Journal of Artificial Intelligence and Engineering Applications

Website: https://ioinformatic.org/

15th June 2024. Vol. 3. No. 3; e-ISSN: 2808-4519

Prediction of Patient Visit Levels Based on Type of Service at Patar Asih General Hospital Using the Monte Carlo Method

Sri Mulyana[1], Ichwanul Muslim Karo karo[2]

[1,2] Universitas Negeri Medan
srimulyana@mhs.unimed.ac.id [1], ichwanul@unimed.ac.id [2]*

Abstract

This study aims to predict the level of patient visits at RSU Patar Asih based on the type of service provided using the Monte Carlo method. The Monte Carlo method was chosen because of its ability to handle data variability and uncertainty that often arises in the context of patient hospital visits. The data used in this study includes the number of patient visits based on the type of service at RSU Patar Asih, such as health services for pregnant women, health services for postpartum mothers, health services for newborns, health services for toddlers, health services at primary education age, health services at productive age. , health services for the elderly, health services for people with hypertension, health services for people with diabetes mellitus, health services for people with serious mental disorders (ODGJ), health services for people suspected of having tuberculosis, health services for people at risk of being infected with the human immune system (HIV)during the period 2021, 2022, 2023.The prediction results from this simulation obtained an accuracy of 81.75%, providing a fairly accurate estimate of the level of patient visits in the future. These predictions can be used by hospital management for resource planning, such as medical staff allocation, drug and medical equipment inventory management, and operational scheduling. Thus, the results of this research have the potential to improve operational efficiency and overall quality of hospital services. It is hoped that this research can contribute to more effective and efficient hospital management through data-based predictions, thereby increasing patient satisfaction and optimizing hospital resources.

Keywords: *Monte Carlo Method, Patient Visit Prediction, Hospital Service Types, Resource Planning, Operational Efficiency*

1. Introduction

Services basically cover various very broad aspects of life. In the context of national life, the government or business owners have a role in providing various services needed by the community. This service includes regulation and various other services to meet community needs in the fields of education, health, utilities, etc [1]. Health is a basic need that every community in a country must have to achieve a sustainable life [2]. Every local government is obliged to provide facilities and infrastructure to support health in order to create a prosperous society, one of which is the Patar Asih Private General Hospital which is located at Jl. Bakaran Batu No.188, Tumpatan, Beringin District, Deli Serdang Regency, North Sumatra. Patar Asih RSU provides health services to the community as a form of providing local health services.

Quality health services are an indicator of satisfaction, which has an impact on patients' desire to return to institutions that provide effective health services [3]. Patar Asih RSU is currently facing difficulties in planning and preparation due to uncertainty in the number of patient visits. Management is unable to predict the number of patients who will come, so that the available resources are often insufficient to meet service needs. To overcome this problem, a simulation is needed to estimate the number of patients who will visit Patar Asih RSU. The Monte Carlo method is one approach that can be used to make this forecast. Monte Carlo simulation is a data processing tool that is often used to solve problems involving uncertainty[4].

Monte Carlo is a simulation method that uses random numbers generated from a Linear Congruential Generator (multiplicative generator) to estimate the number of visitors based on previous visit data[5]. The Monte Carlo method is the basis of an algorithm in a simulation method that uses a problem solving approach by providing random values (random numbers) to achieve more accurate and thorough results [6].

Monte Carlo simulation is a very practical method and is often used to solve real engineering problems, especially in repairable systems [7]. Its strong ability to simulate real processes and random system behavior makes Monte Carlo simulation-based approaches very useful for reducing uncertainty in reliability modeling [8]. The Monte Carlo algorithm uses existing probabilities and densities to determine the optimal or best choice[9]. The aim of using the Monte Carlo Method in this research is to improve services at RSU Patar Asih by predicting the number of patient visits that will come in the future based on the types of services available at RSU Patar Asih.

2. Research Methods

Research methods are an approach used to collect, compile and analyze data systematically [10], [11], [12], [13], [14]. This is a scientific method for obtaining and collecting data and its functions. The stages in this research are explained in the framework presented in **Fig 1**.

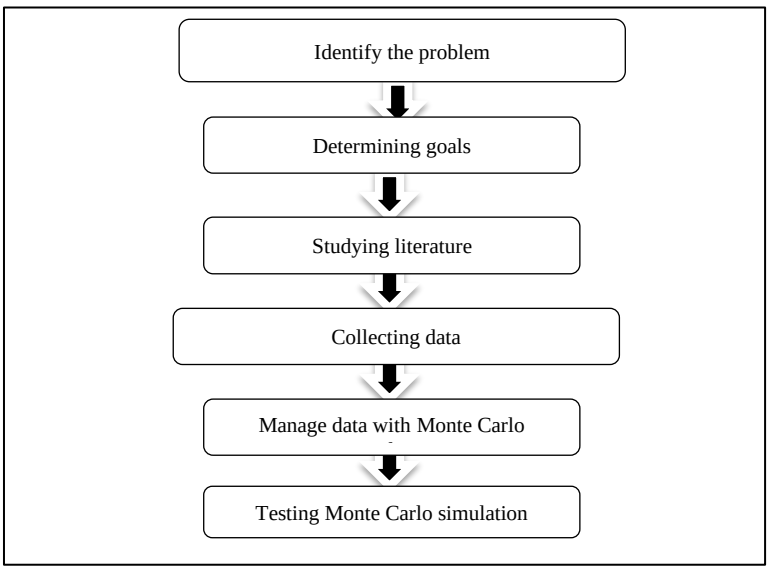

Fig. 1: Research Stages

2.1. Identification of problems

This stage is the initial stage in determining the problem before conducting research on the research object. At this stage, sources of information regarding the problems contained in the research object are sought to find solutions related to these problems. This aims to identify and describe problems and facilitate the steps in solving them

2.2. Determining Goals

The research objective is the final result that is expected to be achieved in a study. This goal must be determined from the start before conducting research. Setting research objectives is very important because this ensures that the research conducted has clear benefits and is relevant to its use.

2.3. Studying Literature

To achieve the research objectives, the first step is to study some relevant literature that is thought to be useful. After that, the literature will be selected and those most suitable for use in research will be selected. Literature sources can include articles, scientific journals regarding Monte Carlo simulations, as well as other reading materials that support this research topic.

2.4. Collecting data

Collecting data is a step in gathering all the information needed for research. Data collection in this research was carried out by visiting the Patar Asih RSU website directly. The data processed in the research includes the number of patient visits based on services in previous years, namely data from 2021, 2022 and 2023. Next, these data will be processed using a Monte Carlo method simulation approach. Data from 2021 will be simulated to predict patient visits in 2022, data from 2022 will be simulated to predict patient visits in 2023, and patient visit data from 2023 will be simulated to predict patient visits in 2024.

2.5. Processing Data Using the Monte Carlo Method

The steps in processing data using the Monte Carlo method are as follows:

a. Calculating Probability Distributions
   Probability distribution describes the chances of a variable. The probability value (p) of a variable can be obtained by dividing the frequency (F) of the variable by the total frequency (J). The probability distribution formula is presented in Equation (1)

$$P = \frac{F}{J} \quad (1)$$

   Where:
   P: Probability distribution (probability of existing variables),
   F: Frequency of the variable, and
   A: The total or total number of frequencies.

b. Calculating Cumulative Probability Distribution

The cumulative probability distribution is obtained by adding up the probability distribution value for each variable value with the sum of the previous probability distributions. However, for the first cumulative probability distribution value, this value is the same as the probability distribution value of the variable itself.

c. Setting a Random Number Interval
Random number intervals are formed based on the cumulative probability distribution values that have been calculated in the previous stage. The process of assigning random numbers is carried out using the cumulative probability distribution value for each variable. Random number intervals serve as boundaries between one variable and another, and also provide a basis for simulating results from experiments based on the generated random numbers.

d. Generating Random Children
The Mixed Congruent Method (MCM) is a technique for generating random numbers using a series of mathematical equations involving four variables whose values are determined individually. This method is used to generate a sequence of random numbers that are evenly distributed and meet certain statistical criteria. The general equation used in the Mixed Congruent Method can be expressed as:

$$Z_{i+1} = (a * Z_i + c)\ mod\ m \quad (2)$$

Where:
a = Multiplier Constant (a < m)
c = Shift Constant (c < m)
Z = Modulus Constant (m > 0)
Z_i = Initial number (integer≥ 0, Z0 < m)

e. Simulation Experiment
The final stage in simulation using the Monte Carlo method involves matching the predetermined random number interval values with the random number values generated during the simulation.

2.6. Testing Monte Carlo Simulation Results

At this stage, researchers carry out evaluations or tests after obtaining data from simulations using the Monte Carlo method. The evaluation was carried out to determine how accurate the Monte Carlo method was in predicting patient visits at Patar Asih RSU.

3. Results and Discussion

Simulation data processing to predict the number of patient visits based on type of service using the Monte Carlo Method includes several important steps:

3.1. Data on Number of Patient Visits Based on Type of Service at Patar Asih Hospital

The data used to predict patient visits based on service type, namely data for 2021, 2022 and 2023, can be seen in **Table 1**.

Table 1: Data on the number of patients based on services for 2021, 2022, 2023

Kind of service	2021	2022	2023
Pregnant Women's Health Services	43,449	45,364	46.3
Maternal Health Services	40,792	44,465	44,349
Newborn Health Service	40,028	40,146	39,938
Toddler Health Services	146,156	146,577	152,545
Health Services at Primary Education Age	331.47	351,825	358,431
Health Services in the Productive Age	861,326	891.252	921.406
Health Services for the Elderly	175.142	186,948	198,797
Health Services for Hypertension Sufferers	474,585	467,187	536,233
Health Services for Diabetes Mellitus Patients	37,445	37,966	45.133
Health Services for People with Severe Mental Disorders (ODGJ)	2,504	2,573	3,275
Health Services for People Suspected of Tuberculosis	21,871	48,497	62,589
Health Services for People at Risk Infected with a virus that weakens endurance Human Body (Human Immunodeficiency Virus)	21,298	29,053	54.03
Total	**2196.066**	**2291.853**	**2463.026**

3.2. Determining Probability Distributions

In this study, the data will be used to predict the number of patient visits based on services in 2021, 2022 and 2023 in **Table 1**. It can be seen in **Table 2**, namely the calculation of the probability distribution obtained from the number of services per type divided by the total for each year and so on.

Table 2. Probability Distribution

Kind of service	2021	2022	2023
Pregnant Women's Health Services	0.02	0.02	0.02
Maternal Health Services	0.02	0.02	0.02
Newborn Health Service	0.02	0.02	0.02
Toddler Health Services	0.07	0.06	0.06
Health Services at Primary Education Age	0.15	0.15	0.15
Health Services in the Productive Age	0.39	0.39	0.37

Health Services for the Elderly	0.08	0.08	0.08
Health Services for Hypertension Sufferers	0.22	0.20	0.22
Health Services for Diabetes Mellitus Patients	0.02	0.02	0.02
Health Services for People with Severe Mental Disorders (ODGJ)	0.00	0.00	0.00
Health Services for People Suspected of Tuberculosis	0.01	0.02	0.03
Health Services for People at Risk Infected with a virus that weakens endurance Human Body (Human Immunodeficiency Virus)	0.01	0.01	0.02
Total	**1**	**1**	**1**

3.3. Determining the Cumulative Probability Distribution

Next, the cumulative value is calculated by adding each cumulative variable value with its probability distribution variable value, except for the initial value of the cumulative variable. The results of the cumulative distribution calculation can be found in **Table 3**.

Table 3. Cumulative Distribution

Kind of service	Distribution Probability			Distribution Cumulative		
	2021	2022	2023	2021	2002	2023
Pregnant Women's Health Services	0.02	0.02	0.02	0.020	0.02	0.02
Maternal Health Services	0.02	0.02	0.02	0.038	0.04	0.04
Newborn Health Service	0.02	0.02	0.02	0.057	0.06	0.05
Toddler Health Services	0.07	0.06	0.06	0.123	0.12	0.11
Health Services at Primary Education Age	0.15	0.15	0.15	0.274	0.27	0.26
Health Services in the Productive Age	0.39	0.39	0.37	0.666	0.66	0.63
Health Services for the Elderly	0.08	0.08	0.08	0.746	0.74	0.72
Health Services for Hypertension Sufferers	0.22	0.20	0.22	0.962	0.95	0.93
Health Services for Diabetes Mellitus Patients	0.02	0.02	0.02	0.979	0.97	0.95
Health Services for People with Severe Mental Disorders (ODGJ)	0.00	0.00	0.00	0.980	0.97	0.95
Health Services for People Suspected of Tuberculosis	0.01	0.02	0.03	0.990	0.99	0.98
Health Services for People at Risk of Being Infected with a Virus That Weakens the Human Body's Resistance (Human Immunodeficiency Virus)	0.01	0.01	0.02	1,000	1.00	1.00
Total	**1**	**1**	**1**	-	-	-

3.4. Determining Random Number Intervals

Following are the steps to determine the limit value on a random number interval:

1. The initial limit for the first variable is 1.
2. The final limit is obtained by multiplying the cumulative probability value of each variable by 100.
3. The initial limit for the second variable and so on is calculated by adding 1 to the final limit value of the previous variable.

The results of determining the random number interval can be seen in **Table 4**, **Table 5**, and **Table 6.**

Table 4. Random Number Intervals in 2021

Kind of service	Amount	Cumulative Probability	Random Number Intervals	
			Beginning	End
Pregnant Women's Health Services	43,449	0.02	1	2
Maternal Health Services	40,792	0.04	3	4
Newborn Health Service	40,028	0.06	5	6
Toddler Health Services	146,156	0.12	7	12
Health Services at Primary Education Age	331.47	0.27	13	27
Health Services in the Productive Age	861,326	0.67	28	67
Health Services for the Elderly	175.142	0.75	68	75
Health Services for Hypertension Sufferers	474,585	0.96	76	96
Health Services for Diabetes Mellitus Patients	37,445	0.98	97	98
Health Services for People with Severe Mental Disorders (ODGJ)	2,504	0.98	99	98
Health Services for People Suspected of Tuberculosis	21,871	0.99	99	99
Health Services for People at Risk of Being Infected with a Virus That Weakens the Human Body's Resistance (Human Immunodeficiency Virus)	21,298	1.00	100	100

Table 5. Random Number Intervals in 2022

Kind of service	Amount	Cumulative Probability	Random Number Intervals	
			Beginning	End
Pregnant Women's Health Services	45,364	0.02	1	2
Maternal Health Services	44,465	0.04	3	4
Newborn Health Service	40,146	0.06	5	6
Toddler Health Services	146,577	0.12	7	12
Health Services at Primary Education Age	351,825	0.27	13	27
Health Services in the Productive Age	891.252	0.66	28	66
Health Services for the Elderly	186,948	0.74	67	74
Health Services for Hypertension Sufferers	467,187	0.95	75	95
Health Services for Diabetes Mellitus Patients	37,966	0.97	96	97
Health Services for People with Severe Mental Disorders (ODGJ)	2,573	0.97	98	97

Health Services for People Suspected of Tuberculosis	48,497	0.99	98	99
Health Services for People at Risk of Being Infected with a Virus That Weakens the Human Body's Resistance (Human Immunodeficiency Virus)	29,053	100	100	100

Table 6. Random Number Intervals in 2023

Kind of service	Amount	Cumulative Probability	Random Number Intervals	
			Beginning	End
Pregnant Women's Health Services	46.30	0.02	1	2
Maternal Health Services	44,349	0.04	3	4
Newborn Health Service	39,938	0.05	5	6
Toddler Health Services	152,545	0.11	7	11
Health Services at Primary Education Age	358,431	0.26	12	26
Health Services in the Productive Age	921.406	0.63	27	63
Health Services for the Elderly	198,797	0.72	64	72
Health Services for Hypertension Sufferers	536,233	0.93	73	93
Health Services for Diabetes Mellitus Patients	45.133	0.95	94	95
Health Services for People with Severe Mental Disorders (ODGJ)	3,275	0.95	96	95
Health Services for People Suspected of Tuberculosis	62,589	0.98	96	98
Health Services for People at Risk of Being Infected with a Virus That Weakens the Human Body's Resistance (Human Immunodeficiency Virus)	54.03	100	99	100

3.5. Generate random numbers

The Mixed Congruent Method requires four main parameters that need to be set first, namely a, c, m and Zi. At this stage the next parameters will be filled in with the values a = 72, c = 31, m = 101, Zi = 95. After determining these values, the next step will be a calculation to generate random numbers. Random numbers have an important role in simulations because they help in determining the possible outcomes of a simulation. Simulations are used to represent real-world situations where there is uncertainty or variation in possible outcomes. 12 random numbers were obtained, namely 95, 1, 2, 66, 80, 75, 10, 14, 99, 95, 100, 98. These numbers will be used to predict the number of patient visits at Patar Asih General Hospital based on the type of service.

4. Simulation Results

The results of the simulation experiment to predict data for 2023 will be used as a basis for predicting the following simulated years. Prediction results will be displayed in **Table 7**.

Table 8. Simulation Results

Kind of service	Real Data 2023	Simulation Results	Level of accuracy %
Pregnant Women's Health Services	46.30	45.133	97.48
Maternal Health Services	44,349	46.3	95.79
Newborn Health Service	39,938	46.3	86.26
Toddler Health Services	152,545	198,797	76.73
Health Services at Primary Education Age	358,431	536,233	66.84
Health Services in the Productive Age	921.406	536,233	58.20
Health Services for the Elderly	198,797	152,545	76.73
Health Services for Hypertension Sufferers	536,233	358,431	66.84
Health Services for Diabetes Mellitus Patients	45.133	54.03	83.53
Health Services for People with Severe Mental Disorders (ODGJ)	3,275	3,275	100
Health Services for People Suspected of Tuberculosis	62,589	54.03	86.33
Health Services for People at Risk of Being Infected with a Virus That Weakens the Human Body's Resistance (Human Immunodeficiency Virus)	54.03	62.589	86.33
Average	**205.2522**	**174.4913**	**81.75**
Total	**2463.026**	**2093,896**	

Based on the simulation results presented in Table 8, it shows a decrease in patient visits which can be seen from the total simulation results of 2093,896 compared to real data in 2023, namely 2463,026, so that the Patar Asih RSU can prepare the medical personnel needed by looking at the predicted number of patient visits. . And the accuracy level of the simulation results is 81.75%, which can be said to be quite good in predicting the number of patient visits at Patar Asih General Hospital based on the type of service.

5. Conclusion

This research succeeded in showing that the Monte Carlo method is an effective tool for predicting the level of patient visits at Patar Asih General Hospital based on the type of service provided. By using historical data on patient visits and applying Monte Carlo simulation, this research was able to produce fairly accurate estimates of the number of patient visits in the future. The simulation results obtained to predict the number of patient visits at RSU Patar Asih were 81.75%. This can provide valuable insight for hospital management in planning and managing resources more efficiently.

Implementation of these prediction results allows hospitals to optimize staff allocation, inventory management of drugs and medical equipment, as well as operational scheduling, so as to improve the quality of services provided to patients. Additionally, precise predictions enable hospitals to respond to changing patient visit patterns more quickly and effectively, which in turn can improve patient satisfaction and overall hospital operational efficiency. Overall, this research shows that a data-driven approach to predicting patient visit rates can provide significant benefits in hospital management. It is hoped that these findings can become the basis for further studies and further applications in other hospital management contexts, so as to continue to improve the quality and efficiency of health services.

References

[1] W. I. Nurlayla, A. Mahendra, and W. Weny, "Pengaruh Kualitas Pelayanan dan Harga terhadap Kepuasan Pasien BPJS di Rumah Sakit Adam Malik Medan," *JEMBATAN : Jurnal Ekonomi dan Manajemen*, vol. 1, no. 1, pp. 25–36, May 2024, [Online]. Available: https://journal.beaninstitute.id/index.php/jembatan/article/view/18

[2] J. R. Mulia and G. W. Nurcahyo, "Prediksi Pemakaian Obat Kronis Menggunakan Metode Monte Carlo," *Jurnal Informasi dan Teknologi*, pp. 81–85, Apr. 2022, doi: 10.37034/jidt.v4i2.198.

[3] A. E. Syaputra and Y. S. Eirlangga, "Prediksi Tingkat Kunjungan Pasien dengan Menggunakan Metode Monte Carlo," *Jurnal Informasi dan Teknologi*, pp. 97–102, Apr. 2022, doi: 10.37034/jidt.v4i2.202.

[4] R. Rafiska, "Prediksi Jumlah Kunjungan Pasien Menggunakan Simulasi Monte Carlo," *Journal of Computer System and Informatics (JoSYC)*, vol. 3, no. 3, pp. 141–146, May 2022, doi: 10.47065/josyc.v3i3.1690.

[5] D. F. Dendi Ferdinal, S. Defit, and Y. Yunus, "Prediksi Bed Occupancy Ratio (BOR) Menggunakan Metode Monte Carlo," *Jurnal Informasi dan Teknologi*, Sep. 2020, doi: 10.37034/jidt.v3i1.80.

[6] A. Eko Syaputra, Y. S. Eirlangga, and S. Sapriadi, "Peningkatan Pelayanan Laboratorium Dengan Memprediksi Kedatangan Pasien Menggunakan Metode Monte Carlo," *JURNAL FASILKOM*, vol. 13, no. 3, pp. 586–593, Dec. 2023, doi: 10.37859/jf.v13i3.6242.

[7] R. Lubis, "Simulasi Jenis Penyakit Pasien yang Berobat Menggunakan Metode Monte Carlo," *Jurnal Sistim Informasi dan Teknologi*, pp. 42–46, Mar. 2022, doi: 10.37034/jsisfotek.v4i2.121.

[8] M. A. Naim and D. S. Donoriyanto, "Pengendalian Persediaan Obat Di Apotek Prima Farma Dengan Menggunakan Simulasi Monte Carlo," *JUMINTEN*, vol. 1, no. 2, pp. 1–11, Mar. 2020, doi: 10.33005/juminten.v1i2.11.

[9] T. Yogo and P. M. M. C. D. M. J. P. Zonasi, "PENERAPAN METODE MONTE CARLO DALAM MEMPREDIKSI JUMLAH PENGUNJUNG PERPUSTAKAAN UNIVERSITAS LANCANG KUNING Digital Fakultas Ilmu Komputer Universitas Lancang Kuning) 4 (Program Studi Mekatronika Universitas Lancang Kuning)," 2024.

[10] R. W. Dari, "Prediksi Tingkat Penjualan Pupuk Urea dengan Metode Monte Carlo," *Jurnal Informasi dan Teknologi*, pp. 271–275, Dec. 2022, doi: 10.37034/jidt.v4i4.251.

[11] A. M. H. Pardede, "SIMULASI ANTRIAN PELAYANAN PADA GARDU TOL BINJAI," May 2019, doi: 10.31227/osf.io/a2jpy.

[12] A. M. H. Pardede, "SIMULASI ANTRIAN PELAYANAN BANK MENGGUNAKAN METODE EKSPONENSIAL." Jun. 04, 2018. doi: 10.31227/osf.io/3857f.

[13] "Simulasi Antrian Pelayanan Berkelompok Oleh Banyak Server," ID, 2013. doi: 10.13140/RG.2.2.20027.52008.

[14] C. A. P. Saragih and A. M. H. Pardede, "Simulasi Antrian Pelayanan Bank Dengan Menggunakan Metode Gamma," *Jurnal Teknik Informatika Kaputama (JTIK)*, vol. 2, no. 1, pp. 14–23, 2018.