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Simulation Prediction of the Number of Foreign Tourist Visits to Indonesia

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Abstract. One of the main drivers of the Indonesian economy is the tourism sector. The Indonesian Ministry of Tourism targets the number of foreign tourists visiting Indonesa in 2025 to be around 14 to 16 million tourists. The fluctuating number of foreign tourist visits must be predictable to anticipate any decreases or increases in the number of visits. This allows the government to establish relevant policies regarding the infrastructure that must be prepared and the promotional strategies to be implemented. The purpose of this study is to simulate the estimated number of foreign tourists visiting Indonesia per entry point per month in the coming year using the Monte Carlo method and measure the error rate using MAPE. The simulation results showed an average growth rate in foreign tourist visits of 30.9% from air entry points, 24.2% from sea entry points, and 53.9% from land entry points in 2024. The average accuracy rate of the Monte Carlo reached 66.24%, with an error rate (MAPE) of 45%. The results of the study indicate that the Monte Carlo method proved effective in predicting trends in foreign tourist arrivals, although its accuracy still need improvement. This study provides a strategic reference for Indonesian tourism growth.

Keywords: Tourism, Foreign Tourists, Simulation, Prediction, and Monte Carlo.

1. Introduction

The tourism sector in Indonesia is one of the pillars that supports inclusive and sustainable national economic growth (Nugrayasa, 2025) The Indonesian government, through the Ministry of Tourism, has a vision to make tourism a leading sector that contributes significantly to the national economy and improves public welfare by 2025. Its mission includes improving the quality and sustainability of tourist destinations, effective tourism promotion, enhancing human resources, developing culture-based tourism products, and enhancing supporting infrastructure (Kementerian Pariwisata RI, kemenpar.go.id, 2025)To achieve the government's target of attracting 16 million foreign tourists by 2025 (Susila, 2021)the simulation and prediction of visitor numbers are crusial. Fluctuating visitor data is often difficult to explain and anticipate, necessitating a quantitative approach to model these trends. This study implements a Monte Carlo Simulation method as a tool to predict the number of foreign tourist visits to Indonesia (Kementerian Pariwisata RI, kemenpar.go.id, 2025). which can serve as a basis for the government and stakeholders in developing more targeted policy strategies.

The number of foreign tourist visits to Indonesia, data obtained from the Central Statistics Agency (BPS) over the past five years, namely from 2020 to 2025, shows an average number of foreign tourist visits of 7.4 million visits. Post-pandemic, this number of tourists has

increased, even meeting the government's target for 2024. Tourist visits are influenced by several factors, such as competitive travel costs, promotional strategies, and the availability of adequate travel routes (Widians, Puspitasari, & Anggita Sari, 2019) This fluctuating condition underscores the importance of accurate predictions to anticipate decreases or increases, enabling the government to prepare relevant facilities, infrastructure, and promotional strategies.

The entry points for international tourists to Indonesia are divided into three categories: air entry points, sea entry points, and land entry points. Air entry points refer to the arrival of international tourists through airports in Indonesia, such as Soekarno-Hatta Airport (Tangerang), Ngurah Rai Airport (Bali), Yogyakarta International Airport (Yogyakarta), and others. Sea entry points refer to international tourists entering through seaports by ship, such as Batam Center Port (Batam), Tanjung Pinang Port (Jakarta), Tanjung Perak Port (Surabaya), and so on. Land entry points refer to the arrival of international tourists through Border Crossing Posts (PLBN) located at national borders, such as Skouw (Papua), Atambua (East Nusa Tenggara), Aruk (West Kalimantan), Nanga Badau (West Kalimantan), and Entikong (West Kalimantan). The choice of entry point for international tourists is determined by accessibility, cost, and policies issued by the Indonesian government.

Simulation is a quantitative approach that is often used to assist in decision making by illustrating the cause-and-effect relationship within a system (Lubis, Adiwijaya, & Hardyanto, 2023), (Fujimoto, Bock, Chen, Page, & Panchal, 2017). The Monte Carlo method is a computational algorithm that uses random samples repeatedly to obtain results (Paramita, Efriyanti, Zakir, & Imamuddin, 2024), (Cortés, 2023). Monte Carlo simulation can be viewed as a trial to explore probabilities by utilizing sample data to address problems (Kueppers, Rau, & Scharf, 2024), (Ramadan, Gio, & Rosmaini, 2020). Simulations using the Monte Carlo method have been widely applied in various fields of life, such as finance, manufacturing, as well as technology and data. Several studies have used the Monte Carlo method, including research on predicting coconut production by generating random values for a period of nine years (Afdal & Linarti, 2023). In addition, Monte Carlo simulation is applied in analyzing the causes of failure and improving the reliability value of filter-2321, which is one of the critical components in a phosphoric acid production plant (Afdal & Linarti, 2023). Previous research applied Monte Carlo simulation to predict the number of BPJS insurance claims (Indah Lestari, 2022), and research that estimates the annual factory maintenance budget (Thomas & Weiss, 2021).

Based on this background, this research aims to present an effective prediction model using Monte Carlo simulation to estimate the number of foreign tourist visits to Indonesia based on entry points per month. The results are expected to provide useful information for the government and stakeholders in formulating policies that can support sustainable tourism growth.

2. Literature Review

2.1. Simulation

A simulation is a mathematical model that attempts to emulate the behavior and operation of a real-world process over time (Pinder, 2022). Three reasons for using simulation:

a. Most people cannot deeply understanding how probability models the uncertainty of future events and forecasts are never exact or perfect.
b. Making decisions in the face of uncertainty is a core business analytics activity.
c. A major portion of business analytics involves data analysis.

2.2. Prediction

Prediction is the process of estimating events that might occur in the future by relying on data or information from the past and current conditions. The goal of prediction is to minimize the difference between the predicted outcome and the actual event (Srisulistiowati, Khaerudin, & Rejeki, 2021). Prediction does not provide a definitive answer to future events, but rather attempts to get as close as possible to what will happen in the future.

2.3. Metode Monte Carlo

The Monte Carlo method is a computational approach that uses random sampling to solve problems (Jing, 2025). The stage of simulation analysis for predicting the number of the foreign tourist visits using the Monte Carlo method involves several steps (Madao, Sukiastini, & Kalensun, 2023): 1. Creating probability distributions for each main simulation variable; 2. Calculating cumulative probabilities; 3. Determining random number intervals; 4. Generating random numbers; 5. Conducting simulations based on the generated random numbers.

3. Research Methods

This study uses a descriptive quantitative approach, which aims to forecast population conditions or future trends by using data in the form of quantitative numbers that are then analyzed statistically (Mukhid, 2021). The stages of this study can be seen in Figure 1.

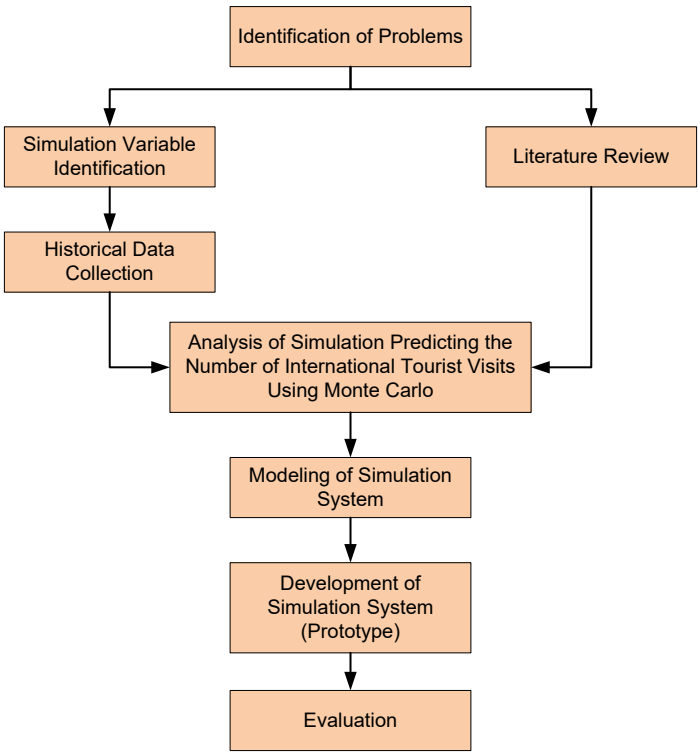

Figure 1. Research Stages

The first step of figure 1 is identity of problems which is related to predicting the number of foreign tourist visits per entry point per month in the following year. The next stage is to identify the simulation variables that will be used when predicting the number of foreign tourist

visits to Indonesia. The simulation variables used to predict the number of international tourist visits to Indonesia consist of three random variables: air entry points, sea entry points, and land entry points. The next stage after identifying the simulation variables is to collect historical data in the form of the number of international tourist visits from the year 2008 to 2023 for each entry point, where the data is taken from data released by the Central Statistics Agency (BPS). The literature review stage involves searching for references related to the Monte Carlo method as the simulation model to be used in this study

After the simulation prediction analysis stage, the next step is to model the prediction simulation system using an object-oriented approach, which consists of software requirements specification (SRS), use case, and class diagram of the developed system. The next stage is to build a simulation system in the form of a software prototype using the Python language.

The final stage is the evaluation stage, which involves calculating the accuracy of the prediction results using the Monte Carlo method. The method used is the Mean Absolute Percentage Error (MAPE), with the MAPE formula shown in Equation (1) (Erdianita, Mumpuni, & Aditiawan, 2023).

$$MAPE = \frac{\Sigma\left|\frac{\text{actual data}-\text{prediction data}}{\text{actual data}}\right| \text{ x } 100\%}{\text{n}} \quad (1)$$

where:
n : total number of periods

The smaller the MAPE result, the more accurate the prediction method is considered to be, with the value range as follows on table 1 (Windarni, Setiawan, & Rahmatalia, 2023).

Table 1. MAPE Value Range

MAPE Value	Mean
MAPE < 10%	Very Good Forecasting
10% ≤ MAPE < 20%	Good Forecasting
20% ≤ MAPE < 50%	Competition Feasible Forecasting Models
MAPE ≥ 50%	Bad Forecasting

To calculate the level of accuracy using formula (2) (Prasetya, Santi, & Primasari, 2023).

$$A = \left(\frac{\text{Min}}{\text{Max}}\right) \text{ x } 100 \quad (2)$$

Where:
A : Accuracy
Min : The smaller value between total predictions and total actual values
Max : The larger value between total predictions and total actual values

4. Results and Discussion

The results of the simulation variable identification revealed three random variables, which are the main variables in the simulation: the number of foreign tourists from air, sea, and land entry points. In addition, there are three additional variables, namely the growth in the number of tourists from each entry point. The historical data used is the number of foreign tourists from air, sea, and land entry points obtained from the Central Statistics Agency (BPS) (Statistik,

n.d.). Table 2 – 4 shows the table of the number of foreign tourists per month from 2008 – 2023.

Table 2. Historical Data of the Number of Foreign Tourists via Air Entry Points (Statistik, n.d.)

Year	Month #											
	1	2	3	4	5	6	7	8	9	10	11	12
2008	270189	294147	312324	285113	321657	327611	369353	385538	318911	338085	321359	370881
2009	294794	270702	324597	316141	346170	364887	426217	390155	331184	376600	346575	390712
2010	340049	359018	423943	402118	431258	434110	486783	431164	401250	431614	396216	416954
2011	394893	395228	420178	431339	417037	468813	543170	446871	471222	473750	459210	479549
2012	460031	417115	453805	444598	469019	475928	520409	446606	499071	495817	498838	519868
2013	449297	481181	507704	467817	503039	564997	545003	564762	578721	531645	591980	588254
2014	544958	518574	546784	530165	551646	616754	589071	627366	597470	594312	553480	630352
2015	514693	569113	568134	537918	553773	596079	617198	622058	661105	627112	553965	632243
2016	548863	592968	631176	640094	661824	611469	785275	793587	760591	757044	706431	738303
2017	746666	720428	749150	812927	809941	763470	1002611	1014475	883842	802479	701307	663359
2018	643177	740440	845635	848734	805452	817405	1073385	1006054	911326	855240	716298	825635
2019	706704	731517	758821	772038	711229	829067	975870	977033	900409	855796	777244	838978
2020	821851	562150	255067	783	506	1463	4069	5728	9991	12280	16085	23599
2021	1731	7110	12852	18326	14040	16234	7175	1609	4748	15722	19909	17786
2022	14555	17834	39062	97401	183830	280482	387184	422500	424198	447074	429979	551927
2023	484497	487449	554665	560434	659065	707476	819496	826446	777537	707584	656709	731293

Table 3. Historical Data of the Number of Foreign Tourists via Sea Entry Points (Statistik, n.d.)

Year	Month #											
	1	2	3	4	5	6	7	8	9	10	11	12
2008	89296	102762	108215	93401	105042	115706	101001	113357	90081	97278	105472	131170
2009	97421	80681	101978	91428	94537	100206	82814	91030	79471	84539	89639	119339
2010	119784	127592	131280	120526	132703	147125	136132	122624	117983	123252	134152	170959
2011	119878	135620	139213	141849	144348	169653	164244	136033	136953	143100	151406	192385
2012	157604	125930	157808	142636	141789	176875	142341	148134	142041	151940	149830	196679
2013	131189	158618	174784	135951	154845	183730	134321	166472	152985	148108	171430	211860
2014	169926	141922	175797	157164	159893	195824	151048	163879	156103	172218	167909	226683
2015	155981	172490	168997	169374	195528	180225	155923	189359	159912	161844	166239	226412
2016	148144	172209	172770	169731	177581	170910	142820	146917	160347	155045	147629	216451
2017	230174	186669	220326	233538	209193	233765	226979	235311	229735	222271	230070	324624

Year	Month #											
	1	2	3	4	5	6	7	8	9	10	11	12
2018	220044	261044	304859	236833	230118	289312	252458	280868	264522	243901	259832	370629
2019	304479	340751	378698	328884	335111	386152	311429	368408	327642	332319	358264	388495
2020	313541	192604	111323	45058	46615	47060	46942	49542	45109	41370	40970	44467
2021	37667	29300	35317	30918	39720	29929	35511	33497	33397	38245	32741	39230
2022	58442	51539	60357	69085	105719	134664	184193	164918	196668	207390	193894	299967
2023	224851	191063	236181	235660	214326	276039	225106	220199	212770	186161	190258	291763

Table 4. Historical Data of the Number of Foreign Tourists via Land Entry Points (Statistik, n.d.)

Year	Month #											
	1	2	3	4	5	6	7	8	9	10	11	12
2008	1043	1613	1610	1234	1606	1553	1363	2331	1790	1430	1672	2744
2009	1581	1175	1859	1497	1814	1820	1451	1578	2192	1314	1855	3054
2010	1262	2432	1873	1538	2073	2099	2134	1874	1816	1139	1915	3281
2011	1647	2297	2044	1831	2201	2118	1559	2643	1759	1506	2269	3380
2012	2324	1787	2121	1503	1973	2514	1741	3036	1371	1665	2761	3101
2013	1368	2291	2291	1408	2009	2581	1559	3038	1474	1559	2330	2948
2014	1535	1609	1699	1430	1785	1703	2488	1568	1445	1731	1936	3535
2015	1265	1873	2440	1491	2424	1662	2573	1710	1693	1455	2513	3753
2016	36791	38740	30704	23577	21022	22609	28095	26406	23900	35085	49268	60278
2017	131128	116291	90301	124921	129454	146766	141001	143457	136654	136815	130653	159048
2018	234618	196019	212932	216754	207135	215957	221388	224099	195095	192464	181353	209290
2019	190552	171728	174392	173309	203196	218884	180874	184827	160668	158319	145273	149594
2020	155019	118011	119765	112225	114721	108038	104731	106279	93884	98643	87421	96013
2021	87117	69378	71810	63512	85673	80681	84563	83427	81955	92170	97927	106603
2022	63301	48136	59210	63590	65371	68737	73744	83091	79740	79764	80910	100575
2023	89121	70924	78398	69717	80323	79276	76587	85993	79938	84774	84260	121486

Before generating random numbers, a probability distribution is first created, the cumulative probability distribution is calculated and the random number interval per entrance is determined based on the historical data in Tables 2 to 4, the results of which can be seen in Tables 5 to 7.

Table 5. Probability Distribution, Cumulative Probability, and Random Number Intervals for the Number of Foreign Tourists Arriving by Air (2008–2023)

Class Intervals	Middle Value	Freq.	Prob. Dist.	Cumulative Prob.	Random Number Interval
506 - 119713	60110	25	0.13	0.13	1 - 13
119714 - 238922	179318	1	0.01	0.14	14 - 14
238922 - 358129	298526	19	0.10	0.23	15 - 23
358130 - 477337	417734	42	0.22	0.45	24 - 45
477338 - 596545	536942	41	0.21	0.67	46 - 67
596546 - 715753	656150	23	0.12	0.79	68 - 79
715754 - 834961	775358	27	0.14	0.93	80 - 93
834962 - 954169	894566	8	0.04	0.97	94 - 97
	Amount	**192**			

Table 6. Probability Distribution, Cumulative Probability, and Random Number Intervals for the Number of Foreign Tourists Arriving by Sea (2008–2023)

Class Intervals	Middle Value	Freq.	Prob. Dist.	Cumulative Prob.	Random Number Interval
29300 - 69209	49255	25	0.13	0.13	1 - 13
69210 - 109119	89165	21	0.11	0.24	14 - 24
109120 - 149029	129075	40	0.21	0.45	25 - 45
149030 - 188939	168985	45	0.23	0.68	46 - 68
188940 - 228849	208895	25	0.13	0.81	67 - 81
228850 - 268759	248805	15	0.08	0.89	82 - 89
268760 - 308669	288715	7	0.04	0.93	90 - 93
308670 - 348579	328625	8	0.04	0.97	94 - 97
	Amount	**192**			

Table 7. Probability Distribution, Cumulative Probability, and Random Number Intervals for the Number of Foreign Tourists Arriving by Land (2008–2024)

Class Intervals	Middle Value	Freq.	Prob. Dist.	Cumulative Prob.	Random Number Interval
1043 - 26995	14019	101	0.53	0.53	1 - 53
26995 - 52947	39971	7	0.04	0.56	54 - 56
52947 - 78899	65923	14	0.07	0.64	57 - 64
78899 - 104851	91875	26	0.14	0.77	65 - 77
104851 - 130803	117827	12	0.06	0.83	78 - 83
130803 - 156755	143779	9	0.05	0.88	84 - 88
156755 - 182707	169731	8	0.04	0.92	89 - 92
182707 - 208659	195683	7	0.04	0.96	93 - 96

Amount	**192**

The next step is to generate random numbers. The generated random numbers are used to obtain the values of each random variable, where in this study the Python language syntax is used, namely randint(a,b). The random numbers generated using this syntax are integer random numbers in the range of a to b. The random number requirements based on tables 5 to 7 are known to be integer random numbers between 0 and 100.

Simulations based on generated random numbers will yield the values of the main simulation variables. For example, the simulation variable is the number of foreign tourists from the air entrance. If it is assumed that the random number generated for this variable is 92, then based on Table 5 it is known that the random number 92 is in the 7th random interval class with an interval of the number of tourists of 715754 – 834961. So the simulation of the number of foreign tourists from the Air Gate is (715754 + 834961) / 2 = 775357.5 ≈ 775358 tourists, or can be taken from the middle value of each respective interval. The same procedure was performed for the other main simulation variables. Table 8 shows the random numbers generated for each main variable and their simulation results for 12 months in 2024.

Table 8. Prediction Simulation Results in 2024

Period of the th Month	Random Number			The Number of International Tourists Simulation Results		
	Airport Gate	Harbor Gate	Border Gate	Airport Gate	Harbor Gate	Border Gate
1	92	25	4	469891	321150	15641
2	37	73	11	604001	186450	74035
3	44	10	49	1006331	141550	103232
4	19	81	66	738111	51750	15641
5	21	81	37	469891	186450	103232
6	62	45	25	469890.5	231349.5	220020
7	58	97	86	67560.5	141549.5	132429
8	98	31	64	335780.5	51749.5	15641
9	30	14	70	469890.5	141549.5	74035
10	97	25	39	469890.5	141549.5	74035
11	63	1	69	604000.5	141549.5	15641
12	74	22	6	67560.5	96649.5	132429
			Total	**5772799**	**1833297**	**976011**
			Average	**481067**	**152775**	**81334**

Table 8 shows the predicted proportion of foreign tourist arrivals to Indonesia at approximately 67% via air, 21% via sea, and 11% via land. The total number of tourists in 2024 is predicted to be around 8.5 million. The simulation also shows an average growth rate of 30% via air, 26% via sea, and 53% via land. After the prediction simulation analysis stage is complete, the next step is to model the simulation system to be built, consisting of a use case diagram (Figure 2) and a class diagram (Figure 3). The simulation system development

stage uses the Python programming language, with an example interface display as shown in Figure 4.

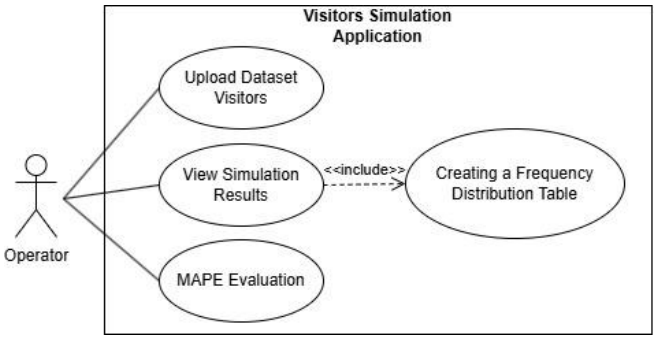

Figure 2. Use Case Diagram of Simulation for Predicting Foreign Tourit Visits to Indonesia

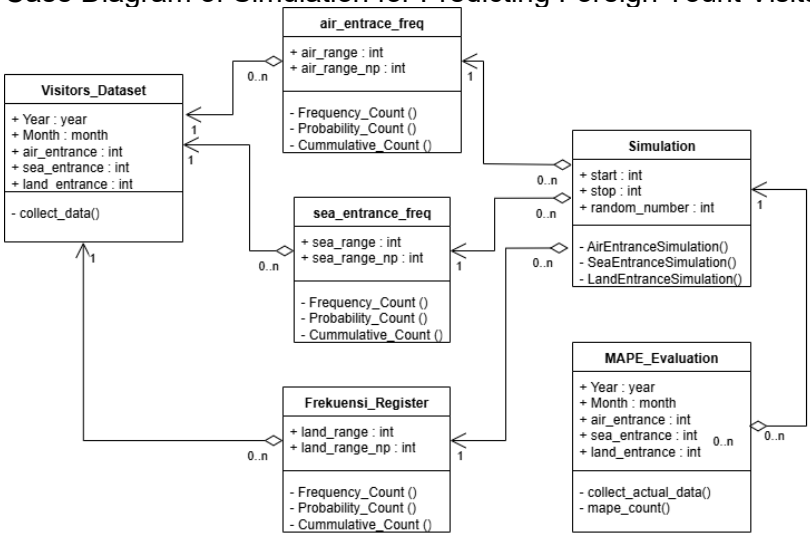

Figure 3. Class Diagram of Simulation for Predicting Foreign Tourit Visits to Indonesia

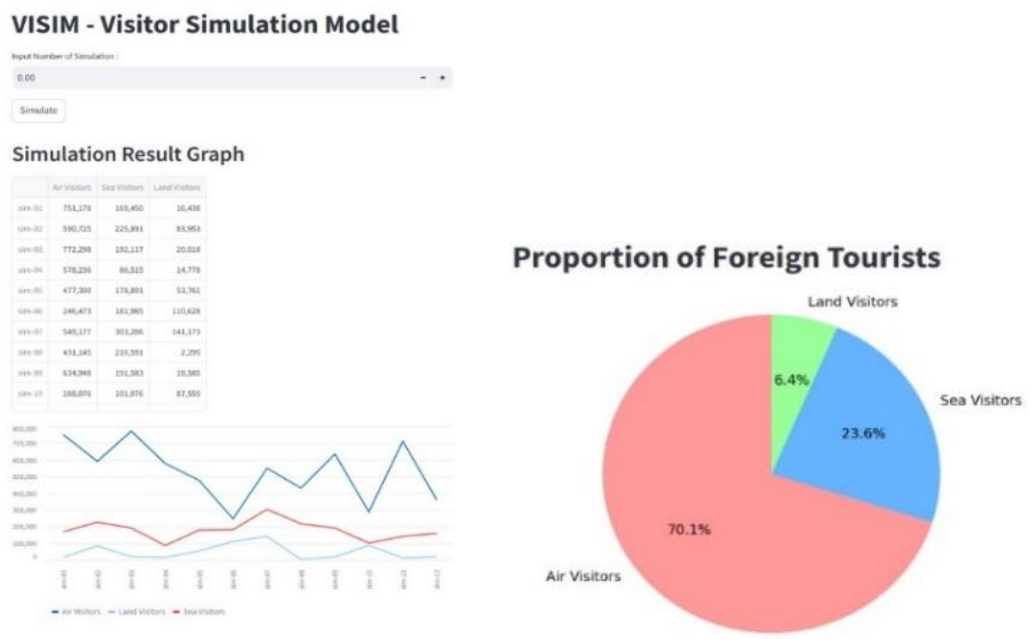

Figure 4. Interface of Simulator for Predictions of Foreign Tourist Visits in 2024

The final step is to measure the level of prediction error generated by Monte Carlo using MAPE. The results of MAPE using formula (1) are shown in Table 9.

Table 9. Monte Carlo Prediction Mape Simulation Results For 2024

Month#	Actual Data 2024			Prediction Simulation Result			Percentage Absolute Error per month		
	Air Entry	Sea Entry	Land Entry	Air Entry	Sea Entry	Land Entry	Air Entry	Sea Entry	Land Entry
1	631961	198072	97713	469891	321150	15641	0.26	0.62	0.84
2	735072	239718	87359	604001	186450	74035	0.18	0.22	0.15
3	682439	252013	107409	1006331	141550	103232	0.47	0.44	0.04
4	750085	211716	105157	738111	51750	15641	0.02	0.76	0.85
5	835722	212718	97059	469891	186450	103232	0.44	0.12	0.06
6	821654	261165	115122	469890.5	231349.5	220020	0.27	0.43	0.39
7	994583	212433	103740	67560.5	141549.5	132429	0.28	0.39	0.30
8	987547	248758	103641	335780.5	51749.5	15641	0.30	0.43	0.33
9	941903	231748	105607	469890.5	141549.5	74035	0.26	0.43	0.39
10	859747	218620	115500	469890.5	141549.5	74035	0.31	0.36	0.29
11	756972	223293	111802	604000.5	141549.5	15641	0.28	0.41	0.34
12	832865	264692	131073	67560.5	96649.5	132429	0.28	0.40	0.33
						MAPE Result	**28%**	**42%**	**36%**
						Average	**35%**		

The MAPE calculation results (Table 9) show an average error rate of 35%, indicating that the Monte Carlo method used to simulate predictions of foreign tourist visits to Indonesia is considered adequate (as per Table 1), and the accuracy level using formula (2) is approximately 79%. While the results are satisfactory, the MAPE value of 35% also indicates room for improvement. The main weakness of this model lies in the use of historical data covering periods of extreme anomalies (such as the COCID-19 pandemic) in year 2020 to 2022. This data can distort the probability distribution and reduce prediction accuracy. Therefore, future research could explore more adaptive modeling techniques or use data adjusted for such periods. These prediction results can inform government and stakeholders to make strategic decisions regarding resource allocation and promotional strategies in the future.

5. Conclusion

The prediction simulation to estimate the number of foreign tourist visits per entry point per month in the next year has an accuracy rate of around 79%, and the Monte Carlo method used in this study is quite capable of predicting the number of foreign tourist visits, so that it can be used by parties who need this information to prepare adequate infrastructure and determine the right promotional strategy for their tourism.

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