

Evaluation of waiting time for outpatient services at Respira Hospital Yogyakarta using discrete system simulation

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ABSTRACT

The Ministry of Health of the Republic of Indonesia has established standard rules for the quality of outpatient service in hospitals. One indicator of the quality of outpatient services at a hospital is the patient's waiting time to be served either by a specialist or other services such as a pharmacy. Respira Hospital Yogyakarta is a special pulmonary and respiratory hospital in Yogyakarta that continues to improve the quality of its services. Based on the results of observations and interviews it is known that in terms of waiting time, patients at Respira Hospital Yogyakarta still have to wait to get service. Examples of queues that occur include patients waiting for a specialist doctor's examination for around 75 to 90 minutes, waiting at the pharmacy and cashier for up to 60 minutes or more. This study attempts to evaluate the waiting time for outpatient services at Respira Hospital Yogyakarta using a simulation. Based on the simulation results, it is known that the patient's waiting time in the system is 217.33 minutes and the longest waiting time is in the pediatric polyclinic and pharmacy departments. After the scenario implementation were made, namely in the pediatric polyclinic and pharmacy sections, the waiting time decreased to 177.19 minutes. This means that evaluations carried out using simulations can help hospitals reduce waiting time for outpatients.

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1. INTRODUCTION

The Law of the Republic of Indonesia Number 44 of 2009 [1] explains that hospitals, as one of the individual health service facilities, are part of the health resources that are essential to support the implementation of health efforts. One form of health service for patients is examination activities at outpatient polyclinic, which start from registration until the patient leaves the health service center. During the service process from registration to completion, patients will be served alternately with other patients according to the order and processing time for each service. At every service point, patients have the opportunity to wait for service, whether long or short. Ideally, patients should not have to wait a long time to receive service. Long waiting times for services will affect satisfaction with hospital services [2]–[6].

The Respira Hospital in Yogyakarta is one of the healthcare units that consistently strives to improve the quality of service for patients [7]. Respira Hospital is a public hospital specializing in respiratory and lung diseases located in Yogyakarta. Respira Hospital provides outpatient services not only for respiratory diseases but also for internal medicine, pediatrics, surgery, tuberculosis (TB), and general disease polyclinic. In general, the service process at Respira Hospital begins with registration, a general examination in the anamnesis section, service in the specialist doctor polyclinic, pharmacy service, and payment or cashier. With each service provided, Respira Hospital aims to offer the best possible care, as evidenced by public information on the community satisfaction index on the official Respira Hospital website, with a score of 83.28% [8]. The standard customer satisfaction level is $\geq 90\%$. Therefore, Respira Hospital must continue its efforts to enhance the quality of service for patients [9].

Waiting time is one of the indicators of patient satisfaction with the quality of healthcare services [10][11]. Based on observations and interviews with several patients, it is known that there are still patients waiting at various service points in Respira Hospital. Examples of queues include patients waiting to be examined in the general examination room (anamnesis) for approximately 30 minutes, waiting for a specialist doctor's examination for about 75 to 90 minutes. After activities in the polyclinic, patients still wait in the pharmacy and cashier polyclinic for up to 60 minutes or even more. The Regulation of the Minister of Health of the Republic of Indonesia [9] stipulates that waiting time is the time required from when a patient registers until being served by a specialist doctor. The standard waiting time for a patient to be served by a doctor in the specialist polyclinic is ≤ 60 minutes, while the waiting time for pharmacy section is between 30 to 60 minutes depending on the type of drug being processed. The service hours at Respira Hospital start from 07:30 to 16:00, with the earliest polyclinic time at 08:00 and the latest at 14:00. This means that at the end of each polyclinic session, there are still patients queuing for medication retrieval and payment.

The duration of waiting time is influenced by factors from both the service provider (hospital) and the service recipient (patient). The service provider (hospital) will deliver services according to the varied conditions of the service recipient (patient). The problem becomes more complex because these factors are largely uncertain [12][13]. This aligns with the regulations set forth by the Minister of Health of the Republic of Indonesia [9] which emphasize that the provision of healthcare services in hospitals involves characteristics and organizational structures of high complexity. No one can predict the number of patients that will come, the duration of the process in the polyclinic, the payment system used, the drugs that need to be prepared, and other factors [14]. Waiting activities within a system are non-value-added activities and should be eliminated as much as possible to ensure the smooth operation of the system [15][16][17]. To address these issues, research is needed to evaluate the current service system and identify the service points that contribute to waiting times. This will enable improvements at each service point to reduce waiting times, ultimately leading to an enhancement in the quality of hospital services in accordance with established standards.

One approach that has the capability to evaluate a system without disrupting its operation while providing a comprehensive understanding, identifying constraints, and supporting decision-making is through simulation [18]. Simulation has long been used to address issues in hospitals or healthcare service units, serving as a decision-making tool for polyclinical purposes, facility planning, resource allocation, and other problems [19]. One form of simulation that can be utilized is Discrete Event System Simulation (DESS). DESS is an example of the most popular simulation technique due to its ability to model various variations and uncertainties within a system. Because of DESS's ability to intricately model complex systems, it is often used to address operational-level problems such as capacity planning, constraint identification, patient flow redesign, and other operational issues [20].

Research on patient waiting times using DESS has been conducted previously. In 2009, Puspitasari [21] conducted research at the Sadang Serang Community Health Center. This study aimed to determine the number of seats and rooms needed during queues using DESS. Another study aimed to determine the average waiting time for patients in each subspecialty and develop improvement scenario models to enhance hospital service performance with the indicator of reducing patient waiting times. The analysis was conducted using a queue simulation method based on spreadsheets using Microsoft Excel [22]. Subsequent research aimed to assess the effectiveness of the number of counters during service and create a simulation model of the drug queue system at the drug retrieval counter of the hospital [23]. Research on rescheduling changes in the registration section has also been conducted to reduce waiting times by simulating several scenarios in the currently used appointment scheduling system, resulting in a patient scheduling design based on the system's conditions [24][25]. Unlike previous studies focusing on specific parts of the hospital service system, this research attempts to simulate the outpatient service system from patient entry through registration until exiting the system. The study aims to provide

alternative scenarios for reducing waiting times at each service point, allowing service to patients to be improved according to established standards. Simulation is performed using the ProModel software, which is widely used due to its ease of use and flexibility in simulating systems [26].

2. METHOD

The research was conducted in the outpatient department of Respira Hospital in Yogyakarta. Respira Hospital has several outpatient polyclinic, and in this study, four polyclinic were investigated, namely the pediatric polyclinic, internal medicine polyclinic, and two respiratory disease polyclinic. This is because these four polyclinic have patients to be served every day.

Patient registration for outpatient services at Respira Hospital can be done online or on the spot, but patients still need to go to the registration desk upon arrival at the hospital for confirmation. In the registration area, patients do not have to wait long because there are two registration servers that can immediately assist with a short processing time. After registration, patients will be directed to a general examination at the anamnesis section. The anamnesis section has four nurses who will examine patients before proceeding to the polyclinic of specialist doctors in internal medicine and respiratory diseases, excluding the pediatric polyclinic. Pediatric patients will go directly to the pediatric polyclinic for examination by a specialist doctor.

After seeing the doctor, patients will go to the pharmacy section (pharmacy 1) to submit the prescribed medication to the pharmacist. The pharmacy section will check the required medications for the patient. After checking and preparing the medications, the pharmacy section will call the patient to provide a billing note to be taken to the payment or cashier section. Patients will then go to the cashier section to make payment and subsequently wait for a call from the pharmacy section (pharmacy 2) for medication collection. In short, the patient service process in the outpatient department at Respira Hospital follows the flowchart in Figure 1.

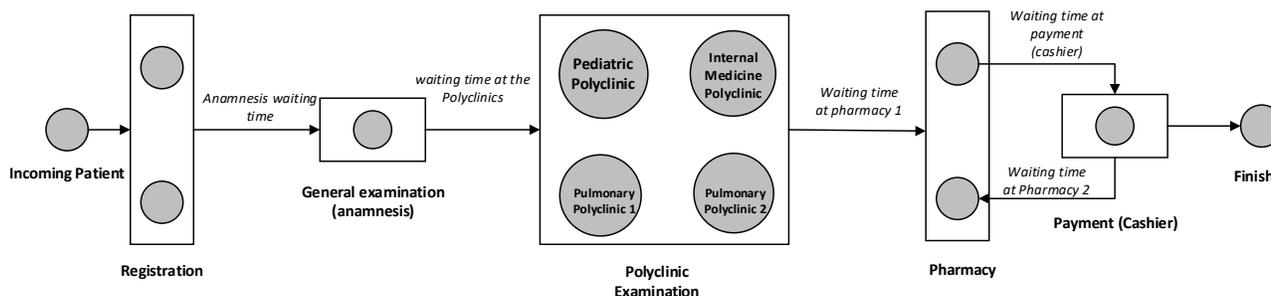


Figure 1. Illustration of the outpatient service flow system at Respira Hospital

Based on Figure 1, it can be observed that there are several potential waiting times, including waiting time at the anamnesis section, at the doctor's polyclinic, at the pharmacy section, and at the payment section at the cashier. The research process follows the simulation steps outlined by [27], consisting of 12 main stages as depicted in Figure 2.

The first stage begins with the formulation of the problem to be addressed, followed by the second stage involving the determination of objectives and the research plan using DESS simulation. The third stage, concurrent with the fourth stage, includes the development of a conceptual model and data collection. The conceptual model in the simulation study illustrates the flow of the outpatient service system at Respira Hospital. Data collection for this research is conducted through direct observation, secondary data from hospital documents, and direct interviews with patients. The data used include processing times and inter-arrival times for each activity from registration to payment at the cashier. Additionally, data on the number of service providers or servers for each section, the number of patients undergoing examinations, the proportion of patients for each polyclinic, and other data are collected for the simulation model construction process. Alongside data collection in the fourth stage, data input analysis is performed by testing the data used. The distribution of the collected data is tested as an input to the simulation model, and the normality of the data is assessed using the Shapiro-Wilk test.

The fifth stage involves translating the conceptual model and required data into the simulation language using Promodel software. Promodel is one of the DESS software applications used to simulate a healthcare service system in a hospital. The sixth stage ensures that the simulation model is verified. Verification is conducted to confirm that the simulation

model aligns with the conceptual model created by the modeler. The verification process includes checking for errors in the simulation model, verifying the alignment of the data entered into the simulation model, and ensuring the reasonableness of the simulation output. The seventh stage is simulation validation. Validation is performed to ensure that the simulation model aligns with the real system. Validation is conducted by performing a t-test validation. If the simulation model is valid, the process proceeds to develop system scenarios (eighth stage). If not, the simulation model construction, conceptualization, and data collection need to be repeated until it is deemed valid.

The validated model is then used to address the problem by building scenarios or alternative systems (ninth stage). The ninth stage involves running the prepared scenarios and observing the system's response to the created scenarios. Additionally, in this stage, a comparison of scenario results is conducted, and the scenario that brings about better changes in the actual system is selected. If more scenarios are needed, additional scenarios are developed (tenth stage). If not, the process moves on to the twelfth stage, which is documentation and reporting (eleventh stage). Documentation and reporting aim to determine the steps to be taken in implementing the scenarios built into the actual system (twelfth stage).

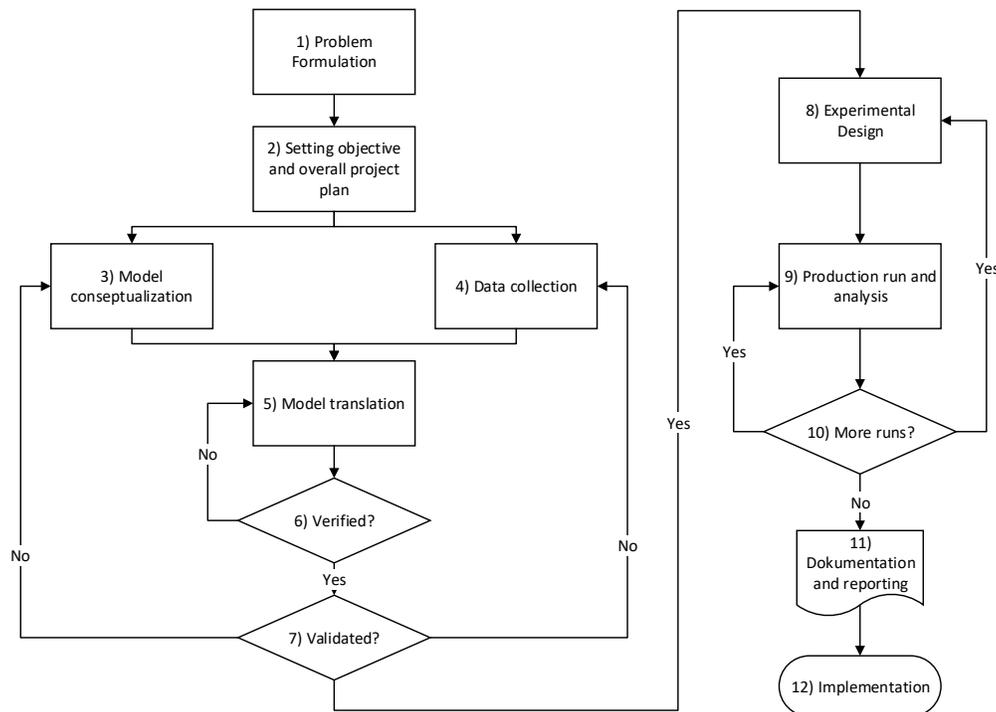


Figure 2. The research stages employ Discrete Event System Simulation (DESS) [27]

3. RESULT AND DISCUSSION

The research stages are conducted in accordance with what was explained in the previous section. The collected data will then be tested for its probability distribution and normality before being used for constructing a simulation model using Promodel. Probability distribution tests are conducted using the stat-fit application available in the ProModel software. Meanwhile, normality testing is done using the Shapiro-Wilk method since the sample size is less than 50. The conclusion drawn from the test is that if the significance value is < 0.05 , the data is not normally distributed; if the significance value is > 0.05 , the data is normally distributed. Table 1 describe the time data obtained along with the programming language used in the Promodel software.

Table 1. Time data at each processes

Processing Time Data	Distribution of Time
Registration	WAIT L(0.996, 0.687) MIN
Anamnesis	WAIT 3.+E(6.61) MIN
Internal medicine polyclinic	WAIT 1.+L(2.55, 2.08) MIN
Pulmonary polyclinic 1	WAIT U(4.92, 3.92) MIN
Pulmonary polyclinic 1	WAIT B(0.06, 7.94, 1.41, 2.3) MIN
Pediatric polyclinic	WAIT U(13.5, 11.5) MIN
Pharmacy 1	WAIT 10.+L(38.3, 68.5) MIN
Pharmacy 2	WAIT 2.+L(26, 26.4) MIN
Cashier	WAIT U(0.975, 0.975) MIN
Time between arrival of patient	L(1.16, 1.7)
Medication processing time	2.+L(2.98, 3.59)

The simulation model is developed with the assistance of ProModel software. The tested data then becomes input for the simulation model. The process of building the simulation model using ProModel begins with creating a layout, location menu, arrival menu, entity menu, and process menu. Figure 3 illustrates the flow of outpatient services at Respira Hospital. show examples of menu commands in ProModel. In this context, movements are defined by the transfer time between locations.

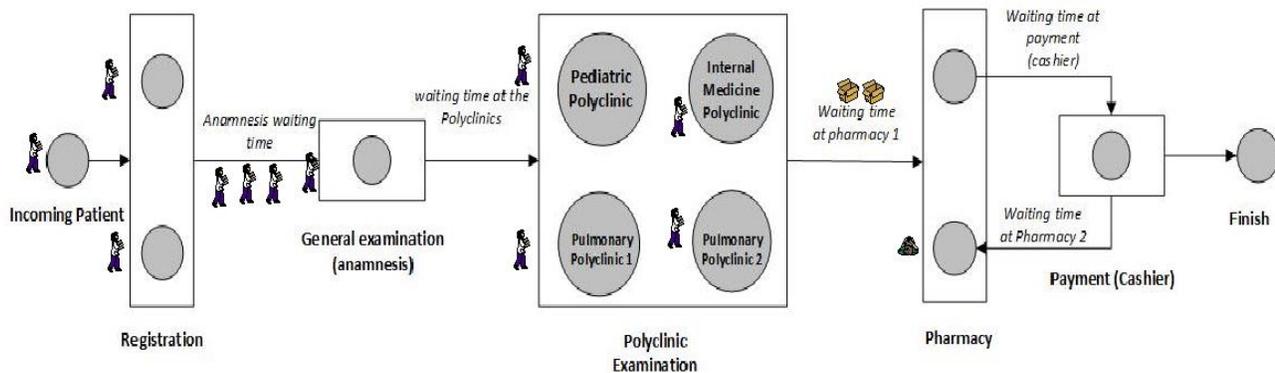


Figure 3. Simulation layout using ProModel

The hospital's working hours are from 07:30 to 16:00. However, in reality, some patients remain in the system even after the operation hours, hence the simulation is run for 9 hours with 20 replications over the course of 20 days. The simulation model operates for 9 hours to observe how the system functions. Before conducting the experiment, the model will first undergo validation testing. Validation was conducted using data from patients who were successfully served and discharged from the hospital. Figure 4 displays the output result, showing the number of patients in each polyclinic. The validation test is performed using the Student's t-statistic.

Name	Scheduled Time (MIN)	Capacity	Total Entries
Poli anak	540.00	1.00	22.00
Poli penyakit dalam	540.00	1.00	25.00
Poli paru 1	540.00	1.00	29.00
Poli paru 2	540.00	1.00	14.00

Figure 4. Simulation results of patient output for each polyclinic

The Student's t-validation test, or t-test, is a type of statistical test used to compare the averages of two independent data groups. The main function of the Student's t-validation test is to determine whether there is a significant difference between the averages of the two data groups. The data tested includes the output data from the real system compared to the simulation results, as shown in Table 2 .

Hypothesis:

H0 : $\mu_1 = \mu_2$, There is no significant difference between the simulation output data and the real system data.

H1 : $\mu_1 \neq \mu_2$, There is a significant difference between the simulation output data and the real system

Table 2. Real system output data and simulation results for validation

No	Real system output (x1)	Simulation output (x2)	No	Real System Output (x1)	Simulation output (x2)
1	73	74	11	70	58
2	87	84	12	101	77
3	107	71	13	93	79
4	93	88	14	112	90
5	61	81	15	43	78
6	114	82	16	51	86
7	74	86	17	130	88
8	83	70	18	108	88
9	96	80	19	59	75
10	73	84	20	76	89

$$\bar{x}_1 = 85,2$$

$$S_1 = 22,94983087$$

$$\bar{x}_2 = 80,4$$

$$S_2 = 8,00920523$$

$$S_p = 17,18781698$$

The alpha used is 5%, so the table value of t is: $t_{\alpha/2, df} = t_{0.025, 38} = 2,02439$

Calculate the value of t, $t = 0,883121619$

Conclusion: Because the t value lies in the acceptance area (i.e. between -2.02439 to 2.02439), accept H0 and conclude that the simulation model output is not significantly different from the output in the real system.

Based on the results of the simulation report, an evaluation of the outpatient service system at Respira Hospital can be conducted. In terms of improving the quality of hospital services, a crucial aspect that requires attention for evaluation is the waiting time. The simulation report provides information on patient waiting times, as detailed in the entity section. The explanation of waiting times is in accordance with Table 3.

Table 3. The explanation of waiting times (simulation reports)

No	Parameter	Value
1.	Number of registered patients	90 patients
2.	Patients successfully served until entering the pharmacy section	88 patients
3.	Patients successfully served until completion (received medication)	84 patients
4.	Patients still within the service system when the service system is completed	5 patients
5.	Average time spent by patients to receive service until the pharmacy section	14,22 minutes
6.	Average time spent by patients to receive service from the pharmacy section until completion	67,09 minutes
7.	Average time spent by patients within the system (from registration to pharmacy)	233,38 minutes
8.	Average time spent by patients within the system (from pharmacy to completion)	81,17 minutes
9.	Time spent by patients waiting to be served from the registration to the pharmacy process	217,33 minutes
10.	Time spent by patients waiting to be served from the registration to the pharmacy process	9,74 minutes

Based on the information, it can be concluded that patients spend more time waiting to be served than during the actual service process. The waiting time for patients within the system is 217.33 minutes. Through the evaluation process using the simulation model, it is observed that the waiting time in the pediatric polyclinic is caused by patients who come for examinations not passing through the anamnesis or general examination section. The general examination for pediatric patients is directly conducted by the specialist doctor during the polyclinic examination. This results in a longer process in the pediatric polyclinic, causing longer waiting times for patients.

The next waiting time occurs in the pharmacy section. Patients are called twice by the pharmacy section, prolonging the process. After the examination in the polyclinic, patients proceed to the pharmacy section to submit the prescription from the doctor (referred to as pharmacy 1). Subsequently, patients wait until they are called again by pharmacy 1 and go to the cashier for payment. Next, patients are called again by the pharmacy section (pharmacy 2) to receive the medication. The waiting time for patients to receive medication is the same as the medication preparation process. The process of calling patients to submit documents to the pharmacy continues with the pharmacy preparing the medication. Therefore, with different types of medication, patients who submit documents later may receive medication earlier.

The validated simulation model will then be used for system evaluation and scenario development. In this research, scenarios related to the use of the anamnesis section for the general examination of pediatric patients will be developed, and a faster pharmacy service subsystem will be proposed by trimming unnecessary activities. The scenario was conducted at the pediatric polyclinic due to the absence of anamnesis examinations in the previous facility, leading to prolonged examination processes at the polyclinic. Table 4 summarizes the scenarios to be developed and the parameters of the changes obtained.

Table 4. Patient waiting time reduction scenario

No	Scenario	Change parameters
1.	Pediatric polyclinic patients who did not previously go through the anamnesis section will undergo an anamnesis examination. Consequently, the process time for patient examination in the doctor's polyclinic will be reduced, but it will add time to the anamnesis examination, which has a capacity of 4 (four) nurses.	- Reduction of the process time for pediatric polyclinic examination - Addition of process time for the anamnesis section

No	Scenario	Change parameters
2.	Streamlining service time in the pharmacy by ensuring that the medications to be prescribed are already in stock in the doctor's polyclinic and pharmacy information system. With this, patients can proceed directly to the cashier and then to the pharmacy to pick up the medication and receive education.	- Elimination of processes or activities in pharmacy 1; patients go directly from the cashier to pharmacy 2.

Based on the results of evaluations and improvements to the outpatient service system, the waiting time for patients to receive services was reduced from 217.33 minutes to 177.19 minutes as describe in Figure 5. While the reduction did not meet the set standard of ≤ 60 minutes, the resulting time was still lower than that of the previous system. Therefore, the scenarios applied in the simulation model can be considered for implementation by the hospital.

model untuk jurnal dess coba2 Skenario.MOD (Normal Run - Avg. Reps)							
Name	Total Exits	Current Qty In System	Avg Time In System (MIN)	Avg Time In Move Logic (MIN)	Avg Time Waiting (MIN)	Avg Time In Operation (MIN)	Avg Time Blocked (MIN)
Patient	89.75	0.25	195.59	1.99	0.00	16.40	177.19
Medicine	0.00	19.05	0.00	0.00	0.00	0.00	0.00
Finished Patient	89.75	0.00	27.30	0.02	1.04	26.13	0.11

Figure 5. Scenario report simulation

4. CONCLUSION

The evaluation of waiting times for outpatient services at Respira Hospital in Yogyakarta reveals that patients have consistently experienced waiting times exceeding the standards set by the Ministry of Health of the Republic of Indonesia. Patients spent 217.33 minutes waiting for services, while the standard waiting time should be ≤ 120 minutes (including waiting for medication). This research aims to emulate a real system through simulation. The simulation model, which has been validated, is then subjected to experimentation. The scenario constructed involves altering the flow pattern of the pediatric polyclinic, which previously did not include anamnesis, to now include anamnesis and streamline activities in the pharmacy section. The results of implementing this scenario demonstrate a reduction in patient waiting time to 177.19 minutes. Although this time still exceeds the recommended standard, it represents an improvement. Further research would benefit from a more detailed analysis at each service point to achieve enhanced results.

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