0.9001	0.6879
Q2	0.7959	0.7359	0.9164	0.9275	0.8044
Q3	0.9072	0.8286	0.9628	0.9619	0.9602
Q4	1.0000	1.0000	1.0000	1.0000	1.0000

Source: Data Proceed, 2022

C. Determine the Random Number Intervals

The calculation of random number intervals is used to find the limiting value that is the minimum and maximum. Table 4 describes the intervals of random numbers of each profit. The results of the random number interval will be used as a guide in carrying out the simulation process to produce forecasting results.

TABLE IV. PROFIT RANDOM NUMBER INTERVAL FOR 2019-2021

ASII		BOLT		GJTL		IMAS		INDS	
F	Interval	F	Interval	F	Interval	F	Interval	F	Interval
2,569	0-0.09	-32,584	0-0.12	-369,695	0-0.09	-1,127,767	0-0.15	-13,476	0-0.05
3,031	0-1-0.17	-26,322	0.13-0.15	-300,720	0.097-0.1	-947,435	0.16-0.2	-6,977	0.05-0.06
3,494	0-18-0.27	-20,060	0.16-0.28	-231,744	0.11-0.12	-767,104	0.21-0.22	-478	0.07-0.11
3,956	0.28-0.37	-13,798	0.29-0.30	-162,769	0.13-0.18	-586,773	0.23-0.28	6,021	0.12-0.28
4,418	0.38-0.45	-7,536	0.31-0.34	-93,794	0.19-0.42	-406,441	0.29-0.32	12,520	0.29-0.41
4,649	0.46-0.56	-1,274	0.35-0.43	-24,818	0.43-0.57	-226,110	0.33-0.37	19,019	0.42-0.45
5,112	0.57-0.6	4,988	0.44-0.48	44,157	0.58-0.59	-45,778	0.38-0.59	25,519	0.46-0.48
5,574	0.61-0.63	11,250	0.49-0.64	113,133	0.6-0.84	134,553	0.6-0.88	32,018	0.49-0.55
6,037	0.64-0.7	17,512	0.65-0.72	182,108	0.85-0.9	314,885	0.89-0.9	38,517	0.56-0.68
6,500	0.71-0.79	23,774	0.73-0.74	251,083	0.91-0.92	495,216	0.91-0.92	45,016	0.69-0.8
6,962	0.8-0.9	30,036	0.75-0.82	320,059	0.93-0.96	675,547	0.93-0.96	51,515	0.81-0.96
7,425	0.91-1.0	36,298	0.83-1.0	389,034	0.97-1.0	855,879	0.97-1.0	58,014	0.97-1.0

Source: Data Proceed, 2022

D. Random Number Generation

The formula used in R Program to generate random numbers is as follows:

```
U=runif(12) #as simulated for the next 12 quarters (3 years)
U
```

The overall result of the generation of random numbers can be seen in table 5.

TABLE V. RANDOM NUMBER GENERATION FOR 2022-2024

Year	Random Number				
	ASII	BOLT	GJTL	IMAS	INDS
2022					
Q1	0.8775	0.2649	0.0520	0.2108	0.6940
Q2	0.7685	0.0695	0.7991	0.0716	0.9864
Q3	0.2789	0.9071	0.1269	0.3204	0.3452
Q4	0.5291	0.9922	0.7074	0.9373	0.4491
2023					
Q1	0.9629	0.0640	0.5300	0.8014	0.8845
Q2	0.9803	0.6751	0.8974	0.7385	0.4072
Q3	0.9133	0.3309	0.0379	0.9693	0.9340
Q4	0.0707	0.4478	0.5283	0.4790	0.9939
2024					
Q1	0.3275	0.8341	0.5858	0.2669	0.9876
Q2	0.3700	0.1859	0.9468	0.5738	0.9476
Q3	0.7155	0.5112	0.8033	0.9961	0.0058
Q4	0.7577	0.4749	0.1928	0.2235	0.0724

Source: Data Proceed, 2022

E. Perform Forecasting Using Simulation Procedures

Profit forecasting is carried out from 2019 to 2021. Monte carlo simulation experiment using two random number generation or two iterations. The results of profit forecasting with monte carlo simulation can be seen in table 6. Table 6 describes the results of profit distribution in 5 automotive and component sub-sector companies using monte carlo simulations. From the forecasting results, it was obtained that the total profit forecasting for three years of ASII is IDR 62,275 trillion, BOLT is IDR 53,594 billion, GJTL is IDR 711,669 billion, IMAS is IDR 826,315 billion, and INDS is IDR 253,959 billion.

TABLE VI. PROFIT FORECASTING RESULTS BASED ON MONTE CARLO SIMULATION 2022-2024

Year	Profit (Loss) Forecast (IDR)				
	ASII (in billion)	BOLT (in million)	GJTL (in million)	IMAS (in million)	INDS (in million)
2022					
Q1	6,962	-13,798	-36,9695	-947,435	-748
Q2	6,500	-26,322	11,3133	-112,776	6,021
Q3	3,725	36,298	-36,9695	-767,104	6,021
Q4	4,650	36,298	11,3133	855,879	58,014
2023					
Q1	7,425	-32,584	-24,818	675,547	6,021
Q2	7,425	23,774	182,108	675,547	6,021
Q3	2,569	-13,798	-369,695	855,879	38,517
Q4	2,569	4,988	-24,818	134,553	38,517
2024					
Q1	3,725	36,298	44,157	-947,435	38,517
Q2	3,725	-20,060	251,083	495,216	19,019
Q3	6,500	11,250	113,133	855,879	51,515
Q4	6,500	11,250	-369,695	-947,435	-13,476

Source: Data Proceed, 2022

Based on the table of profit (loss) forecast results, a chart will be made as in Figure 1, Figure 2, Figure 3, Figure 4 and Figure 5. The formula used to surface the graph is as follows:

```
plot(profit_prediction_table1, xlab="Quarter", ylab="Profit Prediction", type="o", col="blue")%/%
lines(profit_prediction_table2, type="o", pch=21, col="red")%/%
title(main="Profit Forecasting 2022-2024", col.main="red", font.main=4)
```

The picture below is a chart for profit forecasting from PT Astra Internasional Tbk, PT Garuda Metalindo Tbk, PT Gajah Tunggal Tbk, PT Indomobil Sukses Internasional Tbk, and PT Indospring Tbk for 2022 to 2024.

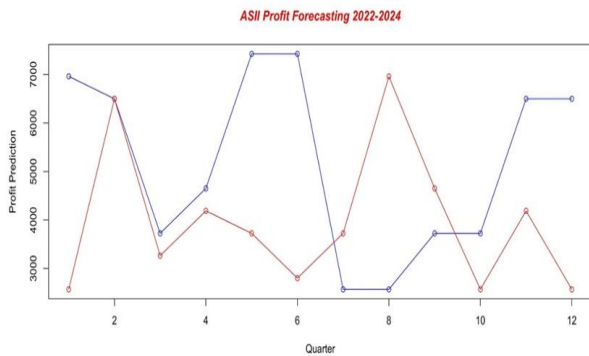


Fig. 1. ASII Profit Forecasting for 2022-2024

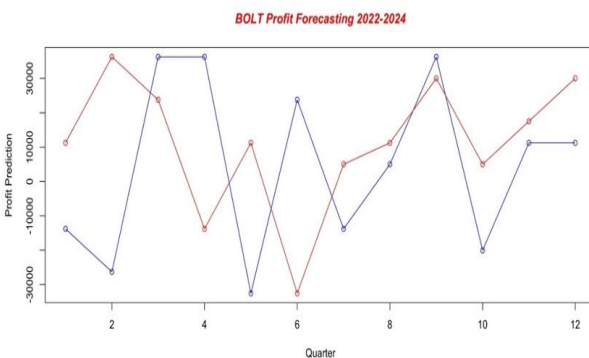


Fig. 2. BOLT Profit Forecasting for 2022-2024

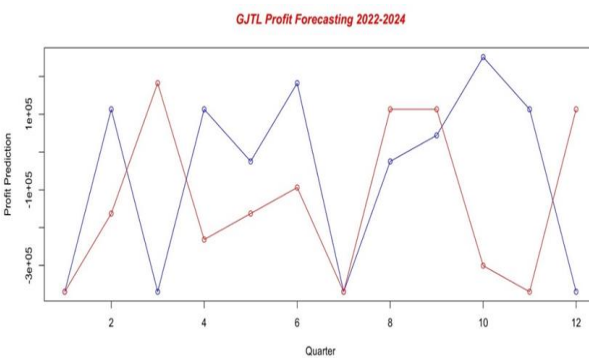


Fig. 3. GJTL Profit Forecasting for 2022-2024

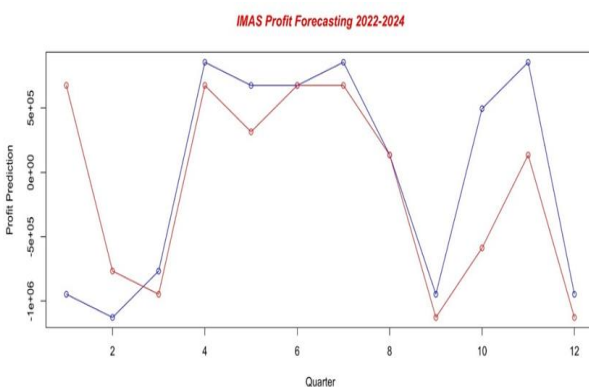


Fig. 4. IMAS Profit Forecasting for 2022-2024

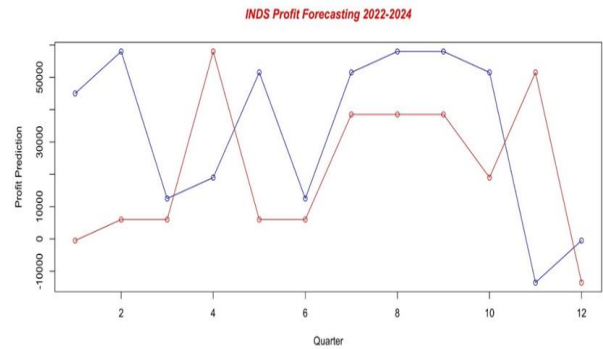


Fig. 5. INDS Profit Forecasting for 2022-2024

V. CONCLUSION

Based on the results of data processing, it can be concluded that the results of profit forecasting for five automotive and component sub-sector companies using monte carlo simulations for 2022 to 2024 are as follows. Profit forecasting for PT Astra Internasional Tbk is IDR 62,275 trillion, PT Garuda Metalindo Tbk is IDR 53,594 billion, PT Gajah Tunggal Tbk is IDR 711,669 billion, PT Indomobil Sukses Internasional Tbk is IDR 826,315 billion, and PT Indospring Tbk is IDR 253,959 billion. These results can provide information to the company to evaluate the production and sales planning that will be carried out so that the fulfillment of demand and also the expected profit can be met and consumer satisfaction will increase.

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